



*Utilising games and design-research methodology to promote physical activity among adolescents.*

BEC, R.

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***UTILISING GAMES AND DESIGN-RESEARCH  
METHODOLOGY TO PROMOTE PHYSICAL ACTIVITY  
AMONG ADOLESCENTS***

***VOLUME 1 – THESIS***

***BEC.R.***

***PH.D.***

***2015***

This paper presents independent research by the National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care South Yorkshire (NIHR CLAHRC SY). The views and opinions expressed are those of the authors, and not necessarily those of the NHS, the NIHR or the Department of Health.

*"Toys are not really as innocent as they look. Toys and Games are preludes to serious ideas"*

Charles Eams

## Abstract

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Physical activity (PA) in adolescents is low which has contributed to significant rises in obesity leading to poor physical and mental health. Antidotes to this sedentary culture are required from both a prevention and treatment perspectives yet engaging adolescents in PA, one side of the energy balance equation, remains a challenge. 'Gaming culture' among youths might be an alternative approach and it is with this in mind that this research-through-design project explored how design practice and behaviour change theories can be combined to create, develop and refine game(s) to promote PA among adolescents aged 11-12.

The iterative design process, supported by user-centred enquiries, used 'making' as the main method of enquiry and led to a contribution to knowledge. Design and knowledge in this research were interwoven: designing was the driver yet it is only through testing this design in context that understanding and knowledge could be verified, hence informing the next design development stage. A variety of design research techniques were used to explore, research, and understand situations and users, as well as to develop, review and evaluate prototypes. Various stakeholders such as design colleagues, friends, a family of users as well as 48 future end-users took part in this research.

The iterations resulted in 'Boost Up!' which comprised a series of games utilising PA as a game currency. 'Boost Up!' explored how a 'blending experience' combining awareness and rewards via a gaming framework might promote repeated play to motivate an increase in PA behaviour. A final mixed-method study was used to evaluate the engagement of participants with 'Boost Up!' as well as its efficacy for promoting PA behaviour.

Through testing the different versions of 'Boost Up!', a range of factors were identified for engaging adolescents (e.g. appropriation, instant feedback), which might be useful to those wanting to promote PA among this population, or even to monitor them.

Furthermore, a new way to capture and report findings obtained when using a research-through-design methodology, using an Annotated Design History technique, was created. This approach may be of use to future design researchers. As a conclusion, the processes and techniques used in this research demonstrate the potential of using research-through-design methodology for health interventions.

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## ***Conference Presentations & Exhibitions***

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### ***CONFERENCE PRESENTATIONS***

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Bec, R., (2012). Creating Physically Active Games for Young Adolescents, *Proceedings of the 11th International Conference on Interaction Design and Children*. Bremen, Germany, pp. 331-334. ISBN: 978-1-4503-1007-9. Available at: <http://dl.acm.org/citation.cfm?id=2307160>

Bec, R., (2013). Evaluating games that promote physical activity among young adolescents aged from 11-14, *European Design 4 Health Conference*. Sheffield, UK.

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### ***POSTERS***

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This thesis is printed in two volumes. The first volume forms the body of the thesis and the second volume corresponds to the appendices.

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## Abbreviations

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AR	Action Research
DRE	Designer/Researcher Enquiry
LPA	Light Physical Activity
MPA	Moderate Physical Activity
MVPA	Moderate-to-Vigorous Physical Activity
PA	Physical Activity
RCT	Randomized Control Trial
RtD	Research through Design
SDT	Self Determination Theory
TTM	Transtheoretical Model
TPB	Theory of Planned Behavior
UCE	User-Centred Enquiry
UCE1W3	User-Centred Enquiry 1 Workshop 3
VPA	Vigorous Physical Activity
V1 & V3	Version 1 & 3 of 'Boost Up!' (concepts)
V2 & V4	Version 2 & 4 of Boost Up! <sup>TM</sup> (working prototypes)

## ***Chapter I- Introduction***

---

This design practice-led research aims at creating, developing and refining engaging game(s) that will be played repeatedly over the long term to promote physical activity (PA) among adolescents aged 11-12.

### **1.1 BACKGROUND**

#### ***1.1.1 Obesity, a Serious Problem***

Over the past 30 years, obesity has significantly increased across the developed world. At the simplest level, obesity reflects an imbalance in the 'energy in – energy out' equation and yet it is often seen as a consequence of the complexity of human behaviour, influenced at multiple levels including environmental, societal and individual (Sallis & Glanz, 2009). Changes in modern society and associated lifestyles have also influenced the energy balance equation, by changing the way we eat and the way we move. For example fast foods and snacks have become part of our daily diet and the urbanisation of our environment has led to a more sedentary lifestyle: Green (2002) even refers to it as the 'Couch Potato Society'. PA is an important factor in the prevention and treatment of obesity (DH, 2011) and should be promoted on a daily basis. Yet on average only 15% of boys and 19% of girls in England achieve the recommendation of 60 minutes a day, every day of the week (BHFb, 2012). Therefore, there is an urgent need to combat sedentary behaviours in young people, which have reached epidemic proportions (Maddison et al., 2011).

#### ***1.1.2 The 'Serious Games' Movement***

Actions to help increase PA among children and young people could emphasise fun and enjoyment (BHF, 2014). The motivation and fun that games can provide have recently been explored to tackle serious issues from education to professional training, and health is another growing field: they are the serious games (Zyda, 2005).

More specifically on promoting PA, a range of interactive games have been created, dubbed 'exergames'. Health psychologists and researchers have led studies on exergames to examine their effectiveness for promoting PA by measuring the energy expenditure consumed by the players when playing (Lieberman et al., 2011). The studies reported that exergames have potential for increasing energy expenditure, especially compared to traditional video games and Media (TV/videos-games/computer/internet/digital books and magazines), which young people use for approximately 5h a day (Roberts et al., 2009). About 50–60% of this time is devoted to television (Roberts et al., 2009). Yet not many exergames promote Vigorous PA (VPA) report Peng et al. (2013) or when they do, it is for a short period of time only (Daley, 2009).

### ***1.1.3 MA Work, a First Exergame***

Promoting PA through the playing of games had already been explored prior to this PhD study during an Industrial Design MA (Bec, 2011). This previous degree led to the creation of 'Gener-G', a traditional board game that incorporates electronics; this type of game combines the traditional aspect of gaming (tangible and physical) with electronic or digital components; this approach is referred to in this thesis as 'Hybrid Games'. 'Gener-G' has a 'Two-Stage' concept that dissociates exercising from the playing of the game, which differs from most existing exergames. This game is played in two stages: 1- Exercise over a period of time to accumulate energy which is stored in a 'battery'; 2- Players plug these 'batteries' into a board game and use the energy stored in them as 'currency' to play the game. The energy accumulated in the battery depends on the quantity of exercise done in Stage 1. 'Gener-G' is played as a family, an important environment to promote PA (BHF, 2012; 2014). Family based rewards can be gained throughout the game: players pick up and trade cards corresponding to household tasks. The winner is the last player in the game with energy remaining and has the opportunity to avoid household chores such as cleaning the table or watering flowers and enabling them to secure enjoyable activities such as control of the TV remote.

An 'integration prototype' (Houde & Hill, 1997) of the game was built and tested over a week in a family environment, (Figure 1) enabling feedback from a user group for whom the game was designed. The four members/players from the family self-



Figure 1 – A family playing the Hybrid Game 'Gener-G'

reported their amount of PA done and the designer/researcher met the family to observe the playing of the board game (Stage 2) at the end of the week. According to these self-reported levels, a defined amount of energy was transferred into each player's battery, from which players were able to play the game.

A follow-up focus group interview was held after the game with all the members of the family. The main feedback was that the concept was a good incentive for the players to do PA but needed improvements in both stages. Stage 1 was too limited to generate energy as only a pedalling machine could be used (whereas in the tests, the family members could do any types of PA); Stage 2 was really complex due to the use of physical energy and to the diverse manipulations: there were many switches and buttons that could be confusing and energy could be lost when transferring from one

battery to another. Also, fairness between all the players in the actual play of the board game in Stage 2 needed reviewing. The hypothesis was that players doing more PA in Stage 1 were more likely to win the game, however for maintaining engagement in the play of a game, uncertainty of winning is crucial and players should still be able to develop strategies to win (Salen & Zimmerman, 2004). The definition of 'game play' is that a player's actions must change the actions of the other player, making him think of alternative moves, thus allowing players to develop new strategies (Salen & Zimmerman, 2004); however when playing 'Gener-G', interactions between the players were limited and strategy was more of a focus in Stage 1 and not so much in Stage 2. Finally, the continuous dimension of gaming had to be explored further and repeated play was not evaluated.

It was therefore impossible to say whether this game and its concept could actually promote the right levels of PA and engage the players in repeated play and over a prolonged period of time (weeks, months, years) so that habits can be engrained. This game nevertheless raised interesting questions about behaviour change.

## **1.2 METHODOLOGY**

Obesity is a complex multi-faceted problem and many factors have been identified as causing its increase, at an individual level (e.g. biological, psychological), at a societal level, at an economic level, and even at a governmental level (e.g. built environment, food production...). Figure 2 (Foresight, 2007) illustrates the complexity of the obesity problem. In designer jargon, this kind of multi-faceted problem can be defined as a '*wicked problem*' (Rittel & Webber, 1973). The complex and 'tricky' nature of a wicked problem makes it impossible to define clearly. It is only by finding '*good enough*' solutions that the problem can be identified and partially resolved.

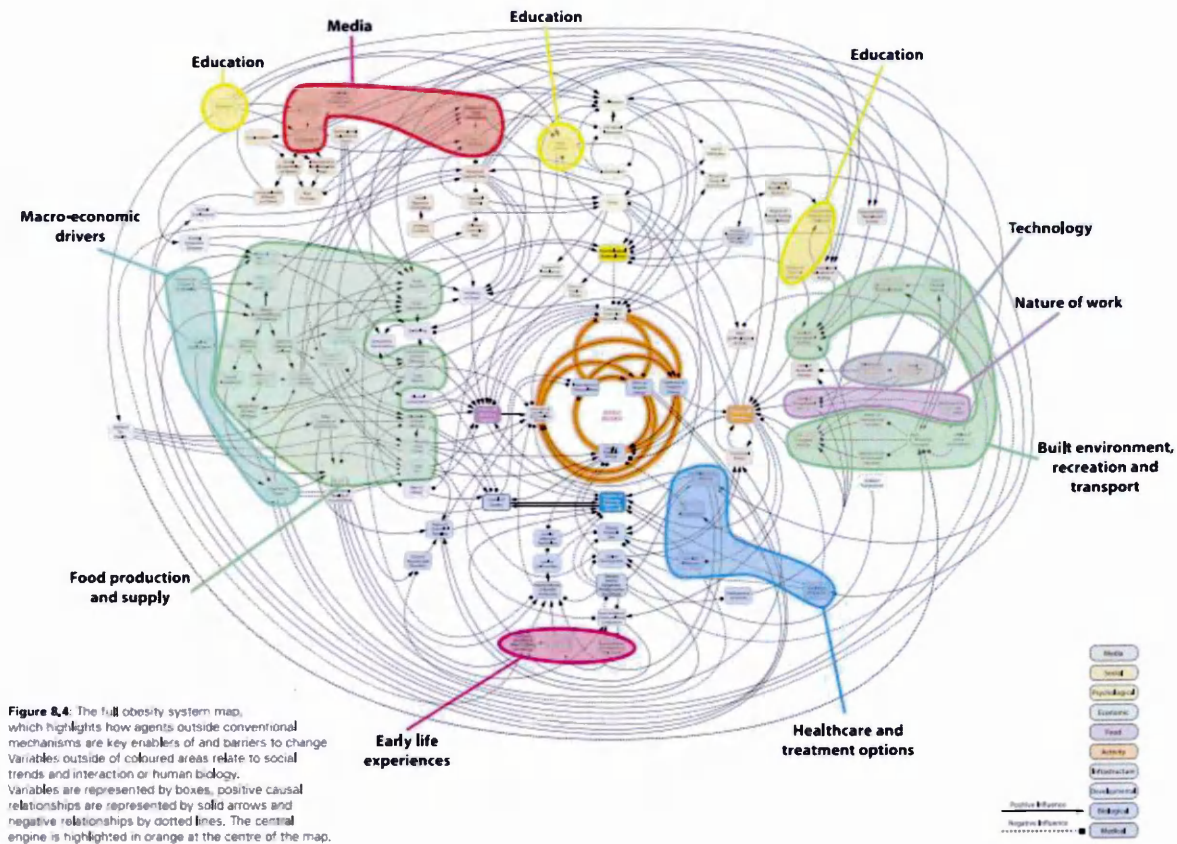


Figure 2 – The Obesity System Map, Foresight Report (2007)

Health research, which aims to discover how the world is, has produced a range of theories and models of behaviour change that are useful to understand the various factors that may or may not affect how an individual behaves. Yet a majority of obesity prevention programmes have not been effective in promoting PA in young people (Summerbell et al., 2005) and therefore alternative approaches for promoting PA appear warranted. A number of researchers call for bringing together game designers with health behaviour change experts (Kato, 2012b; Peng et al., 2013) and value design methods in the process of games creation and development (Matheson et al., 2013). The process, often participatory and empathic regarding the users, consists in conceiving, proposing, designing and implementing new systems and technologies through iterative prototyping (Fallman, 2007). Another aspect of Design is that it approaches things holistically, which is particularly suited for multi-faceted or wicked problems (Zimmerman et al., 2010).

This is why Design and more specifically Research through Design (RtD), particularly suited for multidisciplinary research (Zimmerman et al., 2010), shows potential for undertaking this research. RtD is based on practice and on the making of ‘things’ (e.g. object, prototype, image, drawing, interactive system, service...) as a way to explore. It is through users interacting with these things, which embed knowledge, that exploration is possible and understanding and knowledge are developed.

In relation to Fallman’s (2008) interaction design research triangle, this project explores what outcome(s) it is possible to create in order to develop knowledge that is ‘true’ (acceptable) but which will also be ‘real’ (effective) since a main aim of the research is to produce an outcome that will be implemented in the real world. This research hence looks at exploring how PA can be promoted through games, as well as what kind of game(s) it is possible to create and refine to ensure acceptability and adoption. Additionally, it looks at effectiveness during play, to ensure long term repeated use and to promote the appropriate levels of PA.

### **1.3 THE RESEARCH**

To guide and inform the research and evaluation processes within this thesis, and to ensure outcomes were valid, a range of participants were recruited to take part in the study at different stages. The process in this study consisted of implementing a series of seven work packages, alternating between ‘Designer/Researcher’ enquiries and ‘User-Centred’ enquiries to create, develop and refine a game’s concept and its game play. The Designer/Researcher enquiries are different activities that have been conducted without the end-users. This type of enquiry generally involves only the designer but occasionally other designers or stakeholders. User-centred enquiries correspond to interventions taking place with the future end-users at specific stages in the game(s) development to increase appropriateness and adoption of the outcome.

## **1.4 OUTLINE OF THE THESIS**

### **1.4.1 Chapter Two**

Chapter two describes the importance of promoting physical activity to tackle obesity. It also provides a critical overview of the different psychological theories and models found in the field of health behaviour change, and considers the potential of games as a mode of tackling 'serious issues' like obesity and inactivity. Particular attention is given to the identification of factors that may or may not provide an engaging experience to promote physical activity in the long term. Finally, an overview of the methods and processes used in Design is presented, highlighting differences with those typically used in Health Sciences research.

### **1.4.2 Chapter Three**

Chapter three presents a debate around design research methodologies. It also attempts to demonstrate how design practice, techniques and processes can be part of a methodology that follows the criteria of research, and in doing so justifies the use of a research through design (RtD) methodology in this research project. A detailed description of the methodology adopted for this research is then presented along with the overall process that is undertaken in this research. An account of the design techniques (i.e. methods) used to generate and collect data is also described.

### **1.4.3 Chapter Four**

Chapter four describes the detailed design processes and activities that have been applied to this research, which consists of alternating between designer/researcher and user-centred enquiries. A detailed description about the aim and type of activities undertaken for each enquiry as well as an account about who was involved at each stage of the process is also presented. Finally, a justification behind the choice of the design techniques used at each given stage is outlined.

### **1.4.4 Chapter Five**

Chapter five describes the work executed under the 'designer hat' and reports the evidence gathered throughout the entire research that led to developing the game to

create. A range of key factors that have influenced the design of the game are listed, clarifying why such features of the game have been added, dropped, or modified. This chapter also demonstrates how evaluating a design in context creates (tacit) knowledge that informs in turn the next phase of designing in an iterative process (e.g. through making another prototype version). The final version of the game created is also described in this chapter.

#### **1.4.5 Chapter Six**

This chapter reports the findings that were obtained under the 'researcher hat'. There are two types of findings: those coming out from the evaluation of the final version of the game created (presented in the previous chapter), and those coming out from a 'reflective narrative' analysis, which took place at the end of the research project and which was used to make the (tacit) knowledge explicit.

#### **1.4.6 Chapter Seven**

Chapter seven reviews the contributions to knowledge achieved through this research by: demonstrating the originality of the game created, revisiting the set of factors that were identified as promoting engagement and continuous play among the sample population, and reviewing the 'reflective narrative' technique which is a new way for design researchers to capture and report findings obtained when using a research through design methodology.

#### **1.4.7 Chapter Eight**

In this chapter, the validity and benefits of the findings from this research, their limitations as well as those of the design research methodology applied are discussed. Practical recommendations for further work are given, both in relation to improving the game and further testing the knowledge and hypotheses developed along this research. In addition, the case for using research through design methodologies in the context of health is put forward.

#### **1.4.8 Chapter Nine**

The chapter nine summarises the contribution to knowledge and gives a conclusion.

## ***Chapter II- State of the Art***

---

### ***2.1 OBESITY, AN EPIDEMIC***

#### ***2.1.1 Statistics***

Obesity has become an epidemic worldwide. Obesity has almost doubled since 1980 to affect 500 million people (WHO, 2013). In 2011 over 40 million children under the age of five were classified as overweight (WHO, 2013). Obesity and related conditions have been the target of many government campaigns and actions however statistics have not stopped increasing. The National Obesity Forum report estimates that half of the UK population will be obese by 2040 (NOF, 2014), which was originally predicted to be by 2050 (Foresight, 2007). Obese children have a 70% chance of becoming obese adults (NHANES, 2002).

Evidence shows obesity negatively impacts young academic performance and long-term health prospects in adulthood (Crimmins & Saito, 2001), with increased risks of serious conditions such as type 2 diabetes, heart disease, and stroke among others (WIN, 2008). Overweight and obesity is the fifth leading risk for global deaths, causing a total of at least 2.8 million deaths every year among adults (WHO, 2013). Treating this long-term condition is a financial burden (DH, 2011) and intervention is required to halt the rise in obesity.

#### ***2.1.2 Physically Active Lifestyle & Youth***

PA has been established as an important factor in tackling obesity, both at a curing and prevention level (Matheson et al., 2013; Sallis et al., 2006; DH, 2011; Nader et al., 2008; Verloigne et al., 2012; WIN, 2008). However people across all continents and cultures do not engage enough in PA. Furthermore, research has recently identified sedentary behaviours causing increased risk of obesity, stating that even if moderate-to-vigorous PA (MVPA) increases it does not necessarily mean sedentary time will decrease (BHF, 2012; Verloigne et al., 2012). This is expressed in the concept of

"activitystat" which can be characterised by a rise in energy expenditure being followed by an increase of sedentary time (Goldfield et al., 2014). Being sedentary should be recognised as a separate risk factor in its own right (BHF, 2012).

PA promotion from the earliest age can be effective (NICE, 2007) however young people require support to be more active as PA habits wear off during adolescence (Aarts et al., 1997). Promoting PA from an early age was shown to be beneficial as a long term strategy since the patterns of PA that are learned and engrained in childhood and adolescence are more likely to be maintained throughout the entire life of an individual (WHO, 2003). Daily lifestyles can prevent or tackle obesity (Lieberman 2013) and regular PA in childhood and adolescence improves strength and endurance, helps build healthy bones and muscles, helps control weight, reduces anxiety and stress, and increases self-esteem (USDHS, 2008).

In the past, PA used to be part of a lifestyle where people walked or cycled to work (DETR, 1999), and children and young people had more freedom to play outdoors and walk to school (Hillman et al., 1991). PA has changed from a natural component of everyday life to something that we now need to choose to do as deliberate 'exercise' (Cavill & Bauman, 2004).

### **2.1.3 Health Recommendations for Young People**

Objectives have been recommended for youth to accumulate at least 60 minutes of MVPA on most, if not all days of the week (NASPE, 2004). A recent study (British Heart Foundation, 2012b) shows that the recommended levels of MVPA are still met between 8-11 years old and are not met between 12-15. Nader et al. (2008) have identified a precipitous drop in MVPA from the age of 9 however it is around the age of 13 that boys and girls start failing at meeting the recommendations.

Sedentary behaviours have been identified only recently so recommendations about it are lacking. Yet efforts should be "*directed towards a general reduction in sedentary behaviour and breaking up periods of prolonged sitting*" (BHF 2012, p8). Verloigne et al. (2012) posit that obesity prevention programmes should target reducing sedentary time besides promoting PA. They also highlight the gender difference that girls are

generally more sedentary and spend less time in all intensity activities than boys from the youngest age. This disparity also increases during adolescence.

The health recommendations set for adolescents should:

- Promote a minimum of 60 minutes of MVPA a day (Verloigne et al., 2012).
- Incorporate at least three days a week of VPA including those that strengthen muscles and bones (DH, 2011).
- Reduce sedentary behaviour by breaking up periods of prolonged sitting (BHF, 2012).

#### ***2.1.4 Age Group for this Research: 11-12 Years Old***

The age of adolescence is a key life stage where people are more likely to be open to change (NICE, 2007). It is common in England for pupils to change school between primary and secondary school and this change may affect their behaviour and lifestyle, and consequently their PA levels. Therefore this research focuses on promoting PA among 11-12 years old adolescents (Year7).

#### ***2.1.5 What Physical Activity for this Age Group?***

Interventions promoting PA should be multi-level based and centred on the idea of 'Active Living' (Sallis et al., 2006). Active living points to four domains where people have opportunities for being more active throughout their daily life (from light to vigorous PA): Active Transport (from/to school or work), Occupational Activities (at school or at work), Household Activities (at home), and Active Recreation (in the community/neighbourhood). Encouraging active living is a point echoed by NICE (2007) and the Start Active, Stay Active report (DH, 2011). This report also defines three forms of PA to promote to help meet these recommendations, and that can be undertaken across the four domains described previously: 'Everyday activity' (e.g. active travel, DIY), 'Active recreation' (e.g. recreational cycling, active play), and 'Sport' (e.g. swimming, fitness training). Those three types of activity correspond to respectively light PA (LPA), moderate PA (MPA), and vigorous PA (VPA) even though the boundaries between each category are sometimes blurred.

The transition adolescents are subject to affects the type of activity they engage with. There is a shift of activity when growing up (DH, 2011) and an 11-12 years old adolescent may be at the transition between free play (associated with children), often unstructured, and more structured activities (e.g. dance, active travel). The same 'Start Active, Stay Active' report (DH, 2011) also states that young people should engage in different types and nature of activity depending on their age (children or young people). It therefore seems worth exploring how these different types and forms of PA (LPA/MPA/VPA) can be promoted to encourage adolescents to meet the health recommendations. To do so, opportunities to do PA should be available on a daily basis (DH, 2011) and can be promoted through PA intensities: sedentary time can be reduced by promoting LPA (Verloigne et al., 2012).

It is therefore clear that more research is needed to find ways to support this population engaging in activities of all intensities of PA levels as well as reducing their sedentary time.

## **2.2 HEALTH PSYCHOLOGY TO UNDERSTAND BEHAVIOUR CHANGE**

### **2.2.1 Constructs & Theories of Behaviour Change**

The Health discipline and more specifically the domains of health psychology and health promotion have generated a range of theories and models based on notions/constructs which are helpful in understanding the factors that influence an individual's desire and ability to change behaviour.

#### **2.2.1.1 Theory of Planned Behaviour**

- Definition of the Theory of Planned Behaviour

Ajzen (1991) developed the Theory of Planned Behaviour (TPB) which was identified as one of the most validated and widely applied theories in predicting exercise behaviour (Biddle & Nigg, 2000). It is primarily a model of intention formation attempting to explain how the formation of intentions to perform a behaviour are influenced by an individual's Attitude, Subjective Norm and Perceived-Behavioural-Control (Ajzen,

1991). Attitude can be defined as the perceived value of the outcome when undertaking a behaviour. The subjective norm refers to the perceived social pressure and models provided by significant others like family and friends to adopt or not adopt a behaviour. The concept of perceived-behavioural-control is similar to Bandura's (1986) concept of self-efficacy and reflects the degree to which a person believes that they have the resources and opportunities to perform a behaviour.

A main proposition of this theory is that people will engage in a behaviour when they evaluate it positively (attitude), believe that significant others want them to participate in it (subjective norm), and perceive it to be under their control (perceived-behavioural-control).

- Limits of the Theory of Planned Behaviour

Even though Gollwitzer et al. (2005) and Adriaanse et al. (2009) have experimented with success the implementation of intentions and that this model has been found effective for predicting PA (Hager et al., 2002; Hausenblas et al., 1997), it inadequately accounts for group level change or for the processes responsible for ensuring that intentions are turned into action (Sutton, 1994). Ajzen (1991) managed to define the three main components forming intentions ('Part 1' in Figure 3) yet a gap remains for turning these intentions into actions ('Part 2' circled in green in Figure 3).

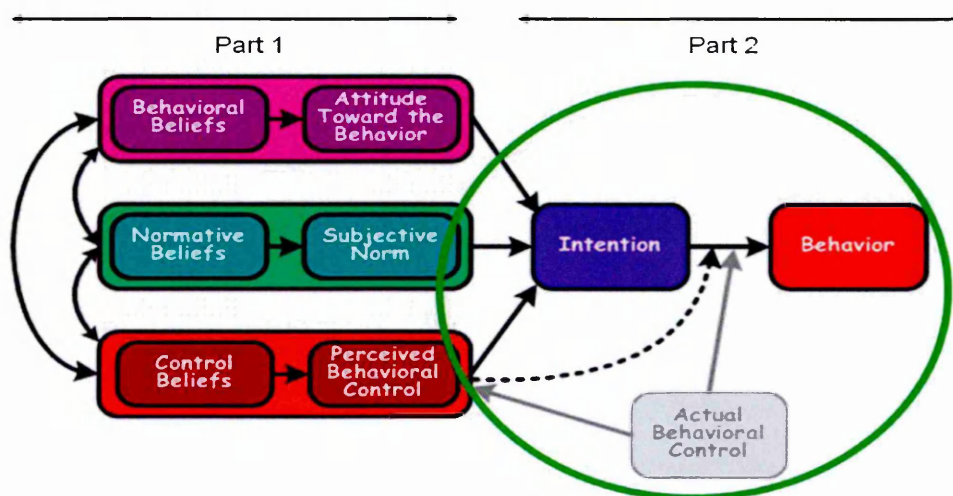


Figure 3 – The TPB and the intention behaviour gap

According to Sheeran (2002), when people have developed intentions to modify their behaviour only 53% will actually implement them. This intention behaviour gap is often cited as a shortfall of the TPB (Sheeran & Orbell, 1999).

#### 2.2.1.2 Self-Efficacy

Self-efficacy is a construct in itself and is often applied in different theories across the health behaviour change literature. Self-efficacy can be defined as the belief in our ability to succeed in specific situations. Self-efficacy is acquired from actual performances and vicarious experiences of learning through modelling (successes raise self-efficacy and failures lower self-efficacy), forms of persuasion (i.e. verbal encouragement), physiological reactions (i.e. heart rate, feelings of anxiety...), and also through co-participation (Bandura, 1997).

How people act can often be predicted better by their levels of self-efficacy than by their actual skills (Bandura, 1986) and it is a key factor to promote healthy behaviours. Dishman et al. (2004; 2005) demonstrated that increasing self-efficacy leads to increasing PA yet this was found among adolescent girls only. It seems self-efficacy can influence decision making about being physically active since it affects goal-setting and intention (Dishman et al., 2006).

#### 2.2.1.3 Perceived-Behavioural-Control vs. Self-Efficacy

The differences between perceived-behavioural-control and self-efficacy are somewhat difficult to draw out and Fishbein and Cappella (2006) stated they are the same. They both deal with the perception of the ease/difficulty to adopt a particular behaviour but in addition, the perceived-behaviour-control adds the concept of controllability. In both cases the performance of the behaviour is up to the individual.

#### 2.2.1.4 Self-Determination Theory

- Definition of the Self-Determination Theory

Borne out from the theory of motivation (Deci & Ryan, 2002), Self-Determination Theory (SDT) explores the relation between motivation and action and differentiates intrinsic and extrinsic motivation. According to SDT, if people do not value a behaviour,

it is unlikely they will be intrinsically motivated to adopt it or maintain it. The idea of SDT consists in motivating individuals extrinsically at the start to initiate a behaviour, and to then progressively support them to appreciate the adopted behaviour and its benefit(s), which leads to intrinsic motivation. To be intrinsically motivated individuals must satisfy three needs (Ryan et al., 2008): 1) the need for competence (i.e. raising people's self-efficacy to give them confidence), 2) for autonomy (i.e. doing it because I enjoy it) and 3) for relatedness (inputs and guidance from others). It is by implementing these three needs that intrinsic motivation is developed over time and that maintenance can be promoted.

- Limitations of the Self-Determination Theory

Teixeira et al., (2012) highlight that motivation is a crucial factor for promoting maintenance in behaviour, especially for supporting sustained exercise however more research is needed to apply this theory to PA. There is a need to differentiate the motivational elements considered as intrinsic vs. extrinsic among individuals in order to apply them appropriately and at the right moment in the process of change.

Furthermore, extrinsic motivation is useful to initiate a change and develop autonomous self-regulation or to enhance intrinsic motivation however its use over time does not lead to maintenance of behaviour. This has been a shortcoming of this theory which has been often used to initiate the change in behaviour through the positive use of extrinsic factors (i.e. external pressure, use of incentives, rewards...) but not enough on the maintenance of the behaviour (Ryan et al., 2008). The balance resides in earning small prizes that are just enough to keep individuals continuously motivated and engaged in the new behaviour. Ryan et al. (2008) also highlight that rewards must be used with parsimony since evidence shows that the larger the reward, the poorer the performance. Intrinsic motivation can be fostered through autonomous regulation as well as through goals associated with PA (e.g. social engagement, challenge, skill development, mastery) according to Teixeira et al. (2012), and leads to more effective results for adopting a behaviour (e.g. in weight loss) and to a better maintenance of it (Ryan et al., 2008).

### 2.2.2 The Transtheoretical Model

The Transtheoretical Model (TTM) describes the stages through which individuals are thought to progress when adopting a behaviour. It attempts to set-out a behavioural change process and is based on several theories of psychotherapy (Prochaska & Norcross, 1999). TTM is probably the most widely used theory of change in health promotion (Spencer et al., 2006).

- Stages of Change

The Transtheoretical Model consists of five stages of change (Figure 4), labelled as: Pre-Contemplation, Contemplation, Preparation, Action, and Maintenance.

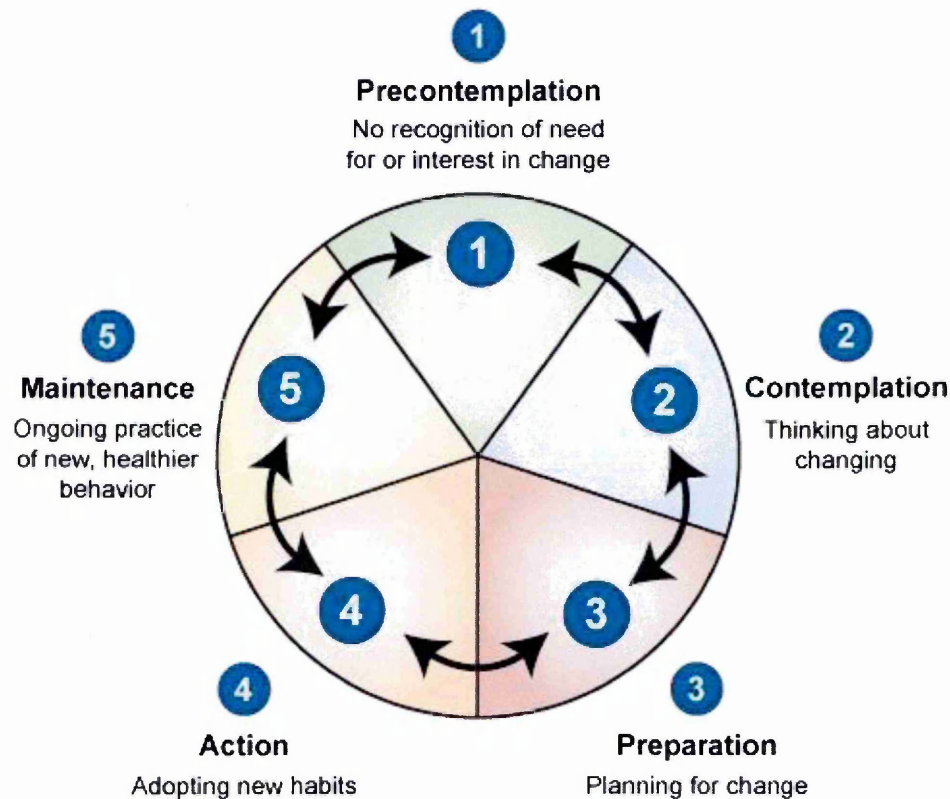


Figure 4 – TTM and the 5 stages of change (Prochaska & Di Clemente, 1983)

The principle is that self-efficacy is low in the early stages and is reinforced throughout the change so that individuals become more confident in the new behaviour and avoid relapsing to their old (unhealthy) habit/behaviour.

- Processes of Change

The processes involved in changing behaviour are of primary importance when applying this model. There are ten processes of change that are applied across the five stages. The processes are categorised in two groups: experiential processes and behavioural processes.

- Experiential processes include consciousness raising (learn more about the behaviour), dramatic relief (emotional experiences associated with change), environmental re-evaluation (understanding how a behaviour affects the physical/social environments), self-re-evaluation (emotional and cognitive reappraisal of adopting a behaviour) and social liberation (awareness and acceptance of social changes for behaviour change).
- Behavioural processes include counter-conditioning (replacing the unhealthy behaviour by the new one), helping relationships (looking for external social support to help initiate and maintain the change), reinforcement management (rewarding the changes about the new behaviour only), self-liberation (believing in one's ability to change and making commitments to change) and stimulus control (using reminders and cues to support adoption of the behaviour).

It is crucial to implement these processes at the right moment in the stage of change. To facilitate the implementation of behavioural processes, a support partner or rewards can be used (Spencer et al., 2006). These processes are matched to a specific stage of change, which are only useful to describe and communicate how the process of change works (e.g. raising awareness at the start to gradually promote action and maintenance).

- Limitations of the TTM

Although the TTM is the most widely applied it has also been highly criticised. For Aveyard et al. (2009), little experimental evidence exists to suggest that application of the model is actually associated with changes in health-related behaviours, especially

when used with adolescents, and the model has been shown to make incorrect predictions for explaining behaviour change (West, 2005).

More specifically centred on promoting PA this model needs more research (Hutchison et al., 2008). Adams & White (2005) explain the limitations of this model by four points. First, PA behaviour is more complex than other behaviours such as smoking, for which this model was originally created, which is about cancelling an addicting behaviour rather than taking one up. For instance, individuals could be in a number of different stages of change depending on the type of activity considered. Second, determining when an individual moves from one stage of change to another is decisive yet has not always been taken into consideration. Third, exercise behaviour may be influenced by some other factors that have not been taken into consideration in the model. Finally, some interventions aiming at promoting PA using this model may have not been complex enough in order to illustrate the model point by point: some studies used only one point or referred to only one stage of the model and the interventions were not accurately based on the model. When all the dimensions of the model have been used in the interventions, effectiveness has been reasonably common for a short term, but long-term effectiveness was found to be rare and few studies have actually implemented the processes of change appropriately (Hutchison et al., 2008).

### ***2.2.3 The Behaviour Change Wheel***

All the theories and models presented so far aim to provide guidance and a framework to identify, at an individual level, the factors that may be an obstacle to behaviour change. However it seems the context in which individuals implement a behaviour is equally important yet often discarded (Michie et al., 2011b). Michie et al. (2011b) created instead the Behaviour Change Wheel (Figure 5) as a more complete framework to help promote behaviour change. Michie et al. (2011b) state a behaviour, which encompasses volitional and non-volitional mechanisms, is generated through a combination of three components: 1) Capability (knowledge and skills), 2) Motivation (goals, conscious decision making, emotional responses, habits), and 3) Opportunity (external factors) as shown in green in Figure 6. Therefore instead of only mapping an individual's behaviour onto the theoretical determinants, the behaviour change wheel

recognises the context in which the behaviour takes place. It is a combination of personal conditions (e.g. physical, mental) with external influences (e.g. social, physical) that a behaviour may be undertaken or not.

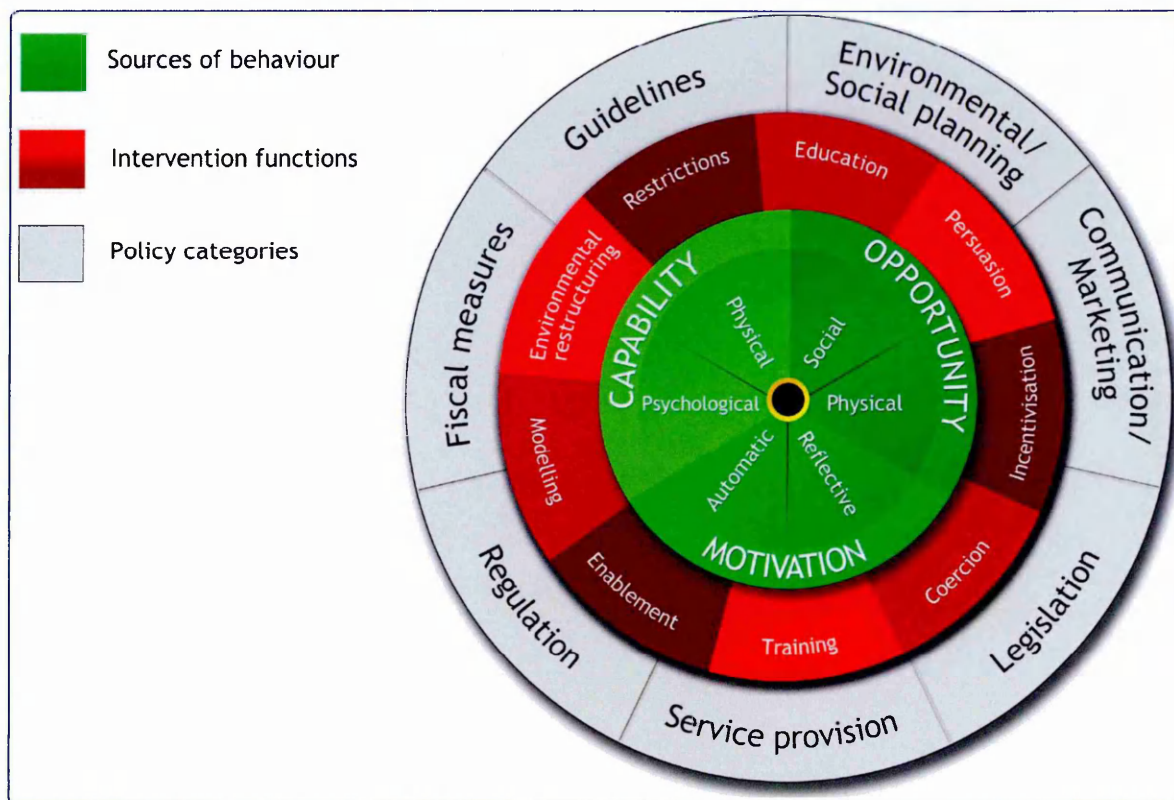


Figure 5 – The Behaviour Change Wheel (Michie et al., 2011b)

#### 2.2.4 The Use of Theories & Models of Behaviour Change

There are numerous theories and models of behaviour change that have been applied to PA related research and that led to effective interventions. However these interventions might have limitations, like the size of the samples and the non follow-up after the programme delivered for instance (Sallis et al., 2006; NICE, 2007). It is therefore unclear how effective these theories and models can be. Even though these theories and models often do not explain or predict an actual behaviour (change), they are useful to understand the different elements influencing behaviour change and affecting an individual's intention and/or motivation to act and adopt a new behaviour. Hence to ensure promoting action as stated by Brug et al. (2005), the concepts and constructs from the theories need to somehow be applied in the individuals' lifestyle. As shown in Figure 5 (Michie et al., 2011b), there is a need to

motivate individuals, show they are capable of performing a new behaviour, and provide opportunities to perform this behaviour. To do so, behaviour change techniques (i.e. self-monitoring, feedback, rewards...) that are drawn from the psychological literature (NICE, 2007) and that have received much research attention in the adult population (Michie et al., 2011) can be used. A novel approach to translate the motivation into action hence must be explored. One such approach seeming to be compatible with the implementation of such behaviour change techniques among young people is gaming.

## **2.3 GAMES, A SOLUTION TO BEHAVIOUR CHANGE**

### **2.3.1 Games for 'Serious Purposes': the Serious Games**

Digital games are played enthusiastically and often across demographic groups, whether it is voluntary or imposed as part of a programme (Lieberman, 2012). Games can be manifested in different ways (from quiz question to puzzle to solve), have a multitude of options (e.g. massive multiplayer, online team-based), and can involve hundreds of people playing for many hours (Lieberman, 2013). Kato (2010) describes games as voluntary, intrinsically motivating, engaging, and Lieberman (2013) as immersive, social, cool and fun. The features games provide have recently been strategically employed to engage people in a range of serious issues: they are the serious games. Zyda (2005, p26) defines a serious game as *"a physical or mental contest, played with a computer in accordance with specific rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives"*.

Serious Games were first introduced for the purpose of education, to make learning more fun (Breuer & Bente, 2010). These types of games were not intended to be played primarily for amusement but for transmitting knowledge: they are the 'educational games' or 'edugames'. During the last decade, the concept of serious games became much wider since it encompassed games from the video game industry that were used for a serious purpose but which were not created for this purpose

(Djaouti et al., 2011b). A good example is the commercial off-the-shelf game 'America's Army' that was originally designed to be played by the general public but which was used by the US Army to train new recruits (Zyda, 2005).

This has considerably extended the definition and the use of serious games and consequently their relationship to learning. Many fields of application (i.e. health, psychology, sociology, pedagogy...) showed interest in the use of serious games, as much from the market industry as from the academic world. Before 2002 'Education' represented 65.8% of all serious games. More recently, Djaouti et al. (2011a) showed education represented 25.7% (Figure 6).

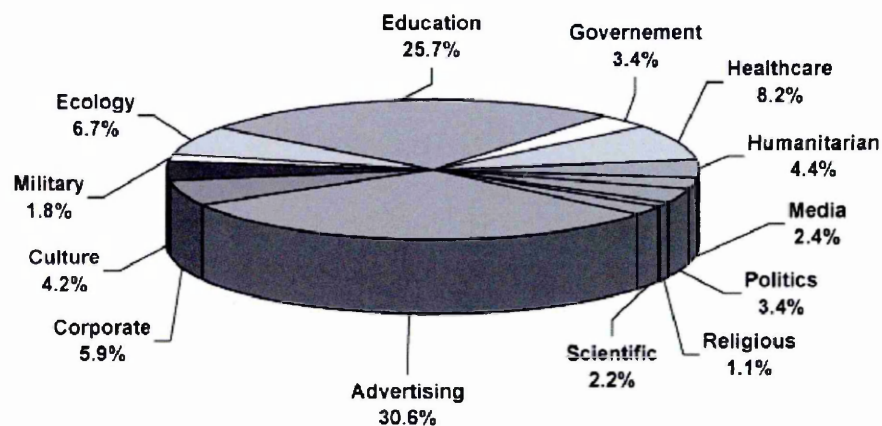


Figure 6 – Market segmentation of Serious Games released after 2002  
(Djaouti et al., 2011a)

In their definition of serious games, Djaouti et al. (2011b) associate serious games with video games, which seems quite restrictive since there are other forms of games that are non-video-based and that can provide fun and entertainment (i.e. traditional games like card, board games) and sports for instance (Breuer & Bente, 2010). Yet both Djaouti et al. (2011) and Breuer & Bente (2010) agree the aim of the serious games created before 2002, whose purpose was mainly educational, aimed at promoting learning through fun. In these games, 'learning' was the main objective and 'fun' a means to educate more efficiently.

### 2.3.2 Classifying Serious Games

There have been many attempts at classifying serious games by sectors according to the application area they fall into (e.g. military, government, political – Michael & Chen, 2006) and the purpose for which these games have been designed (e.g. advergames, games for science and research, games for health – Sawyer & Smith, 2008) among others. Since serious games can be very diverse, teaching about different topics (e.g. History, Physics, Sustainable Development, Health, Religion), aiming at providing different types of knowledge (e.g. historical facts, environmental awareness) gained in different ways (e.g. rote memorisation, exploration, trial and error) and on different platforms (e.g. Computers, Gaming platforms, Mobile phone), the sub-categories defined in the taxonomies can be quite similar and redundant (Breuer & Bente, 2010).

To overcome this and provide a proposition that is open to change and encompasses all types of games of all genres on any platforms, Breuer & Bente (2010) created a table classifying serious games through the type of platform used (e.g. computer, consoles), the subject matter (e.g. World War II, sustainable development), the learning goals (e.g. language skills, historical facts), learning principle (e.g. rote memorization, observational learning). This classification system is flexible, open, and *“can be used not only by game designers to advertise their products, but also by researchers to describe and compare games and by educators and learners who use them to express their view of and experience with the game”* (Breuer & Bente 2010, p19). Following this classification but unrelated to it, a website was created by Djaouti and his colleagues to browse serious games (mainly video-based) according to the games’ ‘Purpose’ (e.g. educative, informative, training), ‘Market’ (e.g. Healthcare, education, advertising), and ‘Audience’ (age groups).

### 2.3.3 A Review of Serious Games

Alongside the fact digital technology allows games to be played across media, time, social spaces and networks (Klopfer et al., 2009), the potential of learning through games is recognized. The efficacy and benefits of serious games promoting healthier behaviours is attracting attention from public and governments, and more conferences

are taking place (e.g. 'Games 4 Health Conference'). Some US governmental programs such as "Global Kids, One Economy, and Computers for Youth" bridge school, home, and community via the use of game technologies (Lieberman, 2013).

Lieberman (2006) identified nine ways serious games can be beneficial since they can:

- Increase motivation to learn;
- Increase perception and coordination;
- Increase thinking and problem-solving;
- Develop knowledge;
- Develop skills and behaviours;
- Support self-regulation and therapy,
- Increase self-concepts (e.g. self-esteem, self-efficacy);
- Promote social relationships;
- Develop attitudes and values.

Serious games have been shown to change one's attitude and behaviour by, for instance, providing a simulated environment to practice behavioural change in a safe and entertaining way (Lieberman, 1997; Street & Rimal, 1997; Thai et al., 2009). Those environments allow players to experience their actions in a virtual world, increase self-efficacy and give a sense of control (Breuer & Bente, 2010) to overcome their fear (Lieberman, 2012). Evidence also shows serious games can increase participation and motivate children to meet PA expectations and can engage those who often drop out (Thai et al., 2009).

Games seem particularly suited for promoting behaviour change since some features share aspects with behavioural change procedures (e.g. feedback, modelling, challenge), which are key to promote change (Baranowski et al., 2008). The three needs identified in SDT are aspects games are particularly good at promoting (Schell, 2010): need for competence through rehearsing in a virtual environment, need for autonomy through choosing the games to play, and the need for relatedness through being connected to others and receive support to maintain engagement. To encourage the adoption of behaviour, rewards can also be used parsimoniously to avoid undermining intrinsic motivation (as explained in 2.2.1.4).

## **2.4 GAMES FOR HEALTH**

### **2.4.1 Definition**

Games for Health are a type of serious game aiming at promoting the player's growth and healthy development through fostering skills, knowledge, and habits (Thai et al., 2009). Outcomes include health literacy, physical fitness, cognitive fitness, skills development, and condition management (Thai et al., 2009). Games for health can enhance treatments for patients, train (e.g. through simulation), educate (Kato, 2012a) or teach, offer insight, motivate, enhance self-management, distract from uncomfortable treatments, increase motor skill and cognitive functioning (Susi et al., 2007).

Games for Health have generated a wide range of games on a variety of platforms and environments to promote and improve PA, nutrition, mental health, safer sex negotiation, disease, self-management and adherence to one's treatment (Lieberman, 2013). Even though more research is needed to improve the design of entertaining, engaging, challenging and effective games promoting health (Lieberman, 2012), there has been important growth in the field of serious games for health (Kato, 2012b; Lieberman, 2013). A high number of projects have targeted all age groups (children, teens and older adults), in a range of environments (schools, homes, rehabilitation centres), for overweight and non-overweight individuals (Lieberman et al., 2011), and involving various stakeholders (e.g. hospitals, therapists, individual consumers – Susi et al., 2007).

### **2.4.2 Games for Health Classification**

Again, there have been numerous attempts at classifying games for Health: Thai et al. (2009) distinguished five categories (exercise games, brain fitness, condition/disease management, healthy eating, and professional training); and Susi et al. (2007) gave eight categories (physical fitness, education in health/self-directed care, distraction therapy, recovery and rehabilitation, training and simulation, diagnosis and treatment of mental conditions, cognitive functioning, control/stress). The difficulty of classifying games for health is similar to the one associated with serious games since there can be

cross-over between categories (e.g. a game might educate about health issue(s) through teaching knowledge and/or through providing simulation experience). These categories are classed according to the purpose for which they are used, from a 'Health' point of view.

However since health promotion can be done through games available in different format and on different media, Lieberman (2012) distinguished two categories of games based on 'technology': 'technology-based' and 'technology-supported'. In the first category, the game is in the technology and cannot be disassociated from it (generally screen-based). In the second, the technology is only part of the game (e.g. used to give information or real-time feedback) however players are involved in real/physical-world activities (e.g. Geocaching). It seems that most serious games to date fell into the technology-based category however they become more and more available on mobile phones and other handheld and/or medical devices (e.g. inhalers, spirometers, blood glucose meters), making them playable from anywhere, at any time, with distant teammates (Lieberman, 2012).

### ***2.4.3 A Review of Games for Health***

Lu et al. (2012) posit that video games are promising to promote health among young people since they can teach knowledge, develop/rehearse skills, and change behaviour (Susi et al., 2007; Lieberman, 2012). Lieberman (2012) adds these games for health are interactive, engaging, social and immersive, which can be very motivating and effective when well designed. The use of phones for health promotion (e.g. SMS, apps) has developed rapidly and their omnipresence might facilitate behaviour change (Bernhardt et al., 2013). This rapid growth seems to be explained by the use of tailored information and messages that are better processed by the receiver (Bernhardt et al., 2013) and that have shown increase in the retention rate of the knowledge acquired (Randall et al., 1992; Ricci et al. 1996; Kato et al., 2008). Cugelman (2013) highlights the importance of feedback for promoting behaviour change and shows how gaming/gamification is particularly suited for promoting digital health behavioural interventions (technology-supported or technology-based) since it tackles the various constructs needed to support behaviour change.

From a health psychology perspective, these games for health can provide direct or indirect positive physiological and psychological effects (e.g. players' attitudes, emotions, self-confidence) on individuals, which are known to influence behaviour change. Yet even though some games demonstrated increasing some of these effects like self-efficacy and knowledge (Kato et al., 2008; Kato, 2012b), evidence is limited. This is mainly due to the non-report of null studies, or to the poor research design of evaluations, which should use scientific rigor (Kato, 2012a). Nonetheless some games were evaluated rigorously and demonstrated improved health related knowledge, adherence to medical recommendations, and greater self-efficacy (Kato, 2012b). A good example of a game evaluated with scientific rigor is 'Re-Mission' (randomized-controlled trial over three months) which has shown to increase adherence to treatment and game play, resulting in a better understanding of the importance of staying positive and be disciplined about anti-cancer treatments, an important aspect for fighting the disease (Kato et al., 2008).

Lieberman (2012) has identified two main limitations to games for health. First, even though they can reach all demographics, they have to be adapted to the preferences of the players, which can be very different according to age and gender, and therefore specific populations should be targeted. Second, the use of digital technology to play these games should be used wisely and sparsely.

These kinds of games may potentially bridge the gap between knowledge and action in helping people implementing intentions or in promoting action, since people already know what they have to do (Thai et al., 2009). When well designed, Lieberman (2013) explains these games can be a powerful component of health communication campaigns and can be created for different purposes (e.g. hook the player, supplement and reinforce campaign messages, or stand on their own).

## **2.5 GAMES PROMOTING PHYSICAL ACTIVITY: THE EXERGAMES**

### **2.5.1 Definition**

Exergames, otherwise called active-play video games, exertainment, active games, or technology-mediated physical activity (Lieberman et al., 2011), is a category within the games for health. They aim at promoting ‘exercise’ by increasing the energy expenditure when playing the ‘games’, hence ‘exer-games’. The field of exergames is fairly recent and is still in construction (Oh & Yang, 2010; Lu et al., 2013) nevertheless the game industry as well as health promoters, government and researchers from different backgrounds have shown interest (Lieberman et al, 2011).

Exergames aim at increasing PA however the numerous appellations come from the confusion around the type of ‘exercise’ promoted through these games. In essence, ‘exercise’ is defined as an intentional activity aiming at improving or maintaining fitness levels whereas PA has a much wider definition encompassing any movements and activities done throughout our daily movements and life, whether it is deliberate or not (Oh & Yang, 2010). Since exergames aims at promoting MVPA and/or reducing sedentary behaviour, the desired effect of an exergame is to increase a player’s energy expenditure compared to sedentary behaviour. Therefore ‘exergames’ in this thesis refers to promoting PA in the wider sense, including skill-related fitness (i.e. agility, balance, coordination...).

Most of the time exergames are defined as a form of video game (Baranowski, 2013; Oh & Yang, 2010; Collins English Dictionary) however technology-supported games have emerged recently and are growing (Lieberman, 2012). Hence the definition of exergames is rather: a genre of games involving a form of digital technology, that requires energy expenditure to play the game (adapted from the definition of Lieberman et al., 2011).

### **2.5.2 Classifying Exergames**

Since exergames involve a form of digital technology to promote some form of PA, different classifications may be possible. We will use as a reference the two categories given by Lieberman (2012): technology-based and technology-supported (see 2.4.2).

However the boundary between these types of games can sometimes be blurred since there are games or platforms that are screen based but which require movements from the players in the real world; yet these games are classed as technology-based (e.g. 'Kinect').

### **2.5.3 A Review of Exergames**

- **Levels of Engagement**

The fun aspect of (exer)games has the potential to engage different ages and abilities. Levels of engagement when playing are crucial since they directly affect the quality of the workout, for instance increasing heart and respiratory rate (Lieberman et al., 2011). Enjoyment is associated with increasing treatment adherence (Rhodes et al. 2009, Lamboglia et al., 2013) or exercise attendance (Peng et al., 2013), even for those who usually do not engage with traditional PA methods (Thai et al., 2009; Daley 2009) or in regular PA (Lieberman et al., 2011).

Competitive, collaborative, and enjoyable exergames have potential (Lieberman et al., 2011) since they appear to lower the perception of exertion (Fogg, 2002) and they were also preferred compared to a same game that does not require doing PA (Lieberman et al., 2011).

- **Environment Implementation**

Exergames were implemented in a variety of environments such as schools, senior centres, fitness centres, homes, and medical and community-based settings (Lieberman et al, 2011). It appeared that even though exergames play is restricted to a limited space, which might limit the intensity of the PA, more PA occurred during exergaming than during PE lessons (Shayne et al., 2012). However Maloney et al. (2008), who conducted the study in homes, suggest exergames should be used outside of PE lessons. Studies done in the home environment led to inconsistent results (Lamboglia et al., 2013; Goldfield et al., 2014) and more research is needed to find out whether they are appropriate as part of the PE curriculum (Lieberman et al., 2011). Nonetheless since Sallis et al. (2006) advise the design of multi-domain interventions,

it seems worth exploring how a same exergame or a range of exergames can be implemented to be played in different environments.

- Health outcomes

Exergames have shown positive results for therapy purposes by improving reaction time, eye-hand coordination, feelings of success, PA levels, and social involvement (Lieberman et al., 2011). It has also improved attitudes towards PA (Rhodes et al., 2009) and levels of self-efficacy among obese children who have low confidence about PA, since players can practice in a safe and controlled environment that does not threaten them (Daley, 2009). Playing exergames has also reduced adiposity (BMI) among overweight and obese children (Maddison et al., 2011).

Exergames require more energy expenditure than sedentary games (Lieberman, 2012; Stach, 2012; Graves et al., 2007; Lamboglia et al., 2013; Biddiss & Irwin, 2010) and have been shown to engage young people in MPA and even VPA but many do not (Daley, 2009). Nonetheless, long-term behavioural changes were observed in a randomized study involving children playing Dance Dance Revolution for 28 weeks, and which concluded that VPA was increased (Maloney et al., 2008). Barnett et al. (2011) reviewed studies that explored the use of exergames over time to examine the factors sustaining engagement and the potential increase in PA. MPA was achieved with many exergames however VPA seemed to be less common. It was also generally reported that the use of exergames declined over time except in a multiplayer exergame (Barnett et al., 2011). Another study led over 6 weeks among children found that exergames could be an alternative for engaging pupils in PA during breaks (Duncan & Dick, 2012). There is a general agreement around the need to better engage children in consistent levels of activity to meet the public health recommendations of 60 minutes of MVPA a day (Daley, 2009; Peng et al., 2013; Barnett et al., 2011). Yet most exergames promote LMPA (Peng et al, 2013), and those that promote VPA generally do so over a short period of time only (Daley, 2009; Maloney et al., 2008).

To engage players in continuous play and avoid drop out like in Chin et al. (2008), Daley (2009) posits there is a need to explore factors such as novelty, users' preferences and levels of difficulty (Daley, 2009). To Peng et al. (2013) it is through

using multiple games (especially with story and plot development) that sustainability may be promoted.

Lieberman et al. (2011) argue that exergames can be a gateway to physically active and daily lifestyle by promoting habits. This view is shared by Lamboglia et al. (2013) who encourage the use of exergaming among young people to adopt more active lifestyle. However this conclusion is seen as lacking evidence by Goldfield et al. (2014) claiming their findings were based on a small number of studies and that interventions were led in laboratory setting. Lieberman et al. (2011) call for researching new ways to promote maintenance over the long term.

- A Shift to Real-World?

Lieberman (2013) has listed the different types of activities that exergames have involved players in (e.g. dance moves, step aerobics, kickboxing, Hula-Hooping, martial arts, biking...) however these activities were completed on dance pads, balance platforms, or through gestures detected by cameras or by handheld remote controls. Technical problems and failure were reported (Graves et al., 2007; Shayne et. al., 2012), suggesting that creating exergames relying on digital technologies only (i.e. technology-based) is limited. Moreover, the amount of energy expended when playing exergames was less than most real sports (Graves et al., 2007) and therefore do not replace conventional activities (Peng et al., 2013). Furthermore, exergames have not shown supporting the social rituals the same way traditional sports do (Bogost, 2007), which was nonetheless identified as an important feature to promote PA (Simons et al., 2013). All of these findings seemed to be concluded from the evaluation of exergames that were technology-based, and therefore restricted to a small space of play (e.g. dance pad, movement recognition on a small scale perimeter). Goldfield et al. (2014) call for the need for more research in the field of exergames and the importance and benefits of doing PA in the natural environment, involving meaningful and social interactions. It hence seems worth exploring how to shift exergames towards conventional activities, as suggested by Lieberman et al. (2011) to ensure higher levels of VPA are reached. One way to do so is through creating technology-supported games, where play experience is taken away from the screen and

implemented into the physical world – and described as pervasive games (Lieberman, 2013) – which is a way to motivate players exploiting their context (Shirazi et al., 2010).

- Self-Managed & Non-Structured PA?

Peng et al. (2013) report a lack of evidence about the efficacy of exergames over a long term in a non-structured and self-directed use among young people. However Biddiss & Irwin (2010) argue that self-directed exergames may be a way to promote LMPA and Lieberman et al. (2011) also advance that conventional activities such as sports, as well as unstructured and imaginative free play should be explored. Dishman et al. (2005) also encourage self-management strategies since these directly affect self-efficacy levels, which have shown increasing levels of PA among adolescent girls (Dishman et al., 2004). It therefore seems worth exploring the use of exergames in a non-structured and self-managed manner to explore the continuous play of exergames. A good example that promotes PA in an unstructured and self-managed way is Zamzee; it is not a game yet it is a ‘Two-Stage’ gamification. Zamzee consists of wearing a three-axis accelerometer throughout the whole day that does not record steps but MVPA levels. There is no interface on the device which must be connected to a computer via USB (in Stage 2) to find out how much exercise was done since last connected. Zamzee promotes PA throughout the users’ daily lives in a self-managed manner, and has shown to increase levels of MVPA by 59% in a randomized control trial <sup>1</sup> (Omidyar, 2012). Social networking and support were used to initiate and maintain the users’ behaviour, which is a crucial feature to improve health outcomes by motivating and acknowledging one’s behaviour (Lieberman, 2012). Zamzee uses extrinsic rewards (small prizes) to initiate behaviour and intrinsic motivation to sustain the behaviour through positive experiences. What seems important when promoting exergames in a self-directed use is to create a context to help appreciate these rewards through giving autonomy, control and connection to others (e.g. users, friends).

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<sup>1</sup> This study has not yet been published in a peer reviewed journal.

- The 'Two-Stage' concept: A Valid Direction?

The Two-Stage concept, which was inherent to 'Gener-G' and which received positive feedback at the time (see 1.1.3), appeared to be particularly suited for this research. Exergames do not replace real sports (Daley, 2009). Lieberman et al. (2011) posit conventional activities and real play (e.g. football, cricket, gymnastics) should be promoted, and activity led in a non-structured and self-managed manner is worth exploring (Peng et al., 2013). The Two-Stage concept takes place in the real world, which allows players undertaking their favourite activities or real sports in a more self-managed manner to generate a currency to play games afterwards. Therefore finding out how/if 'Gener-G' &/or the Two-Stage concept are engaging seem worth exploring.

#### 2.5.4 Learning & Acting

- Learning

From the serious games classification website *"an exergame is a physical or cognitive training game"* (SGC, 2013). Mueller (2009) state exergames aim at promoting sports and exercise to support physical, social and mental health benefits. Whether it is training or supporting, games for health, and more especially exergames, have the intention to promote a behaviour rather than knowledge (only). As Gary Knell asked: *"What is literacy and learning today? Is it memorizing a lot of facts, or is it having the capability to manoeuvre your way through data to find answers to questions that come up in your life?"* (Thai et al. 2009, p27).

- Behaviour

The TTM suggests people 'learn' first by raising awareness about the danger and limitations about their actual behaviour and the benefits of adopting a (healthy) behaviour. This is done through the first three stages of change to develop intentions before implementing them in the 'Action' stage. Games aiming at developing cognitive knowledge around PA do exist (i.e. 'Edugames' or the 'retro serious games' like Blast Off, which sets the player as an astronaut who, the same way rocket needs fuel to blast off, needs to have the right kinds of fuels to be healthy) however exergames focus on promoting action and developing skills. In relation to the Transtheoretical

model, these types of games aim at inserting individuals directly onto the 'Action' stage regardless of where they belong on the stages of change and of their levels of awareness.

This approach seems particularly useful since there is a gap between intention formation and implementation (see 2.2.1), meaning that even though people know the information or have intention, they do not act. Promoting behaviour change by inserting individuals into the 'Action' stage first may be another way of implementing change and of learning. Lieberman et al. (2011) argue individuals can learn from their actions after repeated behaviour as they start noticing the change in their body composition, develop positive feeling about doing PA, leading to a better mental health with higher self-efficacy, which motivate to engage more in PA.

## **2.6 'BLENDING EXPERIENCE' & EXERGAMES**

Serious games have this duality between the player's intention and the game's purpose: players want to have fun but the games should promote learning (here a healthier/more active behaviour). For a serious game to be effective it must provide the right balance between entertainment and learning; Breuer & Bente (2010) define this as a 'blending experience'. To them the effectiveness of learning depends on the players' enjoyment of the experience, which was defined as key by Duncan et al. (2011) to sustain this behaviour. A blending experience must not juxtapose learning and knowledge (e.g. adding nice graphics to educational messages) but blend them so that fun and learning are interwoven. Hence fun promotes engagement which develops knowledge. Habgood & Ainsworth (2011) explain that good learning games focus on developing 'intrinsic motivation', which can be done by delivering learning material through the parts of the game that are most fun to play. The blending experience is therefore a crucial aspect to take into consideration when designing any serious games.

However a 'blending experience' in Breuer & Bente (2010) refers to traditional learning (for educational purposes) which is the acquisition of knowledge. Yet in the context of

this thesis, the learning relates to performing a behaviour. This section therefore aims to give a definition of what a 'blending experience' is in the context of exergames. In the context of this research, the researcher here concluded that three conditions have to be met for an exergame to provide a blending experience:

1. When the PA done affects the content of the game (e.g. a player's move);
2. When PA is presented as a positive behaviour;
3. When players make PA as a conscious behaviour, as a goal (e.g. to inform/raise awareness about the players' behaviour).

To illustrate better how the three aspects can provide a blending experience, a range of existing exergames were selected and related to each of these aspects. Even if at least one of the three aspects was found among existing exergames, none were found combining the three aspects at once.

### *2.6.1 Physical Activity Affects the Game Experience*

Ensuring that PA directly affects the game play is a way to create a meaningful and engaging experience since players see the purpose of doing PA by associating it with the game experience. This can be done in two ways, through affecting:

1. The player's game play (at an individual level). This relates more to single player exergames where one player does PA that affects his/her own game play only. A good example for this is the famous exergame Dance Dance Revolution during which players dance to their favourite tunes by replicating on a dance pad the combinations of moves that they see on the screen. Players have to move (more or less quickly according to the difficulty of the level) to replicate the step dance combinations following the rhythm of the song being played. Therefore in order to win the game and improve their performance players must time their real-world moves with the content of the game.
2. Another player's game play (at a group level). PA affecting the game play can also be viewed from a more social perspective if the PA done can somehow affect the interactions with other players. This kind of interaction between

players was not found in existing exergames which may be explained by the fact that exergames do not seem to support social rituals (Bogost, 2007).

A counter example where PA is totally independent and unrelated to the game play is Gamercize. Gamercize is not really an exergame or a game but more a system using existing platforms (Xbox PS3 or Wii) to function. 'Players' exercise on an indoor bike, stepper or 'rower' and if the PA is interrupted, the game pauses until the player starts exercising again. Therefore the PA done when 'Gamercizing' does not seem to blend at all since it is simply a distinct layer added to existing games. It is a sort of cadence players have to get into to keep the game going, making the energy expenditure spent while 'gamercizing' more constant and less interrupted than other exergames (Duncan & Dick, 2012).

### ***2.6.2 Physical Activity is a Positive Behaviour***

The second aspect of a blending experience is to ensure PA is seen as a positive behaviour. Giving value and developing positive attitudes and disposition towards PA might encourage the adoption of a healthier lifestyle over the long term. In order to promote this positive experience, cheating about one's PA levels should be prevented.

It is argued that although Gamercize gets players exercising, this may not be suited for exploring maintenance in the behaviour since does not show a positive perspective of PA: in Gamercize players are penalised for not doing enough PA. This may impact the way players perceive exercise, as a punishment rather than associating it with a positive experience.

### ***2.6.3 Making Physical Activity Conscious, as a Goal***

This comes in the continuity of the two first aspects to enhance the value of adopting an active lifestyle by making it more obvious, conscious or self-initiated, and where PA affects the game play in a positive way. It is thought that this can be done in different ways, through:

1. Informing/raising awareness.

## 2. Sharing information about PA performance (referring to the concept of self-evaluation).

It was reported that one of the benefits of exergames is that they can distract from the discomfort of exercising (Fogg, 2002); this conclusion came from tests realised on machines that could be considered as early prototypes of Gamercize. Adding PA as an extra layer and using the game to distract users from doing PA may be a good way to initiate a behaviour, however the game becomes solely the goal, which is thought to be limited to promote PA on a long term.

Another example that does not make PA as a goal is the two-staged game Pokémon Heart Gold. In this game, players can do PA in Stage 1 to increase the powers of the players' monsters when playing the game in Stage 2 through wearing a Pokéwalker (pedometer). Even though the PA done in Stage 1 can affect the content of one's game play (i.e. providing players with stronger monsters) it is neither compulsory nor a goal in itself. Besides the play of the game in Stage 2 does not incorporate any forms of PA. Nonetheless Pokémon is the only exergame found that allows undertaking conventional activities and that rewards players for doing so, if they wear the Pokéwalker.

In 'Gener-G', the game created prior to this research (see 1.1.3), PA was promoted throughout Stage 1 only. Even though PA was increasing chances of winning the game, it was not reported to players, who did not have access to the amount of PA they had done.

'Fitbit Ultra' is not a game but a fitness tracker used to manage a healthier lifestyle (PA + diet) through the combination of a device (accelerometer) based on a digital service (website). Users wear the tracker all day long to measure the PA and can log into their account on the website or the Fitbit app to get more detailed information (e.g. activity bars representing PA patterns every 5 minutes) about their intensities of PA (light/moderate/vigorous), as well as logging food intake or PA that could not be recorded (e.g. activities done in water). Logging one's activity was found to be rewarding (Munson & Consolvo, 2012). Fitbit also gives extra information accessible directly from the interface on the device about: steps, distance, calories burnt, floors

climbed, the time, and how active users have been for the past three hours through the representation of a 'growing flower'. When picking up the device, random messages appear, some of them using fun (e.g. Love You; Walk me!; Step Geek...). The driver for using Fitbit comes from the intrinsic motivation of the users to adopt a healthier lifestyle however the different options available through the product and the service (e.g. information, reliability) help to maintain a healthy behaviour. Accessing information especially when it is visual (e.g. an evolving graphic) can be a motivation although more research is needed (Munson & Consolvo, 2012).

Another good example illustrating this idea that PA should be made conscious is Zamzee. A customisable profile onto the Zamzee website in Stage 2 is set for each user, allowing them to decide who to share the information with, what information, and customising their avatar. Users can also 'make a status' about how the points have been earned by associating a series of pre-composed sentences about the type of exercise done (walking, skateboarding...) and how it has been done (dangerously, fearlessly...) or who with (with my families, like a star...). A humorous note can be added when giving the message through random associations (e.g. dancing on the clouds, with zombies, bouncing like a pro, doing footie with mad skills) which enables getting likes' from the players' network. This is also a way to provide social support and make new friends, contributing to motivation.

There are a number of exergames and tools aiming at promoting PA like those presented above yet none of these examples combines all three dimensions of a blended experience as defined in this section. There is therefore merit in creating an exergames(s) that combine those three aspects of the blending experience.

## 2.7 USING DESIGN TO CREATE EXERGAMES

This section introduces how Design might be a viable way to create exergames (while exploring how a blending experience might be promoted) and presents the process of creating games for health.

### 2.7.1 Using Design for Health Purposes

Health psychologists give an account of the motivational factors leading to behaviour change and that are gathered into theories and models, but they seem to be limited for PA promotion (see 2.2.4). Policies or action plans around PA appear limited since difficult to implement and the reductionist approach seems an obstacle for making progress in prevention of non-communicable diseases such as obesity. Matheson et al. (2013, p1078) even go so far as to say that *"scientific evidence, while true, has been useless for effecting change"*. Since human behaviour is irrational and complex tackling the wicked problem of obesity holistically and through a solution-driven approach like in Design seems worth exploring. Matheson et al. (2013, p1081) explain that *"designers can have a profound influence on social innovation. The critical balance of creative and intuitive thinking (design thinking) with technical and content expertise (analytical thinking) has been very successful in diverse settings and organizations"*.

### 2.7.2 Creating Games for Health

To create effective and well-designed games, it is crucial to involve research experts in Health for the whole duration of the research, and early in the process, so as to be involved in the defining of the game scope (Kato 2012b). Then, formative research must be conducted to understand the targeted population (Lieberman, 2012) and develop knowledge about them (e.g. beliefs, interests, tastes, perceived obstacles). Involving target group(s) is a way to develop the game's content and format and gain insights about how it should be implemented (Kato, 2012b). To increase effectiveness, behavioural theories should be part of the research (Kato, 2012b; Lieberman, 2013; Peng et al., 2013) from these early stages (Kato, 2012a). Behavioural constructs (e.g. self-efficacy, observational learning, risk perception, health beliefs, motivation, persuasion) as well as strategies (e.g. social comparison, social networking, message

tailoring) and games features (e.g. compelling story telling, sharing results, team collaboration) should be explored together (Kato, 2012b).

Cugelman (2013) demonstrated the benefits of using gamification for health behavioural change and highlights the importance of games being fun and engaging to be more effective when designing digital health interventions. Levels of fun and engagement are even more important that they directly affect the quality of the workout (Lieberman et al., 2011). Therefore another important aspect when creating games for health issues is its evaluation. There are two types of evaluation that can be distinguished:

1. Formative evaluations, which must be iterative when developing and refining games to ensure the quality of impact. It is through iterative game-testing that the right balance between entertainment and the serious goal can be reached (Lieberman, 2012). Every evaluation or validation taking place in the design development should be based on theories and models combined in a coherent manner (Kato, 2012a). Before the game is completed, Kato (2012b) suggest leading a 'dosing study' over time to ensure that the intervention has the desired effect, ideally with a control group. It is during this stage of evaluation that level(s) of fun when playing the game should also be assessed since they have a direct effect on their level of engagement into the game (Lieberman, 2013).
2. Summative evaluations. Finding out what impact(s) the game in question might have on one's health is crucial (Kato, 2012b; Duncan et al., 2011), over the short and long term (Lieberman, 2012). Hence a summative evaluation should finally be undertaken to measure the impact of the game(s) intervention on the players' health (Kato, 2012b) over the short and long term to find out how the player's responses contribute to improved health-related knowledge, skills, attitudes, social interactions, behaviours and outcomes (Lieberman, 2012). The adopted approach should be the one a psychologist would take, with an evaluation of cognitions and adopted behaviours (Kato, 2012b), using

Randomized Control trials and adequate control groups (Kato, 2012a), as this type of evaluation is the standard for evidence-based medicine (Kato 2012b).

As a conclusion, Design has merits to be employed for this research and some authors such as Matheson et al. (2013) even make a call for it.

## **2.8 PROCESS & RIGOUR IN DESIGN**

The process of creating a game as a designer and the process of evaluating a game for its impact(s) on health as a health researcher are very different. This section describes the main differences between Design & Science processes and subsequently presents the core principles and techniques that Design applies, and which seems appropriate for tackling complex issues such as obesity.

### **2.8.1 Processes and Outcomes in Design and Science**

Design and Science are two disciplines that nowadays seem to be very distinct. Design is radically different from Science (Cross, 2007). Design is independent from Science and has developed its own methodology and “*designerly way of knowing, thinking and acting*” (Cross 2007, p55).

The Sciences look for an absolute and universal truth that is valid all the time and everywhere. In contrast, Design “*deals with the specific, intentional, and non-existing*” (Stolterman 2008, p59) by looking at the present for creating the future and exploring what the world could be like. Design is more focused on answering the question ‘what if’, to see what changes occur, and seek for changes and ‘*new realities*’ (Stolterman, 2008). In essence, Design is a theory of action followed by meaning rather than meaning followed by action (Overbeeke & Wensveen, 2003).

Unlike in the Sciences, Design does not try to isolate variables which could actually lead to worse results (Stolterman, 2008). Design is driven by creating holistic solutions to problems (Swann, 2002) aiming at improving the complex situation identified in the existing world. It is through providing solutions that a problem can be approached holistically.

Adopting a holistic approach to problems is actually what allows design to deal with 'messy situations' (Cross, 2007) or 'wicked problems'. In essence, a problem that is wicked cannot be understood until after the formulation of a solution, and solutions are not right or wrong but '*good enough*' and that is a continuous process (Rittel & Webber, 1973).

Due to the complex nature of wicked problems, and therefore to their richness, the multiple facets of a phenomenon/situation can challenge, fulfil, and stimulate creativity (Stolterman, 2008). Creativity in Design is crucial since it aims at constructing an artificial world that does not exist and "*is tied to a domain that derives its creative energy from the ambiguities of an intuitive understanding of phenomena*" (Swann 2002, p51).

### 2.8.2 The Design Process

The UK Design Council (2005) illustrated the design process as a double diamond (Figure 7). Each diamond represents the alternation of the way designers think: divergent and convergent.

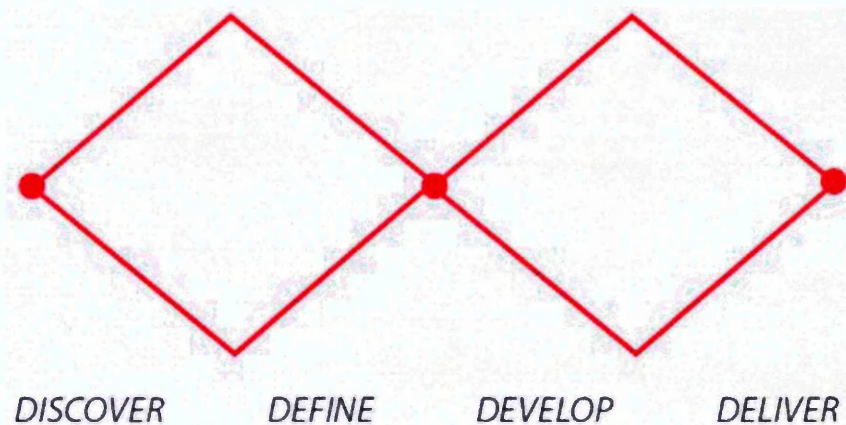


Figure 7 - The Double Diamond diagram (UK Design Council, 2005)

As the shape of the diamonds suggest, their first halves 'open up' (divergent thinking) and their second halves 'close down' (convergent thinking). The process in which this alternation of funnels and inverted funnels falls into is composed of four main phases: Discover, Define, Develop, Deliver. This double diamond diagram is useful to understand how ideas can be created and developed. However, it is a simplistic way of

representing the design process that is in reality messy, especially at the start of the process. Figure 8 below of Sanders & Stappers (2008) also represents the development of ideas across the design process but gives a better account of how messy this process is, which starts with a very “fuzzy” phase where everything is considered and taken on board to stimulate inspiration. This exploratory phase is a way to figure out what matters and what does not, through considering many different aspects (user and context's understanding, materials, technologies...). It is during this phase that the ‘possible’ (Fallman, 2008) and ‘what if’ is explored, sometimes with the future end-users, and where the terms of the problem are defined (‘design criteria’ in Figure 8).

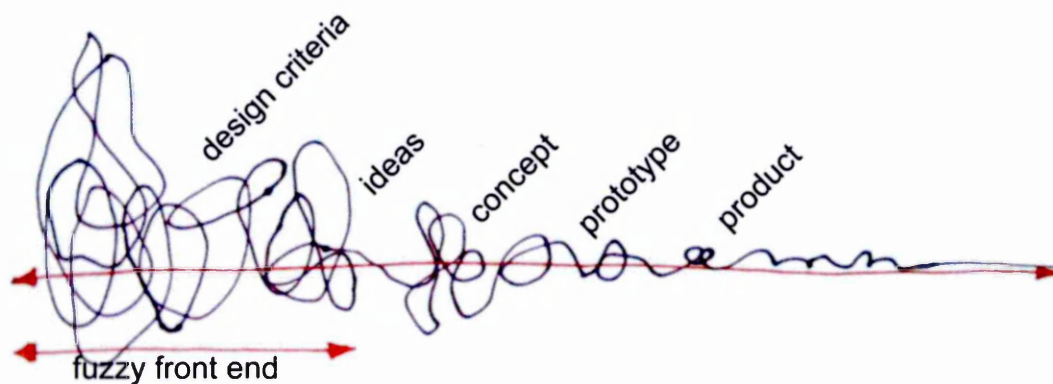


Figure 8 – The Design Process (Sanders & Stappers, 2008)

A range of ideas emerged which then get refined and developed through the making of prototypes (i.e. products, systems) of different degrees of finishing, as much physically as technically or aesthetically (Gaver & Bowers, 2012). Prototypes represent the designer's vision of the artificial world and are created to explore how they are received in the ‘real world’ in which they are evaluated. Through iterative cycles of creation, evaluation, and modification, prototypes are refined which reflect the development of the designer's understanding as to their role and use in the real world. Therefore this drawing could also be used to describe the development of the designer's understanding of the (wicked) problem to solve, and how the pieces of the puzzle come together.

Design practice always results in ‘things’ (i.e. products, systems, services, artefacts) that embody both the designer's understanding and their vision of possible answers to the wicked problem. It is only by going through these iterative cycles that

understanding is developed and that the ‘messiness’ of the situation can start making sense.

### 2.8.3 Participation in Designing

Design is about exploring and giving form to new things (Fallman, 2007), to create new realities (Stolterman, 2008) that become possible through iterative tests and evaluations in context. Participatory design is a mindset (Sanders, 2002): it is of a belief that participants have something to offer because they are the experts and future end-users. In essence, participatory design has the goal of improving the knowledge foundation and of producing more realistic expectations, more appropriate and with a deeper involvement of the users (Mønsted & Onarheim, 2010). Glaserann & Kanstrup (2008) also argue that involvement of users has shown to lead to better outcomes, which are more likely to be approved and adopted by the end-users. This view that the future end-users are experts of their own experience and that their involvement in the project will lead to better outcome is very pragmatic. Carroll & Rosson (2007) share this point of view but also add that since the end-users are also the target, they have a right to involvement (moral reason).

There also exist different degrees and natures of participation: Sanders (2002) posits that involving participants in different types of activities (saying, doing, making) can deepen understanding by revealing different types of knowledge (Figure 9), which can lead to better results. Traditional research methods are mainly about finding out what

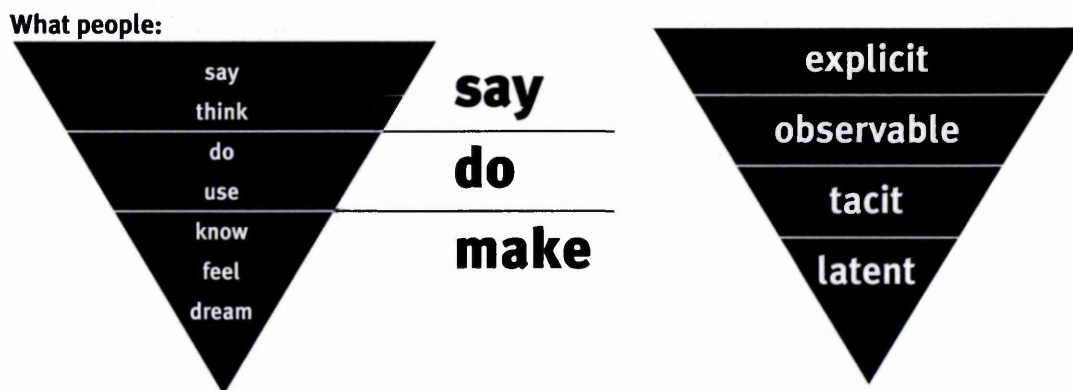


Figure 9 – Different activities reveal different types of knowledge (Sanders, 2002)

people say and think and involve focus groups, interviews & questionnaires, however listening and/or observing what people do, see and use is not enough (Sanders, 2002). As opposed to traditional interviews, making can reveal different types of knowledge (Sleeswijk Visser et al., 2005) and provide greater level of insight and unexpected outcomes (Gauntlett, 2011).

#### 2.8.4 Designerly Ways of Knowing

The main method of enquiry in Design is through making, as a way of probing and understanding the relationship between people and objects or artefacts. Designers explore this relationship at different levels (i.e. emotional, functional) to see how it can relate to the future possible world they envision. Therefore designers are not always interested in the 'thing' in itself but more about the reaction(s) to it. This is why it is common for designers to use artefacts as a way of communicating with the future end-users. Artefacts are tools that can be manifested in different forms, formats and mediums (i.e. prototypes, images, drawings, interactive systems, books, exhibitions, websites, videos...) to best suit the audience (Gaver & Bowers, 2012). They may be used by the designer to test ideas of the vision of the artificial world and see how they are received in the real world, or made by the future end-users who engage in design activities. These artefacts may be a "*proposition for a preferred state*" (Zimmerman et al. 2010, p311) used as tools for discussion of this preferred state and of what it implies, which is also a way to better understand the current states. They are a way to explore the different opportunities for change and they can be of different nature according to the intended outcome: they can be a form of statement, more or less radical or critical in order to provoke a reaction from the people interacting with it, but they can also be prototypes of different degrees of finishing, or tools for creative activities that are used in a participatory context. Often they represent possible solutions, answers or visions of the artificial world to explore how the future could be (and not on what the present or the past are), giving the opportunity to all the stakeholders involved in the research to discuss, explore, and pro-actively shape the future (Zimmerman et al., 2010).

### 2.8.5 What is Rigour when Designing?

As an emerging discipline, there is still a need in Design to understand "*what constitutes the rigor and discipline of design practice*" (Stolterman 2008, p60) as Design is not science and must define its own terms and rigor (Gaver & Bowers, 2012).

Design practice is driven by uncertainty, the unknown, the untested, but this does not undermine rigour. Swann (2002) explains that ambiguity, and indirection (Gaver et al., 2004), both lead to creativity since a high degree of uncertainty often unfolds things in unpredictable ways, which may change the initial focus of a project (Dalsgaard & Halskov, 2012). However a change in focus does not mean it is less rigorous. Instead, it means that the data is rigorously analysed in relation to the original focus and that reflection and knowledge gained during the process showed potential for developing the project in a direction that was not thought or imagined before. Rather than a shift, it may be more relevant to describe it as a 're-adjustment' to come up with a more appropriate and pertinent solution.

When testing in context, designers look for inspiration for creating something new while adapted to the needs of the future end-users. A designer is immersed in the data looking for opportunities to produce something meaningful, adapted, and new. A designer therefore aims at producing data that will allow generating creative stimuli as well as developing understanding about the users and how they interact with the 'things' or artefacts presented to them. Creative stimuli are therefore used to create and develop the artificial world, and are combined with the designer's understanding about the real world to ensure meeting the user's expectations and needs when implementing his/her vision about the artificial world into the real world. Looking for inspiration in the real world to trigger creativity and vision in a possible artificial world is essential to produce innovation: "*the quality and value of design research is its 'unreliability' and 'invalidity', manifested in creativity, innovation, and different ways of seeing*" (Fallman & Stolterman 2010, p267).

Since creativity is a core element in design practice, designers need to ensure that they have a set of data as diverse as possible to increase the creative stimuli. This data

analysis, combined with the vision of the designer, is the driver for developing the solution(s), however, it is crucial to go through iterative cycles of testing in context.

### ***2.8.6 Design is Suitable to Tackle Obesity***

Section 2.7 suggested Design in a Health context might be beneficial. This section develops this idea and presents two reasons why Design is particularly suited for tackling the wicked problem that obesity is.

Firstly, the solution-driven exploration taking place in Design enables a search for new realities through engaging in design activities to develop understanding, generally with future end-users. Since the goal in Design is not to discover the truth but to provide solutions for (societal) changes through the making of artefacts (Zimmerman et al., 2010), all the different aspects that constitute the users' experience can be explored holistically. Fallman (2008) lists a range of aspects involved in a user experience and which can be experienced at different levels: physical, sensual, cognitive, emotional, and aesthetic; but users' experience also involves relationships between form, function and content as well as fun and playability. Based on practice including test and evaluation in context, design has the ability to approach problems as a whole (Stolterman, 2008), making it suitable for multi-faceted problems (Zimmerman et al., 2010).

Secondly, Brown (2005) refers to the design discipline as being a 'T-shaped skill'. The vertical bar on the T represents the set of skills knowledge within one discipline whereas the horizontal bar refers to the design discipline being able to collaborate with other discipline by integrating their knowledge. Therefore designers should have the ability to take on board all these sets of skills and knowledge from others' disciplines and be at the centre of a multi-disciplinary team (Fallman, 2008). The role of the designer is to integrate the given knowledge and language from across disciplines and to propose solutions in a holistic manner (Zimmerman et al., 2010). Therefore designers need to develop different sets of skills to communicate within the multi-disciplinary team (Fallman, 2008) so that all the languages and knowledge transmitted by other disciplines can be reformulated into another language, the one of the

designer. This is often done through creating and making as a way to synthesise the knowledge into a 'thing', often visual and tangible.

As a conclusion, Design seems particularly suited for tackling health related issues, and more especially the 'wicked problem' that obesity is since effective in multi-disciplinary contexts. However Design may be seen as lacking in rigor due to its subjectivity in interpretation. The challenge for designers in multidisciplinary contexts comes from demonstrating that the activities done through practice are justified, structured and rigorous, while making sure the collected data will be appropriate to further develop the design (Fallman & Stolterman, 2010).

## **2.9 CONCLUSION**

Obesity is a serious problem and many government campaigns have highlighted the dangers of sedentary lifestyles (Ekblom-Bak et.al., 2010; Weiler et.al.,2010) and the benefits that regular PA can provide (Matheson et al., 2013; Weiler et.al.,2010).

Focusing on children and young people is important to engrain healthy habits (NICE, 2007). This research will therefore focus on 11-12 years old, when entering secondary school (Year 7).

There is a wide range of theories and models available in health psychology that explain well the various factors influencing behaviour change and provide a basis to design interventions (Lu et al., 2013) however they should focus on promoting action rather than motivation only (Brug et al., 2005). Furthermore, since interventions based on psychological theories or models for promoting behaviour change have not always been consistent and that most obesity prevention programs (Summerbell et al., 2005) or those increasing PA (O'Connor, 2009; Frémeaux et al., 2011) have not been effective, it seems appropriate instead to use concepts drawn from those theories and models (NICE, 2007) to inform the design of programmes aiming at promoting PA rather than driving them.

An area that may have the potential to change behaviour while using concepts drawn from the psychological literature is the serious games and games for health. Games for health have already shown various benefits for promoting learning and behavioural patterns. However evidence shows that applying these concepts and combining them with user-centred approaches when designing and evaluating serious games led to more successful results (Peng et al, 2013; Kato, 2012b; Bernhardt et al., 2013; Lieberman, 2012).

A lot of exergames seem to be technology-based however Lieberman (2012) posits technology should be used parsimoniously, especially when Rideout et al. (2010) show the amount of time already spent in front of digital or screen-based Media. Furthermore, the cost of some exergames and the complexity of the technology can be problematic (Shayne et al., 2012; Graves et al., 2007). Despite the success of a few exergames, there is a lack of evidence showing the effectiveness of exergaming for promoting MVPA (British Heart Foundation, 2012c). No exergames so far have been shown to enable meeting the recommendations of 60 minutes of MVPA: most of them generally provided LMPA only (Peng et al., 2013) and when MVPA was promoted it was over a short period of time (Daley, 2009).

However it is difficult to draw definite conclusions about the use of exergames from the literature since it is not always clear whether the findings apply to 'active video games' only (relating to technology-based games) and/or to others forms of exergaming that are not necessarily technology-based (i.e. technology-supported or non-technologic). For instance it is unlikely the conclusions reached about exergames demanding minimum space (Lieberman et al., 2011) or being costly (Shayne et al., 2012) apply to technology-supported games, which is a growing sector. These questions about the 'scale of play' or the cost of exergames seem less relevant to technology-supported games.

One explanation for exergames not meeting health recommendations might be that designers failed to create compelling and effective exergames via a full blending experience. Even though each of the individual aspects established in 2.6 were found in a range of exergames, or tools or gamification (e.g. Fitibit, Zamzee), they were

implemented independently, in isolation, and none have shown to promote those three aspects in combination. One explanation why exergames have failed so far to meet the health recommendations over the long term might be that none have successfully combined those three aspects into one experience.

Using Design as a main method of enquiry to create outcomes that will be appropriate and accepted by the future end-users seems worth undertaking. This is done through using Design techniques that trigger creativity for creating, developing and assessing outcomes in context, with the future end-users, and in an iterative process. In this research, the outcome aims to improve the future end-users' health (i.e. PA) and therefore the nature of this research is multidisciplinary. However since Design is a discipline drawing out from the Humanities, it involves a lot of subjectivity and interpretation from the Designer, who might judge it rigorous to change the direction of a project for instance. The challenge in this context of exergames creation resides in demonstrating a type of rigour that will be accepted by all disciplines while ensuring creating an appropriate outcome through designing.

## **Chapter III- Methodology**

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Following what we know about the process and techniques used in Design, this chapter considers the methodological approach adopted within this research project. The aims and objectives of this design research are first presented and a definition of 'design research' is then outlined. A debate to define what design research is and what criteria are needed to ensure validity in design research is also considered.

### **3.1 AIM & OBJECTIVES OF THE RESEARCH**

Informed by the literature review (chapter II), the primary aim of this research focused on creating, developing and refining engaging game(s) to promote physical activity (PA) among adolescents aged 11-12 years. To achieve this, four key objectives were identified:

1. To examine the properties and types of games that do or do not attract the sample population
2. To explore how to create games that are engaging to play repeatedly, regularly, and over the long term
3. To explore how PA can be embedded into game(s) that attract the sample population
4. To explore the feasibility of delivering a game(s) to promote PA in the sample population

## 3.2 DESIGN RESEARCH DEFINITION

### 3.2.1 Design & Research

Through a desire to establish design as a discipline recent attempts have been made to place Science at the heart. With this in mind, Cross (2007), suggests there are three ways of conducting design within a scientific paradigm: 1) 'Scientific Design', 2) 'Design Science', and 3) 'Science of Design'. Scientific Design is typical of the majority of design practice (Cross, 2007) mixing intuitive design methods with scientific data to guide decisions (e.g. choosing the properties of a material based on its robustness as well as its design potential). Design Science is an extension of Scientific Design, which recognises general laws to optimise the outcome of the design process (e.g. general rule to look at material properties at the start of a project). Finally, Science of Design is about analysing and studying the design principles, practices and processes from an observer's point of view. What all these approaches have in common is an attempt to define the intellectual and scientific approach of the designer and design methods, yet 2.8.1 outlined that the Design process can be very different to the traditional Scientific approach of understanding a particular problem – in this instance how to increase PA in adolescents.

This is also the case when researching. Whilst, Design and Science both aim at producing new knowledge (Fallman, 2007), Science looks at establishing universal truths about what the past and present world are and aims to describe the world as it is. When leading experiments, Science-based research attempts to make sense of what exists by isolating variables to create knowledge that is generalisable. There is this idea that any findings produced from a scientific approach will be objective, however "*there is no such thing as 'objective' Humanities*" (Archer 1995, p8). Although, isolating variables in this way can be useful to describe and understand how the world is/works, this is not the approach of Design (Stolterman, 2008). Instead, Design and designers approach problems holistically and seek to generate results that are specific to the context in which the experiment was led and this is why Design can produce findings and knowledge that are transferrable but not necessarily generalisable. Findings may be appropriate within a context but it is up to designers in a new situation to judge

whether these findings remain useful or valid in that context (Archer, 1995). Moreover, even though the investigator should limit the impact they have on the intervention (should be an observer not interfering with the situation), “*it can hardly ever be objective, in the strict sense of the word*” (Archer 1995, p12). Therefore findings will not be generalisable or only to a very limited degree, and it is more appropriate in Design to speak about transferability of the findings rather than ‘generalisability’.

With this in mind, it could be argued that instead of giving a definition of Design research through ‘scientising’ Design like Cross (2007) did, the methodological approach used in Design should be defined in its own terms and rigor (Gaver & Bowers, 2012), much in the same way that science can be defined (Archer, 1995).

### 3.2.2 A Definition of Design Research

There is some debate as to the various types of design research that exist. Archer (1995) proposes three kinds of design research:

- Research *about* practice; this strand is quite similar to the ‘Science of Design’, which looks at Design from an observer point of view. It consists of studying design practice but this study is not necessarily led by designers but by others such as ethnographers, even though designers might also conduct their own ethnography. The aim of researching *about* design practice is to produce knowledge about design or designing as a human activity but that knowledge does not necessarily help the process of designing (e.g. design history), as is the case with ‘Science of Design’.
- Research *for* practice looks at undertaking a range of activities that will generate knowledge directed towards improving the designers’ practice (e.g. effectiveness of the use of probes to create a game). Again, this might not be led *by* designers but it has to be of help *for* designers to increase the quality of their outcome(s).
- Research *through* practitioner action relates to practice, which is inherent to the designer’s activity (i.e. designing). Here the knowledge produced is explicitly intended to inform and ultimately improve practice that is not

necessarily limited to the designer themselves. As described in 2.8.4, through making ‘things’ that are evaluated in context, designers analyse interactions users might have or not with the ‘thing(s)’, thus developing new understanding and knowledge. This knowledge can be multi-fold: to improve the designed outcome, enhance the methods used when designing, or provide insight about the ‘things’ in their context (i.e. identifying what it is that makes users act or not act with the things). Hence, researching through designing becomes a way to create knowledge that might be of use to designers or to other disciplines. This is why some suggest Design is particularly suited for multi-disciplinary projects (Brown, 2005; Fallman, 2008). So it is *about* design but it’s about design *for* designing, *through* practice (designing).

These definitions of design research given by Archer emphasize the designer’s practice and place emphasis on the role of the designer in research compared to the paradigms described by Cross (2007).

Archer’s definitions (1995) relate to Frayling (1993) who speaks about research *into* art and design, research *through* art and design, and research *for* art and design. However, Frayling’s definition of ‘research *for* art and design’ has an implied practice element which could refer to Archer’s definition of Research *through* practice. To underline the importance of the designer in the research process, Frayling (1993) illustrates the research *for* art and design by giving the example of Picasso gathering reference material to produce a better painting. In that example, Picasso’s exploration is to inform his own practice, yet it is not made explicit to others since he does not aim to communicate the results of his investigation but simply apply knowledge gained in his work (i.e. to inform his own practice). That said, in the definition of research *through* art and design given by Frayling, the practitioner makes the knowledge gained through practicing purposely explicit and available so that others can replicate the process. Frayling gives different examples about areas in which the practice can take place (‘material research’), what it is for (‘development work’), and how it can be done (‘action research’).

Nonetheless, Frayling's definition seems confusing since it is through practice that Picasso researches yet it is defined as 'research *for* art and design'. Archer's (1995) definitions will hence be used as a reference in this research and will be referred to as 'research about design' (to help understand what is design as a discipline), 'research for design' (as developing methods to help designers improving their practice), and 'research through design' (to generate knowledge that can be also useful to other's practice, not necessarily to designers).

### 3.2.3 What is a Valid Research Methodology?

Archer (1995) defined the common aspects that any research methodology must articulate to be recognised as valid. It has to be:

- Systematic;
- Knowledge directed;
- Communicable or transferrable (not necessarily generalisable in the positivist meaning).

These three points are intended to strengthen the methodologies used in Design research by bringing rigour and structure to the design process, which as discussed in 2.8.2, can be a 'fuzzy' process.

### 3.2.4 Rigour in Design Research

Since research is a systematic enquiry aimed at generating communicable knowledge (Archer, 1995), its process needs to be made visible in the same way as it has been in Action Research (Swann, 2002). Hence to be able to produce knowledge and communicate it in a clear and transparent way, documenting the design process systematically is crucial and needs to be applied to Design methodologies to avoid these being seen as "*an attitude to doing work [rather] than a systematic method of inquiry [and there is therefore a] need to more clearly define how research through design fits into both research and practice*" (Zimmerman et al. 2010, p311). Being systematic is even more important in light of 2.8.5 in that creativity, a core element in design practice, involves a lot of data interpretation and subjective judgements on the

meaning of the data that being an inherent part of the process. For other researchers to be able to take account of subjective interpretations and judgements, the process through which they were determined should be "*visible and open for critique*" (Stolterman 2008, p62). Adopting a systematic and transparent approach also:

- Makes the research more relevant, especially when there is a 're-adjustment' in the project that is often justified but that needs to be explained and articulated (as explained in 2.8.5);
- Allows the maturing of theory(ies) through making criticism possible (Koskinen et al., 2008). Being able to understand how findings or theories emerged throughout a research project is crucial for others to understand the process that led to such conclusions. Therefore being able to distinguish what is factual (i.e. objective) from what is interpretative (i.e. subjective) is required for opening them to critique.

To achieve transparency, Frayling suggests supporting this type of research with tools such as a research diary that documents the process "*in a step-by-step way*" (Frayling 1993, p5). In this instance, rigour is achieved through recording in an honest and clear way the intention(s) set before leading a participatory intervention (regardless of its degree of participation or nature), the observations made during the intervention, the analysis following the intervention, and how it affects the next cycle of action.

Being systematic is crucial, but so is the way to communicate the findings of the research. There are many aspects of the designed artefacts that may not be captured in a given theory since the (tacit) knowledge may not be as well articulated as the artefacts themselves (Gaver, 2012). Therefore using words to communicate the knowledge embedded in the design may not always be the most effective way of communicating the research and the knowledge gained. Instead, Gaver (2012) suggests that artefacts represent the theory and should be presented as part of the knowledge and that annotations should be used to complement or illustrate the design. Annotations are crucial, especially in multi-disciplinary contexts, since they can be used to describe the approach at a general level, or at a more detailed level to highlight issues or aspect(s) of the design that may otherwise be overlooked, and to

articulate issues or rationales that are embedded in the artefacts (i.e. interpretation(s) of the design researcher). In this way, the annotations complement the created artefacts, which cannot be substituted. Since Design involves the creation of artefacts during the whole process, a series of (revised) artefacts are built. Gathering them together - presented as an 'annotated portfolio' - is a way to constitute a portfolio that defines an area within the design space (Gaver, 2012). These annotated portfolios constitute the design rationale and are a way to communicate the research across various disciplines.

### ***3.3 DESIGN METHODOLOGY, PROCESS & TECHNIQUES IN THIS RESEARCH***

Based on the description of the Design process (2.8) and the conditions that have to be satisfied to conduct research (3.2.3), this section presents the methodology developed for this research to achieve the aims and objectives set in 3.1.

#### ***3.3.1 Methodology in this Research***

This research aims to develop, create, and refine engaging games that promote repeated play and PA among young adolescents. Therefore, it involves the practice of design (to create exergames) and hence adopts a research through design (RtD) approach.

- Definition of Research through Design

RtD consists of offering changes through the making of artefacts used to explore different possibilities to a problem ('problem solving') or to formulate a problem ('problem setting'). Zimmerman et al. (2010) would even say that RtD aims not only to change but to improve society by broadening the scope for designers, challenging the current perceptions of our world. Evaluating artefacts in context is the basis for exploring how future end-users might interact or not with the artefacts which will allow developing knowledge: this is the 'Designerly way of knowing' (see 2.8.4). It is only through making, testing, observing/analysing, and changing/developing accordingly, to test again in an iterative process that it is possible to adjust this vision.

However, there can be instances in Design where designers are focused on producing solutions rather than producing knowledge. The previous Picasso example illustrates this idea well - that the artist does a form of research to increase the quality of the outcome(s) yet what is communicated is the final outcome(s) only (i.e. the painting) and not the process. Being rigorous and bringing in creativity during the process (as defined in 2.8.5) while being systematic to communicate it in a more transparent way (i.e. opened to critique as presented in 3.2.4) is therefore of primary importance when undertaking RtD.

- A Design-led Methodology to Research

Fallman (2008) distinguishes three areas into which Design research can fall (Figure 10): Design Practice (the practice of Design such as in a consultancy company) which

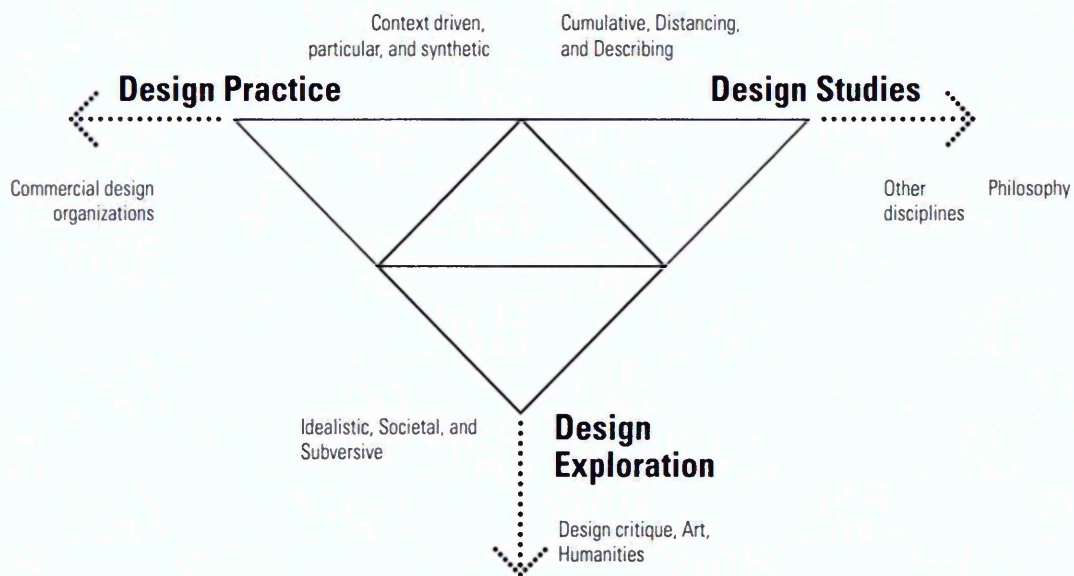


Figure 10 – The interaction design research triangle, Fallman (2008)

looks at being ‘real’ since it is anchored in the real world; Design Studies (to build theories within the field e.g. design methods, tools or techniques) which looks at being ‘true’; and Design Exploration (to see what happens – it is the ‘what if’ question) which looks at exploring what is ‘possible’. Moving between these areas (in a triangle within a triangle) is what leads to originality and innovation as illustrated in Figure 10 (Fallman, 2008).

In relation to Fallman's interaction design research triangle (2008) presented here, this research starts at the bottom of the triangle to explore what is possible ('what if') and progressively moves towards the top left to implement something in the real world ('real') with the aim of creating generic knowledge ('true'). Therefore the methodology adopted for this research is underpinned by RtD, but also fits well into the top left corner of the triangle.

- A Comparison with Action Research

Action Research (AR) is defined as a *"systematic enquiry conducted through the medium of practical action; calculated to devise or test new, or newly imported, information, ideas, forms or procedures and generate communicable knowledge"* (Archer 1995, p5). AR has foundations in the social sciences and has often been applied to design since it offers design researchers a flexibility to employ practical action within a robust research framework in which design work and research cannot be easily disassociated (Koskinen et al., 2008; Archer, 1995). Similar to the realities of a designer's practice, applying an AR methodology consists of applying a series of cycles to the data collection and synthesis process. These can be summarized in four steps: 1) plan, 2) act, 3) observe, and 4) reflect. Being systematic at all stages of the research is crucial and will enhance the confidence of any findings as well as ensuring a transparent process (Swann, 2002). To achieve this level of rigour, Swann (2002) argues there are four points that a design researcher will need to satisfy in applying an AR method:

1. Consider a societal issue: aiming to improve the practice and providing positive change to a social situation;
2. Ensure a cyclic and iterative but systematic approach as defined by Archer (1995) under the four points named previously: Plan, Act, Observe, Reflect;
3. Achieve a participative process in a collaborative way (based on the notions of co-design and co-production);
4. Ensure reflection 'on practice' not only 'in practice', which is a natural feature when designing.

There is a connection between the RtD/Design-led methodology adopted for this research and AR during which a spiral of cycles of ‘planning, acting, observing, and reflecting’ are undertaken in an iterative process. In relation to this definition of AR given by Swann (2002), the methodology adopted for this research draws from AR since it:

- Aims to provide positive change to a social situation
- Is cyclic and iterative
- Reflects *in* practice as a designer (i.e. to design an outcome – the exergame)
- Reflects *on* practice as a design researcher (i.e. to generate knowledge)

However the methodology developed for this research differs from AR in two main ways:

- It does not look at improving the practice of the designer or design researcher (i.e. it does not aim to research *for* practice). For example, there does not seem to be any framework in Design advising what would be the best technique(s) to apply in a given situation yet this research did not try to generate any. There exists a set of Design research techniques that might be recommended according to the result expected however it is up to the design researcher to decide what technique(s) is best to apply at any given stage. However, a reflection *in* and *on* practice was conducted to improve the quality or originality of the outcome but it remained mainly tacit throughout the process.
- It is not participative in a collaborative way. Future end-users are involved in the design development however they do not drive the overall project (i.e. they are involved at specific stages in the research only). Furthermore the nature of their involvement is not (always) based onto ‘co-design’.

### **3.3.2 Designer & Researcher in this Research**

On one hand it is recognised that the researcher should be the same person as the designer (Sanders & Stappers, 2008; Lee, 2008) since there is a need to “*have a comprehensive knowledge of the primary sources*” (Archer 1995, p8) to have a better

understanding of the users and of the (tacit) knowledge that were gained on field. On the other hand Dalsgaard & Halskov (2012) suggest that designers often wear two hats at different stages in the process: the designer hat and the researcher hat. This dual role adds a level of complexity in terms of showing rigour in the research process, especially in a multi-disciplinary context, since the knowledge is more difficult to externalise and less obvious. This ambiguity comes from wearing this ‘double hat’:

- As a designer who must be rigorous when designing (i.e. who is looking for creative stimuli and who reflects ‘in’ practice to improve the quality of the outcome, as described in 2.8.5) – this notion of ‘rigour’ in this case relates to the Picasso example who conducts a form of exploration to create an original outcome yet this remains internal to the artist (i.e. tacit);
- As a researcher who uses Design practice to research (i.e. who must be systematic during the exploration process to make it more transparent and to produce knowledge that is accessible to other researchers, as defined by Archer (1995) and described in 3.2.3).

Even though wearing the ‘double hat’ of designing and researching might bring challenges, it seems important that the person who researches also designs since there is a better general understanding of the primary sources, for instance the tacit knowledge. The designer and the researcher are the same person in this research and will hence be referred as the ‘designer/researcher’.

### **3.3.3 The Process**

As outlined in 2.8.2, the Design process applies different modes of thinking (divergent and convergent) at different stages to create and refine a ‘thing’, which is most often a prototype(s) that is tested in context (i.e. with (end)-users in an iterative process). Since a goal of this research is to create and refine a game, the process adopted for this research consists of alternating between User-Centred Enquiries and Designer/Researcher Enquiries.

- User-Centred Enquiries

The goal of user-centred approaches is about understanding the user(s) and translating that insight into principles and prescriptions to use and focus on exploring possibilities to ensure meeting the needs of the users (Sanders, 2002). Matheson et al. (2013) advise the development of initial solutions that are approached with empathy, creativity and rationality to fit the individual needs into suitable contexts. Furthermore, following Sanders' (2002) point (presented in 2.8.2) that 'saying, doing, and making' reveal different types of knowledge, this research adopted a mix of activities for use within workshops driven by the results expected. In addition, future end-users were recruited at key stages in the design development process to ensure the enquiry was user informed. Even though the nature of participation evolved across the research, enquiries involving future end-users will be referred to in this research as user-centred enquiries (UCEs).

- Designer/Researcher Enquiries

The designer/researcher enquiries (DREs) are a way to develop understanding and knowledge that is tested through the user-centred enquiries, which further develops the designer/researcher's understanding. DREs are a way for the designer/researcher to analyse the UCE's data (i.e. reflect 'on' practice) to develop assumption(s) through (re)-formulating a response (e.g. prototype). DREs are therefore a way for the designer/researcher to formulate an assumption/idea to test, based upon a combination of the theoretical knowledge gained when reviewing the literature ('true'), the practical knowledge gathered on the field ('real'), and the vision of the designer ('what if').

In these enquiries the designer/researcher was generally working alone, although inputs from others were sometimes required such as other designers or other users (e.g. families, friends, youngsters) that are not necessarily of the same age as the end-users for which the design of the game is intended (11-12 years old) but that help visualising what seems to work or not when play testing it.

- An Iterative Process of Designing to Generate Knowledge

*To distinguish RtD from design practice, [...] it should be conducted within a research program that focuses the inquiry across several cases so that the results work to support or challenge commonly held assumptions"* (Zimmerman et al. 2010, p311). For Zimmerman et al., it is therefore through iteration of cases that knowledge can be generated. The knowledge created through testing the design in context is applied to the next phase of design development to refine it, improve it and test it again in an iterative process to keep developing understanding and knowledge (here to increase engagement of the game). Yet the development of the game(s) in this project is part of the research process since each cycle of iteration is a way to develop the design of a game(s). Design and knowledge are interwoven since the testing of the game(s) in UCEs generates knowledge, which is then applied in the design of the game(s) (when creating new prototypes in DREs). The game(s) development is used to better understand game play (develop knowledge) and its evolving design is the practical application of that understanding. As Koskinen et al. (2011) explained, this research adopted the principle of "thinking to build" and "building to think".

Figure 11 below illustrates this and how the iterative process of designing, testing in context, and developing to test again can generate knowledge. In this diagram, we can see how:

- An outcome can be designed (i.e. created, developed and refined) – and ultimately implemented through iterative process – and what are the various elements that might guide or inform its design (e.g. participant's comment, literature);
- Knowledge comes from a combination of the emergence of themes/assumptions that are repeated from one UCE to another with how these themes/assumptions relate to the existing body of literature.

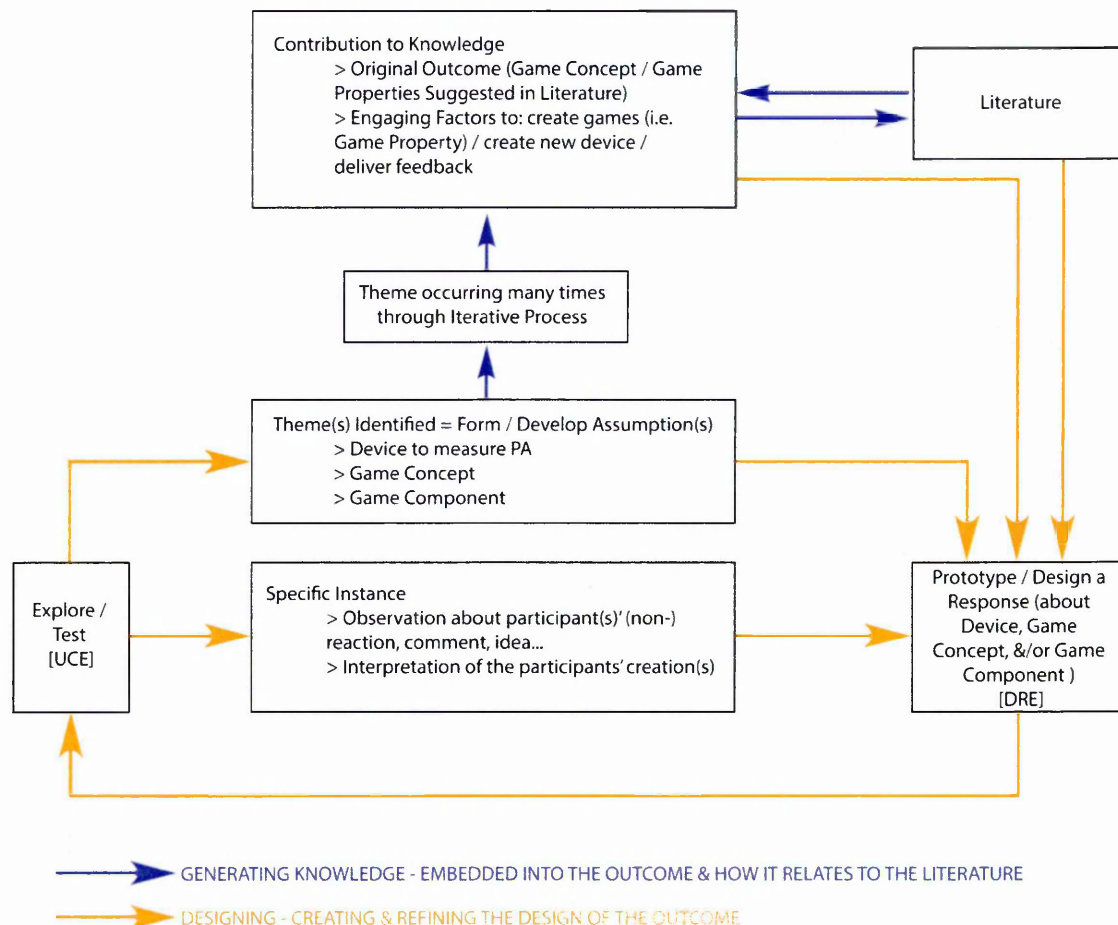


Figure 11 – Iterative cycles to design and potentially generate knowledge

Each UCE is a way to test the engagement of the game(s). This generates data that can be used to enhance understanding and therefore knowledge (as a researcher), as well as refining the design of the game(s) (as a designer). To further develop the game, the designer/researcher also draws on what is found in the literature during designer/researcher enquiries. Therefore the design of the game is guided by:

- A practice-based understanding of the various activities led with the users or with other designers (i.e. informal development tests, chats in corridor...);
- An evidence-based understanding of the literature that is analysed, compared, and related to the practice;

It is only by going through the iterative cycles, which combine practice-based evaluations and evidence from the extant literature, that knowledge is created. Comparing the results, analysing data, highlighting the differences or similarities that were incorporated or withdrawn from one design response to another (e.g. from one

prototype to be tested again in context) is a way to establish what works and what does not. The reaction(s) to each series of prototype(s) establishes an understanding of what works or not and hence building knowledge through iterative tests (i.e. what is repeated throughout the enquiries suggests it is engaging). Going through iterative cycles is even more important in this research since a main characteristic in Design is that it approaches things holistically. Identifying precisely what factors cause the participants' engagement can be challenging, especially since this might be explained by a combination of factors/themes. This is why it is important in Design to capture data from multiple sources to make sense of the data as a whole, even though the design development process sometimes relied on specific instances (e.g. participant's comment, reaction or non-reaction).

The methodology developed for this research project aimed to create, develop, and refine the design of a game(s) in an iterative process (under the 'designer hat'). Designing, making, testing and modifying iteratively allowed development of the game. However a research methodology must also create knowledge ('under the researcher hat') and meet the two other criteria presented by Archer (1995) in 3.2.3 (i.e. systematic and communicable as well as knowledge directed). Therefore, the evidence gathered along the way was collected systematically yet it was used to inform the design development of the game. It is only at the end of the project that a review of the design history (i.e. reflection 'on' practice) was undertaken to identify common themes and recurring features from the data. The process adopted for this methodology therefore intends to create an outcome that is real, like Picasso, yet unlike him, the understanding and tacit knowledge gained along the way is made explicit, through a reflective narrative. To do so, the data was spread across two maps (as shown in Figure 12): one about the design development (right side) and the other about knowledge development (left side). These maps consisted of pulling out the key events that informed the design development of the game (under the 'designer' hat) and the themes recurrent across all enquiries (under the 'researcher hat').



Figure 12 – The two maps developed at the end of the research

It is when similar/comparative themes emerged in several UCEs that it was possible to be more confident about the theme (e.g. an engaging factor or game property). Instances where engagement was promoted (i.e. aspects/games that engaged participants in undertaking PA) or not promoted, were also analysed and compared with the goal of defining what aspect(s) might be an obstacle or a source of engagement. We could say that finding out what might be the commonalities across the various experiences that showed success in promoting engagement is a ‘Designerly way’ to ‘isolate variables’. All this process of reflecting *on* practice is explained in more details in chapter IV (‘Research Process’): 4.8.2 presents the creation of the visual maps, 4.8.3 describes the method used to analyse the data, and 4.8.4 presents the method created to deal with the data (i.e. to analyse, regroup, and report it).

To summarize, each UCE analysis derived themes (i.e. game properties) that were used in the following ways:

1. To generate assumptions about game properties that might promote engagement;
2. To test/confirm assumptions about how engaging are the game properties;
3. To find ways about how to increase the engagement of these game properties.

### 3.3.4 A Mixed-Method Approach

Analysing (non-) interactions from the end-users with the 'thing'/prototype is what allows creating and developing understanding and knowledge. It is therefore by engaging and reflecting in design activities with the future end-users that knowledge is built. Consequently, capturing these interactions or non-interactions is crucial. To help make sense of these interactions, diversifying the way of capturing them, as shown in Figure 13, is a good way to strengthen this understanding.

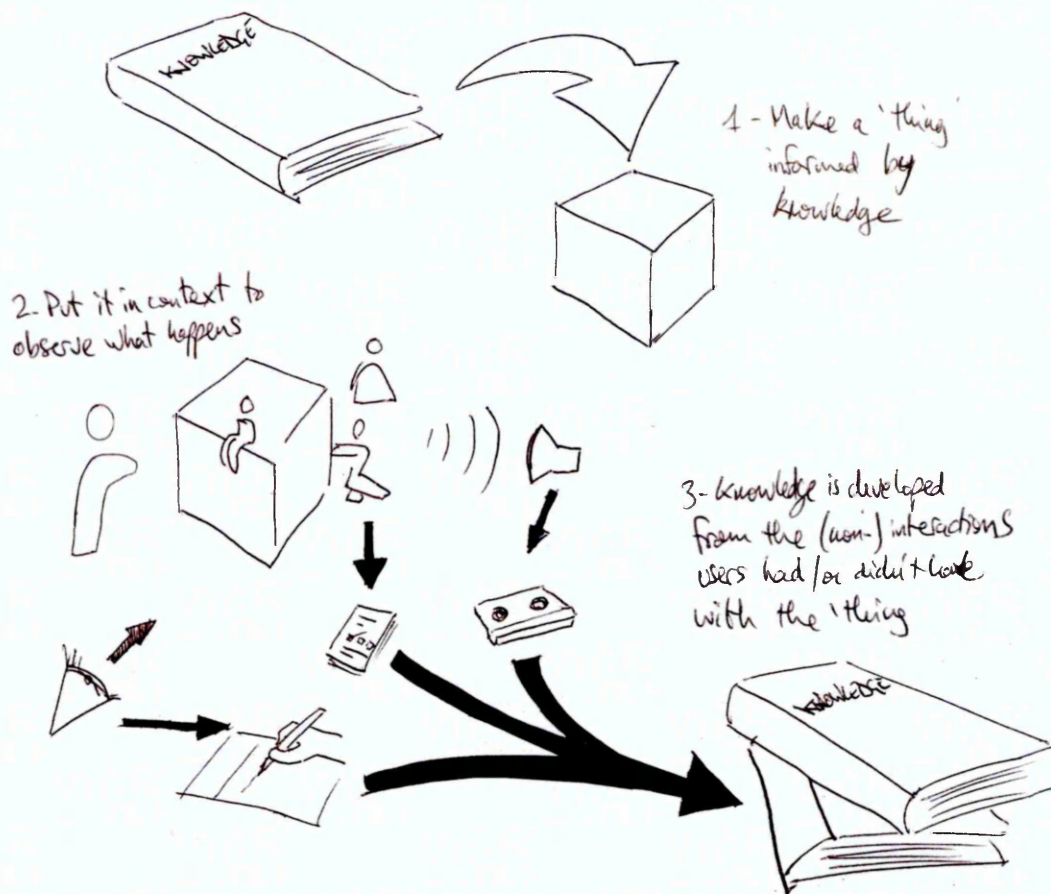


Figure 13 – Capturing users' interactions with a 'thing' to produce knowledge

Obtaining information by different means can highlight confirmations or conflicts in these interactions and this is why a mixed-method approach was chosen for this research: as a way to triangulate the data. This is what Cross defines as a '*designerly way of knowing, thinking and acting*' (Cross 2007, p55) as already mentioned in 2.8.4. Designing and making hence becomes a way for designers to synthesise their vision and knowledge gained, and artefacts become the designers' language. They are tools

or vehicles to communicate with all the stakeholders involved in the research, whether they are the users or the rest of the (multi)disciplinary team.

- Being Systematic in this Research

In relation to Archer (1995)'s definition of research (3.2.3), being systematic is what allows communicating the research in a way that is opened to criticism since the knowledge as well as the overall process that led to the creation of knowledge is made visible.

To be systematic, a record of the intentions, observations, and conclusions were created respectively before, during, and after each enquiry. Other methods for capturing the data were also used and were similar across all UCEs. Here is a summary of the methods used for capturing data during each UCE:

- A description of the aims of the enquiry as well as a description of what was expected by the end of it. This type of description was also done for each workshop within an enquiry;
- After each workshop audio records were transcribed by the designer/researcher who could therefore come back to these at any time;
- Observations done by the designer/researcher were also recorded. Observations covered different aspects such as how engaging was a technique used, what was the participant(s)' reaction and, assumptions about why this was the case;
- Questionnaires were translated into quantitative data when possible or into a summary description for each participant to have a general overview and enable comparison between participants;
- A record of the participant's creation was photographed/scanned and a description of their meaning was created, using sometimes the transcription of the audio record to further refine it;

A word document was created for each of the above points to avoid confusion between what falls under the interpretation of the designer/researcher (subjective) against the facts (objective).

- Design Research Techniques in this Research

A design research technique is described in this thesis as a general term to speak about what some would refer to as methods. Since this term 'method' was found problematic within a multi-disciplinary context (i.e. it does not have the same signification according to one's discipline), it was preferred using 'design research techniques' instead, to avoid confusion among disciplines. The range of design research techniques chosen to analyse data were specific to the design development stage of the game(s) to create. More information about the type of techniques used and at what stage is presented in the following chapter IV that describes the research process.

The design research techniques were selected across this Design-led research to provide the most efficient results for the given goal, but also to obtain the best engagement possible when leading user-centred enquiries to ensure the participants being pro-active. Since this research looks at creating games, some of the research techniques and artefacts were inspired by the nature of the project and incorporated gaming attributes and components (e.g. bringing challenge, fun, team play, use of dice...). This influenced the degree of involvement of the participants in the activities.

### **3.3.5 Ethics Approval**

Ethical approval for this research was gained from the Faculty Research Ethics Committee (FREC). Consent and assent was gained prior to any data collection. A copy of the consent form(s) for each enquiry can be found in Appendix 4.

### **3.4 CONCLUSION**

This research project aims to create, develop and refine a game(s) using design practice as a method of enquiry. RtD is the underpinning research methodology which has the main goal of being 'real' (i.e. implementing the designed outcome into the real world). This design-led methodology is user-centred at different stages during the research to test and develop the game to see what works or not, which also allows developing understanding. It is only by going through an iterative process of designing, testing, and modifying again in an iterative process that knowledge is created. Therefore the designer in this project is the researcher, who combines the (tacit) knowledge gained through interacting with the end-users during UCEs with the literature found in DREs to further refine the development of the game. Even though this project aims at developing and refining a game(s), it must meet the criteria defined by Archer (1995) of being systematic when collecting data to generate knowledge that is transferrable. A mixed-method approach is therefore chosen to capture the UCEs' data, which is used to develop the design of the game(s) (under the designer hat) as well as to generate knowledge (under the researcher hat). All the data is collected systematically (i.e. a document for each medium capturing data as well as a log diary keeping track of all the objectives of every activity and enquiry done throughout the research is created) to ensure analysing the data honestly (i.e. by referring to the raw data rather than to an interpretation of it).

## ***Chapter IV- Research Process***

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This chapter presents the process used to create, develop and refine the design of the created game(s) as well as for generating knowledge. A general overview of the process of the design of the intervention is first introduced to get a sense of the purpose of each enquiry. A more detailed description of the process and of the techniques used along the duration of the research project with a justification of the choice of these techniques is subsequently presented.

### ***4.1 INTERVENTION PROCESS – ENQUIRIES OVERVIEW & AIMS***

#### ***4.1.1 An Overview of the Enquiries Conducted in this Research***

As presented in the previous chapter, the research consisted of alternating between designer/researcher enquiries (DREs) and user-centred enquiries (UCEs).

- Designer/Researcher Enquiry 1: a Theoretical Understanding

DRE1 aimed to gain theoretical understanding by undertaking a literature review (presented in Chapter II) in the domains of ‘Health Psychology & Behaviour Change’ and ‘Serious Games’ (which includes ‘Games for Health’ and ‘Exergames’).

- User-Centred Enquiry 1: Immersing through Practice

Based on these first theoretical insights, a practice based exploration was conducted (UCE1) to learn about the future end-users and explore possibilities to promote engagement and acceptability of the game(s) to create (i.e. to look for creative stimuli). To open up the space and diverge the thinking, participants were involved in a series of workshops to perform a range of (creative) activities as co-designers with a special emphasis into ‘Making’ to unravel tacit knowledge (Sanders, 2002). However it was important at the end of this enquiry to find out if and which of the ideas generated during the workshops were approved by others. Therefore all the ideas

generated by the designer/researcher and by the participants were grouped in categories of games and gathered onto posters that were presented to a wider group of pupils from Year 7, who had to give feedback.

- Designer/Researcher Enquiry 2: Brainstorming

After having developed insights about how to promote engagement among these people, DRE2 looked at developing concepts for a game promoting PA on a long term period. The analysis that led to the creation of the posters in the previous enquiry was then related to the literature and combined with the rest of the qualitative data (e.g. observations or original feedback or comment from participants) to look for nuggets for inspiration, to trigger creativity for brainstorming ideas.

This led to the creation of a framework used to brainstorm ideas of exergames, which resulted into the development of a game concept (V1), 'Boost Up!', a game composed of two sub-games. Following this brainstorming activity, early prototypes were built and tested iteratively with the supervisory team, colleagues and potential end-users.

- User-Centred Enquiry 2: Prototyping

UCE2 aimed at clarifying what the V1 game concept might be and what the game might look like to ensure engagement, as well as testing a first 'concrete prototype' version of 'Boost Up!' (V2). A series of workshops taking the shape of 'micro-experiments' was conducted to find out first how engaging 'Boost Up!' V1 might be (e.g. about the concept, the types of games chosen, the duration of the games, the graphics...), to then respond to it by building a first 'integration prototype' (Houde & Hill, 1997) to test in the last workshop. This research approach of conducting micro-experiments was inspired by Houde & Hill's (1997) description of prototyping and Hansen's (2006) discussion of strings of experiments.

- Designer/Researcher Enquiry 3: Iterative Prototyping

Due to time constraints, only certain features were incorporated into the integration prototype (V2) tested in the last workshop of the previous enquiry (UCE2). Based on the findings and feedback captured previously, 'Boost Up!' game mechanic, play, rules

as well as visuals/graphics were revisited in DRE3. A new concept was developed (V3) and were turned into prototypes to test, modify accordingly, and test again iteratively with a wide range of stakeholders of diverse age and professions (different teams of designers, groups of friends and a family). By the end of DRE3, another integration prototype of 'Boost Up!' was built (V4) and needed to be tested.

- User-Centred Enquiry 3: Evaluating

The V4 prototype was hence evaluated in UCE3, which took the shape of a pilot study, to explore the usability as well as the efficacy of 'Boost Up!' to promote PA in young people. To do so, a series of workshops was conducted during which a baseline about each participant's levels of PA was set in order to award the currency to play 'Boost Up!' V4.

This was possible through adopting a mixed-method approach which used quantitative measures to find out whether 'Boost Up!' might increase PA and qualitative data to explain why and how this might be improved.

- Designer/Researcher Enquiry 4: Extracting Knowledge

A final enquiry (DRE4) took place to construct a 'Reflective Narrative' based on a review of the design history of the game. The purpose of this activity was to pull out the various elements and events that informed the design development of the game throughout the overall process (e.g. participants' creation or feedback about aspects of game, attribute of materials) and to look for commonalities about what seemed to be a source of engagement among the people that took part in the research.

#### ***4.1.2 A Summary of the Research Enquiries***

To help understanding how this alternation of enquiries took place, Figure 14 gives an overview of the process, with a brief presentation of the aims, methods used and type of stakeholders involved for each enquiry.

## Designing to Generate Knowledge - Combining Theory, Practice, & the Designer/Researcher's Vision



Figure 14 – A summary of the aims, methods and stakeholders involved at all stages

The user-centred activities took place in schools with Year 7 and were part of the physical education lessons for two main reasons: to ensure attendance rate from the selected participants and to assist the researcher, who was not expert in working with 11-12 years old adolescents. A more detailed account of all the stakeholders involved at all stages in the research is given in Appendix 8.

The rest of this chapter gives a detailed description of the design research process and techniques adopted. It also discusses the rationale behind the choice of these techniques which were sometimes adapted in the particular context to ensure that the overall goals were achieved.

## **4.2 DESIGNER/RESEARCHER ENQUIRY 1: LITERATURE REVIEW**

### **4.2.1 Aim & Objectives**

DRE1 consisted of undertaking the literature review reported in chapter II. The review enabled an understanding to develop of the various factors that may engage individuals or be an obstacle to behaviour change. This literature review was not trying to generate trends or identify what theory might be best suited to promote PA (even though this was taken in consideration). A broad scope review was therefore chosen since the aim was to develop an understanding of the various elements that might promote behaviour change or not and to also find out what was missing among exergames (promote MVPA + repeated play over long term).

### **4.2.2 Who is Involved?**

Only the supervisory team was involved as external advisors for the designer/researcher. The team pointed towards important readings in each of their respective disciplines (i.e. Health and Design) and helped to refine the review done in the area of Games/Serious Games.

### **4.3 USER-CENTRED ENQUIRY 1: EXPLORATORY WORK**

#### **4.3.1 Aim & Objectives**

The start of the design process is really "fuzzy" (Sanders & Stappers, 2008). It is a discovery stage where the understanding of users and contexts, alongside materials, technologies and other characteristics of the design outcome(s) are explored to answer the need and expectations of the future end-users. To bridge the generational gap between the designer/researcher and the end-users, the objectives for this enquiry were to:

1. Understand the lifestyle, tastes and motivations of the end users in general, but also related to games/gaming and PA;
2. Explore the possibilities for a game(s) to fit into the end-users' everyday life (idea of continuous play);
3. Find out how attractive and engaging the Two-Stage concept could be for the participants.

This enquiry was highly exploratory and participative, emphasising the notions of co-design and co-creation, and during which design tools and artefacts were used to provoke, criticise, and arouse interest or imagination. Presenting already formed ideas to the participants would have restricted the scope for creation since they would have been guided into a specific direction. Participants instead were involved in creative activities to let their imagination go wild and to develop their own ideas.

#### **4.3.2 General Structure**

The school chosen for UCE1 was from a rather privileged background to cope with the difficulties faced by a novice researcher wanting to optimise the participation and results. The method created for this project was an eight weeks process that can be split into three phases: A, B, C (Figure 15). This enquiry was mainly decided based upon practicality since it had to fit within the school's timetable: Pre-activities ('phase A') were undertaken before half-term holiday; a 'Fun day' was planned on the last day of the term/year ('phase C') but data from the workshops ('phase B') had to be analysed

for that event – two weeks were judged sufficient to do so. This way, a total of four workshops could be conducted, which also seemed to give enough time to develop a better understanding of these people. Yet the designer/researcher did not know what type of things would elicit information from 10-11 years old children. Therefore as shown in Figure 15, ‘phase A’ consisted of developing an initial perception of the pupil’s tastes, attitudes, norm and hobbies through questionnaires; ‘phase B’ aimed to stimulate the imagination of both the designer/researcher and the participants through a series of four workshops; and ‘phase C’ to get feedback from other pupils about the ideas generated in ‘phase B’.

#### 4.3.3 Phase ‘A’

The first step consisted of introducing the project to two classes and distributing questionnaires (that can be found in Appendix 6.A). The questionnaire explored the pupils’ tastes about PA and games and was created in a fun and attractive way (i.e. with visuals thought engaging). Based on the quality and originality of the answers, participants would be recruited. However across both groups, only ten boys and three girls filled the questionnaire and completed the consent forms. Two of these boys did not want to miss their PE lessons therefore a third group was created during lunch time. The morning group was made of three boys and three girls, the lunch groups of two boys, and the afternoon one of five boys.

The second step assigned participants a ‘Journalist’ activity to do during their holiday. Each participant was given a pack containing a disposable camera as well as papers and pencils to illustrate a series of 12 words (e.g. ‘Mysterious’, ‘Logo’, ‘Fail’, ‘Awesome’) by taking pictures or drawing to represent any given words. This activity was inspired by the use of cultural probes developed by Gaver et al. (2004) however instead of using the pictures as a catalyst to inform the designer/researcher activity, these were used as a basis to provoke focus group discussions (Workshop 3) which was then used as a basis to involve participants in a creative activity (Workshop 4).

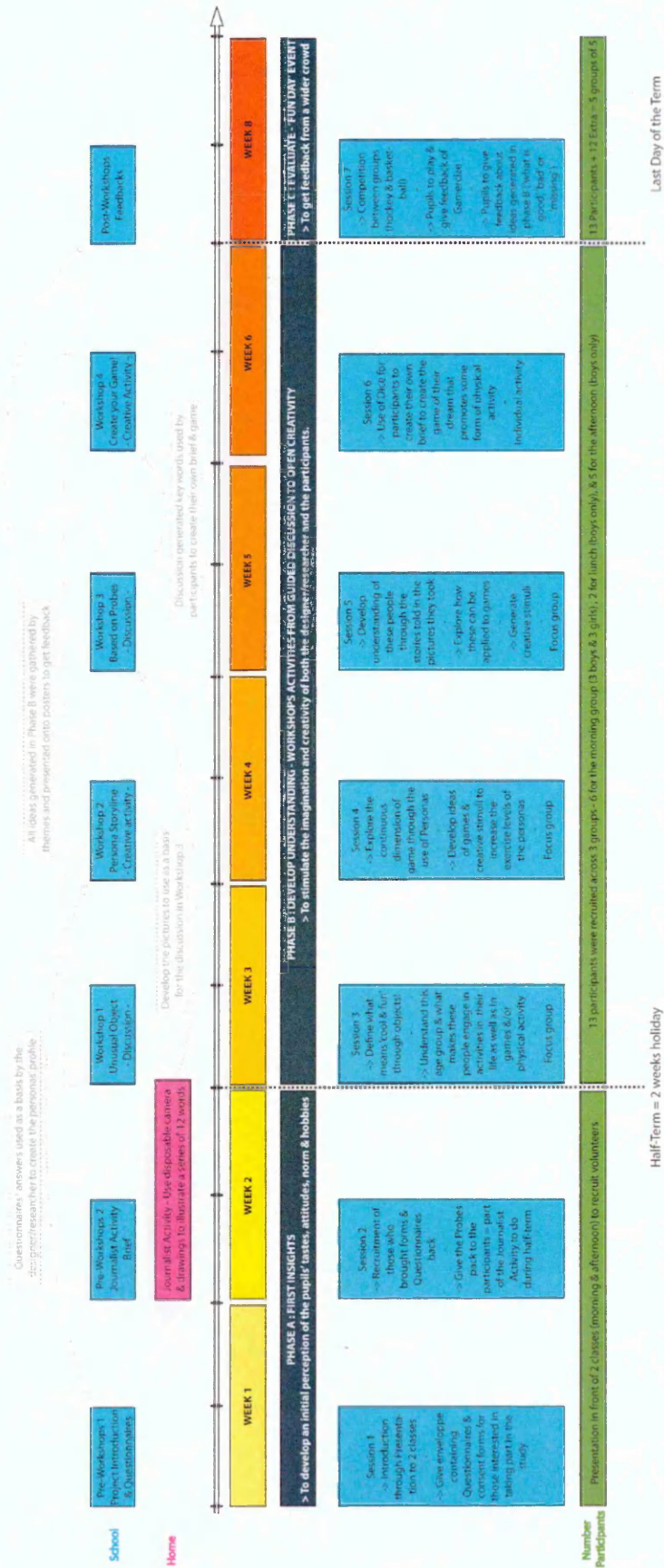


Figure 15 – UCE1 Plan of Intervention

#### 4.3.4 Phase 'B'

Workshop 1 was a way to introduce each other and to define what 'cool & fun' means for these participants within a focus group discussion. Participants were asked to bring their favourite object to illustrate their definition of 'cool & fun'. The researcher also brought original objects (e.g. 'spy glasses' with mirrors on the side to see behind, an old version of the Game boy, a 3D kit, one of the first versions of iPod...).

Workshop 2 consisted of exploring the continuous dimension of gaming through the use of personas that were created by the designer/researcher. Inspired by the three characteristics given in Brandt (2006) and based upon the answers gathered in the questionnaires (completed in 'Phase A'), each persona had different body size, gender, tastes and attitudes about PA and games. Participants had to create a 'day in the life' of these personas and improve their PA levels according to their profile.

Workshop 3 was based on the pictures taken by the participants during their holiday and which had been developed for this workshop. To understand better why a particular picture was taken for each word, participants explained the story behind them. This relates to Sanders (2002) who posits that users producing artefacts can unravel tacit knowledge yet Sanders recommends that the stories behind the artefacts should be told by their creator(s). This activity generated a range of words that were ranked by the participants from the least to the most important. It was also discussed whether these words should be somehow represented in games and how they might be manifested (e.g. 'Suspense'; what is good/bad about suspense? How do you create suspense in games?).

The most highly ranked words and those identified as interesting or potentially creative in the previous workshops were then reported onto four dice created by the designer/researcher and presented to the participants in Workshop 4.

In the last Workshop 4, each participant threw all the dice and wrote the words chosen onto a sheet given to them to make their own brief (Figure 16) to create the game of their dream, the only constraint was that it had to promote a form of PA. This last

workshop was a way to narrow down the uncertainty created through the probes and already channelled in Workshop 3.



Figure 16 – Words of the dice thrown by one participant reported on the brief sheet

#### 4.3.5 Phase 'C'

The Fun day event was about developing a better understanding of the future end-users by widening the number of people, sharing visions, perspectives, and reflections. It consisted of getting feedback about the ideas generated across all the groups throughout UCE1 as well as playing and discussing the Gamercize machines (as presented in 2.6.1). All the ideas generated by the participants in 'phase B' as well as some generated with or by the designer/researcher up till then (e.g. 'Gener-G') were gathered by genre and presented onto posters: 'Orienteering' games, 'Two-Stage' games, 'Existing Consoles', 'New Consoles', and 'Augmented Reality' games. These posters were presented to the rest of Year 7 to get feedback from pupils who were not familiar with the project. Therefore 25 pupils that included the 13 participants were

recruited for 'phase C'. The Gamercize equipment was played using an Xbox, and an extra Nintendo Wii with Wii Fit was also available.

To analyse the data generated in UCE1, a 'Designerly broad brush thematic analysis' was conducted between 'phase B' and 'phase C', which involved a thematic grouping of genres of games. To do so, this 'Designerly broad brush thematic analysis' drew onto a method similar as the one described by Braun & Clarke (2006) since it mixed deductive and inductive approaches: most of the posters presented groupings of ideas generated by the participants using a bottom-up approach but some posters also presented categories that were already identified by the designer/researcher such as the 'Two-Stage' concept (i.e. top-down). Getting feedback about the identified groups was a way to find out if and which of these genres and ideas would be approved by other end-users of the same age (i.e. to develop assumptions for promoting engagement).

#### **4.3.6 Who is Involved?**

The presentation in 'phase A' was made to two classes although only thirteen participants came back for the journalist activity in that same phase. They are the same thirteen participants that took part in 'phase B'. Added to these thirteen, twelve other pupils from the two classes were selected for the Fun day event ('phase C').

### **4.4 DESIGNER/RESEARCHER ENQUIRY 2: A FRAMEWORK FOR BRAINSTORMING**

#### **4.4.1 Aim**

Having gained insights and understanding about the future end-users by combining the theory (DRE1) and the practice (UCE1), DRE2 was conducted away from the future end-users to apply divergent thinking to 'open up' the research (as described in 2.8.2) through brainstorming ideas of exergame(s). DRE2's aim was to define a game or a range of games that will be suitably engaging to promote repeated play – and therefore repeated PA – on a daily basis and over a long period of time. In order to

give rigour and improve the quality of the results generated during the brainstorming activity, a framework was created to organise the ideas.

#### **4.4.2 Defining a Framework**

The framework was created based on the entire data of UCE1 (i.e. 'phase B' and 'C') and followed the same method, mixing inductive and deductive analysis. The 'Designerly broad brush thematic analysis' defined engaging genres of games (i.e. posters presented in 'phase C') however this analysis aimed to identify a list of engaging game concept, types and properties. To do so, a 'data trawling' analysis was conducted. This analysis consisted of trawling through the data collected that might be useful to provide inspiration and generate ideas of games. This included a combination of factors that were found engaging at different stages in 'phase B' and phase C' of UCE1 with a selection of specifics that seemed to be particularly interesting and promising in relation to the aim of the research (to create exergames(s) that promote repeated play over the long term). The specifics correspond to a selection of comment(s) or idea(s) of games created by the participants from which notions were abstracted at a more general level and summarised into a keyword(s). The list of keywords that resulted from this activity was used to constitute the framework. However this framework was done quickly, by the designer/researcher only, and aimed at looking for inspiration for designing games and not for generative genres. This is where this approach differs from Braun & Clarke (2006) since the purpose of this 'data trawling' did not explore inter-rater reliability (i.e. did not aim to generate a general truth about what game properties are engaging to these people). This analysis process was instead very subjective, as a designer, and aimed to provide inspiration and increase the quality and originality of the games when brainstorming ideas in DRE2. Trying to look for a general truth would have hidden specificities of the data, which are what trigger imagination and creativity in Design.

The framework was therefore created with the goal of generating ideas of exergames that would promote repeated play (and PA) over a long period of time. To do so, the framework was based on:

- A selection of genres of games identified as engaging (based onto the ‘Designerly broad brush thematic analysis’ described in 4.3.5). ‘Two-Stage’ and/or ‘Orienteering’ games received positive support (some participants even created their own game in Workshop 4 based on these two genres) and they were non-digital (i.e. without electronic components which can be costly, time consuming and distracting when assessing the core mechanics of a game – Salen & Zimmerman, 2004). These two genres were therefore selected.
- The overall data in UCE1, identified as initiating and sustaining engagement, includes:
  - A list of Design Principles, corresponding to the game properties the exergame(s) could illustrate to potentially increase engagement (i.e. Personalised, Multi-Stage, Evolve/Change, Multi-Context);
  - A list of types of games the exergame(s) could illustrate (i.e. Permutation, Double Path, Multi-Games (i.e. with Sub-Games), Strategy, Scale Up, Team Up);
  - A list of attractive games (e.g. TAG, Top Trumps, Star Wars, Kick the bucket, FIFA 11...).

#### ***4.4.3 The Concept for a Game ‘Boost Up!’***

Based on the framework, ideas for games were brainstormed. The ones that seemed to promote the best engagement in terms of play and PA were selected and developed forwards. Early prototypes of some of these ideas were made and play tested with design colleagues. After a few iterations of play testing and designing (i.e. adding ideas/aspects, combining ideas, features...) the first version of a game concept ‘Boost Up!’ (V1) was created. Composed of a series of games (a card game, a board game, and an ‘avatar’/character to create), ‘Boost Up!’ explores the continuous dimension of play through a concept that is Two-Stage based and is linear.

Even though ‘Boost Up!’ remained a concept at this stage, the games were developed to a certain degree of play in order to evaluate the core mechanics with a set of ‘workable rules’, which are rules that are developed enough to be able to play the

games although not necessarily fully resolved (Salen & Zimmerman, 2004). Salen & Zimmerman (2004) actually advise making cheap prototypes to test iteratively as early as possible since rough versions promote interactions that allow the definition of the fundamental rules of a game as well as its core mechanics. However it was still unknown whether the concept and the games being created were attractive or engaging to the target audience.

#### ***4.4.4 Who is Involved?***

The outcomes of play testing and feedback in DRE2 were reviewed with design colleagues and the supervisory team who were used as ‘participants’. The supervisory team, composed of researchers from both design and health backgrounds, helped in advising on the exergame concept (at a general level) and the design colleagues were involved in practical tests. For instance, images of the card game being tested with colleagues were shown to the supervisory team, who described the play of the game as very sedentary. This was mainly due to the concept of the game (Stage 1 to do PA, Stage 2 to play) where only stage 2 was reported. The subsequent research explored how to blur those two stages (i.e. bring ‘PA into gaming’ and ‘gaming into PA’).

#### ***4.4.5 Remaining Questions***

Before building a first fully working prototype of ‘Boost Up!’, there was a need to explore:

- If V1 was engaging over the long term and how to increase its engagement (e.g. is the linear concept of playing one game after another engaging?);
- The engagement of the games mechanisms (e.g. are card and board games engaging?);
- Aesthetic qualities of the graphical presentation;
- The type of device for measuring PA;
- How to bring ‘PA into gaming’ and ‘gaming into PA’.

## **4.5 USER-CENTRED ENQUIRY 2: PROTOTYPING TO CLARIFY 'BOOST UP!'**

### **4.5.1 The Challenge**

The main challenge at this stage was to communicate the concept to the participants recruited for this UCE2 in an engaging manner, without spending many resources (time and money) on developing high tech prototypes, as suggested by Salen & Zimmerman (2004). Houde & Hill (1997) explain prototypes can be very simple with a low degree of fidelity (e.g. using a match box to represent a mouse), or much more complex with increasing amounts of details. Choosing low fidelity or high fidelity prototyping depends on the audience and on the way the designer/researcher will use the prototype to explore the desired aspect(s). When prototyping, Houde & Hill (1997) suggest there are three main aspects one or more prototypes can cover: the 'role' (function of an artefact in the users' life), the 'look and feel' (sensory experience of using an artefact), and the 'implementation' (techniques and components). In the context of this thesis, 'role' and 'implementation' relate to the core mechanics and in contrast, the 'look and feel' to the 'skin' of the game. Houde & Hill's idea is that at the early stages of a project, separate prototypes are built in the aim of exploring each of these aspects independently. After a certain number of iterations, an 'integration' prototype (Houde & Hill, 1997) is built as a way to synthesise those three prototypes into one. Yet building prototypes to explore throughout UCE2 each of the three aspects of the game individually would have been of low resolution and therefore not engaging for the participants.

### **4.5.2 Aim & Objectives**

The objectives of UCE2 were to:

1. Explore how engaging is V1 and how to make it more engaging;
2. Explore the three aspects ('role', 'implementation' and 'look and feel') named by Houde & Hill (1997) in order to;
3. Turn the conceptual game (V1) into a first concrete prototype to evaluate (V2).

The V2 prototype aimed at being a first ‘integration prototype’ with a reasonable level of precision and fidelity. Therefore this first prototype would be a concrete representation of the design idea (V1) yet used as a ‘*learning vehicle*’ (Floyd, 1984 – p3) to evaluate how engaging it can be.

#### 4.5.3 Who is Involved?

UCE2 was led with a selection of participants that were recruited in another school in Sheffield to diversify the sample. Still taking part during the PE lessons to assure attendance, the workshops took place for one hour each week, for five weeks.

Since the sample from UCE1 did not represent genders equally (2 girls out of 13 participants), participants for this second enquiry were not recruited on a voluntary basis. Instead, a group of eight participants (4 boys and 4 girls) were selected upon their good behaviour at school, which also helped to ensure cooperation. The selection gathered pupils with different body sizes although this was not a criterion of selection.

#### 4.5.4 The Plan

To gather together a body of information relevant for designing the game to test, participants engaged mainly in ‘Saying’ in focus group discussions, but also in ‘Making’ (i.e. creating their own game) and ‘Doing’ (i.e. playing existing games). These activities were part of a series of micro-experiments, which consisted of using existing games that related to ‘Boost Up!’ and that had high levels of precision (since already available on the market) with engaging graphics, game mechanics, and of different types (i.e. within card games, there are simple vs. complex games, educational, fast...). Therefore these existing games were used as prompts, stimulus, to investigate the three aspects named by Houde & Hill about each component of ‘Boost Up!’ (around card & board games, and PA). The experiments in this context are seen as a range of activities (i.e. creative, focus group discussion, play testing) led to develop the game, not to find similarities in the results.

As shown in Figure 17, the four first workshops implemented the micro-experiments evaluating a range of existing games. Results of these micro-experiments (i.e. notes about observations, summary of questionnaires, audio transcripts) were recorded and

## User-Centred Enquiry 2 - From the concept of a game (V1) to an 'Integration Prototype' (V2)

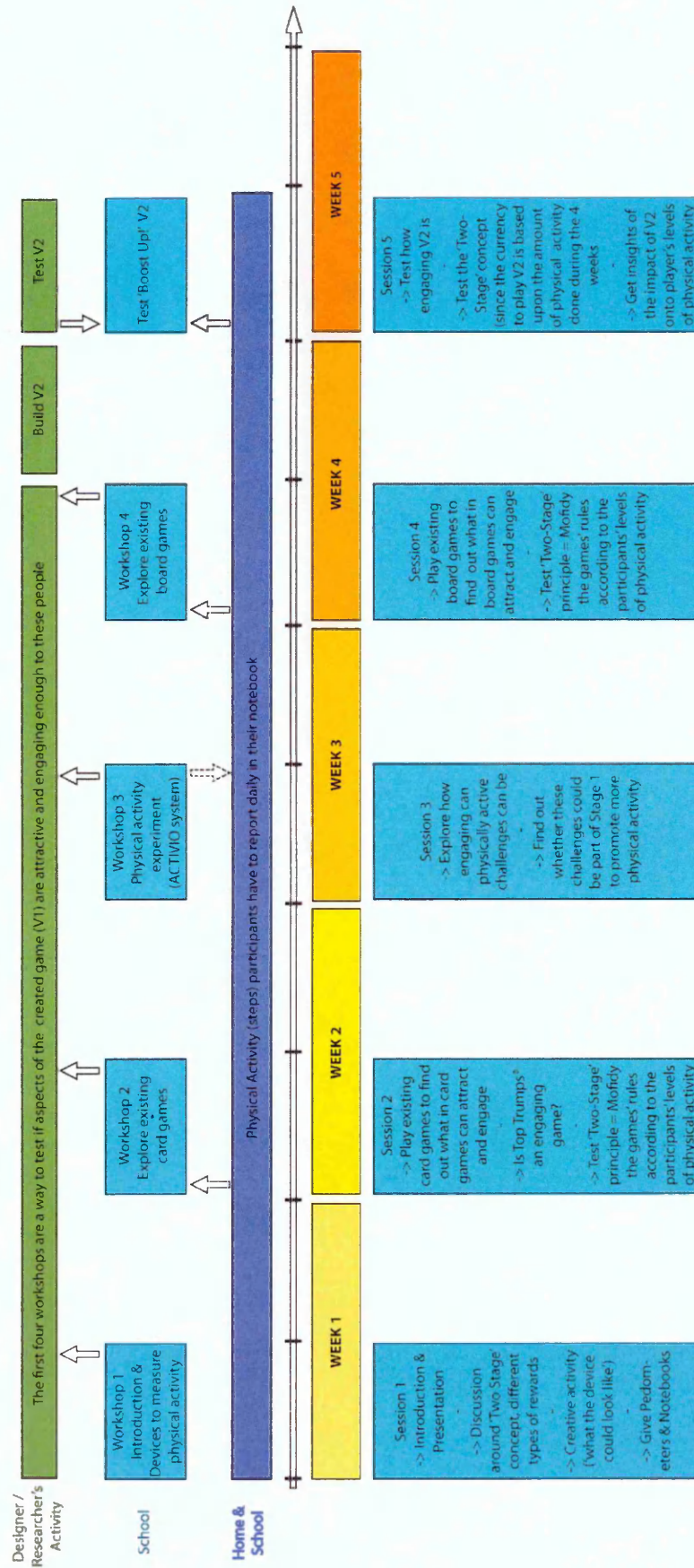


Figure 17 – The plan for UCE2

quickly compiled before the last Workshop 5 for which the V2 integration prototype of 'Boost Up!' was made.

- A Plan Centred Around the Use of Pedometers

At the end of Workshop 1 a pack containing a notebook as well as a simple and cheap pedometer (Figure 18) was given to the participants who had to wear it every day by



Figure 18 – The pack given in W1: a pedometer and a notebook

clipping it on their trouser/top. The pedometer had only one black button used to reset the number of steps this is why participants were given a notebook to report their daily number of steps before resetting the pedometer.

The purpose of giving pedometers in Workshop 1 was twofold: get feedback around their use (including acceptability among this age group) and testing the Two-Stage principle: 'the more PA done, the more rewards when playing games'. As shown in Figure 17, the idea was to test this principle by modifying the rules of existing card games (Workshop 2) and board games (Workshop 4) according to the participants' self-reported levels of PA done throughout the week (e.g. having more chance cards, an extra throw of the dice).

However participants did not engage with the pedometers and did not report their PA levels, which affected the activities done in Workshop 2, 4, and also in Workshop 5. The following section introduces the new plan that was modified according to this setback and that is illustrated in Figure 19.

## User-Centred Enquiry 2 - From the concept of a game (V1) to an 'Integration Prototype' (V2) - Modified Plan

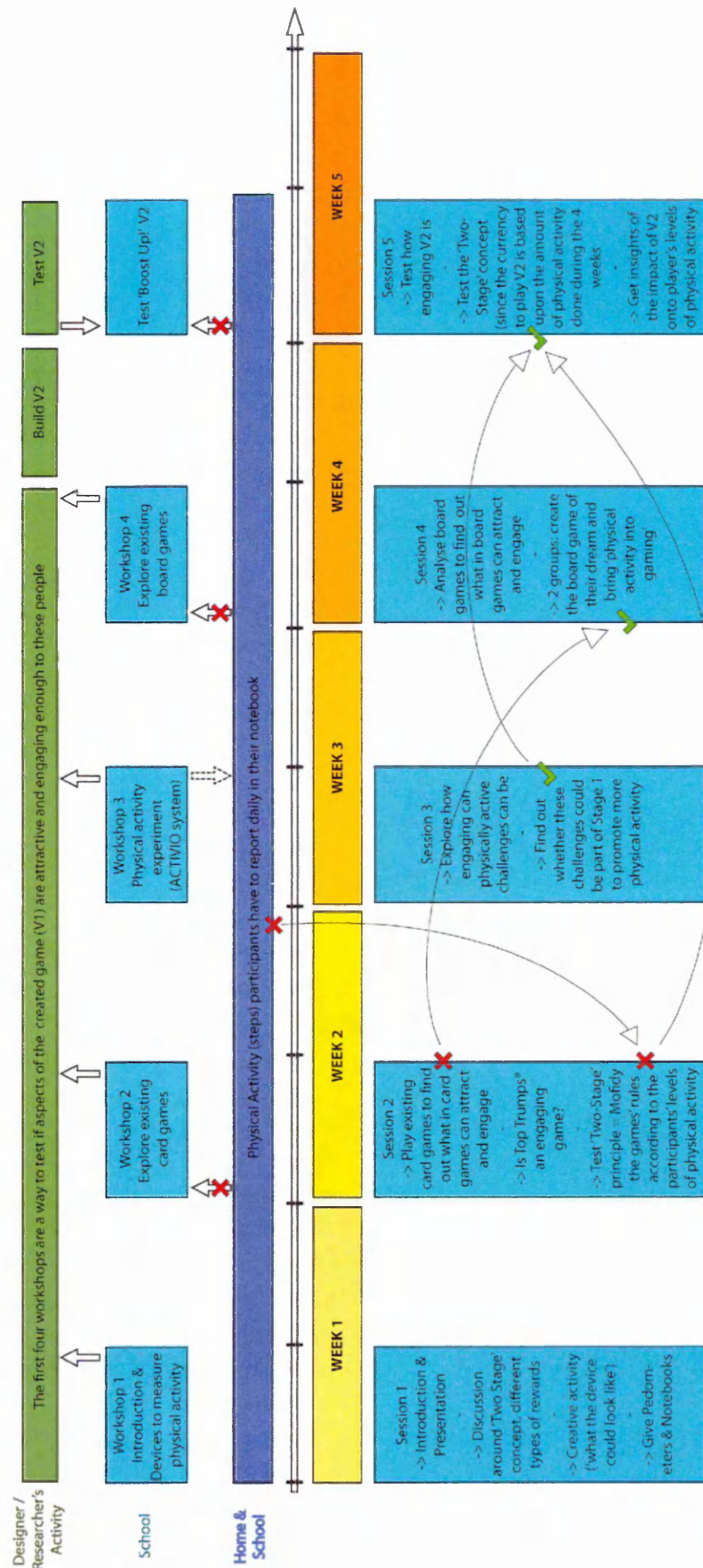


Figure 19 – The (modified) plan for UCE2

- The Workshops' Content (Modified Plan)

Workshop 1 introduced the researcher and built trust with the participants. The core concept of the project was introduced through a drawing (Figure 20). Doing so was also a way to explore the device (i.e. how it could be worn, measuring PA in a fair way...). To facilitate the communication of the concept and these questions around the device, participants compared and assessed similar existing concepts available on the market ('Pokémon Heart Gold' and 'Zamzee').

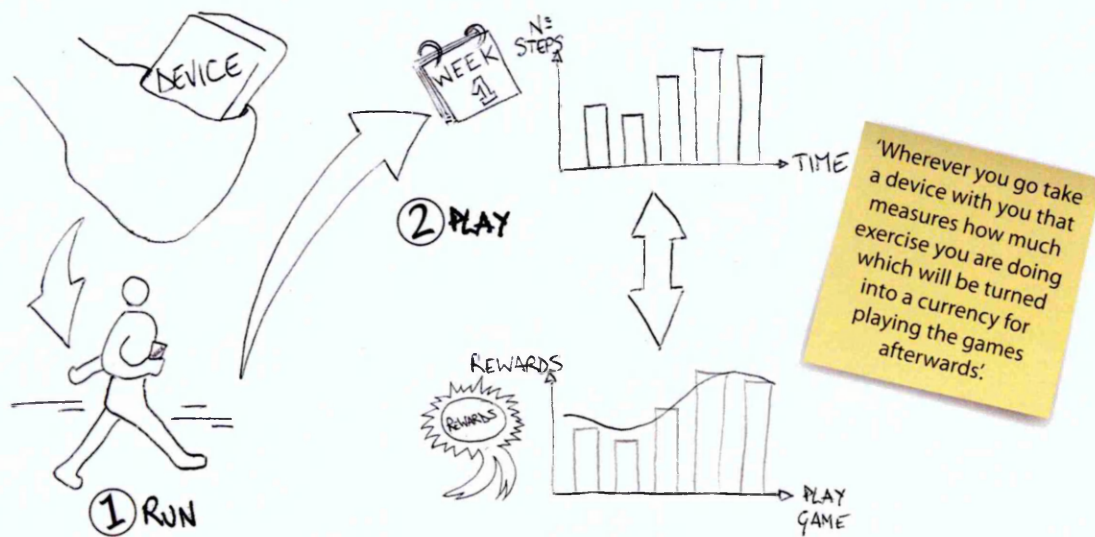


Figure 20 – An illustration of the Two-Stage concept presented to the participants

Workshop 2 consisted of playing a variety of card games of different types (mainly Entertainment, Educational and Combat) with various features, themes and graphics to find out what can be attractive to both genders. The card games presented to them were: Pokémon (game with monsters fighting against each other), Fruit Ninja, Scopa, UNO, and three different versions of Top Trumps® (Baby Animals, Marvel Ultimate Heroes, and Wonders of the World). Since it was realised only on that day that participants had not engaged with the pedometers, the idea that 'the more PA the more game benefits' could not be tested. This made the session not as interesting as it was hoped that it would be. A focus group discussion also took place to discuss how to bring 'PA into gaming'.

The purpose of Workshop 3 was to find out whether PA challenges could be part of Stage 1 in 'Boost Up!' to breed competition and encourage more PA ('Gaming into PA'), and also to compare the drawbacks of pedometers vs. heart rate monitors. Workshop 3 started with a focus group discussion around their experience with the pedometers they had been asked to wear since Workshop 1. The rest of the session was based on experiencing heart rate monitors through the ACTIVIO fitness system, enabling participants to get instant feedback about the PA they are doing. Players wear chest heart rate monitors allowing them to see their performance (heartbeats) projected on the wall via a video projector. To make this system more playful, a card game combining luck, strategy and PA challenges was created (see the rules in Appendix 1.B.3.2).

Workshop 4 explored which properties in board games might promote engagement. Since playing games in Workshop 2 was not really successful, participants in Workshop 4 analysed three existing board games (Monopoly, Mouse Trap and Pictionary) which showed different ways of playing (go around vs. go from point A to point B), different 'look and feel' (2D vs. 3D, different tokens, building landscape...), and different ways the uncertainty of winning is manifested. Drawbacks of these games were discussed in a focus group and were used as a basis for participants to make their own board game since 'Making' had been shown in UCE1 to reveal good information about the participants' tastes. Split into two groups, participants in Workshop 4 were provided with a range of material (e.g. images, stickers, plastic cups, coloured papers and pencils, rubber hands) to support this creative activity. 'PA into gaming' was also explored since participants were asked to promote a form of PA when playing the game they created.

On the basis of these four first workshops, 'Boost Up!' was refined in terms of types of games to play, graphic, shapes, customization and duration of the game. An 'integration prototype' (Houde & Hill, 1997) was realised for this last Workshop 5 which aimed at gathering feedback about how attractive the card and board games were (V2), and whether the principle of the Two-Stage concept could be an incentive to do PA.

#### 4.5.5 The Content of Workshop 5

Even though participants in UCE1 seemed keen on the idea, it was crucial in this last workshop to test the Two-Stage principle that could not be tested previously. Therefore Workshop 5 aimed at two things:

1. Evaluating V2 card and board games.
2. Testing how attractive can be the Two-Stage concept and the principle of earning rewards based upon PA levels.

To award pupils with game advantages when playing V2 games, PA levels needed to be known. Consequently we began this final workshop 5 by doing PA to allocate currency for the game play. The game played in Workshop 3 (with the ACTIVIO system) was used to generate the currency as a Stage 1 and 'Boost Up!' V2 was then tested as a simulation of Stage 2 (Figure 21). The winner of the PA stage chose first which character to play with and also earned three main advantages for playing the board game in Stage 2: choosing first which character (card) to play with; earning an extra 'Chance' card; and throwing the dice twice at the start.

At the end of Workshop 5, each participant threw three dice created by the designer/researcher to gather feedback that was shared among the group and discussed. The three dice were used in combination:

1. *Dice1* was used to define the type of activity/game to get feedback about (i.e. the card game, the PA challenges, the board game, the device, and the real time feedback).
2. *Dice2*, to define what type of feedback to give (i.e. like; dislike; improve) about the activity/game defined through *Dice1*.
3. *Dice3*, to associate the type of activity/game obtained through *Dice1* with elements of their world/imagination (i.e. objects, bands, persons/personalities, brands, shops). This dice allowed identifying graphics by exploring the participants' world and gain visual references about their tastes and lifestyle.

## UCE2 W5 - Test of the Two-Stage Principle



Figure 21 – Workshop 5, an implementation of the Two-Stage principle

The designer/researcher was sometimes ‘adjusting’ the conversation based on the dice throw to ensure there was no repetition in the discussion and to ensure all feedback were useful for triggering inspiration in the following designer/researcher enquiry.

#### **4.6 DESIGNER/RESEARCHER ENQUIRY 3: ITERATIVE PROTOTYPING**

UCE2 allowed the building and testing of a first prototype of ‘Boost Up!’, as well as gaining insights about factors that seemed to promote engagement throughout the whole ‘Boost Up!’ experience.

##### **4.6.1 Aim & Objectives**

In this third designer/researcher enquiry (DRE3), the aim was to develop the game within the given resources (i.e. time and budget), and to a point where it could be tested in another UCE. To do so, the insights and feedback gathered from previous enquiries (UCEs and DREs) were combined with the designer/researcher’s perspective, and informed by the literature. This enquiry was multi-fold and consisted of:

1. Developing the overall game mechanics of ‘Boost Up!’ (how the games fit together);
2. Developing the rules for the games played in ‘Boost Up!’;
3. Developing ‘Boost Up!’ graphics;
4. Creating a conversion algorithm to translate the PA done in Stage 1 into currency to play the games in Stage 2;
5. Finding a way to store/handle that currency.

##### **4.6.2 Developing ‘Boost Up!’**

The game mechanics of ‘Boost Up!’ was refined first and resulted in the creation of a new ‘ideal’ concept (V3) to prototype and test. However the developed concept incorporated technology that would have been costly to prototype as well as time consuming, without knowing if the concept would be fully engaging. Furthermore,

even though the game mechanics were developed first, the other points presented above also needed to be worked out together. This was done through iterative prototyping, which took place with different stakeholders to develop and refine each of the above points. The tests undertaken for developing both the card game and the board game used the versions built for V2 to save time and money.

To borrow Hansen's (2006) term, these tests were undertaken in a 'lab setting' (i.e. away from the end-users). The goal in this enquiry was not to see if the game promoted PA but to increase the engagement and acceptability of the game (e.g. define how long it should take to play it, how easy it is to understand, how it fits into the players' lifestyle etc.) to ensure prototyping a game that works (i.e. without conflict of actions when playing it) and that could be played repeatedly over time. At this stage the game's overall concept, the rules for each sub-game, and the game components and graphics were developed together.

#### **4.6.3 Who is Involved?**

Many stakeholders were involved in this enquiry to test the games. Generally designers evaluate their prototype within the team as a way to get first feedback on other possibilities of the presented design before reviewing it with end-users (Houde & Hill, 1997). Therefore two core teams made up of designers were involved in testing the games in an iterative process to keep developing their concept, rules and graphics. The games' development and tests took place over eight weeks and each team was asked to test a game every two weeks, in alternation. Stakeholders involved in this enquiry were used as 'participants'.

It was found that people who had not previously been involved in testing the game were giving interesting insights that were more difficult to see for those who were already familiar with the game through being involved in earlier testing. This is why at later stages another team made of friends was recruited for testing both games as they were being finalised. Furthermore, before testing V4 in context, with the future end-users, a version close to the final one was tested with a family to get informal feedback with players of an age similar to the end-users as it had never been played by this age group.

#### **4.6.4 Remaining Questions**

Turning ‘Boost Up!’ V3 concept into physical prototypes led to the creation of a new series of prototypes of a higher level of detail and finishes in the game concept, rules and aesthetic: they are ‘Boost Up!’ V4.

A key aspect in ‘Boost Up!’ is how the currency is attributed to players according to their PA levels on a daily basis so that novelty, a factor identified as engaging (Daley, 2009), and hopefully continuous play may be promoted. Yet in relation to the aim of developing a resource effective prototype (i.e. cost & time), it was not possible to develop V4 prototypes as an autonomous system. Nonetheless all the prototypes used in V4 have been selected or conceived to promote the best engagement possible and to limit cheating around players’ levels of PA. However it was unknown how engaging was ‘Boost Up!’ among the future end-users, which is a crucial factor to promote behaviour change. It was also unknown whether ‘Boost Up!’ had any impacts on players’ levels of PA. A third user-centred enquiry was undertaken to test ‘Boost Up!’ and answer these questions.

### **4.7 USER-CENTRED ENQUIRY 3: EVALUATE ‘BOOST UP!’**

#### **4.7.1 Evaluating Games for Health Purposes**

The final version of a game must be validated through a summative evaluation (Lieberman, 2012) to assess the impact of the game on a player’s health (e.g. does it increase PA) and behaviour (e.g. does it affect one’s attitudes) as reports Kato (2012b). Duncan et al. (2011) add that ‘exergames’ should also be assessed against the energy expenditure they require when playing, over the short and long term (Lieberman, 2012). However games can only be effective if appealing and compelling to the future end-users (Lieberman, 2013) and so it also seems important to measure game usability and engagement in any evaluation. The gold standard approach for exploring the efficacy and effectiveness of complex interventions in a health context lies with Randomized Controlled Trials (RCT). Although offering a robust framework within which to establish impact, RCTs require interventions to be ‘fully described’ (such that

they can be implemented and replicated by others) with existing evidence pointing towards likely effectiveness or cost effectiveness (Craig et al. 2008, p4). Since V4 was not autonomous enough at this stage, the designer/researcher played an important role in this enquiry, simulating the computer in a 'Wizard of Oz' style (i.e. a term used in experiments where users interact with a system that appears to be autonomous – Shiomi et al., 2007) thereby ensuring the 'Boost Up!' prototypes were implemented according to the game's overall concept. Therefore a 'pilot study' seemed more appropriate at this stage of the intervention design. Pilot studies are typically undertaken to pre-test the feasibility of an intervention to determine resource requirements. Pilot studies also allow the researcher to explore engagement with the intervention which might limit drop-out in any future large scale trial as well as providing data upon which to conduct a future RCT (Van Teijlingen & Hundley, 1998).

#### **4.7.2 Aim & Objectives**

The aim of UCE3 was not to generalise the data but to find out how engaging was the game and how this engagement might be increased – by for instance changing parameters of the game. This type of evaluation can be compared to the 'dosing studies' (Kato, 2012b) in which the focus is to improve the effectiveness of a serious game by adjusting one or more parameters of the game. UCE3 had the following aims:

1. To explore to what extent participants understood and engaged with the Two-Stage concept of 'Boost Up!';
2. To determine whether 'Boost Up!' was sufficiently engaging to be played regularly over the period of the intervention;
3. To evaluate if 'Boost Up!' increased PA amongst users;
4. To extract insights into the engaging aspects of 'Boost Up!' from a user's perspective.

#### **4.7.3 Who is Involved?**

UCE3 took place in the same school as UCE2 and was still part of the Year 7's PE lessons. The sample selected was convenient and represented an equal amount of

boys and girls. In total 15 participants were recruited (8 girls and 7 boys) - one boy dropped out half way through the study.

#### **4.7.4 The Evaluation Plan**

A six-week intervention was implemented. The idea was to monitor the participants' PA over the first two weeks of the enquiry to create a baseline (in grey in Figure 22) which would then be used as a reference to award players with the games currencies in subsequent weeks. To achieve a representative picture of the participants' PA, the 'Boost Up!' concept was not revealed until after the baseline was recorded. The length of the intervention corresponded to half a term which seemed to leave enough time to measure PA (i.e. 2 weeks of baseline & 4 weeks while playing the games). Participants were mainly involved in 'Doing' (i.e. assessing V4) but they were also 'Saying' (i.e. giving feedback).

The workshops (in blue in Figure 22) took place for an hour once a week instead of the participant's PE lessons, each having specific aims:

Workshop 1 presented the project, introduced users to each other, and provided each participant with a Fitbit fitness tracker that we will then refer to as 'pedometer'.

Workshop 2 introduced the board game and allowed players to try the game but without using currency based on the participants' actual PA (i.e. the designer/researcher made a selection of character cards, normally played with the card game, that were of similar values). It is important to note that, at this point, participants still did not know the details of the 'Boost Up!' concept; they only knew the board game would be played again the following week and that the character cards would be replaced by a currency given based on the amount of PA they did.

In Workshop 3 the Two-Stage concept was introduced and from this day on, a daily currency was awarded to players by the designer/researcher, who was on site every day, based on their levels of PA done the day before except for weekends (i.e. Fridays to Sundays were averaged and awarded on Mondays). The main framework for converting PA into games currency was also presented, highlighting that the figures on the framework corresponded to the amount of PA done during the baseline and were

therefore personal/individual. A bag containing the box (beads) and the bonus cards was also given to each participant. At the end of this session, it was explained that a game club was opening every day as an opportunity for them to play the board game (see Game Club section below).

In Workshop 4 the card game was introduced and each player was provided with a deck of cards so that they were able to play outside of the workshop or game club (e.g. in breaks, at home). The deck was inserted in a bag given to each participant along with the feedback sheet, the pedometer, and the games currencies (beads and bonus cards).

Workshop 5 was an open session allowing participants to play the game of their choice (card or board game) which provided insight into game preferences and engagement.

Workshop 6 was used to gather feedback using a dice activity again. Focus group discussions took place, rating cards were filled in, and a questionnaire (Q2) was given to find out more about the experience of playing the game from a user's perspective



The Shop (in green in Figure 22) was a room within the school where the designer/researcher was based: it could be described as the ‘home’ of the ‘Wizard of Oz’. The ‘Shop’ was located in front of the cafeteria and was where the banker (designer/researcher) of the games stayed on a daily basis. Therefore participants knew where to find the banker should there be any problems (e.g. rules, currency, questions).



Figure 23 – The activities undertaken at the shop

A day in the life of the ‘Wizard’ at school consisted of collecting pedometers before registration, reading the data, reporting feedback on the box (stickers) and on the sheet, converting the data into game currency, and awarding it accordingly (beads and cards). By the morning break, the box, the cards, the feedback sheet and the pedometer were re-inserted into the game bag for participants (Figure 24). When handing the bags back, verbal feedback was provided with the designer/researcher aiming to increase the participants’ self-belief by reminding them about past successes and future goals (Gray et al., 2013) as well as to encourage self-reflection about their behaviour (Lieberman, 2012). Baranowski et al. (2008) explain feedback can take the form of reinforcement (e.g. congratulate) or information to make next choices (e.g. tips). The feedback at the shop consisted of reminding participants to: wear the pedometer at the weekend; look up regularly the daily average of steps to avoid missing an extra bonus cards; improve where they were lacking (e.g. less sitting, more



bursts of VPA...); relate their performance with the game play by giving examples or tips (e.g. you have a +20 attack, you could take x2 +10...).

The game club (in red in Figure 22) was a room available to the participants during lunch time from the start of Workshop 3. This club was an opportunity for participants to come and play the games, especially the board game that they did not own unlike the card game. The game club was a less formal environment which led to valuable discussions and insights about the participants' lifestyle and PA behaviour, and about what they do in their spare time, who they interact with, play with, and what games and aspects of games engages them.

#### **4.7.5 A Mixed-Method Approach**

A mixed-method approach was chosen, using quantitative data to evaluate 'Boost Up!' impact on the participants' levels of PA and qualitative data to explain why it might have had an impact or not. Qualitative data was therefore used to develop a broader and deeper understanding of the users' behaviour and experience of playing the game (e.g. is the game understood? How can it be made more engaging?).

- Quantitative data from Fitbits

The pedometer was an objective way to detect potential change(s) in the participants' PA. Analysing the data consisted of generating descriptive statistics to find out what the participants' patterns of PA were. The data generated by the Fitbits potentially highlights trend(s) around the impact(s) of the game on the participants' PA levels even if there were many unknown factors (e.g. weather, sample size, involvement of researcher). Yet these types of trends can be helpful to explore further how engagement might be increase among all (i.e. those who engaged in the games and those who did not).

- Data from questionnaires

To assess any potential change in the participants' behaviour or intentions the same questionnaire was given in Workshop 1 (Q1A) and repeated two weeks after the last workshop (Q1B). The questionnaire was based on the constructs of the Theory of

Planned Behaviour (attitude, norm, self-efficacy/perceived-behaviour-control) to examine the potential impact of the games on attitudes and cognitions. This questionnaire can be found in Appendix 6.C.1.

A further questionnaire was used in Workshop 6 (Q2) which gathered general feedback about the game (e.g. was it what they expected and why) and participants' PA (i.e. self-perceptions, motivating factors). This questionnaire can be found in Appendix 6.C.2.

- Qualitative data from informal interviews/interactions and observations;

All the qualitative insights that derived from interactions and observations during the workshops, at the shop, and at the game club were combined with the rest of the data to explain the potential differences observed in the participants' PA. Levels of engagement, enthusiasm, participation at the workshop, at the game club, and participant commitment for coming to the shop or to pick up their bag were all useful to get a holistic picture about how/what was engaging and how to improve this.

#### ***4.8 DESIGNER/RESEARCHER ENQUIRY 4: A 'REFLECTIVE NARRATIVE'***

After analysing UCE3 data in relation to the aims set (i.e. finding out how engaging and how effective to promote PA 'Boost Up!' V4 were), a DRE4 took place.

##### ***4.8.1 Aim***

This alternation of UCEs and DREs enabled the development of understanding and knowledge to develop the game (under the 'designer hat') yet this knowledge must be made explicit (under the 'researcher hat'). As described in 3.3.3, some knowledge was made explicit (e.g. UCE1 data analysis was used to create a framework) however this knowledge was used as a designer to develop the game and was not verified (i.e. it did not look at being an absolute truth). At that point, being 'true' was of concern but it was not the driver, which looked at being 'real' in relation to Fallman's (2008) interaction design triangle (see 3.3.2). Yet being 'true' was the purpose of this 'reflective narrative' activity conducted in DRE4 and it is therefore at this stage that it

was possible to claim knowledge with confidence through finding commonalities from one enquiry to another.

This reflective narrative was two-fold: to report the sequence of events that happened during the whole research and that were used to develop the design of the game (under the 'designer hat'); and to analyse and organise the knowledge developed throughout these events (under the 'researcher hat'). This process of drawing knowledge out is a way to show that the knowledge generated is not just an opinion, but rather the designer/researcher's intuition and sense combined with a rigorous assessment of the data collected. The process for creating knowledge consisted of formulating hypotheses and ideas based on experience, and testing them against the data collected during the UCEs (i.e. verifying that data was repeated across the data collected throughout the entire research).

#### **4.8.2 The Process**

As presented in 3.3.3, two maps were created on which the data collected throughout all UCEs and DREs was reported. The first visual map consisted of presenting the rationale behind the design development of the game while the second one reported the data captured during the various enquiries that led to identifying engaging themes.

- The Chronological Research Timeline

The key events that informed the design development of the game (e.g. participant's comment/feedback, suggestions found in the literature) were pulled out from the data and gathered together into a big timeline (Figure 25). This timeline reports chronologically the activities done in all the DREs and UCEs that led to the development of 'Boost Up!'. The chronological research timeline shown in Figure25 was split into 3 stripes in its length.

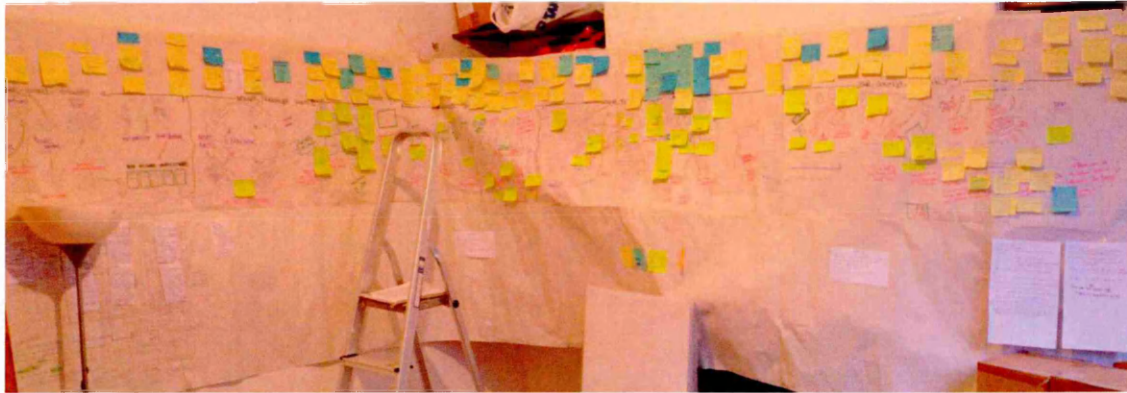


Figure 25 – The Chronological Research Timeline

> The stripe in the middle corresponds to a representation of the activities led in each enquiry combined with the few participants' comment(s) that informed 'Boost Up!' design development; as the game developed, an annotation of the game's content/structure/properties for each version was also reported (green post-its);

> The top stripe is a summary of the findings for each activity led across enquiries (Yellow post-its) and how they might relate to the literature (Blue post-its);

> The bottom stripe presents the data for each UCE that was identified as engaging; this stripe could be described as the early steps of the knowledge creation presented later in this chapter (see Appendix 2.B).

- A Visual Map

The 'bottom stripe' of the timeline presented in Figure 25 was developed further. The idea was to compare the data across the three UCEs to see if there were commonalities in the themes identified (i.e. if the theme(s) identified for each enquiry were repeated from one to another and how they were manifested). Since UCE3 was the enquiry that generated the biggest amount of data, it was used as a basis to create the theme categories and the rest of the themes found in UCE1 & 2 were then added. To facilitate this process, a visual map was created to compile the data that was common to two or three UCEs. The map below (Figure 26) shows UCE3 data (in white) combined with UCE 1 & 2 (in pink post-its). The data is a combination of observations

from the designer/researcher with participants' comments or creation. UCE3 data was regrouped in themes that were refined as UCE1 & 2 data was added. In Figure 26, the emerging themes are a combination of orange and yellow post-its. The blue post-it in the figure above shows the provenance of these themes (i.e. in which artefacts (e.g. prototype, drawing...) the theme was embedded).



Figure 26 – Themes emerging throughout the 3 UCEs

#### 4.8.3 The Method

Using mainly a bottom-up approach, a thematic grouping of the data found in each UCE was realised in this enquiry. This method could be compared to the 'Grounded Theory' as defined by Lacey & Luff (2009) since all the emerging themes were generated from the data itself. The designer/researcher therefore reviewed the data collected for each enquiry, looked for ideas, concepts and elements that might have been repeated across each enquiry's data, using NVivo software to facilitate the management of the data. After a few scans, it was noticed that some of the data seemed to belong to themes that are common across all enquiries. However the data that led to generate a theme might have been embedded in different ways: through a game concept, a game component or through the device measuring PA. Themes

emerged through analysing the data generated by the participants (e.g. feedback, comment, creation) by the designer/researcher (e.g. observation, prototyping), and were also related to the literature (e.g. to see if/how other researchers might have also identify the theme).

Yet again, those themes were not given to other researchers to evaluate how ‘true’ they were. Instead, their reliability comes from their repetition across enquiries. Indeed a same theme could be found in two or all enquiries and could also be manifested in different ways. As explained in the methodology chapter, the repetition of the findings (i.e. of features of the different versions of game tested were found repeatedly) demonstrates a form of reliability that cannot be disregarded. Therefore knowledge is reliable since formed on repeated occurrences, based on practice and tested in context. There were instances where a theme could be branched into a series of sub-themes that might have been found in one or two UCEs only, but which belonged to a same general theme, which hence could be claimed as valid.

#### ***4.8.4 The ‘Annotated Design History’***

The amount and type of data (e.g. participant’s feedback, suggestions found in the literature) was quite important when compiling the maps presented in 4.8.2. To deal with all this data post-it notes were used as a tool to categorise the traceability of the information (i.e. where it comes from). The visuals developed throughout DRE4 are referred as ‘Annotated Design History’. This method of communicating the research data was inspired by the ‘Annotated Portfolios’ (Gaver & Bowers, 2012; Gaver, 2012) yet remains quite different. The annotations do share similarities (e.g. simple and short, acknowledging aspects the prototype did not cover...) yet the ‘annotated design history’ is applied in a different context. It is not a collection of different ideas that are clustered and unrelated, but it aims rather at showing the link between the theory and the product during the design process by reporting turning points in the project and the reasons behind the decisions made. The annotations in the these ‘annotated design history’ visuals, which are also presented throughout the next chapters, were presented on post-it style notes as shown in Figure 27.



Figure 27 – Meaning of the annotated design history's visuals

Illustrating the raw data through the 'annotated design history' visuals was a way to recover the data (i.e. communicate the design development process and the research findings in a comprehensive way) and to show transparency and rigour in both the design development process and the knowledge creation.

#### **4.8.5 Who is Involved?**

Only the supervisory team was involved as an external advisor to the designer/researcher. The team helped to further understand the differences between the disciplines as well as to point out the gaps in the methodology developed throughout this research.

### **4.9 SUMMARY**

The methodology developed for this research project consisted of alternating between DREs and UCEs to create, develop, and refine the design of a game. Within each of these enquiries, a variety of activities were conducted to design a range of prototypes in an iterative process. According to the development stage of the game and the nature of the activities, the choices of design research techniques for each UCE were different yet consistent with the type of thinking adopted during the design process: some were used for exploration purposes through diverging the thinking of the designer/researcher (i.e. triggering imagination) while some were used for refining the thinking. The aims for each enquiry as well as the justification for the use of the techniques for each enquiry are summarised in the table below.

	DRE1	UCE1	DRE2	UCE2	DRE3	UCE3	DRE4
Aim	> Understand engaging factors that might promote behaviour change	> Learn about the future end-users & explore possibilities to ensure engagement and acceptability of the game to create	> Develop a concept (V1) for a game that promotes physical activity on a long term period	> Clarify what the game concept might be & what the game might look like	> Refine the game play, its rules, and its visuals	> Evaluate the last integration prototype of the game developed (V4)	> Refine and develop the game to make it more autonomous and engaging
How = Technique / Approach	> Broad scope literature review	> Questionnaires + Probes + Original objects + Persona + Dice + Feedback > Focus group discussions (W1+3) + Creative activities in group (W2) & individual (W4) + Assess (Fun Day)	> Thematic grouping + Brainstorming ideas + Concept development (V1) > Iterative prototyping	> Micro-experiments > Focus group discussion (W1+2+3+4) + Creative activities in group (W4) & individual (W1) + Assessing devices & game (W3+5)	> V3 = V1 concept revisited > Iterative prototyping > V4 = a second 'integration prototype'	> Pilot study using 'Wizard of Oz' > Focus group discussion (W6) to gather feedback	> 'Reflective Narrative' > Visual maps / timeline illustrated by visuals (= 'Annotated Design History')
Why this Technique / Approach	Understand > What might promote behaviour change > What is missing among exergames > Not trying to generate trends or identify what theory might be best suited to promote physical activity (even though this was taken in consideration)	> Open up space & explore possibilities to create exergames = Creative activities as co-designers (different activities for different types of knowledge – Sanders, 2002) > Presenting ideas to participants would have guided them into a specific direction and restricted the scope for creation > Thematic grouping of ideas (posters) to find out if/which of these ideas were approved by others, not to generate a general truth about these people – method similar to Braun & Clarke (2006) yet done by designer/researcher only	> Look for nuggets of data to trigger creativity for brainstorming > Not to describe the world as it is = Braun & Clarke (2006) method not fully applied since it would have hidden specificities, which trigger imagination and creativity > Cheap prototypes to test iteratively as early as possible = rough versions allow defining the fundamental rules of a game as well as its core mechanics (Salen & Zimmerman, 2004)	> Explore 3 aspects of the game to design (look & feel / implementation / role) in an engaging way = Micro-experiments to find out how engaging & then build an 'integration prototype' to test (V2) as a response > Refer to the socio-technical experiments (Hansen, 2006) > Hypotheses formed throughout the previous phases are tested in early workshops with existing designs and embedded quickly into the integration prototype to test in W5	> Increase engagement & acceptability of the game to prototype a game that works (i.e. without conflict of actions when playing it) and that is played repeatedly over time > Not to see how effective the game is to promote physical activity > Iterative tests conducted with a wide range of stakeholders > Tests conducted in a 'lab setting' (i.e. away from the end-users) – Hansen, 2006)	> Evaluate 'Boost Up!' engagement and impact on players' levels of physical activity > RCT not adapted at this stage (intervention cannot be 'fully described' - Craig et al. 2008) to ensure implementation and replicability. > Games not autonomous enough yet = 'Wizard of Oz' > Not trying to generalise data but to get a sense of how engaging the game is + how to increase it ('dosing studies' - Kato, 2012)	> Identify in all the data gathered so far what seemed to create a source of engagement (i.e. common themes throughout all enquiries) > Bottom-up approach mainly (grounded theory) > Inter-reliability of identified themes = not through giving them to other researchers but through their repetition = Different from Lacey & Luff (2009) > 'Annotated Design History' to enable others recovering the raw data

Figure 28 – A summary of the aim and techniques for each enquiry

A detailed record of the various activities and their findings was collected along the way to provide the key findings that are repeated and claimed as contribution to knowledge. Therefore at each stage of the research observations were recorded as notes, audio records were transcribed, and the various outcomes generated by both the designer/researcher and the participants were categorised and stored.

Since many outputs have been produced during the various enquiries and these outputs were informed by different sources (e.g. statement in the literature, field based data comment or creation), the next chapter presents the findings of these enquiries through a series of created visuals. The purpose of these visuals, which are defined as 'Annotated Design History', is to communicate the findings and to present the design rationale around the design development process. This was done to enable any interested researchers to recover the data by providing a full account of the process and how the findings informed the development of the research project.

## ***Chapter V- An Evidence Based Design***

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The research process described in the previous chapter led to the creation of many outputs and findings. As described in chapter III, these outputs and findings were of two kinds: to create and develop an exergame(s) under the ‘designer hat’ that is then tested in context with end-users, and to develop understandings and new knowledge under the ‘researcher hat’.

This chapter reports the design development of ‘Boost Up!’ and what were the factors that influenced the decisions made around it (under the ‘designer hat’ only). Across the entire research, four main versions (Vs) have been created: ‘Boost Up!’ V1 and V3 were concepts of the game and V2 and V4 were their respective prototypes that were evaluated in context. This chapter therefore presents the iterative design development of ‘Boost Up!’ that led to creating V4 before evaluating it in a final enquiry (UCE3). To develop each version of the exergame(s) (i.e. for each section of this chapter), one or more DRE and/or UCE might have been undertaken.

### ***5.1 CREATING ‘BOOST UP!’ V1***

V1 was developed using the insights and knowledge gained during DRE1, UCE1, and DRE2. As described in 4.2, DRE1 corresponded to the literature review.

#### ***5.1.1 UCE1: Factors & Game Properties to Promote Engagement***

UCE1 looked at exploring what might be a source of engagement in the participants’ lifestyles, in the games they play, and the PA they do. Different notions a game concept could illustrate as well as a range of game properties were identified in this enquiry to initiate and sustain engagement. Furthermore a list of attractive games was established. These are discussed below.

#### 5.1.1.1 Evolve/Change

Evolve/Change occurred many times across the intervention (in Workshops 1, 3 and 4) and was identified as being a source of engagement for these people. This idea was identified through games they created (e.g. evolving a character/avatar) or through the pictures taken during the journalist activity (e.g. a gnome to illustrate the word 'surprise').

It was therefore assumed that having a game in which something evolves/changes could be a way to engage end-users playing the game on a longer period of time, as well as to bring novelty to it.

#### 5.1.1.2 Series of Games or Sub-Games

Increasing the PA levels of the given personas in Workshop 2 led two groups out of three to create a game composed of a series of games. The first idea included conventional activities and real sports (e.g. Basketball, swimming pool), and the second idea encompassed an orienteering game, a game playable on a portable console, and 'Tag' type of game. Both ideas incorporated the games as part of the lifestyle of the personas and were fitted into their day so that PA could be done throughout the whole day, through a wide variety of activities.

Being able to choose from amongst a range of games or even of options seemed important for the participants. Choosing whom to play with, what to play, and what seemed to be influencing factors to initiate and sustain engagement.

#### 5.1.1.3 Identity

The question of identity was recurrent throughout the enquiry, and especially in Workshop 1, which was aimed at defining what 'cool' and 'fun' meant to them.

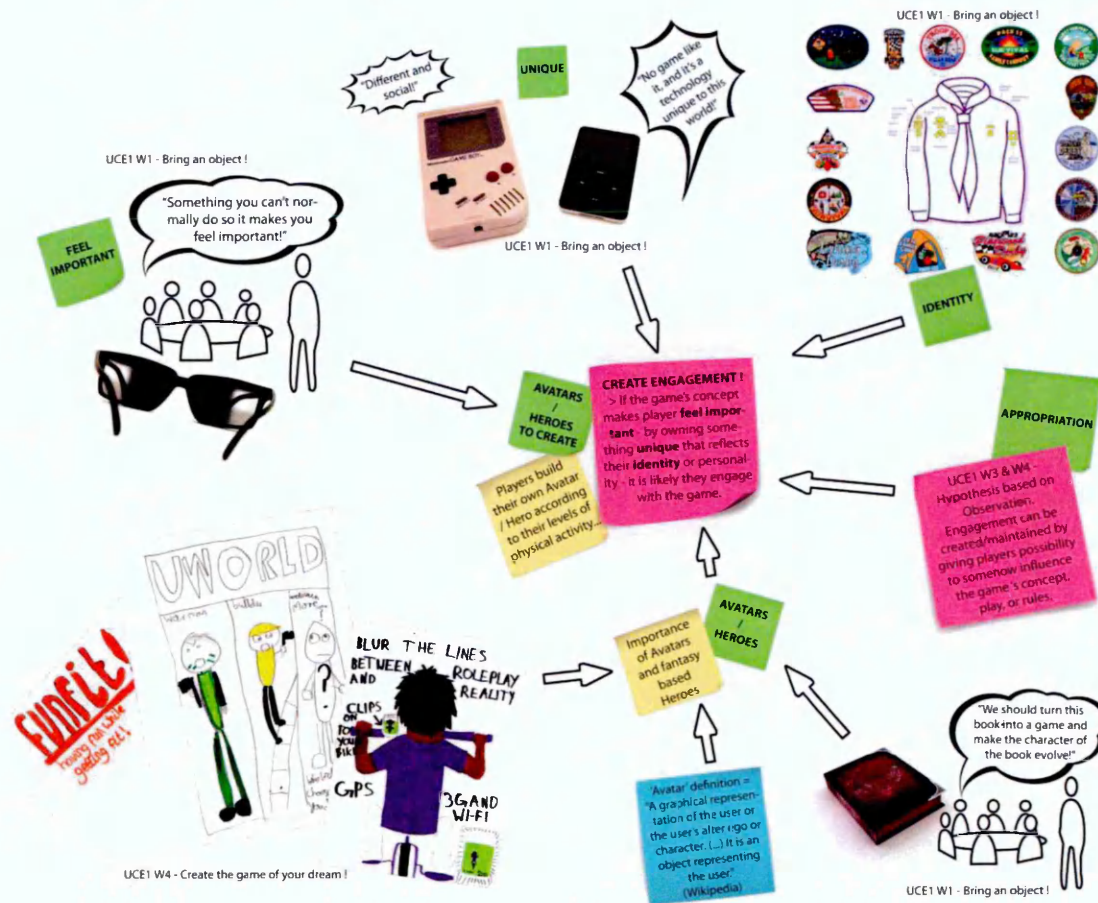


Figure 29 – Identified key terms to create a potentially engaging concept

> Participants showed enthusiasm about the objects presented in Figure 29 since through them, young people felt 'Important', having an 'Identity', and being 'Unique'.

> Avatars/Heroes. An avatar is usually represented as a virtual model yet from its definition it is thought it could also be represented as a physical object. Hence if the game(s) play or concept somehow reflects one player's identity (a form of avatar) or input, it may sustain the player's engagement. Furthermore, combining the physical manifestation of the avatar with what has been assumed as creating engagement (e.g. evolve/change) might be engaging.

#### 5.1.1.4 Appropriation

A hypothesis was formulated from the observations done in Workshop 3 and 4: participants became much more pro-active when they realised the words they

generated in Workshop 3 (Probes) were reported onto dice to create their own game in Workshop 4. Hence it seems the exer/game(s) should somehow reflect this: if players can influence or affect the content of the game (e.g. rules, play, components), they are more likely to appropriate it and to be motivated to play it. Appropriation through customisation may be a way to promote engagement to tackle continuous gaming.

Therefore by combining all the key terms presented above, one interpretation is that if the concept of the exergame makes players *feel important* by doing or owning something *unique* that reflects their *identity* or personality (e.g. physical avatar), and that evolves/changes on a regular basis, players would see the game or the range of games as being cool and fun and therefore engaging.

#### 5.1.1.5 Social and Multi-player

Feedback and social support were reported as essential (through questionnaires and activities) for engaging young people in doing PA. The norm around games seemed to be about playing with friends mainly, maybe with siblings rather than parents/guardians.

#### 5.1.1.6 Multi-use and Informative

Ideas created by participants in Workshop 1 and 4 around the device measuring the players' PA levels had a main function (e.g. measuring heart activity). Yet these people have incorporated other functions, like being informative or instructional for instance (e.g. adding a watch, showing avatar), beyond the purpose for which the device was originally designed.

#### 5.1.1.7 A list of Attractive Games

Through the questionnaires and the various discussions with the participants, their tastes appeared to be diverse and eclectic yet there seemed to be a common agreement around the 'Hero' theme. Conventional games (e.g. football, swimming, dancing) were appreciated but so were shorter games or less 'official' games (e.g. Tag, Kick the Bucket) as well as traditional (e.g. card and board games such as Top Trumps®) and video games (e.g. Star Wars, FIFA 11, Art Academy).

### 5.1.2 DRE2a: A Framework for Brainstorming

It was mentioned in 4.4.2 that UCE1 analysis led to the creation of a framework to brainstorm ideas of exergames. The brainstorming activity aimed to create exergames that are ‘non-digital’, based on the following themes identified when conducting the ‘Designerly broad brush thematic analysis’.

#### 5.1.2.1 A ‘Non-Digital’ Direction

There are various aspects throughout UCE1 and that the literature supports suggesting that it is appropriate to create and develop exergames that are non-digital or that use digital devices parsimoniously. In this case, and for the rest of the thesis, non- digital refers to a (exer)game that might incorporate a form of digital technology, but that is not restricted to it. The concept of ‘technology-supported’ games presented in 2.4.2 draw on this idea of limiting the use of digital technology in games.

Participants highlighted the importance of creating a game that does not require a phone to run this since they cannot use mobile phones in school (i.e. it is against the school policy). Besides, it was reported that augmented reality games can hurt after prolonged play.

Some issues relating to the use of technology were also found in the literature:

- Exergames should be affordable and accessible to the least active population (Lieberman et al., 2011);
- Exergames do not support social rituals (Bogost, 2007) yet social support is essential for engaging young people in doing PA (Lieberman, 2013);
- Technology-based exergames can fail (Shayne et al., 2012) and they can also sometimes promote PA ‘on spot’, which can be considered by some as being sedentary (Oh & Yang, 2010);
- Technology should be used parsimoniously (Lieberman, 2012). Young people use screen based media for approximately 5h a day with about 50–60% devoted to the television (Roberts et al., 2005) therefore reducing media time seems reasonable.

Therefore creating technology-supported games rather than technology-based seems more appropriate (see 2.5.3) and might tackle the issues raised above. Furthermore, since it is crucial to evaluate game concepts and core mechanics as early as possible (Salen & Zimmerman, 2004), evaluating a technology-based prototype may mislead the results since the testers may evaluate the ‘skin’ of the game (medium/platform) rather than the ‘skeleton’ (core of the game mechanics).

### 5.1.2.2 A Selection of Themes of Game Content

As mentioned in 4.3.5, all the ideas of games generated throughout UCE1 were gathered into five themes of content of games. Many of the ideas were predicated on digital technology which was not practical to develop (e.g. New Consoles) yet Two-Stage and Orienteering games received positive support (some participants even created their own game in Workshop 4 based on these two themes). The Two-Stage concept, which was inherent to ‘Gener-G’ and which received positive feedback at the time (see 1.1.3), appeared to be particularly suited for this research (see 2.5.3).

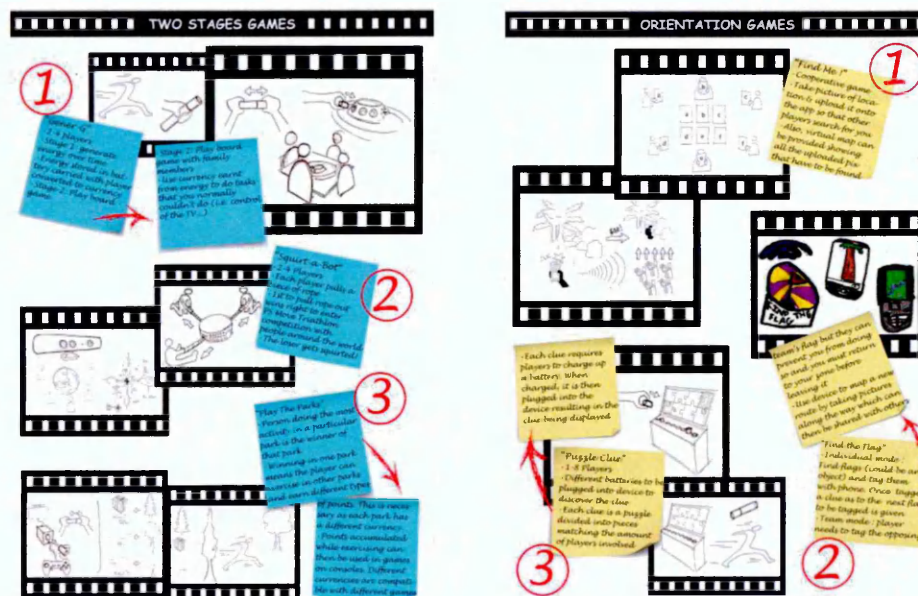


Figure 30 – Posters presenting the ‘Orienteering’ and ‘Two-Stage’ games concept

Therefore to narrow the research down, the brainstorming activity was done within the two themes of ‘Two-Stage’ & ‘Orienteering’.

### ***5.1.3 DRE2b: Brainstorming Ideas of Exergames that Explore Daily Gaming***

Based on the framework just presented, concepts of games that aimed to promote repeated play were explored. A selection of the main concepts generated can be found in Appendix 1.A. however two concepts seemed most promising – which can be found in respectively Appendix 1.A.3 & 1.A.4:

1. 'Evolution', which uses a 'Two-Stage' model: a single card game is played every day but the play changes/evolves from one day to another since the game currency is different (i.e. based on the orienteering game). A board game based on the same concept and using a similar currency is then played afterwards.
2. 'Boost', which is also 'Two-Stage' based: players first create their own avatar during 9 days by which time they then play the board game with it.

Those concepts were therefore prototyped roughly (pencil on paper) to be tested iteratively with designers/colleagues to refine the concept and start setting out the rules of the games. After a few iterations, the game play of the card game was described as not very active. This was mainly due to the way the Two-Stage concept was imagined at the time, with two distinct stages:

1. Stage 1 (PA): do PA to generate currency;
2. Stage 2 (play): to use that currency to play games.

Since this research aims at promoting PA, it seemed worth exploring how PA could be promoted when playing the game(s) in Stage 2 ('PA into gaming') and also how gaming can be promoted when doing PA in Stage 1 ('gaming into PA'), which might also make the games and PA more interesting and engaging.

To bring 'gaming into PA', it was imagined that players could throw each other PA challenges to complete. It is was thought that 'PA into gaming' could be based on a similar concept, by allowing players to complete PA challenges when playing the game (e.g. by picking up a card asking to 'climb the stairs'). All of this is explained in more detail in Appendix 1.A.5.

### 5.1.4 The Concept for a Game: 'Boost Up!' V1

The brainstorming activity combined with the iterative tests resulted in creating the concept for 'Boost Up!' (V1), a game composed of a series of games.

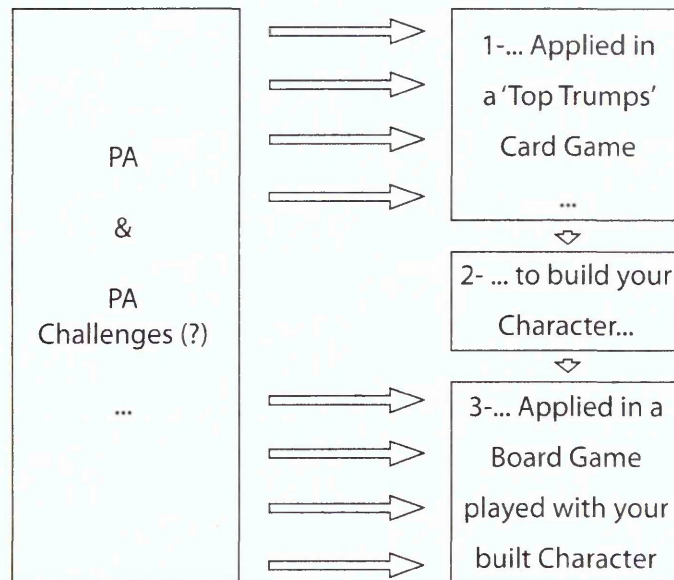


Figure 31 – 'Boost Up!' V1, a linear concept aiming at promoting continuous play

> The 'Boost Up!' themed card game is played first for a specific amount of time, originally set at 9 days like in 'Boost'. During this phase, the card game is played every day, but in a different way since various game components are introduced on a daily basis. Furthermore, it is also during this period that players' avatars/characters are built based onto their PA levels.

> This idea of building an avatar/character which is then used afterwards to play with on the board game comes from the hypothesis generated from UCE1 observation (see 'Appropriation' in 5.1.1.4) – if players have some influence on the game rules or content, then they are more likely to be engaged.

> 'Multi-use', also identified in 5.1.1.6 was also a core component of V1; the common aspects across the games:

- The levels of PA done in Stage 1 give advantages when playing Stage 2 and therefore increase chances of winning the game (e.g. more dice throw, more bonus cards or boosters).

- Boosters allow a temporary increase in value of a character's features (e.g. of a character card or of the character built).
- They all follow the 'Hero' theme which seemed to be what participants found engaging: some of the games listed as being engaging (e.g. Star Wars); the book brought by a participant in the Workshop 1 of UCE1 was fantasy based; and some feedback and conversations gathered during the 'Fun Day' event suggested heroes/characters were potentially engaging.

> This concept promotes novelty in two ways. Firstly, through a daily currency, which is awarded based upon one's PA levels, and which may vary from one day to another (i.e. players earning the game advantages may vary too). The varying amount of currency might also change the tactics players adopt when playing the games. Secondly through offering a series of games to play, which may increase the attractiveness of the game to create and sustain engagement, as identified in UCE1.

> Having variations in the play of the card game (i.e. bringing different components) is a way to spread out the play of each game over time. Continuous play is also tackled through the linearity of the concept (i.e. playing one game after another), which extends the length of time of playing 'Boost Up!'.

### **5.1.5 Key Questions about V1**

This technology-supported exergame concept was fairly developed (rough prototypes and rules were created) however many questions at that stage remained about the level of engagement of the overall concept as well as the spread of the games to promote continuous gaming. These questions are explored below.

#### **5.1.5.1 What device to measure PA?**

It was reported that recommendations for adolescents are 60 minutes of MVPA on most if not all days of the week (NASPE, 2004). However to measure PA as part of

‘Boost Up!’, it was unsure which type of device should be used: Pedometers or heart rate monitors.

NASPE (2004) recommendations correspond to 12,000 steps in Colley et al. (2012) although there are variations in the amount of steps between different countries, age groups, and ways of measuring PA (i.e. pedometer and/or self-report).

Since the aim of exergames is to increase heart rate and respiratory rate to promote MVPA (Lieberman et al., 2011), what matters is not the number of steps but the intensity of the levels of PA and currency should therefore be given accordingly.

Therefore exploring other technologies such as heart rate monitors seemed appropriate. However questions around these devices remain to ensure their acceptability (e.g. which devices are preferred among the end-users, which one is more comfortable...).

#### 5.1.5.2 The Games and their Concept

Iterative testing allowed the development of the ‘Boost Up!’ concept and game rules however questions about their detailed implementation remained.

Top Trumps® was listed as an attractive game in UCE1 although it was unclear whether a Boost Up!™ themed card and board game could be engaging over a long time (e.g. How well/adversely received is the idea of playing the games over nine days?).

Furthermore the Two-Stage concept was found to be attractive in UCE1 however it was uncertain whether the principle of earning game advantages based upon players’ PA levels to increase chances of winning the games was suitably engaging.

More exploration was also needed when bringing ‘PA into gaming’ and ‘gaming into PA’ to find out if blurring the two stages can promote PA in an engaging way and how the blurring could be achieved (e.g. can PA challenges be attractive?).

## 5.2 DESIGNING 'BOOST UP!' V2

Aspects of the V1 concept presented in 5.1.4 were tested during the four first workshops of UCE2 and a first integration prototype (V2) was tested in the last workshop of UCE2, based on the results found in the first four workshops. This section starts by summarising how the workshops helped answer the questions raised previously; a description of V2 is then given; to present other types of findings that emerged from evaluating V2 and that have sometimes been found in combination with findings from the four first workshops. A more detailed summary for each of the four first workshops and how they have influenced the design of V2 can also be found in Appendix 1.B.

### 5.2.1 Answering Key Questions

#### 5.2.1.1 Acceptability Pedometers vs. Heart Rate Monitors

As described in 4.5.4, insights around the acceptability of heart rate monitors and pedometers were gathered through different activities:

- Experiencing the pedometers on a daily basis throughout the duration of UCE2;
- Creative activity about what the device should look/feel like in Workshop 1;
- Experiencing heart rate monitors through the game invented for Workshop 3 using the ACTIVIO system;
- Experiencing these heart rate monitors using the ACTIVIO system again when testing V2 in Workshop 5.

Even though heart rate monitors were found unattractive and not comfortable for all, they were preferred to pedometers but this may be due to the fact that the pedometers they experienced were cheap, inaccurate, and easy to cheat with as presented in Appendix 1.B.3.1 (participants reported that the pedometer was counting steps when dropping the pedometer on the floor).

We also saw in 5.1.5.1 that measuring PA with pedometers may not be accurate. In contrast, heart rate monitors measure the heart activity and can define how intense a

PA is (e.g. they can distinguish moderate from vigorous PA). Furthermore, heart rate monitors seem to measure the effort of an individual, regardless of their level of fitness. Fairness was a factor that participants gave importance to. Finally, since exergames aim at increasing the heart activity to promote MVPA, using heart rate monitors seems appropriate.

Taking all these points into consideration, it seemed that heart rate monitors were worth promoting yet they should be:

1. Not intrusive (i.e. possibility of hiding it)
2. Comfortable (e.g. Velcro not itching)
3. Reliable and fair when measuring PA (i.e. picking up every variations in the heart beat)

Re-designing these monitors to incorporate them into the end-users' lifestyle (i.e. clothes or accessories) might be a way avoiding forgetting or losing the device like it happened with the pedometer in UCE2 and hence seems worth exploring. Yet this is technically difficult to undertake within this research.

#### 5.2.1.2 'Blurring' the Two Stages



Figure 32 – Executing PA challenges with ACTIVIO system in Workshop 5

> The designer/researcher explored ‘gaming into PA’ in Workshop 3 through testing a game that was played with ACTIVIO (see 4.5.4). The PA challenges seemed worth implementing when doing PA in Stage 1 since this game played with ACTIVIO showed great engagement. Participants did not want to stop playing by the end of the session and even when participants were complaining about doing a challenge (since already executed or not feeling confident to perform it) they all ended up executing them. Some participants even wished to pick up the card with the toughest challenge as it gave more points.

> ‘PA into Gaming’ was explored in Workshop 4. When instructing the participants that the board game they were creating (as part of Stage 2) had to promote a form of PA, both groups did so through creating ‘PA squares’ (see Appendix 1.B.4.1).

### 5.2.2 A First Integration Prototype: ‘Boost Up!’ V2

The integration prototype ‘Boost Up!’ V2 was built for Workshop 5 based on the findings of the four first workshops (see Appendix 1.B) and was highly influenced by the findings of the four first workshops, and more especially those from Workshop 4.

#### 5.2.2.1 Identified Graphics



Figure 33 – Graphics participants (girls and boys) found attractive

> Both V2 card and board game were based upon these identified graphics.

### 5.2.2.2 A Card Game



Figure 34 – V2 card game composed of character cards

> Top Trumps® was identified as engaging for these people who also liked cute creatures/monsters (see Appendix 1.B.2) and attractive graphics (e.g. colourful images and text that reflects their world - see Figure 33) and were all combined to create a Boost Up!™ themed card game.

> Rules: players have to collect all the character cards from their opponents to win the game. Each character is made of three features (Attack / Defence / Range) with different values going from 1 to 10. To win a round, players have to own a character card with the highest value. To increase their likelihood of winning the cards, players can boost the features of the character cards using the chance cards that are distributed at the start of the game. See Appendix 3.B to read the full rules.

### 5.2.2.3 A Board Game

- The Board

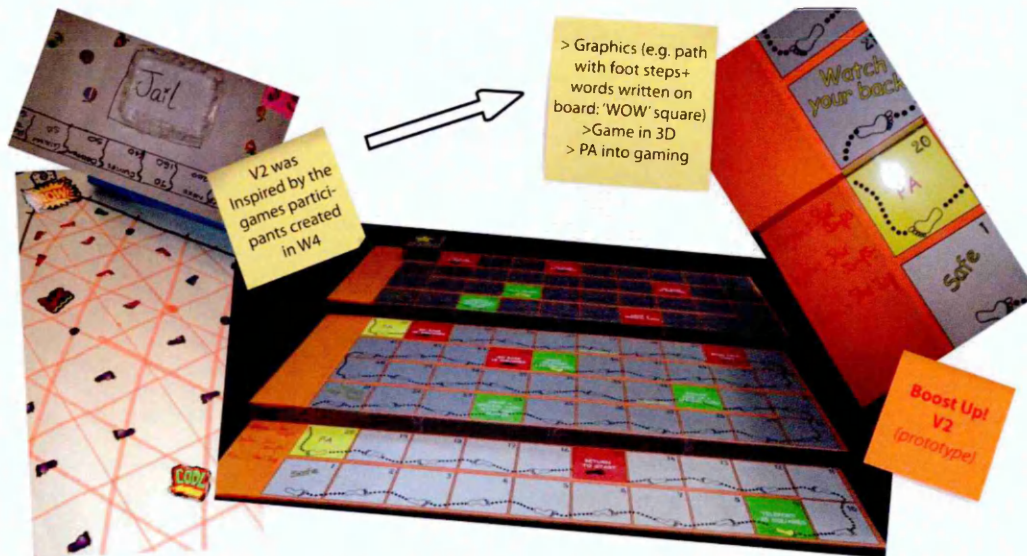


Figure 35 – V2 Board game

> The 'Boost Up!' board game concept remained the same as 'Evolution' (see Appendix 1.A.3.2)

> Rules: The board game contains 100 squares and the first player reaching that square (renamed 'WOW' since adding text/words was reported as engaging) wins the game. Players can attack a player in front if they are within the range of their character; if successful the player attacked will move 25 squares backwards – The 'Attack' of a player attacking must be higher than the 'Defence' of the attacked player for an attack to be successful. There are three zones over the 100 squares: Zone1 (1-20) is a ceasefire zone where players cannot attack each other yet (it is a way to dispatch players); Zone 2 (21-70) has not got any particular rules; Zone 3 (71-100) from which point the teleportation card (Chance card) can no longer be used. – See Appendix 3.A to read the full rules.

> The overall concept had not changed since what was established before starting UCE2 (see 5.1.4) yet the visual aspects of V2 board game were mainly based on the activities done in Workshop 4. This workshop revealed that 3D

games were found attractive and showed that ‘PA into gaming’ can be manifested through implementing ‘Booby Traps’ squares (see Appendix 1.B.4). As a consequence, each zone was made in 3D; to enhance the transition from one zone to another (hence from one level to another) and illustrate the ‘elevation’, two PA squares (number 20 and 60 in yellow) were inserted. Yet ‘PA squares’ in V2 have a positive connotation (one aspect for providing a blending experience), not a ‘trap’. In V2, players landing on this square have the opportunity to pick up a PA challenge card. According to the intensity of the PA challenge executed, players can earn chance cards, which increase the chances to win an attack (and therefore the game). Since the sample was composed of different body sizes with potentially different levels of self-efficacy as to performing in front of the group, the challenge was made optional. Once a challenge is executed, players write down their corresponding score on the side of the board (orange stripe on the side of the game), which illustrated the ‘customise/appropriation’ property identified in both UCEs.

- Tokens

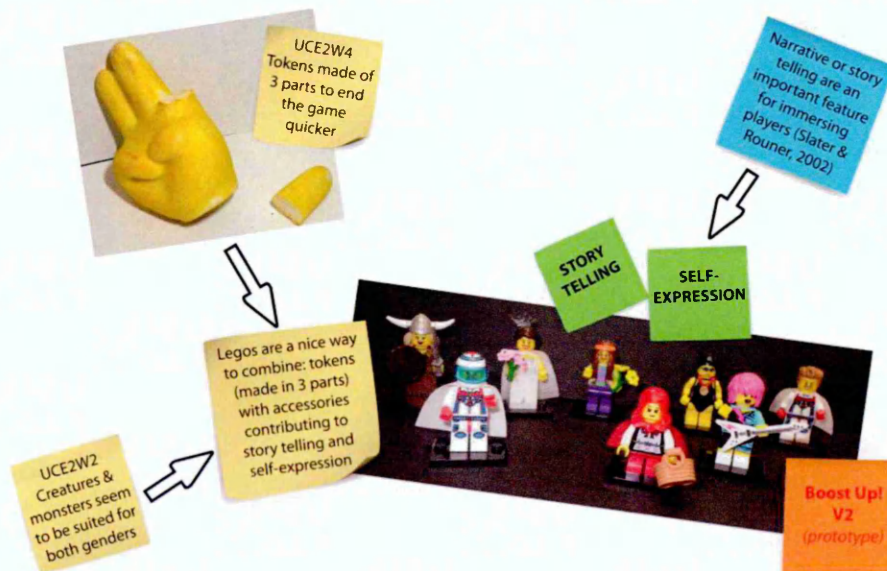


Figure 36 – Legos used as Tokens to play V2 board game

> Participants also created their own version of Monopoly with their own tokens (i.e. rubber hands) that are made of different parts and that each part corresponds to a life (see Appendix 1.B.4.3). The idea of using tokens as lives was used again for

V2 however Legos were chosen instead as they can be dis/assembled easily and the various accessories available (e.g. pink hair, guitar, helmet) may encourage 'Story-Telling' and 'Appropriation', identified as engaging in UCE1.

- Chance Cards



Figure 37 – Influence of the graphics of the chance cards

> The chance cards' graphic were inspired from a combination of graphics (presented in 5.2.2.1) as well as elements from UCE1 (e.g. objects brought into UCE1 Workshop 1).

> There are two categories of chance cards. The cards in the first category mainly allow players avoiding map traps (e.g. protecting against squares such as 'Go back 30 squares', 'Miss a Turn') or avoiding/enabling attacks (e.g. 'Cosmic Shield' to protect against other players attacks, 'Freeze' to force a player to miss a turn, 'Galactic Attack' sending all players back 20 squares...). Cards in the second category allow boosting the characters' features (Attack +10; Defence +10; Range/Energy +25). Even though there are two categories, all the cards are mixed together when playing the board game, and each player receives three chance cards at the start of a game.

### 5.2.3 Other Types of Findings

#### 5.2.3.1 Game Properties

- Fairness & Cheating

Fairness was identified throughout different activities relating to:

1. The type of device for measuring PA (see 5.2.1.1).
2. The way to convert PA into game advantages from Stage 1 to Stage 2: a participant in Workshop 5 claimed for game rewards, judging that finishing second from Stage 1 deserved rewards in Stage 2.

Cheating was reported as positive when playing card games in Workshop 2. Peng et al. (2013) highlight players should not be able to cheat in Stage 1 (i.e. avoid doing PA by for instance putting the pedometer on a dog or on a fan like the Pokéwalker). However players should be able to apply, misapply, or subvert rules to win in Stage 2: this is the idea of 'legitimate cheating' (Salen & Zimmerman, 2004).

- Real-World Based / Replicating Adult's Behaviour

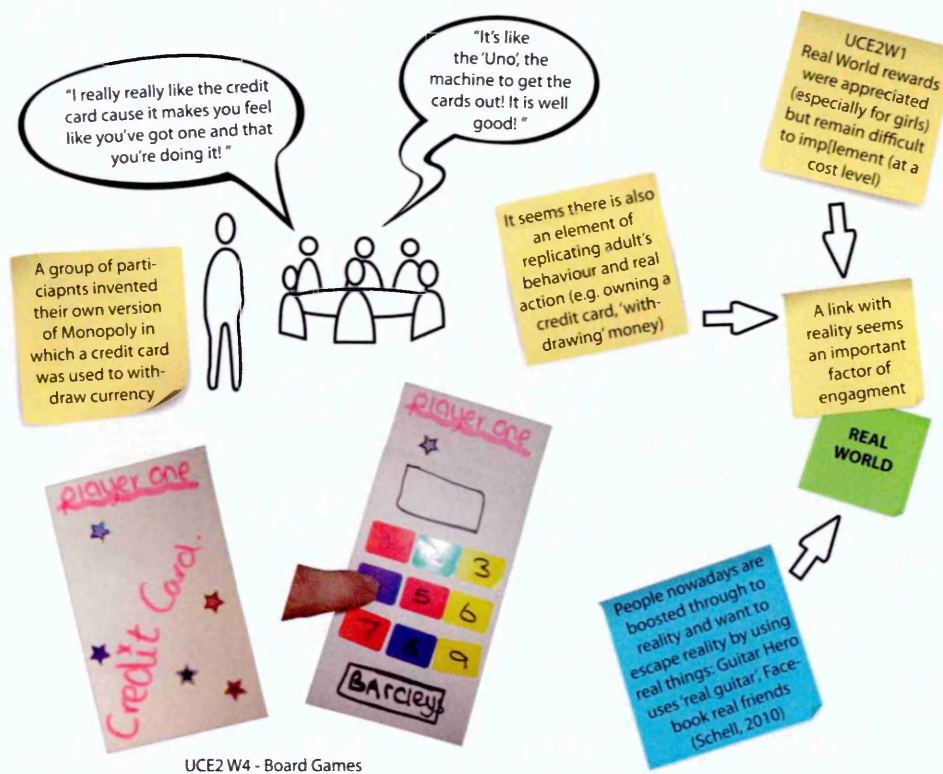


Figure 38 – Engagement through the 'credit card' idea

> Workshop 1 revealed real world rewards were appreciated but they can be costly (see Appendix 1.B.1.3). A link with reality seems to engage people nowadays and making the game more 'real' seemed important.

> Having a (fake) credit card to insert in a 'portable cash machine' to withdraw money seemed to be one way to bring 'reality' in the game. This suggests that relating the game play actions to the real world and/or replicating more grown up/adults' lifestyle might be an incentive for these people.

- Appropriation

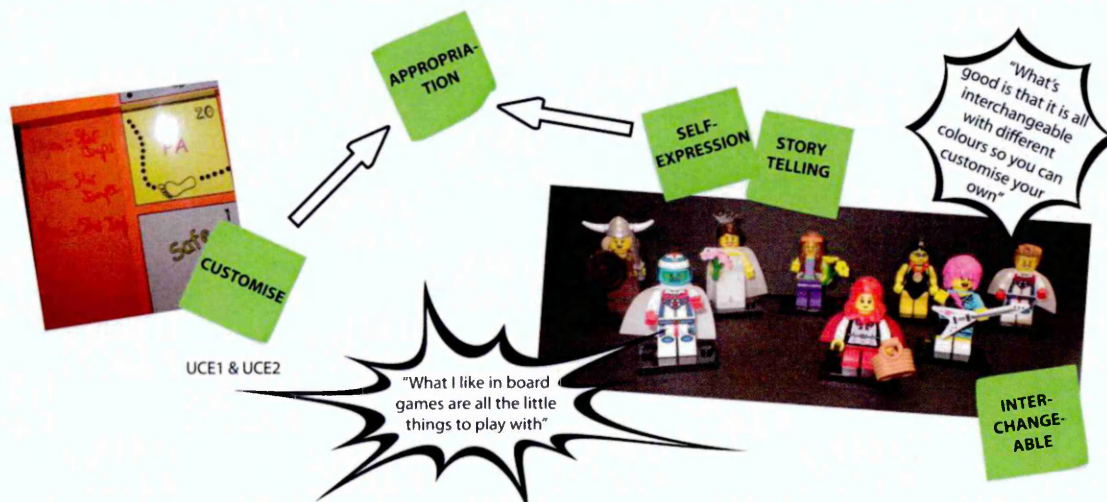


Figure 39 – Appropriation through customisation and self-expression

> Participants loved creating their own token/avatar and swap accessories between them before starting playing the board game in Workshop 5, but they suggested there should be more of them to choose from.

> 'Self-Expression' seemed to be an important feature to immerse the players. Giving tools for developing the players' imagination or ways like customisation of the game allow appropriation and promote a form engagement by immersing players in a world.

- Multi-Use

The 'multi-use' property was identified engaging through:

1. Top Trumps 'Wonders of the World' in Workshop 2, played by both genders (see Appendix 1.B.2). In comparison to 'Marvel' & 'Baby Animals' this game incorporated attractive visuals yet unlike other games, Wonders of the World also had an educational aspect since it provided informative facts about each wonder (i.e. enabling developing knowledge), which was reported by both genders being enjoyable and useful.
2. The enthusiasm showed in Workshop 5 about the idea of using a same currency in different ways, for different games (here the character cards).
3. The Lego tokens used in Workshop 5, which promoted many interactions since made of interchangeable parts with accessories that can be exchanged, swapped, added/subtracted.

#### 5.2.3.2 The Two-Stage Concept/Principle

On three occasions the Two-Stage principle was tested and revealed it was an incentive for the participants to do PA. This was concluded due to the:

1. Enthusiasm shown by the participants in Workshop 1 when presented the existing games based on the Two-Stage concept (see Appendix 1.B.1.1)
2. Success of the card game in Workshop 3 (with ACTIVIO), which consisted of 'doing PA to get points' (see Appendix 1.B.3.2)
3. Test of 'Boost Up!' in Workshop 5, which consisted of 'doing PA to get game advantages':



Figure 40 – Testing V2 board game in Stage 2 of Workshop 5

- > Participants gave positive feedback and really enjoyed playing the whole game: after the hour session ended, most participants (5/6) stayed into their lunch break for an extra hour to keep playing the game. Earning advantages for playing games (Stage 2) based upon PA done in Stage 1 seemed encouraging for doing more PA.
- > The winner of the PA stage enjoyed a lot having control over the game (e.g. the power of decision in the social circle as well as game advantages).
- > Even though participants stayed over lunch, they did not manage to finish a game on the board, and the card game was not tested. It was therefore unclear how the games should fit together to best promote engagement.
- > The PA squares to bring 'PA into Gaming' seemed engaging: even though optional, every time participants landed onto one PA square the challenge was accepted and the score written down on the side of the game.

#### 5.2.3.3 'PA to Win Games' Vs. 'Win Games to Earn Points'

The idea behind implementing V1 linear concept was to motivate players to win the board game, which became easier with a stronger character/avatar (built according to

one's PA levels). In V1, even though PA was the core component to generate currency, the focus was on playing and winning the games, and ultimately the board game. Yet a participant's comment in UCE2 suggested that playing the game could be a way to add points to those won through doing PA in Stage 1 instead of doing PA to win games.

#### ***5.2.4 Remaining Questions***

The engagement observed in Workshop 5 suggested there were elements in the concept of 'Boost Up!' that were attractive and engaging to young adolescents, but certain parts of the content of the games (PA challenges, card and board games) were also attractive. For instance, a board game in 3D with a start and a finish line (rather than going in rounds like in Monopoly) was appreciated and so were the attention to details (e.g. coins, currency, cards...), the fantastic theme mixing heroes with cute and cool creatures.

Yet improvements can be done and ideas should be added, replaced, modified to keep developing both the games and the understanding of young people (e.g. importance of offering different currencies, colourful graphics and text, ways of customising the games...).

The V2 evaluation in the last workshop showed potential for promoting MVPA and more research should be conducted over a long term.

Heart rate monitors were preferred however they need to be explored further. Comparing them with the pedometers was also useful to define what factors seemed engaging or not to identify what criteria a device measuring PA should incorporate to ensure its acceptability (i.e. it suits the end-users' lifestyle).

The question of fairness was of concern for the participants and came up in Workshop 5 when converting the points from the PA stage (measured using ACTIVIO) into game advantages. Converting PA into game rewards or advantages is therefore crucial to maintain engagement and needs to be inclusive to attract players with different profiles, attitudes and behaviour towards PA and/or gaming.

### **5.3 DEVELOPING ‘BOOST UP!’ V3**

The questions raised previously to increase the engagement of the games were explored in DRE3. Based on the further insights gained through UCE2, a new ‘Boost Up!’ concept emerged: this is V3.

#### **5.3.1 Setting the Scene**

After UCE2, the following points seemed important:

- Inclusive & Fair – An unfair conversion of PA into games currency can disengage players (see 5.2.3.1). This question of fairness was even more important since ‘Boost Up!’ aims at gathering individuals with different profiles and behaviour (e.g. body sizes, attitudes, self-efficacy) towards PA and games. Therefore, regardless of how active players are, the system to award the currency should be fair for all (i.e. the least active players still have a chance to win against the most active ones) to promote engagement over a long term.
- Blurring the Two Stages – We saw in 5.2.1.2 how ‘PA into gaming’ and ‘gaming into PA’ could be introduced in ‘Boost Up!’. Since both seemed to promote engagement, it seemed appropriate to explore these further.

Therefore both of these points were used as a basis to generate a currency to play the games in DRE3.

#### **5.3.2 Design Concept Development**

This section shows the development of the idea of bringing ‘gaming into PA’ to promote PA in Stage 1. This was done in two ways: through implementing PA challenges (to encourage action) as well as a league (to promote longevity through continuous play).

### 5.3.2.1 PA Challenges

Since PA challenges (e.g. push-ups, star jumps, jump on one foot) engaged the participants in Workshops 3 and 5 in UCE2, they could be applied to Stage 1 to encourage players into doing more PA as well as reducing the sedentary behaviour.

It is imagined a device would be created that would allow players to 'throw' PA challenges to each other at any time during the day, however there would be a limited time to complete it. The device would be able to detect the type of PA undertaken and reward it (or not) accordingly. This might be a way to encourage doing more PA (e.g. sprints in break time, walking the dog), or at least small changes (e.g. taking the stairs instead of the lift, getting off the bus at the stop before school) throughout the day.

Yet within the constraints of the research it was chosen not to explore this idea further since it would have been not only very costly but also time consuming to develop such a system.

### 5.3.2.2 A League

It was asked what the winner of the board game gets and winning a game did not seem to be enough. Combined with the comment of a participant (see 5.2.3.3) the idea of a league came up. This was reinforced by Bjork & Holopainen (2005) who explained that leagues are particularly suited to promote continuous play, one of the aims of 'Boost Up!'.

Even if the league concept could be ideal for promoting continuous gaming, it was still unclear how the games fitted together. A linear concept like V1 seemed limited and difficult to implement when players could not be active one day for instance (e.g. due to illness): they would miss an opportunity to build the feature(s) of their character, and it would not be fair.

Hence, instead of doing PA and PA challenges to win the game, these are combined with the number of wins of the games to accumulate points to play a league:

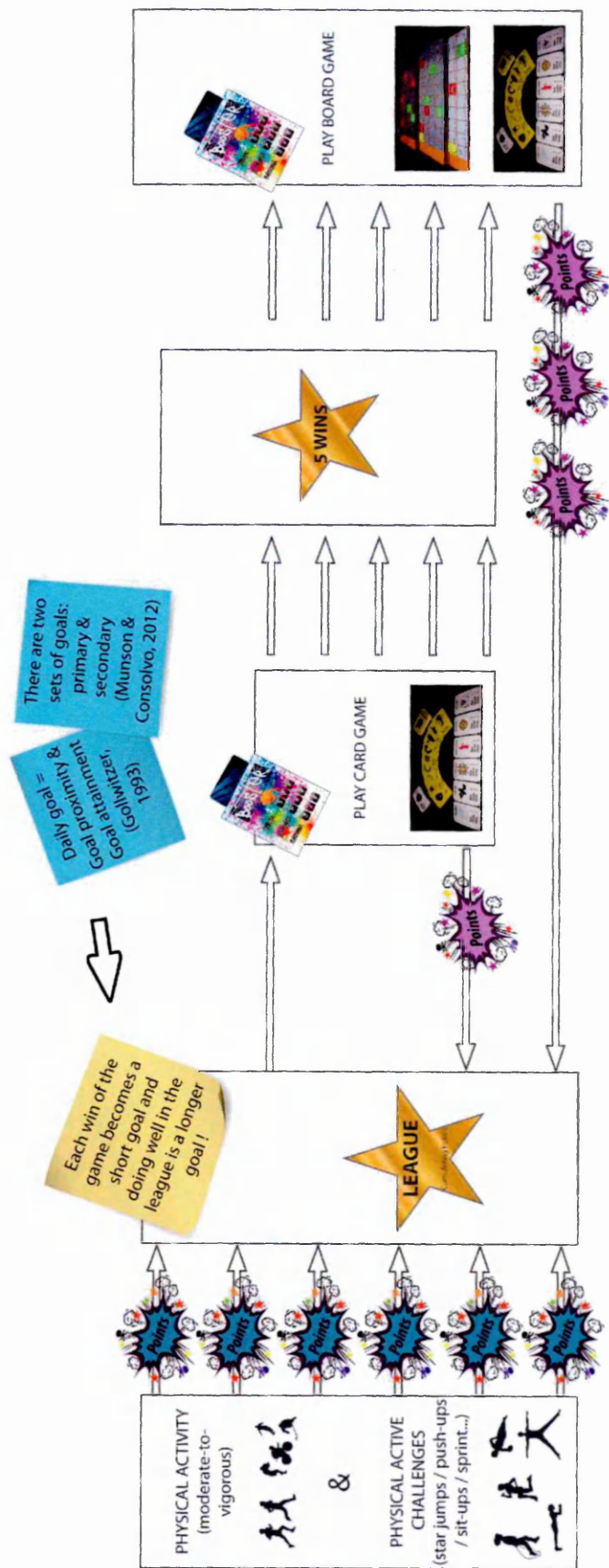


Figure 41 – Accumulating points through doing MVPA & Winning games

> Players have the opportunity to accumulate points in the league either by doing PA (and PA challenges) and/or by playing games. Therefore in addition to making more points towards the league, PA in Stage 1 also gives games advantages which increase the players' chances to win the games. Yet if players want to play a game on the board they must first win the card game five times. Each win of the card game gives players points to accumulate towards the league and winning the board game gives even more points.

> This league concept seemed more inclusive since players have the choice as to how they accumulate points towards the league. Those who do not like playing games can focus on doing PA only and/or doing PA challenges (on their own or not), and those who are less interested in doing PA focus onto winning the games.

### 5.3.3 'Boost Up!' Concept (V3)

Based on the key points set in 5.3.1 as well as the design concepts presented in 5.3.2, 'Boost Up!' concept was refined in V3.

#### 5.3.3.1 A General Concept Including a Range of Games

'Boost Up!' league in V3 is similar to the one presented previously in Figure 41 since players can accumulate points through doing PA and/or winning games. The main difference in V3 is that there is no linearity to play the games, which can be played at any time and without order. If 'Boost Up!' offers a range of games to choose from, and that can be played at any time, it may attract more players and may engage them on a longer term. Therefore both the card and board games are playable with a common currency (Attack/Defence/Energy).

Yet this concept can also be applied to existing games (e.g. Pictionary, Uno, Battle ship). Yet instead of having a currency based on Attack/Defence/Energy like for the 'Boost Up!' games, the amount of MVPA would be converted into game advantages the same way they were attributed when evaluating 'Boost Up!' V2 in UCE2. For instance when playing Pictionary, players could earn extra time to guess what the other player has drawn, or throw the dice another time, or have the dice value

doubled. A framework for each existing game would be created to convert PA into appropriate game rewards/advantages: when plugging their device measuring PA (pedometer/heart rate monitor) into the currency displayer (in blue), players read on the screen what their reward(s)/advantage(s) are.

Based on the observation (see 5.1.1.4) that players involved in developing a game or part of its content (e.g. rules, game, token) is more engaging, it is imagined a 'Boost Up!' community could collaborate to create their own game(s) which may increase adherence to the game(s).

#### 5.3.3.2 A 'Blue Sky Techno Vision' Concept to Prototype

Exploring how to include all sorts of games (existing or not) is beyond the scope of this research. Instead there was a need to develop a concept that would incorporate only the board game, the card game and the PA challenges (to insert in both stages, not only in Stage 1 as described in 5.3.2).



a player it can detect whether the PA challenges received have been completed and when (i.e. how long after receiving it). The heart rate monitor data is then transferred onto the credit card (bottom left) which is inserted into an interactive kiosk available in various environments (e.g. school, centres, clubs). This interactive kiosk is a form of cash point from which players can withdraw their currency. Players get given a number for the PA done for a day and they can choose the breakdown of their currency to withdraw. Once decided they press the 'Sync' button to synchronise their currencies chosen on the screen of the machine with their credit card. Once the card is synchronised, players insert it into their currency dispenser (bottom right) which displays the breakdown of the currency they chose for the day, and are ready to play the games. The entire PA done that same day will be recorded and used to generate a currency for playing the games the following day. Hence every day the currency is reset and the credit card needs to be synced again.

The board game and its rules, already tested once with future end-users in UCE2, were much more developed than the card game. The league idea seemed difficult to implement and there was a need to develop a concept that could be prototyped and evaluated within the constraints of the research.

#### **5.3.4 'Boost Up!' Game Details**

Even though V3 concept was more defined, there were aspects around the currency to refine.

##### **5.3.4.1 Generating a Common Currency**

- The Currency

Firstly, we saw in 5.1.1.3 the importance for players to build/create their own avatars, which influenced the development of V1. However this idea could not be tested in UCE2. Secondly, UCE2 revealed that 'Life and Death' scenario and games in which players make characters/avatars evolve (e.g. by increasing their skills) in the game through real world activities were of interest to these people (see respectively Appendix 1.B.2 & 1.B.1.1). Thirdly, using the character cards as a common currency to

play ‘Boost Up!’ themed card and board games in Workshop 5 was well received by the participants (see 5.2.3.1). Hence how to create more links between the games through a common currency felt worth exploring. Finally, both ‘Boost Up!’ games used the character cards as a common currency. It is therefore imagined that PA can become the basis for players to generate their own character (around the features Attack, Defence, and Energy) that would represent one’s levels of PA. This idea of players creating their own character is applied on a daily basis in V3, not at a specific moment like it was the case in V1.

To increase engagement, it was also imagined PA could become the core aspect to bring more strategy and uncertainty of winning. It is important to highlight that participants in UCE2 reported the importance of having different types of currency (see Appendix 1.B.2), which can be done by adding game components such as bonus cards for instance. Hence bringing strategy and tactics in Stage 2 can be done by combining one or more secret resources that can be of a different nature (e.g. limited number, with a time limit) and with different functions (e.g. permanent, can be swapped), which can be earned from Stage 1. The idea is that if players can develop strategies/tactics and/or have more opportunities that increase chances of winning a game according to their PA levels in Stage 1, it is more likely they will do more PA in Stage 1.

- Currency & Health Recommendations

All of this was combined with the one of ‘Boost Up!’ goals: reaching the health recommendations of 60 minutes of MVPA a day over a long term to engrain healthy habits in players’ lifestyle. The notion of regularity is a parameter to take into consideration when promoting PA (Aznar-Lain & Webster, 2012; DH, 2011) and was the basis behind the following concept.

The idea is that players generate two types of currency around the characters’ features and both are given based upon their levels of MVPA: there is a main currency which is permanent and a second currency made of two temporary boosters. Therefore it was not anymore about giving advantages, as it was the case when testing V2 but to develop an algorithm based on the conversion of MVPA levels into a game currency.

The main currency is based upon the players' levels of MVPA since they started playing 'Boost Up!': it corresponds to the idea of setting an individual baseline based on the amount of each player's PA levels. The value of the features being fixed, this main currency relates directly to the character cards. The two 'boosters' are added and given based upon how active players were in a time shortly before playing the games: 'Booster 1' is given based on the amount of MVPA done for the hour before playing, whereas 'Booster 2' is given based upon the amount of MVPA done for the three days prior to play. These boosters affect the permanent features (i.e. main currency) of a player's character in a temporary way and for a limited number of times. Since regularity is important, the average of MVPA based on a short amount of time should be less rewarding. Hence there are 2 Boosters of type 1 and 5 Boosters of type 2.

#### 5.3.4.2 'Withdrawing' the Currency to Play the Games



Figure 43 – Credit card idea adapted to 'Boost Up!'

> The credit card is individual and is a way for each player to withdraw their daily currency. For this, players insert their credit card into a currency dispenser ('booster') which reveals the values of each feature given according to their levels of MVPA.

> The currency dispenser has three columns of figures that correspond to the permanent features of a players' character (left column) as well as the temporary boosters affecting them (column in the middle corresponds to the MVPA done in the past hour and the right column in the past three days).

> This currency dispenser becomes the common component to play the games.



Figure 44 – Graphic exploration of the currency dispenser

> An exploration of what the currency dispenser looks like was conducted based upon the graphics identified as engaging in UCE2.

## 5.4 DESIGNING 'BOOST UP!' V4

It is during that same enquiry DRE3 that a series of prototypes was built to turn V3 concept into another integration prototype V4 to evaluate.

### 5.4.1 Iterative Testing

At this stage the game play of both the card and board games needed to be developed before prototyping the credit card idea, the currency dispenser, or the interactive kiosk defined as part of V3. However in order to develop the games' rules, the currency generation and conversion needed to be developed. This was only possible through iterative testing.

#### 5.4.1.1 Game-Testing Plan

Unlike the card game, the board game's rules were quite defined and have shown potential in UCE2 for engaging participants. The board game was therefore used as a basis to develop the card game's rules as well as to explore the conversion from PA to game currency. It was important to develop them together to ensure across both games having:

- A coherent relation between Stage 1 and Stage 2 to ensure providing a blending experience.
- A fair conversion of PA levels into a currency that can be used to play both games in an engaging way, while encouraging players to reach the health recommendations.
- An uncertainty of winning: regardless of the amount of currency generated through Stage 1, all players should have the hope to win at any time during game play in Stage 2.

The overarching idea of 'Boost Up!' is to reward the players that are active in Stage 1 however the least active players may be discouraged to play the games if there is no possibility of winning. One way to avoid this is to insert more game components (e.g. chance cards) in the game play to increase the uncertainty of winning. The board game already included chance cards in its game play. These were used again when testing

the card game, as a way to explore the common currency. Even though the meaning of these chance cards was adapted to the card game, they created conflict in the game play and it was unclear which game components were essential to the card game (i.e. what game components should be inserted) to create a simple but engaging game play (e.g. uncertainty of winning). Therefore the card game-testing sessions evaluated different scenarios that corresponded to different levels/layers of complexity (e.g. one vs many currencies, use of chance cards, boosters), to define what the core aspects of the game were and explore how to best reach engagement. Therefore a different scenario was tested in each card game session and different variations were explored within each scenario (e.g. one core aspect of the card game is to use currency to boost the values of the character cards however it was unknown whether they should be hidden or visible to other players, how much the boost value should be...). Through testing the different scenarios, variations, observing testers' behaviour and reactions, getting feedback and comparing how fluid the game play, an engaging game play might emerge.

#### 5.4.1.2 Use of Prototypes at this Stage in the Research

The tests undertaken for developing both the card game and the board game used the versions built for V2 to save time and money.

Alongside the development of the games, the currency dispenser in which the credit card would be inserted needed to be developed too. At that stage, a non-digital direction (or at least a limited use of digital technologies) was chosen again before developing such a digital-based idea.

#### 5.4.2 Requirements when Prototyping 'Boost Up!' V4

Through testing iteratively the card game, the board game and the currency dispenser (see a more detailed description of the tests in Appendix 1.C) a second integration prototype V4 was built. To make this game as engaging as possible, 'Boost Up!' V4 had a set of requirements about the:

- Device measuring PA levels
- Currency dispenser to deliver the games' currency

#### 5.4.2.1 The Device Measuring PA Levels

At this stage, it was still unknown what device measuring PA should be chosen for evaluating 'Boost Up!' in the next enquiry.

In UCE2, participants seemed to prefer using heart rate monitors (as presented in 5.2.1.1) however this might be due to the poor design and quality of the pedometer. Therefore more research was conducted around the use of heart rate monitors. Keytel et al. (2007) demonstrated their effectiveness to measure energy expenditure without calibration across a range of individuals different in age, fitness and morphology. However this was done in a lab-type setting and it is unclear how effective giving heart rate monitors to 11-12 years old adolescents for self-use would be. For instance placing the monitor at the right place on the adolescent's chest is crucial yet doing this task without supervision may be tricky to ensure gathering reliable data. Furthermore, 'Boost Up!' V4 requires players to wear the device measuring PA on a daily basis and for an extended period of time; asking adolescents to put on a chest strap and a data logger is likely to be a disincentive (i.e. seen as a task) and/or intrusive.

What is clear from UCE2 is that the device chosen to monitor PA should be easy to use on a daily basis, as unobtrusive as possible, and sufficiently accurate to measure the various intensities of PA (MPA, VPA, and sedentary time). Understanding how PA intensity can be measured was even more important than the system created to award currency was based on PA intensities (see Appendix 1.C.3). To do so, one option is to use Metabolic Equivalent Minutes or MET's.

Activity	Intensity	Intensity (METS)	Energy expenditure (Kcal equivalent, for a person of 60kg doing the activity for 30 minutes)
Ironing	Light	2.3	69
Cleaning and dusting	Light	2.5	75
Walking – strolling, 2mph	Light	2.5	75
Painting/decorating	Moderate	3.0	90
Walking – 3mph	Moderate	3.3	99
Hoovering	Moderate	3.5	105
Golf – walking, pulling clubs	Moderate	4.3	129
Badminton – social	Moderate	4.5	135
Tennis – doubles	Moderate	5.0	150
Walking – brisk, 4mph	Moderate	5.0	150
Mowing lawn – walking, using power-mower	Moderate	5.5	165
Cycling – 10–12mph	Moderate	6.0	180
Aerobic dancing	Vigorous	6.5	195
Cycling – 12–14mph	Vigorous	8.0	240
Swimming – slow crawl, 50 yards per minute	Vigorous	8.0	240
Tennis – singles	Vigorous	8.0	240
Running – 6mph (10 minutes/mile)	Vigorous	10.0	300
Running – 7mph (8.5 minutes/mile)	Vigorous	11.5	345
Running – 8mph (7.5 minutes/mile)	Vigorous	13.5	405
MET = Metabolic equivalent			

Figure 45 – Measuring intensities of PA (DH, 2011)

> To ensure the effectiveness and validity of the measurement, the intensity of the various activities undertaken (light/moderate/vigorous) or not throughout the day can be measured through energy expenditure or METs (metabolic equivalents task). METs measure the amount of energy expenditure above the energy required at rest and can be used as a common measure across persons of different weight. For example, VPA is detected for all minutes above a certain MET value.

#### 5.4.2.2 The Currency Dispenser

As a result of the iterative tests undertaken in DRE3, an 'ideal currency dispenser' was created. It allowed storing the main currency (three strands with the beads) and all the cards – bonus cards to play with both games (i.e. second currency) as well as the character cards deck (i.e. 'Boost Up!' themed card). Made of plastic (ABS), the design of the dispenser was robust enough to be carried around and to limit cheating. However this 'ideal currency dispenser' (described in more details in Appendix 1.C.4.3) was very expensive and slow to manufacture, which raised issues about delivering the right number of boxes (one per player) in time for the next user-centred enquiry. Therefore a more affordable prototype needed to be created.

### 5.5 '*BOOST UP!*' V4 TO EVALUATE

Boost Up!<sup>TM</sup> is made of two games and has various components that are presented in this section:

- A device to measure the intensity of PA levels (MPA, VPA, and sedentary time) since it is the way to deliver the main currency (see Appendix 1.C.3.1);
- A currency dispenser to deliver the main currency that is suitable to play both games;
- The second currency manifested as bonus cards;
- The card game;
- The board game and its components.

All these points above are presented below and it is the version of the game presented in this section that is evaluated in UCE3.

### ***5.5.1 The Device Measuring PA Intensity***

The 'Fitbit Ultra' fitness tracker measures METs/intensities of PA and seemed particularly suited to the intervention holding the following properties:

- Not too intrusive: Fitbit can be clipped anywhere on the user's body and still measure PA intensities;
- Adapted for measuring PA in relation to the health recommendations and for the currency award system since PA intensities are determined by MET values, given in Fitbit through an 'Active Score'. Fitbit gives METs independently of the users' weight or height unlike the calories burnt statistics for instance. PA intensities are determined by the MET values and based on thresholds: Sedentary Activities MET = 1; Light Intensity Activities MET = 1 to 3; Moderate Intensity Activities MET = 3 to 6; Vigorous Intensity Activities MET > 6.
- The technology embedded in this fitness tracker is well developed and can recognise the type of movement or activity undertaken and if it possible to be performed by a human. Using a combination of distance, time, and elevation to measure an activity, it will not record movements that are not within certain defined parameters. This allows it to detect instances when users may be taking a lift, be in a plane or a car for example.

Based on these parameters and the needs expressed by UCE2, the Fitbit fitness tracker was chosen for measuring the participants' PA levels in the next user-centred enquiry.

### ***5.5.2 Delivering the Main Currency***

This section presents what the final currency dispenser prototype is as well as how the currency is earned.

#### ***5.5.2.1 The Currency Dispenser Prototype***

As stated in 5.4.2.2, a more affordable currency dispenser was needed, as presented in Figure 46.



Figure 46 – Reducing the cost of manufacturing the V4 dispenser (main currency)

> Only the core system displaying the main currency (i.e. buttons allowing the beads to pass from one compartment to another) was manufactured on the rapid prototype and inserted into a card-board box. This considerably reduced

cost and manufacturing time. An Allen key system was adapted to the new box to limit cheating.

> To facilitate the reading of the currencies in the box, colours for each feature were assigned and were consistent with the features displayed on the character cards: Blue corresponds to 'Attack' (VPA), Orange to 'Defence' (MPA), and Yellow to 'Energy' (time spent non-sedentary). Figure 1AJ in Appendix 1.C.3.1 shows how this main currency is generated (i.e. how a colour matches with a feature).

> The card-board box was compatible with the card game. As explained in more details in Appendix 1.C.4.3, players can 'bet' with their main currency to increase a character card's feature when playing the card game, yet the rest of the currency must be hidden from others. This is why both compartments at the extremities of the box have shutters allowing masking the currencies left/burnt.

#### 5.5.2.2 The Main Currency Framework

The framework established to award the main currency was created with the aim of rewarding players who are most active without discouraging the least active (i.e. the least active still have a chance to win). This is why the main currency (beads for Attack/Defence/Energy) was awarded based on an individual performance and the secondary currency based on the health recommendations. Hence the more VPA detected by the fitness tracker, the higher the 'Attack' is; the more MPA, the more 'Defence' players accumulate; but the higher the levels of sedentary are, the less 'Energy' players get. The idea is that players compete with themselves through their average performance ('baseline') that is set when entering the game. This baseline gives players a currency of 5 beads and can be used to inform each player how active they are compared to their set baseline: more than 5 beads (up to 10) means they were more active whereas less than 5 means they have been less active. Increasing levels of MPA or VPA by 10% compared to the baseline awards players 6 beads (respectively for the 'Defence' and 'Attack'). However sedentary levels must decrease by 10% in order to earn 6 beads (for 'Energy'), by 20% for 7 beads, and for decreases

up to 50% players will earn 10 beads. The same process is applied when players are falling below their baseline levels, where -10% awards only 4 beads, -20% awards 3 beads...

### ***5.5.3 Bonus Cards when Meeting Health Recommendations***

The main currency is awarded based upon a player's own performance however bonus cards are given to players meeting health recommendations. Players in 'Boost Up!' can hence earn four bonus cards:

- No recommendations were found about the amount of VPA to do, only that it should be done at least three times a week; therefore a first bonus card was given when VPA was done three times a week.
- When players reach the 60 minutes of MVPA recommended, another bonus card was earned.
- The notion of regularity being important, if players maintained regularity in their MVPA levels from one day to another (or one week to another) they earned a third bonus card.
- When meeting all the recommendations, players were given an extra card, the 'Joker', allowing them to use it as any of the bonus cards presented below.

Therefore earning the bonus cards becomes a secondary goal as suggested by Munson & Consolvo (2012).

#### **5.5.3.1 Card Game Bonus Cards**

Four bonus cards can be earned according to the recommendations. The card 'Boost' can be secured for a full week although 'Double' and 'Switch' or '2 Rounds' (according to the strategy a player wants to adopt) are cards earned on a daily basis. The 'Joker' card, which can be used as any of these cards, is awarded when all the daily and weekly cards have been earned: hence a player needs to have earned the 'Boost' card for a week as well as the daily cards to earn the 'Joker'.

For instance, when doing VPA at least three times a week, a ‘Boost +5’ is given for the whole week; when players do 60 minutes of MPA a day they get the ‘Double’ bonus card for that day; when doing at least the equal amount of MVPA from one day to another, players choose between ‘Switch’, and ‘2rounds’. – see Appendix 4.C.6 to learn more about the meaning of the cards.

### 5.5.3.2 Board Game Bonus Cards

The bonus cards given for the board game are awarded in the exact same way and they are also valid for one turn only.

However bonus cards in the board game boost the player’s character’s features: VPA three times a week awards ‘+10 Attack’; 60 minutes MVPA a day awards ‘+10 Defence’; and an equal amount of MVPA from one day to another awards ‘+10 Energy’. – see Appendix 4.B.3 to learn more about the meaning of the cards.

### 5.5.4 The Card Game



Figure 47 – Character cards

> Character cards, used to play ‘Boost Up!’ themed card game, feature different characters, animals, ‘cute’ creatures and monsters as suggested in UCE1 & 2.

The character cards' values were re-adjusted to have more variances between weak and strong cards. Colour coding of the currencies was applied to facilitate the reading/betting when playing the game.

> See Appendix 4.C to read the full rules and see all the cards.

### 5.5.5 The Board Game

The board game is composed of four main components: the board, the chance cards, a set of tokens, and the health cards.



Figure 48 – V4 Board Game and the cards to play with

> See Appendix 4.B to read the full rules and see all the cards.

#### 5.5.5.1 The Board Game

The board game includes five levels that correspond to five opportunities for players to do health challenges (green crosses on the sides of the board). The 'evolving' landscape visually reinforces the different levels as players 'travel' to get to the 100<sup>th</sup>

square (starting from the sea and ending up in space). See Appendix 4.B to read the full rules and see all the cards.

#### 5.5.5.2 The Chance Cards

The Chance cards enable players to avoid map traps or attacks. Even though some of these chance cards do allow players to affect each other's moves ('Galactic Attack', 'Reverse', 'Freeze'), they are inherent to the board game and have nothing to do with the bonus cards.

'Teleport', 'Super Freeze', 'Galactic Attack', and 'Reverse' cards affect only the players owning them and are therefore used during their turn. All the other chance cards can be used during another player's turn (i.e. to counter an eventual attack). For instance if a player receives a 'Universal Shield' at the start and lands on square 15 (the whirl), this player can use this card to avoid going back to the start or he/she could also keep that card for later in the game if an opponent tries to attack. Another example is the use of the 'Reverse' card against an opponent: played during one's turn it will only affect the chosen opponent during his/her next turn since he/she needs to throw the dice.

#### 5.5.5.3 Health Cards/Challenges ('PA into Gaming')

Based on the success of the PA squares when testing V2 (see 5.2.2.3), Health cards were created. Yet instead of having only one type of challenge for all players, the iterative tests (see Appendix 1.C.2.2) resulted in created three categories of challenges based on the intensity of PA to execute:

1. The 'Fun' category allows players to move around, even if it is low intensity (e.g. 'juggling time (e.g. football, tennis ball, juggling ball) for 1 minute);
2. The 'Skills' category (e.g. 'Hoola Hoop for 30sec') requires a moderate intensity;
3. The 'Strength' category (e.g. 'do as many push-ups as you can for 30 seconds) requires players to move vigorously.

Each category of Health card rewards the player according to the intensity of PA (i.e. the more intense the PA is the higher the reward). Having three categories (Fun = +2;

Skills = +4; Strength = +6) may increase engagement since more options are available regarding the intensity and difficulty of a challenge and may therefore be more suitable to all player profiles (i.e. with different levels of self-efficacy to perform in front of others).

Health challenges are optional and it is only when going from one level to another that players decide whether they want to execute a challenge and which category. To further encourage players taking challenges, a card rewarding them for taking a challenge but which did not ask to execute any challenges at all (i.e. only 'congratulations for taking a challenge') was created in each category.

Health cards are used at any time during the game to increase the players' character features.

#### 5.5.5.4 Tokens

Legos tokens were used again but more figures were provided for V4 since there will be more players and also since participants in UCE2 asked more choice of accessories.

## **Chapter VI- Findings**

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The previous chapter presented the data that was used to develop the design of the game (under the 'designer hat'). This chapter examines the data generated under the 'researcher hat'. Sections 6.1 to 6.4 relate to the evaluation of 'Boost Up!' V4 during UCE3. Section 6.1 reports the relation between the participant's PA levels and their playing of the game while section 6.2 reports the perceived change in PA from the participants' self-analysis. Section 6.3 describes 'dosing' findings that have been made during the intervention to increase engagement and 6.4 summarises the findings from the qualitative review of the game as discussed in the last workshop of UCE3. Even though these four first sections provide input to further develop the design of the game, they have also been made explicit to others (and therefore comply with the criteria of research given in Chapter III). Section 6.5 reports the findings that came out from the 'reflective narrative' analysis conducted in DRE4, which aimed at pulling out the key events that informed the design development of the game as well as those that led to creating knowledge.

### **6.1 'BOOST UP!' V4: PARTICIPANTS' PA LEVELS & FITNESS TRACKERS**

This section reports the PA levels obtained throughout the fitness trackers used during the evaluation of 'Boost Up!' V4 that took place during UCE3.

#### **6.1.1 Fitness Tracker Readings**

Data from the fitness trackers, reported in Figure 49, provided no evidence to suggest that the game succeeded in increasing the PA behaviour of participants.

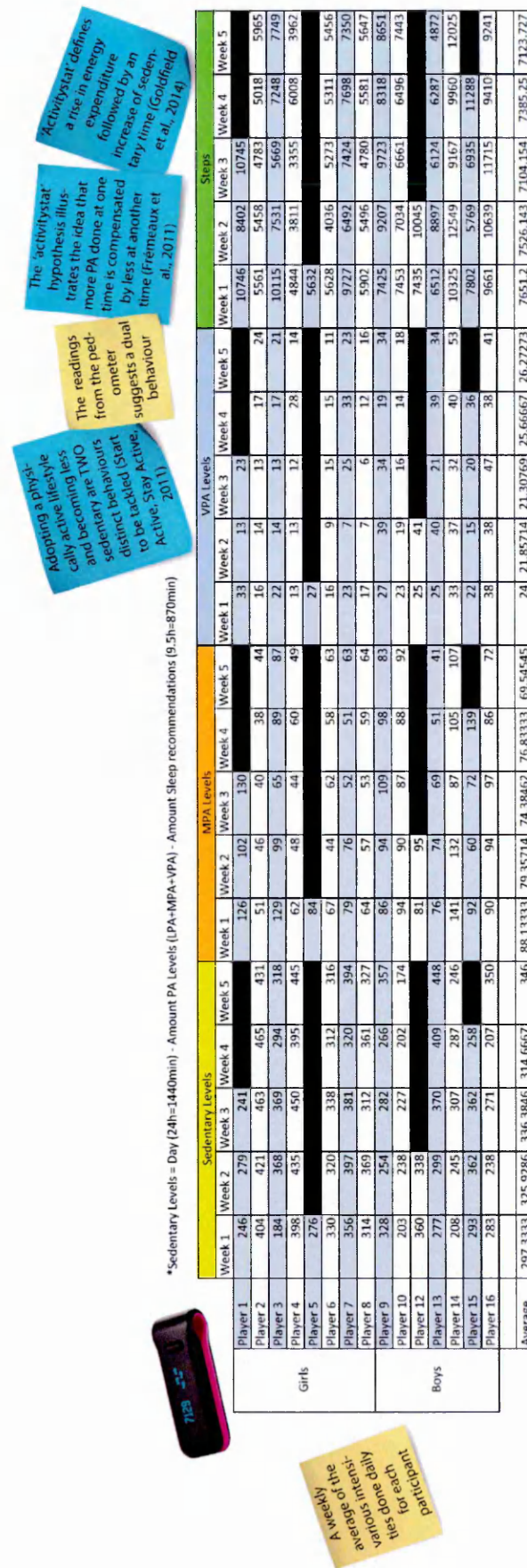


Figure 49 – Readings from the Fitbit's data

> Mean Fitbit data suggested an increase of sedentary levels (W1=297 vs W5=346), a decrease in the MPA levels (W1=88 vs W5=70), a slight increase in VPA levels (W1=24 vs W5= 26), and a slight decrease in the number of steps (W1=7651 vs W5=7124). The table in Figure 50 shows a summary of the averages (in minutes and steps) done by the participants every week for each level of PA intensity:

	Week 1	Week 2	Week 3	Week 4	Week 5
<b>Sedentary Time</b>	297	326	336	315	346
<b>MPA</b>	88	79	74	77	70
<b>VPA</b>	24	22	21	26	26
<b>Steps</b>	7651	7526	7104	7385	7123

Figure 50 – A summary of the participants' averages of PA on a weekly basis

> The Fitbit data showed very high levels of MVPA in comparison to the number of steps: statistics show a MVPA average per participant of 88 minutes per day which is above recommended thresholds of 60 minutes of MVPA. 60 minutes of MVPA is equal to 12,000 steps (Colley et al., 2012) however the average number of steps a day in this enquiry was of 7,358. The number of steps in this enquiry hence had a higher average a day of MVPA but a lower average of steps. This level of variation has been observed in previous studies where pedometers either underestimated levels of intensity (Baranowski, 2013) and/or reported high variations in step count corresponding to 60 minutes MVPA (Colley et al., 2012). More reliable and valid measures of PA behaviour are required.

Figure 51 shows the intensities of the PA levels only for the participants who were monitored throughout the whole UCE3 intervention (i.e. those who did not drop out or lost the pedometers) unlike the readings shown in Figure 49.

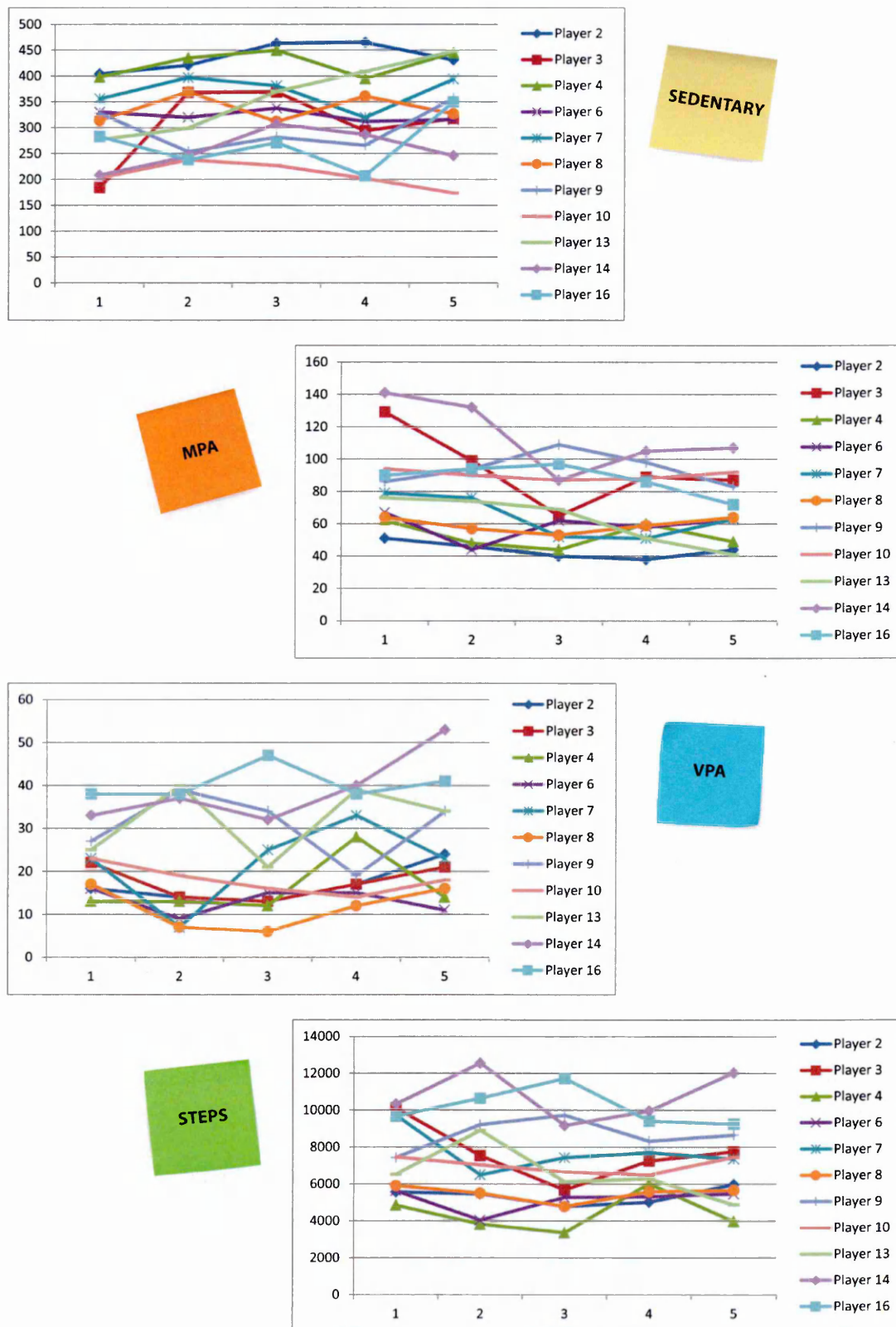


Figure 51 – PA levels of participants monitored until the last day of UCE3

> There was discrepancy when monitoring during the baseline: it generally seems that participants in Week 1 were particularly active and that a drop

occurred in Week 2. This suggests the baseline calculation may not have adequately captured the 'normal' level of activity.

> It also seems that PA levels were particularly low in Week 3 although there were some exceptions.

### ***6.1.2 Individual Fitness Tracker Readings***

In order to understand better how the game affected the participants, data from UCE3 was looked at an individual level to try detecting possible patterns among participants who did or did not engage with the game. This more detailed data analysis suggested that some of this group had a 'dual behaviour', which may be related to the concept of 'activitystat' (Frémeaux et al., 2011). Some participants increased VPA levels yet their MPA decreased; and some reduced the time spent sitting but their VPA also decreased. For instance over the last three weeks of the intervention, Player 4 (girl who did not seem engaging with the games) illustrated well this concept: Her sedentary levels dropped in Week 4 and increased again in Week 5 (W3=450, W4=395, W5=445) however both her levels of MPA (W3=44, W4=60, W5=49) and VPA (W3=12, W4=28, W5=14) decreased during those last two weeks. Furthermore, from Week 1 to Week 5, Player 10 (boy who seemed engaging with the games) decreased the time spent sedentary (W1=203, W5=174) however MPA and VPA decreased too (respectively W1=94, W5=92 & W1=23, W5=18). Further individual analysis applied to participants who seemed to engage with the games (e.g. attending the game club on a regular basis) is presented in Appendix 1.D.3.

## ***6.2 'BOOST UP!' V4: PA LEVELS VIA SELF-PERCEPTION***

This section reports the analysis of the 'pre' & 'post' questionnaires to measure the potential influence of the game onto attitudes and cognitions. Due to the size of the sample, inferential statistics were not appropriate and data here is therefore limited to descriptive. To fully explore the potential of 'Boost Up!' a larger sample is required.

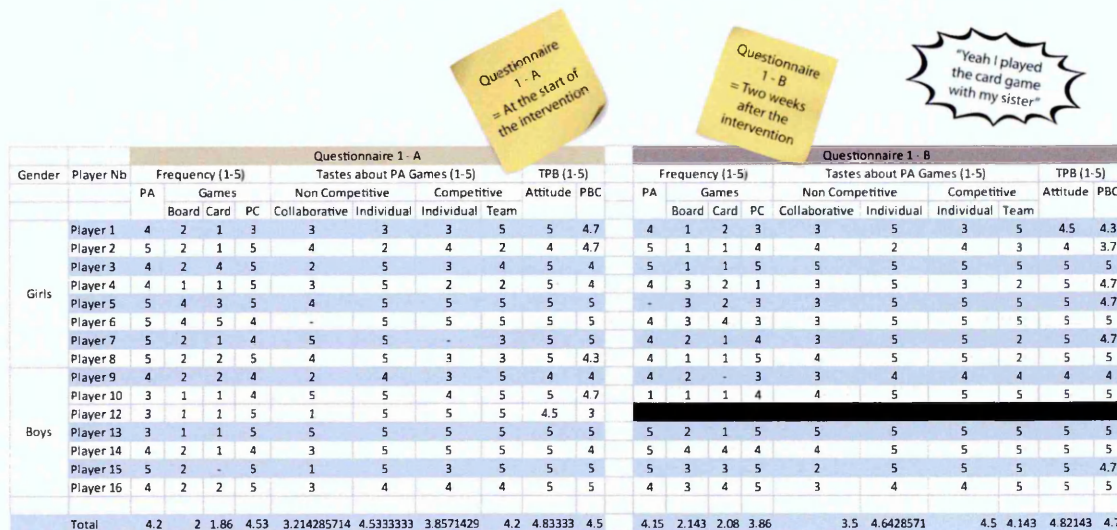


Figure 52 – Q1A & Q1B results to measure a potential change from the intervention

- > No significant changes (n1A=4.2 vs. n1B=4.15) were observed in the frequency of the participants' PA.
- > Attitude towards PA remained the same (n1A=4.83 vs n1B=4.82) and there was no change in the confidence of participants to engage in PA as described by Perceived-Behaviour-Control (n1A=4.5 vs. n1B=4.7).
- > There was no change observed in terms of participants playing card games (n1A=1.86 vs n1B=2.08) – one player played the card game outside of school – or board games (n1=1.86 vs n1bis=2.08). Interestingly, a reported decline in time spent playing computer games was reported (n1A=4.53 vs n1B=3.86).
- > All participants recorded high levels of Perceived-Behaviour-Control and positive Attitude (averages respectively of 4.6 and 4.8 out of 5) towards PA.

The fitness trackers' data did not show any increase in the participant's levels of PA – instead an increase of sedentary levels and a decrease in the MPA levels – however questionnaire 2, given to the participants in Workshop 6 and available in 6.C.2, revealed that the participants perceived themselves being more active. This has previously been observed elsewhere, suggesting that children have an internal 'activitystat' (Frémeaux et al., 2011) which governs the amount of PA they engage in.

### 6.3 'BOOST UP!' V4: 'DOSING' FINDINGS

This last enquiry (UCE3) intended to find out whether 'Boost Up!' V4 increased PA among participants however the game in its current form is not a success. Yet through adopting a mixed method approach (described in 4.7.5) the gathering of qualitative data did enable an exploration of how to increase engagement with the game to design a more stand-alone intervention. This qualitative data (e.g. interactions with the participants at the shop, game club, observation) led at various moments during the intervention to adapt the original plan due to the reality of the situation – this process is in line with dosing aspects of explorative studies Kato (2012b) speaks about.

#### 6.3.1 Resetting the Baseline

The original baseline was based on the first two weeks of the intervention and considered participants PA behaviour prior to introducing the 'Boost Up!' concept or games.

- Observations

In week 4 it was noticed that the baseline was a source of disengagement, either by overestimating or underestimating one's average level of PA. This meant it was easy for those with underestimated baseline values to reach the average set during the baseline (getting 5 beads a day) while those with overestimated baseline values had difficulty reaching their 'average'. In both cases, this seemed to discourage participants.

- Interpretation & Re-adjustment

In week 5 the baseline was reset by taking an average over the past four weeks (i.e. since the intervention started) for each level of intensity (Sedentary, MPA, VPA). Support for this approach is found in the work of Lieberman (2013) who suggests that games should be progressive and incremental and must evolve according to the players' changing abilities. Furthermore adapting the difficulty of the game to the players' performance is crucial (Lieberman, 2006; 2013). This adaptation refers to the notion of goal attainment and goal proximity highlighted by Gollwitzer (1993), and reinforced by Munson & Consolvo (2012) who stipulate goals should be important to

the individual, realistic, with an access to progress and positive feedback. It therefore seemed appropriate and within the scope of the gaming paradigm to reset players' baseline and keep the game challenging. Having a new baseline seemed to 're-engage' some participants although it is unclear whether this was solely due to resetting it (i.e. other factor(s) might have been affecting their engagement).

### ***6.3.2 A More Inclusive Game Club***

- Observations

Although the designer/researcher was encouraging participants at the shop to come to the game club, only a few participants attended twice during the first week after the opening of the game club. Participants were selected from three different classes and did not really know each other; if they cannot hang out with their peers during breaks, it may be unlikely that they would choose to play together.

- Interpretation & Re-adjustment

In Week 4, the game club opened up to non-participating friends, which seemed to increase engagement: only one day out of the two remaining weeks showed zero attendance, suggesting the importance of social interactions. Yet since participants came with friends who were not part of the intervention, rules of the games had to be adapted so that 'non-participants' who did not have any currency to play the games (i.e. beads and bonus cards) could play too. However adapting the rules that way meant the PA participants did was excluded from the game play and did not give any rewards anymore.

### ***6.3.3 A More Inclusive Currency***

- Observations

The data obtained during the baseline showed a high disparity in the PA levels with a sample of participants being generally quite far from the recommendations of 12,000 steps a day (Colley et al., 2012). Across the baseline, averages per day were 8,180 steps (min=3,811 max=12,549) and 319 minutes spent sedentary (min=203 max=435).

- Interpretation & Re-adjustment

The second currency was awarded when meeting health recommendations (see 5.5.3) however, if a big majority of players do not meet the recommendations, as was the case with this sample (11/14 did not meet daily recommendations), they will not be awarded with bonus cards, which will exclude one aspect of the game play and potentially negatively impact motivation. The framework for awarding bonus cards was hence adapted to ensure at least one bonus card for each player was awarded, even for the least active.

Getting to know the individuals to tailor the goal(s) as well as incorporating self-regulatory procedures (goal setting, goal review and problem solving) is crucial to achieve goals, which has shown to lead to more effective results in behaviour change by initiating and maintaining engagement (Baranowski et al., 2008; Lieberman, 2006). Achieving goals gives a sense of control and develops self-efficacy (Lieberman, 2006), a crucial construct to increase PA (Dishman et al., 2006).

Hence Bonus cards were instead awarded based on the number of steps and two extra bonus cards were added to cover all the differences of steps in the participants' performance (with a maximum of 6 cards to earn instead of 4). The revised version of the framework consisted of awarding players with a bonus card when doing at least 4000 steps a day, however 16000 steps were needed to earn the 'Joker' card. Refer to Appendix 1.D.1 and 1.D.2 to see how the award of the Bonus cards (i.e. based on the participants' daily number of steps) differed from what was presented in V4 (in 5.5.3).

#### **6.4 POST-INTERVENTION DISCUSSION**

This section reports the main feedback given by the participants during the focus group discussion that took place in the last workshop of UCE3:

- The board game was preferred to the card game;
- Participants were worried about losing the fitness tracker;

- Some pupils found that the box inserted in a bag appeared to be too big and not handy to carry around school on a daily basis;
- It was reported there was not enough variety of games to play;
- Some participants felt that there was not enough PA done while playing the game;
- It was not clear how well the participants understood the way the currency was awarded (VPA=Attack, MPA=Defence, Non-Sedentary=Energy, & Steps=Bonus Cards);
- Some participants who did not engage in playing the games reported there should be more variety of games to play and not necessarily based on an 'avatar' traits (i.e. to not translate the various intensities of PA into 'Attack', 'Defence' and 'Energy');
- Even those who did not engage in playing the games suggested creating games that are Hybrid (e.g. a board game with electronic components);

### **6.5 THE 'REFLECTIVE NARRATIVE' ANALYSIS**

This section presents the 'Reflective Narrative' analysis conducted in DRE4, which consisted of distinguishing the sequences of events that were used to develop the game to those leading to generating knowledge (as described in 4.8.2). Knowledge in this research was generated through repetition. It is therefore only by identifying which tacit hypotheses (e.g. an identified theme from a UCE) were repeated across UCEs, that (tacit) knowledge can be claimed. It is important to highlight that an identified theme at the time might have been judged engaging (which is a hypothesis) and used to design the next iteration of the game, but it was not necessarily claimed as knowledge if there was a lack of evidence. For instance the credit card idea invented by participants in UCE2 were appreciated by everyone and it was hypothesised at the time that the 'Real-World Based / Replicating Adult's Behaviour' theme might be engaging. Even though this theme was also found in Schell (2010) and that this credit

card idea was used as a basis to develop the currency dispenser in the following phase of the design development of the game, this theme was not claimed as knowledge as it was lacking of evidence beyond the one example occurring in one case study. Therefore DRE4 consisted of reviewing the data of the overall research to decide whether it was legitimate to claim the theme in question as knowledge (e.g. is it common across multiple UCEs? Is there anything relating to it in the literature?).

To demonstrate that this knowledge was ‘true’ or reliable (i.e. and not merely an interpretation of the designer/researcher), there was a need to show its provenance (i.e. where it came from). This was possible through creating the Annotated Design History (see 4.8.4), as a way to illustrate the data gathered so far. These ‘Annotated Design History’ visuals were already introduced throughout chapter V since they illustrate the various snippets of data that affected the design development of the game.

#### ***6.5.1 A Summary of the Design Development***

To show how the key events in UCEs influenced the creation and development of ‘Boost Up!’ (under the ‘designer hat’), a series of posters were done using the Annotated History visuals to illustrate the content. These posters are the result of the Chronological Research Timeline presented in 4.8.2 and they can be found in Appendix 2.A. The posters summarise the key events that informed the development of the:

- Board game;
- Card game;
- Currency dispenser.

#### ***6.5.2 Making Knowledge Explicit***

As discussed in chapter III, testing the game in context with end-users revealed knowledge about how to engage or increase engagement of these 11-12 years old, which in turn informs the next phase of the design development of the game. After having done the chronological Timeline, two other posters were compiled in a way that is similar to those referred in 6.5.1. The first one presents the data that was

gathered around the acceptability of pedometers against heart rate monitors (see Appendix 2.B.1). The second poster compares the two games played during UCE2 and UCE3 that promoted engagement (respectively the PA challenges played with ACTIVIO and the Health Cards played with the board game) – see Appendix 2.B.1.

As a result of this activity, the identified knowledge was developed around:

- Engaging factors that are effectively game properties that can be used to further design ‘Boost Up!’ or for other designers to create new ideas of games (in the context of PA promotion or not).
- The viability of the Two-Stage concept to promote repeated play & PA;
- The device measuring PA (i.e. to increase their engagement and acceptability);

### **6.5.3 A List of Engaging Factors**

As discussed in Chapter III, recurring themes across different UCEs provides reliability about these ideas and hence become valuable for designing engaging games (that promote PA). Undertaking a grounded theory approach across the three UCEs (under the ‘researcher hat’), the thematic grouping that took place in DRE4 led to the identification of a list of 11 themes (i.e. engaging factors):

- |                       |                         |
|-----------------------|-------------------------|
| ○ Multi-Use           | ○ Appropriation         |
| ○ Choice              | ○ Simple / Simplicity   |
| ○ Life / Lifestyle    | ○ Visual Representation |
| ○ Real Time / Instant | ○ Two-Stage             |
| ○ Novelty             | ○ Device Measuring PA   |
| ○ Social              |                         |

To show transparency to the process, a table summarising the data of all enquiries (DREs & UCEs) that led to identify the theme in question was created for each theme. The tables are therefore a way to recover the data and show how the themes

emerged. The raw data reported in the tables is illustrated again by using the visuals in the ‘Annotated Design History’, which encompass a combination of snippets of data:

1. Found in the literature or the literature supports the viability of the theme in question;
2. Coming from a participant’s comment, feedback and/or creation during UCEs;
3. Coming from the designer/researcher’s observation and/or interpretation, which were then used as a way to generate ideas by embedding the theme in question into games’ concept, component, and/or into the device measuring PA.

#### ***6.5.4 Examples of Themes Tables***

Below are three examples (Figure 54-56) of the tables created for the themes along with a written description of the content of the table in question to show how each theme was identified and manifested across the enquiries. The list of themes (i.e. engaging factors) along with the raw data (i.e. table) for each theme can be found in Appendix 2.B.2. In said appendix, a detailed explanation is given to illustrate the content of each table through using the annotated design history.

Abbreviations				
Themes		Attributing Data to X number of Participants		Other
Theme Category	How the Theme Emerged	Number of participants	Coding	
1 = Game concept that seemed engaging	D/R = The theme was embedded into a design response produced by the Designer/Researcher	1	*	DRE = Designer / Researcher Enquiry UCE = User-Centred Enquiry W = Workshop within an UCE
2 = Game Content or Components that seemed engaging	P = The theme emerged from analysing the participants' feedback or creation	2<x<4	**	V1 = First concept of 'Boost Up!'
3 = Elements about the Device that seemed engaging	L = a- Theme identified in the Literature as engaging / worth exploring b- The theme seemed useful in relation to what the literature suggests	5<x<8	***	V2 = First prototype of 'Boost Up!'
		Focus Group Discussion/Activity	****	V3 = Second concept of 'Boost Up!'
				V4 = Second prototype of 'Boost Up!'
				PA = Physical Activity MPA = Moderate Physical Activity VPA = Vigorous Physical Activity MVPA = Moderate-to-Vigorous PA HRM = Heart Rate Monitors SE = Self-Efficacy

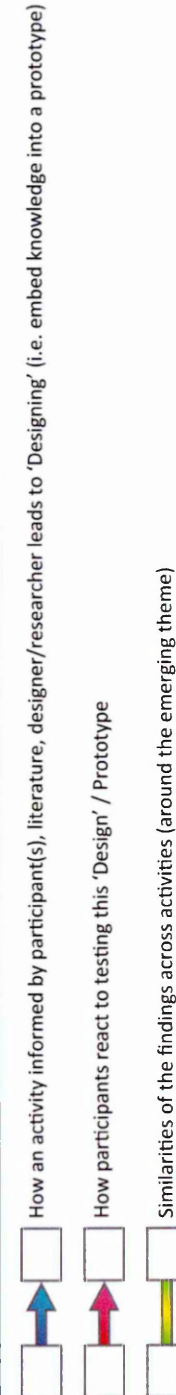


Figure 53 – Caption to read the Themes Tables below

Theme	Enquiries	DRE1	UCE1	DRE2	UCE2	DRE3	UCE3
>Visual Representation (Feedback) is crucial since it was found:  3- To be an incentive, not necessarily to satisfy curiosity but to do better / more / or to be active (e.g. Evolving Graphic)  2- Tangible representation seemed to be an incentive - Explore fixed vs customised (instant) rewards  1,2&3- Numbers might enhance the misperception (i.e. be too brutal) or confusing, which can be disengaging	D/R	1- "Katie goes home after a full day of PA and compares it with her friends" (W2) ****  1- Sharing certain info (e.g. where you live) can be sensitive) – (Fun Day) **  1- "fail can be funny but you can't fail too hard" + "it can be annoying when you don't succeed... & you get laughed at" (W3) ****	1,2&3- Participants agreed on importance of visually representing PA levels (W1+3) ****	1,2&3- What's the best way to represent one's performance? E.g. Mario Kart ghost car as they seemed to be keen on beating their own performance.  The 2 boys kept going up and down the stairs to get as many floors as possible on the Fitbit (Family Tests) **	1&2- Using numbers to report the PA performance (i.e. through Individual Framework) could be seen by others & was confusing (W3+6) *  1,2&3- Participants thought they were doing more PA than they actually did (Shop) ***	3- The number of steps (and the time too) were often checked (W6) ****  3- "did it record yeah the flower was on all day long" (Shop) *  2- "can I take a look at my beads I did loads of PA last Friday" (Shop) *  1&2- "you might do 10 push-ups so you would get +10 bonus card" (Shop) ****	
	P	b- Sharing should give the option to approve or disapprove one's behavior (Michie et al., 2011) since it has motivational factors but should be done infrequently (Munson & Consolvo, 2012)	1,2&3- "graph of PA with bars is good coz it's clear and easy to read" (W1) ****  1,2&3- it's good to know how healthy you are" / "...to improve" / "... to know when to stop" (W3) ****  1&2- "watching others' performance is none of your business" (W3) *	b- Behaviour change is abstract & representing it visually was found effective (Gray et al., 2013)	b- Making achievements visible (even for one self only) is rewarding (Munson & Consolvo, 2012)	b- Evolving graphics was found effective (Munson & Consolvo, 2012)  b- Misperception of PA was found in Prince et al (2008) + 'Activity Stat' (Frémeaux, 2011)	
	L	1,2&3- Yet 'privacy' is of concern (i.e. choosing who to share one's performance with)					

Figure 54 – Demonstrating the validity of the 'Visual Representation' theme

> The visual representation of one's PA performance is an important factor to promote PA since it was found to be an incentive to do better, more, or to be active (first point in the left column). This was concluded from:

- One of the games created by the participants in UCE1 around the persona 'Katie' ('P' line of UCE1 column). In this game, participants gave the possibility to Katie to see her performance and compare it with her friends;
- The designer researcher analysing data gathered during Workshop 1 & 3 in UCE2 ('D/R' line in UCE2 column). Data here refers to feedback given by the participants when critically analysing existing examples (e.g. first box in 'P' line of UCE2: "graph of PA with bar like in Zamzee is good because it is clear and easy to read" – Workshop 1) and questionnaire given in Workshop 3 after experiencing the ACTIVIO system (e.g. second box in 'P' line of UCE2: "it is good to know how healthy you are" / "...to improve" / "...to know when to stop");
- The Literature ('L' line UCE2 column) positing that Behaviour change is abstract and representing it visually was found effective (Gray et al., 2013);
- Experiences around the device measuring PA (as the number '3' refers to), as shown in the two first boxes in the 'UCE3' column of the 'P' line. The first box in the 'P' line of UCE3 refers to the participants' feedback given in Workshop 6 of UCE3, during which most of them agreed that the number of steps (and time) were often checked. The second box corresponds to a participant's comment done at the 'Shop' about the flower on the fitness tracker (that grows when being more active) being an incentive to do PA;
- The literature ('L' line UCE3 column) and more especially Munson & Consolvo (2012) who reported that evolving graphics was found effective;

- Tests led in a family ('P' line DRE3 column) and during which the two boys were competing with each other to get the highest number of floors on their fitness tracker (i.e. they were running up and down the stairs).

> Activities around the game content or component (number '2') also suggested that representing one's performance in a tangible way also seemed to be an incentive (second point in the left column). Support for this can be found in:

- UCE3 and more especially at the 'Shop' where some participants were keen in finding out how many beads they had earned and where they suggested the reward should be tangible as well as proportional to the effort (e.g. "you might do 10 push-ups so you would get +10 bonus card) – Boxes 3 and 4 from 'P' line UCE3 column. This suggests doing more research around the use of rewards and whether they should be fixed (e.g. + 10) or customised (e.g. proportional to the exercise);
- The Literature ('L' line UCE2 column) positing that Behaviour change is abstract and representing it visually was found effective (Gray et al., 2013).

> Using numbers as a way of representing one's performance has shown in this research being problematic (third point in the left column) since it might:

- Be confusing: it was observed in Workshop 3 that when the individual framework was presented to them (first box in 'D/R' line UCE3 column), participants started to compare their numbers (i.e. what was the number of minutes needed to earn a specific amount of beads). However since the framework was based on each individual's baseline, the most active players hence had to do more minutes than the least active. Participants from this age seemed to struggle understanding, which confused them. This was confirmed by the participants when giving feedback in Workshop 6;

- Enhance misperception: since there seemed to be a lot of misperception between the amount of PA participants thought they did and what they actually did (second box from 'D/R' line UCE3 column), using graphics and colour coding to show which category a player belongs might avoid confusion. Exploring further how to best visually represent an activity might be particularly useful in this regard to avoid misperception of PA (as found in Prince et al., 2008) and reduce the 'activystat' (Frémeaux et al., 2011) by raising awareness of their own behaviour.
- > It is also important to consider the question of privacy when representing one's performance (fourth point highlighted in blue in the left column). This appeared to be true through the:
- Feedback written by a participant during the Fun Day event in UCE1 who highlighted that sharing certain information (e.g. where you live) can be sensitive (second box from 'P' line UCE1 column);
  - Questionnaires filled in Workshop 3 of UCE2 after experiencing the ACTIVIO system where it was reported that "watching others' performance is none of [anyone] business" (third box in 'P' line UCE2 column);
  - Literature, which highlights the importance of making one's performance visible (Munson & Consolvo, 2012 – 'L' line DRE3 column) as a way of being able to share it infrequently (Munson & Consolvo – 'L' line UCE1 column) with the option to approve or disapprove one's behaviour (Michie et al., 2011 – 'L' line UCE1 column).

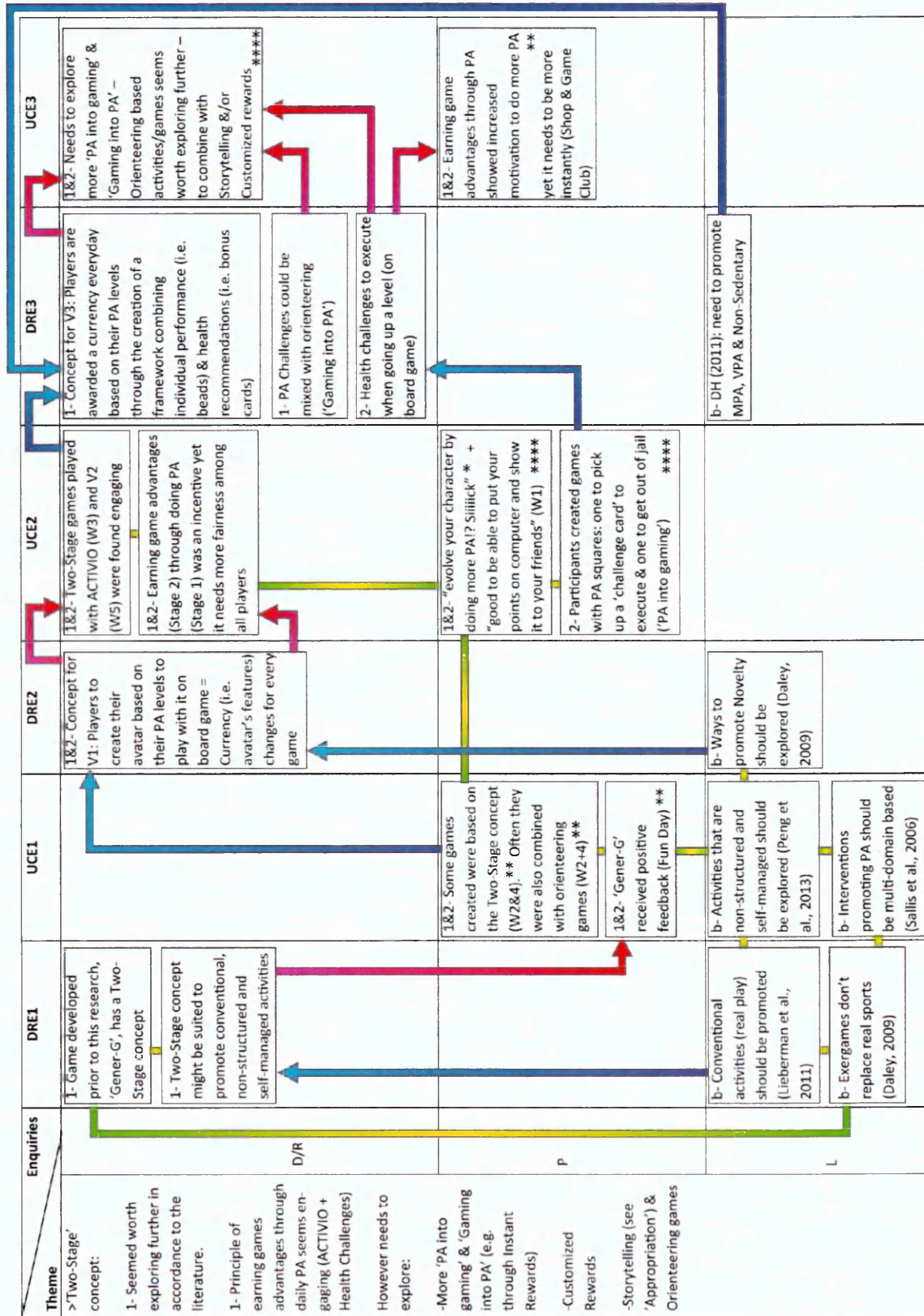


Figure 55 – Demonstrating the validity of the 'Two-Stage' theme

> The Two-Stage concept seemed worth exploring further at the start of the research (first point in the left column) since:

- It is a concept that was inherent to 'Gener-G' (the game created prior to this research) and which was appreciated when tested by a family (first box from 'D/R' line DRE1 column);
- It seemed particularly suited in relation to what the literature suggests (second box from 'D/R' line DRE1 column). This refers to:

-Promoting conventional activities (Lieberman et al., 2011 – first box from 'L' line DRE1 column) since exergames so far don't replace real sport (Daley, 2009 – second box from 'L' line DRE1 column);

-Exploring whether non-structured and self-managed activities could be promoted (Peng et al., 2013 – first box from 'L' line UCE1 column)

-Promoting PA based on multi-domains as suggested by Sallis et al. (2006 – second box from 'L' line UCE1 column);

- Some participants created games based on the Two Stage concept in Workshop 2 and 4 of UCE1, which also received positive feedback at the Fun Day event (respectively first and second box of 'P' line UCE1 column).

> This led to creating 'Boost Up!' V1 concept then tested iteratively in UCE2 and UCE3 (respectively 'D/R' line DRE2 column and 'D/R' line DRE3 column). This concept was then combined with the idea of bringing 'Novelty' to the game, which was presented as an important factor by Daley (2009 – 'L' line DRE2 column) to promote repeated play.

> There have been numerous instances throughout the research that also suggested that the Two-Stage concept or principle of doing PA to earning more

rewards seemed attractive as well as an incentive to doing more PA. This was the case when:

- Reviewing existing examples of Two-Stage concept in Workshop 1 of UCE2 (first box of 'P' line UCE2 column);
  - Participants created games with PA squares that required players to interrupt the play of the games to execute the PA challenges (second box of 'P' line UCE2 column) – this combined with the literature that suggested MVPA and non-sedentary behaviour should be promoted (DH, 2011 – 'L' line DRE3 column) was the basis for creating 'Boost Up!' V3 ('D/R' line DRE3 column);
  - Testing 'Boost Up!' V2 in Workshop 5 of UCE2 that participants reporting enjoying, even though it needed more fairness (first and second box from 'D/R' line UCE2 column);
  - Testing of 'Boost Up!' V4 in UCE3 during which some participants wanted to do more PA to earn more beads and bonus cards ('P' line UCE3 column).
- > Yet this Two-Stage concept needs more research ('D/R' line DRE3 column). One way to explore this further is to bring more 'PA into gaming' and 'gaming into PA' since both ACTIVIO challenges in UCE2 and Health challenges in UCE3 (i.e. 'PA into gaming') showed success to promote PA. This exploration could be done with the customisation of rewards, storytelling, and/or orienteering games that were identified as engaging (since reoccurring throughout the research).

Theme		Enquiries	DRE1	UCE1	DRE2	UCE2	DRE3	UCE3
<p>3- Device - Both Pedometers &amp; HRM were experienced &amp; compared. Even though HRM were not always attractive or comfortable, they were preferred to pedometers. Literature suggest HRM might be more appropriate too</p> <p>The Device should be: Reliable &amp; Fair when measuring PA / Not intrusive (possibility to hide it / Comfortable (not itchy) / Part of their Lifestyle (into accessories)</p>	D/R					3- 29% of participants (2/7) were still wearing the pedometer by the end of the study		Researcher insisted on the fact the pedometer given to them for the study was an expensive kit of technology they had to take care of (W1)
						3- Pedometers were found not functional (kept falling, buttons got in the way), not visually appealing, and not fair however their size was convenient – (W3) ****		3- 69% of participants (11/15) were still wearing the FitBit by the end of the study
	P					3- Heart Rate Monitors were found to promote fairness, adjustable and discreet, however not always comfortable to wear (itchy) or attractive (stigmatising). Being able to hide was judged important (W3+5) ****		3- Design of the FitBit and of its interface was liked and accessing the number of steps was an incentive (Shop+W6) ****
	L					b- Recommendations are of 60 minutes of MVPA on most if not all days of the week (NASPE, 2004). This corresponds to 12000 steps (Colley et al., 2012) although variations in the amount of steps between different countries, age groups, and ways of measuring PA (self-report and/or pedometer).		3- Fitbit used as a watch (i.e. to check time) – (W6) - see 'Multi-use' ****
						b- 60 minutes MVPA is between 10000 & 15000 steps (Tudor-Locke et al., 2011)		3- Pedometer was too small & it should be seen more (e.g. luminous) / It should be waterproof (for swimming) & incorporated into accessories (e.g. bracelet, necklace, belt...) - see 'Lifestyle' ****
						b- The aim of exergames is to increase the heart rate and respiratory rate to promote MVPA (Lieberman et al., 2011)		b- PA should be promoted as part of lifestyle: We need to be more active throughout the day (DH, 2011), for any type of activities undertaken (including conventional activities as suggested by Lieberman et al. (2011)), which would encompass the entire PA done across various domains as suggested by Sallis et al. (2006)

Figure 56 – Demonstrating the validity of the 'Device Measuring PA' theme

> Both pedometers and heart monitors were presented, discussed and experienced throughout this entire research, which allowed comparing them and ultimately gathering valuable insights and guidance to increase their acceptability among this age group.

> When comparing the basic pedometer with the heart rate monitor (through the ACTIVIO system) in UCE2, participants reported that heart rate monitors were preferred since:

- They were adjustable to body sizes, discreet (i.e. hidden under clothes) and found to promote fairness, an important aspect to these people. Yet they were also found uncomfortable to wear and unattractive (i.e. stigmatising) – second box in ‘P’ line UCE2 column;
- Pedometers were found not functional, not visually appealing, and not fair. Yet their size was convenient (first box in ‘P’ line UCE2 column).

> Even though the fitness tracker in UCE3 (i.e. Fitbit) was reported being too valuable (i.e. participants were scared to lose it) it was preferred to a basic instrument of measure (cheap and unattractive). This was concluded from a comparison between the pedometers experienced in UCE2 and UCE3:

- A basic and inconvenient pedometer was introduced throughout UCE2, and 29% of the participants were still wearing it by the end of the enquiry (‘D/R’ line UCE2 column);
- A more expensive and high-tech fitness tracker was introduced throughout UCE3 and 69% of the participants were still wearing it by the end of the enquiry yet this may be due to the designer/researcher insisting on its value (respectively first and second box in ‘D/R’ line UCE3 column).

> The feedback given by the participants in Workshop 6 of UCE3 concluded that:

- The interface was liked and accessing the steps in real time was an incentive (first box of 'P' line UCE3 column);
- The 'Multi-use' aspect it promoted (e.g. steps and time) was appreciated (second box of 'P' line UCE3 column);
- The fitness tracker was too small, should be seen more as well as being waterproof, and suggestions about incorporating it into accessories were mentioned (third box of 'P' line UCE3 column).

> The idea of incorporating the device measuring PA into accessories might be a way to measure PA throughout the entire day (i.e. as part of a lifestyle) and hence have a more representative measure of the activities undertaken, which seemed particularly relevant in relation to the literature ('L' line UCE3 column), since:

- We need to be more active throughout the day (DH, 2011);
- Any types of activities should be undertaken, which include conventional activities as suggested by Lieberman et al. (2011);
- PA done throughout all domains should be taken into account (Sallis et al. 2006).

> As a conclusion it is unclear if heart rate monitors were preferred to fitness trackers, however they need to be reliable and fair when measuring PA, not intrusive (with a possibility of hiding it), comfortable (e.g. not itchy), and part of the user's lifestyle (e.g. embedded into accessories).

> However it seems from the literature that heart rate monitors might be more appropriate since pedometers might not be accurate enough (hence not fair). The literature suggests that:

- Recommendations are of 60 minutes of MVPA on a daily basis (NASPE, 2004). This:

-Corresponds to 12000 steps in Colley et al. (2012) although there were variations in the amount of steps between different countries and age groups – first box in ‘L’ line UCE2 column;

-Is between 10000 and 15000 steps in Tudor-Locke et al., 2011)  
– second box in ‘L’ line UCE2 column.

- The aim of exergames is to increase heart rate and respiratory rate to promote MVPA (Lieberman et al., 2011) – third box in ‘L’ line UCE2 column.

## **Chapter VII- Contribution**

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The multi-disciplinary nature of this research, combined with a RtD methodology led to the creation of various outputs and findings, presented in chapters V and VI. This approach resulted in making original contributions to knowledge concerned with increasing PA in young people as well as to the field of Design. This chapter describes the three contributions that came out from this practice-based research.

### **7.1 ‘BOOST UP!’ V4: AN ORIGINAL OUTCOME**

‘Boost Up!’ V4, as described in 5.5, is a technology-supported game (Lieberman, 2012) that utilises real-world PA (through the use of a fitness tracker) as game currency in an attempt to engage young people in PA. Via a Two-Stage concept, 'Boost Up!' has made a contribution to the field of research exploring how 'exergames' can positively be used to encourage PA in young people.

#### **7.1.1 Demonstrates A Two-Stage Concept**

Implementing a Two-Stage concept has the advantage of creating a unique experience of exergaming since it:

- Provides opportunities to use any real-world PA as a game currency;
- Tackles MPA, VPA and Sedentary behaviour;
- Broadens the application of PA as a currency in a range of exergames;
- Brings novelty within a game;
- Provides interactions and social experiences that are unique;
- Is more inclusive by targeting players with a wider range of tastes about games (in Stage 2);

- Contributes to providing a full blending experience.

Each of these points above is discussed in more detail below to show how ‘Boost Up!’ differs from existing exergames. In addition, brief consideration is given to factors that were shown to promote engagement in PA among participants.

### ***7.1.2 Allows Using Any Real-World PA as a Game Currency***

Exergames are generally inflexible and do not promote any form of PA outside of the game play. In contrast ‘Boost Up!’ is unique because it attempts to utilise any real-world physical activities, from conventional activities (e.g. cricket, football, dance...) to ‘Active living’ (e.g. Active transport), to contribute to the currency of the game. It is a way to create a system of rewards to increase the desire and motivation to be physically active and to seek out opportunities to be physically active throughout the players’ daily lifestyle. The feedback players receive via the game currency is also a mechanism through which the players’ consciousness of how much PA they are doing can be enhanced.

When playing ‘Boost Up!’, PA is not seen as an aim and it is not explicit even though the game’s goal is to promote PA. With such an approach, PA is not the driver but just a means to an end using immediate rewards for being active (i.e. players are not seeking PA per se but rather accumulating more rewards through PA). This concept of using PA as a means to an end is the principle of exergames however no other existing games were found applying this concept to a lifestyle, everyday activities.

### ***7.1.3 Tackles MPA, VPA, and Sedentary Behaviour***

‘Boost Up!’ aimed to promote PA throughout the player’s lifestyle to encourage the young people to reach current health recommendations by increasing MVPA and reducing sedentary behaviour. Unlike existing exergames, each individual intensity in ‘Boost Up!’ is associated with a strand of the main currency (e.g. more VPA gives more ‘Attack’), which informs players about their daily performance in relation to their baseline (e.g. earning more than 5 beads is an increased performance). To increase chances of winning the games, players should undertake PA at each intensity level yet they are free to set their daily goal (e.g. increase from +10% up to +50%). By

associating the different exercise intensities with the currency in the game, this provided an opportunity to teach participants about the different aspects of PA. For example if a player wanted to increase their 'Attack' currency then they had to partake in additional VPA during daily living.

#### ***7.1.4 Broadens the Application of PA as a Currency in a Range of Exergames***

Doing MVPA and reducing time spent sedentary in Stage 1 produces a generic currency that is common to a range of games (i.e. beads and bonus cards are played on both the card and board games). Being able to choose among a family of games is a way to bring variety and to be more adapted to users' preferences.

#### ***7.1.5 Brings Novelty to the Game Experience***

There are aspects in 'Boost Up!' that promote novelty for/when playing the games. This is mainly promoted in two ways:

1. A variety of games to choose from (see 7.1.4).
2. Since the currency is awarded based on an individual's PA undertaken the previous day, it is likely to change, meaning that the currency each player generates is constantly unknown to other players. This develops an imperfect information situation (e.g. not knowing fully, misinterpretation, intentional bluff) and ensures uncertainty of winning which is known to increase engagement (i.e. players do as much PA as possible to surprise or trick each other by earning more currency).

Often (exer)games have a currency that is known, fixed and/or common across all players. The way currency is earned and awarded in 'Boost Up!' differs from these type of (exer)games which might increase engagement by making the experience of the game different and unique every time it is played.

#### ***7.1.6 Promotes a Real-World Social Experience***

'Boost Up!' in Stage 2 promotes a social experience (face-to-face) that is different from existing exergames since interactions between players are promoted. This is because

the games created are traditional (card and board games playable from 2 to 6 players), which may be a way to promote other forms of interactions that do not occur in technology-based games or individual technology-supported games.

#### ***7.1.7 Is Fair & Inclusive for All***

Individual differences exist in the amount of PA undertaken. The whole 'Boost Up!' experience was designed to ensure bringing together different profiles, whether it is about tastes, attitudes, or self-efficacy among others towards PA or games. This was possible through:

- Awarding a currency based upon one's individual performance while aiming at meeting health recommendations. Hence two currencies were awarded: the main one based on an individual's performance in relation to their baseline, which avoids discouraging the least active, but the second currency was awarded through the amount of PA carried out to avoid disengaging the most active.
- Giving choices to players to undertake PA: in Stage 1 (see 7.1.2), whether it is in a team or individually; or in Stage 2, through PA challenges that are optional. This gives the possibility for the ones with lower self-efficacy to choose doing PA in front of others or not. Yet the peer pressure and social experience provided when playing games in Stage 2, which focuses mainly onto playing games and having fun, seems to be a way to encourage PA since players desire to impress their peers (e.g. with the amount of currency earned) or earning their recognition (e.g. by winning the games).

#### ***7.1.8 Delivers A 'Blending Experience'***

Section 2.6 identified three aspects that a game must promote to provide a 'blending experience' in the context of exergames. No exergames were found to cover the three points however it is argued 'Boost Up!' V4 does since PA:

- Affects directly the game play since the games' currencies are a conversion of the different intensities of PA; and

- Is seen as positive in both stages (it increases chances of winning) and the mastery and social experiences around it develop intrinsic motivation; and
- Is more conscious in two ways: by disassociating PA from gaming and by informing players about their levels of PA. This makes PA more of a goal in itself and raises awareness which reinforces the consciousness of the behaviour.

Yet since V4 evaluation did not provide concrete evidence that 'Boost Up!' was able to increase PA, more research is needed to conclude whether a blending experience as defined in 2.6 can do so.

## **7.2 A COLLECTION OF FACTORS IDENTIFIED AS ENGAGING FOR THIS AUDIENCE**

As presented in 6.5.3, a number of 11 factors/themes that effected the participant's engagement were discovered throughout this research:

- Multi-Use
- Choice
- Life / Lifestyle
- Real Time / Instant
- Novelty
- Social
- Appropriation
- Simple / Simplicity
- Visual Representation
- Two-Stage
- Device Measuring PA

These factors are relevant to designing engaging games however three of these factors have a broader implications, which may be of use to people measuring PA and/or designing interventions to promote PA (e.g. exergames) among this age group (11-12 years old).

### ***7.2.1 Engaging through Appropriation***

When there was space for expressing themselves in the game and to somehow influence the content of the games played, participants seemed more engaged. Appropriation of the games was observed through:

- Modifying the rules thanks to core simple rules that facilitate their adoption and hence the play of the game. This relates to the idea of being able to freely explore the games.
- Self-expression; this can be done through making (e.g. creating own character through the use of tokens) or through providing material for developing imagination (e.g. storytelling).

Participants seemed to engage with the idea of being able to adapt the game to their environment/tastes. This understanding of how these young people behave could inform what 'move more' means for these people to design new programmes aiming at promoting PA. Yet this might also be relevant to those designing health behaviour change interventions among this age group. When developing interventions for smoking cessation for instance, finding ways to implement this idea of 'appropriation' might encourage individuals to a change of behaviour, whether it is through the design of a game or not.

### ***7.2.2 Making Feedback Engaging***

Participants appeared to respond to feedback about their performance about PA but they liked to receive feedback in the following ways:

- Privately – With a possibility to share them to targeted members (peers and family);
- Instantly – Rewards are a form of feedback and were highly appreciated and engaging when given in real time;
- With an element of surprise in the message that is delivered and/or when it is delivered;

- Humour-based messages seemed to be engaging, especially when performance was poor;
- Visually – A form of visual representation (physical or digital) of an individual's performance was appreciated.

Instances throughout the study showed that participants seemed more engaged when feedback was given in the form presented above. Therefore similarly to the previous point it is hoped that this understanding can be useful to people designing new programmes aiming at promoting PA or health behaviour change interventions among this age group.

### ***7.2.3 Increasing the Use & Acceptability of Devices Measuring PA***

To be more likely to be accepted and to provide engagement over time, it seems the device measuring PA should:

- Provide feedback accessible in real time to increase motivation when exercising;
- Be part of the users' lifestyle (e.g. incorporated into clothing or accessories such as necklace, hair band, belt, watch...) to avoid individuals forgetting wearing it;
- Be of 'multi-use' to increase its attractiveness by providing different types of information: about PA, including the various intensities of PA (which in this case is the basis to award games' currency), but also more general information (e.g. time);
- Display information in a visually engaging way; graphical representation may be a way to explore further (e.g. virtual flower growing when being active);
- Provide ways to promote novelty (e.g. change of appearance according to the type/intensity of PA done, the season, who is exercising with...) since it can wear off after a while.

Reilly et al. (2008) reviewed a list of accelerometers (devices) used for monitoring children and adolescents. An exhaustive review highlighting the drawbacks for each accelerometer was presented (from a technology perspective) to ensure obtaining the expected results (e.g. the need for calibrating accelerometers according to the user profile is important to measure accurately one's PA performance). This review also provided insights about the benefits of conducting objective measurements (here accelerometer), especially in contrast with self-reports. Yet both UCE2 and UCE3 showed a lack of engagement from the participants with the pedometers/fitness trackers. Similar challenges for acceptability have previously been reported. For example Buccheit et al. (2007) found that participants (children aged 12 years) removed their accelerometer during the day (e.g. to do sport activities incompatible with the device – e.g. swimming) or forgot it (e.g. after a shower) and the insights gathered throughout this research project showed similar examples about the limitations of the acceptability of the device (see 5.2.1.1 and Appendix 2.B). Therefore, regardless of the effectiveness of the technology of the device for measuring PA, the device has to be accepted by the user to be effective. Re-designing a device that suits the end-users' lifestyles and tastes might be useful to monitor more easily people from this age group. This is especially true since it was found that the device can be perceived as stigmatising with several instances reported in this study of participants showing concern about their appearance (i.e. do not want to 'look weird to others'). The various activities conducted across the research suggested that to overcome these issues, creating a device that is embedded into 'normal' accessories (e.g. belt, hair band...) but not in phones (since not everyone has one and phones cannot be used in schools) might be a viable option.

### ***7.3 A METHOD TO SHOW TRANSPARENCY WHEN REPORTING DATA OBTAINED WITH RTD***

We saw in the methodology chapter that a valid research must follow the criteria of Archer (1995) – systematic, knowledge directed, and communicable (see 3.2.3). Yet one challenge when undertaking a RtD methodology is to make the processes

transparency, which is particularly true when the designer and the researcher are the same person like it was the case in this project (as described in 3.3.2).

To show transparency when reporting the data (i.e. to ensure other researchers having a full understanding of the primary sources), the 'Annotated Design History' visuals were created. They were inspired from the Annotated Portfolios (Gaver & Bowers, 2012; Gaver, 2012) but remain different, as described in 4.8.4, since these annotated design history visuals are a way to report the data in a transparent manner. Yet in the context of this design-led research, which aims to create, develop, and refine an outcome that is implemented in the real world (see 3.3.1), there was also a need to show transparency in the interpretation of the data (i.e. show the traceability of a design idea). The posters described in 6.5.1, and available in Appendix 2.A, illustrate this idea of traceability and allow understanding how a key event (participant's comment, designer's observation, literature) influenced the design development of the game and of its concept. These posters were created to show traceability of an idea under the 'designer hat' however since this research has also generated knowledge through repetition (i.e. list of factors/themes), there was also the need to show how these factors/themes emerged. This is how the 'Themes' Data Tables' were created, as illustrated in 6.5.4 and in Appendix 2.B.2. We can see in the latter how the 'annotated design history' visuals were used to illustrate the content of the table and how an idea reported in the table might have been interpreted by the designer/researcher.

Therefore in the context of this design-led research, a new method, or design research technique, was created using the 'Annotated Design History' visuals to show transparency. These were applied to: uses two tools to report the data:

- A range of posters to show traceability of the development of a design idea (under the designer hat);
- A range of 'Themes' Data Tables' to show traceability of the knowledge generated (under the researcher hat)

Therefore we can say that this RtD methodology has created knowledge that is used both for designing (i.e. creating an original game presented in 7.1) and for Design as a

discipline (i.e. for showing transparency in the data and traceability of an idea when conducting RtD). It is therefore hoped that this new design research technique of reporting the data (i.e. Annotated Design History visuals) and the way they have been used to show the traceability of an outcome (design idea and/or knowledge) can be of use to other design researchers applying a RtD or design-led methodology.

## **Chapter VIII- Discussion**

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An original contribution was presented in the previous chapter for those interested in increasing PA among young people as well as for designers wanting to show more transparency when reporting the data obtained with a Research through Design (RtD) methodology. So that the wider learning from this research can be applied to future programmes and/or by other design researchers, the purpose of this chapter is to give an interpretation of the findings presented in Chapter VI. Subsequently the value of the results is discussed in detail and some of the challenges and limitations of applying a RtD methodology and associated processes to the ‘wicked problem’ of increasing PA in young people are outlined. Suggestions for further work are also offered and specificities of undertaking a RtD methodology are highlighted in the aim of clarifying the benefits that such a methodology can bring when applied in a health context.

### **8.1 INTERPRETATION OF THE ‘BOOST UP!’ V4 PILOT DATA**

It was reported in 6.1.2 that it often seemed that it is in Week 1 that participants were the most active across the intervention, whether they were engaging in the game or not, and that a drop in PA levels was read in Week 2 & 3, which seemed to be the least active weeks across the intervention. This might be explained by the excitement of the participants in taking part in a study that involves games and attractive fitness trackers for the first time, but which loses of its interest after week 1. Other explanations might involve the participants being forgetful about wearing the pedometer as the intervention went on however other factors were considered that might account for some of the results.

#### **8.1.1 Bad Weather?**

The study took place over January and February; the weather was very cold and it snowed many times during the intervention (school was shut twice). However it is uncertain how much the bad weather stopped the participants from doing PA since

some enjoyed outdoor activities (e.g. snowball fights, sledging) but some stayed in too. Seasonal effect was already reported as affecting PA levels (Jago et al., 2006) however Wilkin et al. (2006) found that variations in PA are to do with the youth's lifestyle and not the environment.

### ***8.1.2 Games Not Engaging?***

The games seemed to have promoted engagement since half of the participants attended the game club on a daily basis. However the game club attendance could also be explained by factors such as social interaction (being with friends and/or the researcher), a desire to comply with the wishes of the researcher, and/or a supportive and warm (both physically and emotionally) environment. As presented in 6.4, what is clear from the data is that a majority of the participants preferred the board game to the card game.

The success of translating the PA currency to the concepts of Attack, Defence, and Energy in both the card game and the board game remains unclear as some participants reported this as an unattractive feature yet for others it aided engagement. Further work is required to understand how to best translate PA currency into the avatar format used in 'Boost Up!'. One option could be to allow a currency unrelated to these features (e.g. to play existing games as presented in 5.3.3.1) which in turn might have been more engaging; yet further study is required to explore this idea.

### ***8.1.3 Complexity of the Concept and/or Rules?***

As mentioned in 6.4, 'Boost Up!' was a complex game in that it asked participants to translate actual behaviour into skills and traits of an Avatar. If participants did not understand this fundamental concept, it was very unlikely that they would increase their PA. Whilst every attempt was made to convey the core aspects of the game, it remains unclear whether participants understood the overarching concept behind 'Boost Up!' (e.g. where the beads come from). It is questioned whether a 11-12 year old person can understand the notions of Sedentary behaviour, MPA, and VPA (i.e. do they understand that they can generate 'Game Energy' just by standing up).

Furthermore, individuals from this age group might have difficulties to keep up with managing three goals a day (i.e. a goal for increasing VPA, MPA, and decreasing sedentary time).

#### ***8.1.4 Implementation of the Intervention?***

A school environment was chosen for convenience reasons (measuring and recording participants' PA on a daily basis except for weekends) however it was uncertain how effective this was in terms of engagement. Some identified constraints were:

- The games were supposed to be played every day with a currency that had the potential to also change daily – increasing interest – however this was not possible at weekends, which has shown being disengaging (e.g. VPA done on Fridays evening (i.e. Karate Lessons) was averaged).
- A game club at lunch may not fit with the 'busy lifestyle' of the participants as many seemed involved in a range of activities during school time (e.g. film club, cricket, soccer).
- The room in which the game club took place was not always available and so the venue had to change on a number of occasions, which disrupted the routine.
- Lunch time was too short to engage in playing the game fully.
- There was not much space in the classroom to actually complete the Health challenges (e.g. at one stage we had to remove tables to make space to do cartwheels).
- The health challenges were sometimes in conflict with school policy (e.g. participants were told by a teacher not to run in the corridor when they had to do it in less than 30 seconds).

#### ***8.1.5 Trade-Offs Made when Prototyping?***

Due to the characteristics of the available Fitbits, participants could not access their PA intensities in real time (a feature that was identified as engaging), which was identified

as a key aspect for earning the game currency and was deemed important in terms of raising awareness for PA behaviour. Instead a feedback sheet summarising the levels of PA done the previous day and translating them into game currency to play with for the current day was used. It is unknown to what extent this affected game play or the mechanisms thought to influence behaviour in the longer term (i.e. real time monitoring and feedback).

A further unexpected consequence of using the Fitbits was that some participants were worried about losing them hence the extent to which they used them on a regular basis was questionable. There appears to be a balance between perceived expense of technology solutions and the usability of such technologies on a daily basis and/or in the real world with young people.

As a conclusion, the various aspects discussed in this section 8.1 provide valuable insight into the use of prototype games as tools to promote PA in young people. What is more, the mixed-methods approach adopted here adds to our current understanding regarding the resource implications of delivering such games within a pragmatic context such as a school (time and budget). It is hoped that findings here are of use for those undertaking exploratory trials or dosing studies (Kato, 2012b) to evaluate a game before doing large scale investigations in the future.

## ***8.2 CONSIDERATIONS IN FURTHER DEVELOPING ‘BOOST UP!’ OR DESIGNING NEW GAMES***

The testing of ‘Boost Up!’ uncovered a number of issues about the way ‘Boost Up!’ V4 was designed, prototyped and implemented, which might be useful to further developing ‘Boost Up!’ or to creating new games.

### ***8.2.1 Limits in the Product Quality of the Game***

Some material aspects of ‘Boost Up!’ V4 (bag, box and Fitbit) may have interfered with the engagement of the game, with users being worried about losing the fitness tracker. Also, the box inserted in a bag seemed to be too big and not handy to carry around school on a daily basis; therefore the ‘kit delivered’ needs to be convenient and part of the participants’ lifestyle.

### 8.2.2 Adding Technology

There seemed to be an interest in traditional games (e.g. with tangible elements) so adding digital technology to 'Boost Up!' V4 might be beneficial since it might make the game more autonomous, pervasive and comprehensible while promoting remote play.

- Autonomous & Pervasive

The simple fact that the games are traditional (card and board games) is novel, which may extend the scope for variety since not restricted to the boundaries of video games. Adding digital technology might reduce/avoid the researcher's involvement (i.e. through the Wizard of Oz protocol), which might simplify the understanding of the games as well as promote more pervasive gaming and exercising throughout the players' daily life by creating more interactions between players. This might also be a way to implement the PA challenges in Stage 1 (as described in V3).

- Comprehensible

As mentioned in 8.1.3, more data is required to ascertain to what extent participants understood the concept of awarding currencies (VPA=Attack/MPA=Defence/Non-Sedentary=Energy & Steps=bonus cards). Adding technology might help in this regard since it could give feedback about what the current situation about these PA levels is as well as show players where they might make gains (i.e. how well they are doing in relation to any given goal(s)). Adding technology could make it easier to display this feedback, which might also help as a reminder of the three goals (e.g. by letting players know of their daily progress), and hence encourage them to complete any proximal goals.

Moreover, interactions at the game club suggested that participants did not fully understand how to use the Health cards when playing the board game. Making the game more digital could let the players know what choice(s) is available to them in a given situation.

- Remote Play

A form of social interactions, such as being with friends and/or being able to connect/play with remote friends, may also be enhanced by integrating digital technology. Yet since traditional games were appreciated, combining both to create 'hybrid' games (i.e. traditional games incorporating electronic components like 'Gener-G' for instance) seems worth developing (and were even suggested by some participants in UCE3). This refers to creating 'technology-supported' games rather than 'technology-based', as suggested in 2.5.3.

As a conclusion, it seems that exploring a compromise between 'Boost Up!' V4 and technology-based games would be worthwhile, since the participants showed interest in 'hybrid' games.

### ***8.2.3 Adjust Scaling of Rewards***

If self-regulatory behaviour skills are not taught, it is unclear how appropriate it is to ask young people to set their own daily goals, like 'Boost Up!' V4 required, in which players were free to set their daily PA goal to increase in relation to their baseline (from +10% to + 50% to earn more beads) or to earn more bonus cards (i.e. players choose whether they want to decrease sedentary time, increase MVPA time or the number of steps.). Simons et al. (2013) declare that little is known about what values matter most to youngsters and what PA related goals they prefer setting. It is important to ensure goals that are realistic and achievable however Dishman et al. (2004) found that goal setting was not important for increasing PA and Dishman et al. (2006) reported it did not affect self-efficacy. It is therefore also questioned whether letting young persons of this age set their own goals (e.g. increasing of 10%, 20%...) is engaging or whether they need goals imposed.

It might also be worth exploring further the scaling of how the beads are rewarded. In UCE3, players could earn/lose a bead for every 10% of increase/decrease of PA in relation to the baseline. Yet it is questioned whether adjusting the scaling to 5% might be more engaging and further work is required in this regard.

### 8.2.4 'PA into Gaming' & 'Gaming into PA'

Despite the 'Two-Stage' concept seeming to have been an incentive to do PA in some instances throughout the study, it was not possible to say whether this concept could be successfully used more broadly to increase the PA levels of 11-12 year-olds. Yet it seems worth exploring how to bring more PA into gaming and gaming into PA since they seem to be a way to promote instant rewards and feedback, a factor identified as engaging among this population.

- 'PA into gaming'

Even though it is difficult to say whether the health challenges (UCE3) and the challenges done with ACTIVIO (UCE2) were a real success on their own and/or if it was due to the social and/or physical environment (and the presence of the designer/researcher), 'PA into gaming' seemed to be engaging.

It also seems worth exploring how rewards might be customised to increase their fairness. Implementing 'PA into gaming' could be part of orienteering games (which seemed to attract participants across all enquiries), or of a story (e.g. part of a bigger game). Furthermore, creating hybrid games with a set of simple core rules with sub-games that can be more easily adopted by the future end-users may be worth exploring.

- 'Gaming into PA'

Based on the success of the Health cards and the ACTIVIO system, bringing 'gaming into PA' based on PA challenges (idea presented in 5.3.2.1) seems worth exploring throughout the players' day (e.g. before/during/after school) as suggested by BHF (2014), who also reported that pedometer challenges have also shown success. Besides, it was noticed in UCE3 that participants arriving at school late or doing PA when going to school were generally more active. It is imagined that 'active transport' (Sallis et al., 2006) challenges could be implemented. In the V3 concept, players could throw challenges to each other and have specific amount of time to execute them. Devices as shown previously may be accurate enough to be able to recognise with precision whether and when a specific PA was executed and then reward the players

accordingly. Hence developing a system allowing players sending PA challenges to each other at any time during the day may be a way to promote PA throughout daily life, and could also be combined with orienteering or treasure hunt games as suggested in UCE1 and UCE3.

### ***8.2.5 Be More Inclusive***

There seemed to be two main ways to be more inclusive, through:

#### **1. Offering more games to play**

The framework converting PA into game currency could be explored further so that it can be also used to adapt the play of existing games, as suggested in V3 (see 5.3.3.1). This would be a way to offer more games to choose from and could make 'Boost Up!' more inclusive of different tastes in gaming.

#### **2. Include More Players**

The adjustments presented in 6.3.2 (i.e. to give the possibility to non-participants to attend the game club) increased attendance at the game club, hence suggesting the importance of allowing other people (family or friends) to play the games. Yet as presented in 6.3.4, solutions need to be developed to include people who are not part of the 'Boost Up!' experience (i.e. who do not wear any device measuring PA) into playing the games without excluding those who are part of the game experience.

### ***8.2.6 Game Length & Continuous Play***

It is unclear at what stage the duration of a game (being too long or too short) might make it disengaging for this population. It was reported in UCE2 that games going on for a long time (e.g. Monopoly) can be boring however throughout the test of V4 board game, it was reported that playing one game over a few days was not disengaging. Hence exploring longer games (e.g. one move a day) may be a way to promote continuous play and therefore more regular PA.

Tackling the continuous dimension of play can also be done through implementing a league, in which players earn points through winning games and/or doing PA (as

presented in V3 – see 5.3.2.2), may also encourage players playing/winning more often, and therefore exercise more often too.

### ***8.2.7 Open Source Games***

One way to promote multi-domain gaming would be to give the possibility for players to create their own game through open source (game created with the family at home, with friends at the start of the New Year...). The principle behind 'Boost Up!' being that all the games use the same currencies, a set of graphics that can be customisable could be available on an open source platform allowing individuals to make their own game. This may allow 'appropriation', a factor identified as engaging, and hence increase the players' engagement in playing the game.

### ***8.2.8 About the Blending Experience***

Chapter II highlighted that exergames have so far failed to promote the health recommendations. An argument was proposed in 2.6 based on the fact that no exergames were found combining the three aspects together to provide a full 'blending experience'. These three aspects were:

1. To ensure PA directly affects the content of the game experience
2. To promote PA as being a positive behaviour
3. To make PA conscious, as a goal in itself

These three aspects were blended together in 'Boost Up!' V4, yet the level of autonomy of the game and its delivery in UCE3 led to inconclusive results. More research is therefore needed to explore whether exergames that provide a full blending experience might be suited for promoting the health recommendations.

## ***8.3 INSIGHTS & FUTURE RESEARCH QUESTIONS FOR PROMOTING PA***

Even though an objective of the RtD methodology was to implement the outcome (here the game) in the real world (i.e. hence a design-led methodology), this was not possible within the given time of the project. Yet the V4 prototypes could be modified

again to increase engagement based upon UCE3 findings, and more (pilot) study(ies) could be undertaken in an iterative process until signs of engagement are shown (i.e. games are played repeatedly) and evidence relating to the effects on PA could be collected. The ultimate step of this research programme would be to assess the effectiveness of the outcome for promoting PA following the criteria established as valid when assessing outcomes for Health promotion (e.g. an RCT). Testing 'Boost Up!' also provided insights that might be of interest to those wanting to promote PA among this age group.

### ***8.3.1 PA Today for Rewards Tomorrow***

The design of the intervention of doing PA one day to earn currency the following day did not seem to be something participants from this age-group were responsive to. Instead it seems PA should constitute a greater part of the actual play of the game, or there should be a more direct connection between Stage 1 and Stage 2 (e.g. through storytelling) within the game design.

### ***8.3.2 Understanding 'Sedentary' Time, MPA & VPA***

Following on the discussion presented in 8.1.3, it is unsure whether participants understood the overarching concept behind 'Boost Up!' (i.e. the notions of Sedentary behaviour, MPA, and VPA). This raises questions about how useful making these distinctions are in terms of supporting young people to be more physically active and less sedentary. What is more is that players had to figure out what was needed to increase their currency (e.g. how many minutes are needed to increase MVPA or decrease sedentary time to earn more beads). By the same token, it is questioned whether letting players from this age setting their own daily goal in a self-regulatory procedure is suited or not, as already highlighted in 8.2.3. More research is therefore needed to find out whether it is appropriate for people from this age group to:

1. Differentiate what PA might be associated to MPA, VPA, or Sedentary behaviour;
2. Understand the relation between PA and rewards and figure out what amount of PA is needed to earn a reward (e.g. beads, cards);

3. Set a multitude of daily goals, in a self-regulatory way.

### 8.3.3 Design of Devices to Measure PA

It is unclear what device should be promoted for these games, since UCE2 suggested using heart rate monitors however a source of engagement was noticed in UCE3 through the use of fitness trackers (Fitbits) like for instance the messages (e.g. Step Geek) popping up randomly. Since fairness was appreciated, it seems the device should be able to recognise the intensity of the PA undertaken as well as the length of time it has been carried out. The fitness bracelet 'Amiigo' could be used in this context since it can detect the type of workout executed and at what time (push ups, sit ups...). Similarly, heart rate monitors like 'Basis' (Figure 57), which is a simple wristwatch allowing picking up heart beat without wearing any chest strap, could also be exploited.

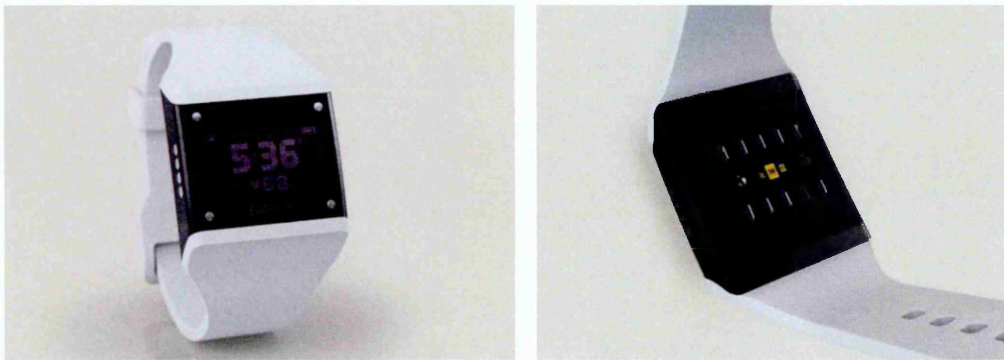


Figure 57 – The heart rate monitor 'Basis'

However, Pate (2010) explains that other methods for measuring PA in young people need to be developed. This research has provided guidance (see 7.2.3) to redesign those devices, whether they measure steps or heart beats, in a way that is engaging and compatible with the individuals' lifestyle (e.g. incorporated into daily accessories, clothes or other 'things'). The examples above seem to take this direction yet there is a need to be for instance waterproof, visually engaging, customisable. Re-designing one that is part of the future end-users lifestyle (i.e. fitted into user's accessories, clothes...) may be a way to make it more acceptable, especially if it is of 'Multi-use', as UCE2 & 3 revealed. Letting the users access their PA information at any time (e.g. real time), in a visually engaging way may also increase their use and/or acceptability of the device.

Exploring shapes, light & sound as a way to interact with the device may be worth considering too. Questions such as ‘what accessories might be suitable to incorporate the right technology for measuring PA’, ‘how light, smart material, and PA can be combined to promote PA’, or ‘how to incorporate PA challenges (which seemed to be engaging) into devices measuring PA’ might be useful to redesign such devices.

### ***8.3.4 Measuring a Representative Baseline***

We saw that a baseline that is not representative of one’s normal levels of PA can be disengaging (see 6.3.1). Yet it is unknown for how long one’s PA levels should be measured to set a representative baseline and when to reset or average it to promote continuous engagement and play (e.g. is it when players reach a specific average of steps compared to the original baseline? Is it when health recommendation or a specific amount of PA is reached at least X times a week?). Therefore more research is required to understand how a baseline that is individual and representative of one’s PA levels can be measured, and how often it should be averaged to promote engagement over the long term.

### ***8.3.5 Tackling MVPA & Sedentary Behaviours at the Same Time***

‘Boost Up!’ was conceived so that it can tackle both behaviours at the same time (i.e. sedentary and MVPA) however it is questioned whether if this is the most effective approach. Some research has shown that focusing on reducing sedentary activities (e.g. TV, video games) among young people may be more efficient than promoting PA or both reducing sedentary time and increasing PA (Robinson, 1999). However Robinson’s (1999) results might be limited since sedentary levels in that study were defined through playing video games only while activities like doing homework, reading, listening to music were not.

## **8.4 LIMITATIONS OF THIS STUDY**

There are a number of aspects that limit the validity of the findings gathered across the various UCEs conducted throughout this research.

### **8.4.1 Promoting Healthy Lifestyles?**

Goldfield et al. (2014) speaks about the limitations of interventions that encourage healthier lifestyle by promoting PA only and not tackling food intake. Malhotra et al. (2015) even argue that doing PA to reduce obesity is only a myth. This is yet nuanced by other researchers such as Baker from the National Institute of Health and Care Excellence who recommend "well-balanced diets combined with physical activity" as reported by Triggler (BBC, 2015). It is unclear to what extent this is true since BHF (2014) explain that focusing on other behaviour may undermine the results of the intervention.

### **8.4.2 Hawthorne & Wizard of Oz Effect**

The Hawthorne effect describes the situation where individuals modify aspect(s) of their behaviour in response to the awareness of being observed. In this research, the designer/researcher might have influenced the research findings as he was strongly involved in the UCEs.

This is particularly true for UCE3 during which 'Boost Up!' did not reach a stage of development that could be evaluated in complete autonomy and where the designer/researcher was an active component ('Wizard of Oz'). The 'Wizard of Oz' delivery and implementation approach, although necessary, is likely to have played a strong part in the participants' responses and it is unknown to what extent the removal of the designer/researcher from the game would influence its engagement value. By the same token, having the designer/researcher on hand every day might have limited opportunity for the participant's to take full control or possession of the games, thereby limiting ownership.

Hence the conclusions reached both around the engagement of the game and the PA levels might be biased.

### **8.4.3 Sample Population**

This research was led in two secondary schools representing different catchment areas in Sheffield (UK) with a total of 48 pupils from different classes of Year 7 (with 2 participants dropping out across the three user-centred enquiries). Yet the size of the sample groups limits the findings that may not be able to be generalised to a wider population. This suggests leading further work with a broader range of young people as the outcome is being developed.

### **8.4.4 Choice of the Environment**

Schools were chosen for convenience reasons (i.e. accessing a large number of 11-12 years old and ensuring attendance). However it is questioned whether this environment was the most appropriate for the last user-centred enquiry which revealed participants preferred playing with their friends rather than classmates.

### **8.4.5 More Iteration & Lower Fidelity Prototypes**

Another approach to this research project would have been to develop and test a range of prototypes of games or mini-games of a low degree of fidelity (Houde & Hill, 1997) to explore many different topics (e.g. suspense, novelty, competition...). Embedding a form of technology, as was the case in the prototypes tested (V2 and V4), where it was hard to prototype (i.e. time consuming and costly). Developing low fidelity prototypes would have enabled the testing of more prototypes and ideas, in a much quicker way and early on in the project, which might have been beneficial to develop a better understanding of the future end-users. The range of games created might have been unrelated to each other (i.e. independent games that are not part of a bigger game) however it is imagined they could be modified in the later stages so that they are part of the same game, the same way 'Boost Up!' games have been created (e.g. through playing them with a common currency). Yet it is questioned whether testing low fidelity prototypes with young people would have had the same effect on their level of engagement, with the game and/or within the workshops. For instance, applying the card board computers techniques used by Ehn & Kyng (1991) – e.g. match box to represent a mouse – may not be appropriate with young people.

Using low fidelity prototypes to represent complex ideas might be a difficult concept to understand for young people and might reduce their level of engagement and interest in the work.

#### **8.4.6 Design-Led Approach**

Even though an original outcome was created, which led to creating new knowledge, we can conclude that this research was limited in three main ways:

- ‘Narrowing too early’ – The overall approach tried to narrow down a game (‘Boost Up!’) too early in the development process;
- ‘Quicker and dirtier’ – There was not quick enough iterations in the tests of the game with the end-users (i.e. more UCEs);
- ‘Less technology embedded’ – Technology might have been getting in the way since all the ‘Boost Up!’ version somehow embedded a form of technology (e.g. ACTIVIO, fitness tracker)

### **8.5 LIMITATIONS OF THIS METHODOLOGY**

The methodology used for this research (i.e. RtD) was chosen to ensure the creation and development of games. This section discusses the limitations of the methodology undertaken.

#### **8.5.1 Holistic Approach & Subjectivity**

When undertaking a RtD methodology, there are two aspects that may limit the viability of the findings:

1. Approaching things holistically is inherent to Design yet this makes it difficult to affirm with full certainty whether the level of engagement observed is due to the identified factor or to another factor or a combination of them. Yet through iteration and comparison with the knowledge available in the literature, it is possible to develop confidence in the findings.

2. The relationship between design researcher and data analysis. Design researchers are embedded in the process which makes it difficult to separate out what is the effect of the game and the effect of the design researcher when analysing the data (e.g. it is unclear how much of the engagement in UCE3 is from the game vs. researcher).

### 8.5.2 A Trade-Off when Conducting Design-Led Research

As presented in 3.2.2, there are different types of research: research *about* design, research *for* design, and research *through* design. Research *through* design is a methodology that can be applied to produce results that can be *about* or *for* design. As demonstrated in this project, one contribution to knowledge looks at improving the practice of design researchers by showing more transparency in the interpretation of the data (i.e. through creating the 'Themes Tables' and the 'Annotated Design History'). Therefore in this case a research *through* design methodology was adopted to produce research *for* Design (as a discipline). Yet since the aim of this research was design-led (i.e. to create, develop and refine engaging game(s) to promote PA among adolescents aged 11-12 years), the research *through* design methodology applied in this project was also used *for* design, as in designing. This can be related to the Picasso example given in Chapter III however unlike him, this research complies with the three points listed by Archer (1995) to conduct valid research (systematic, knowledge directed, and communicable – see 3.2.3). Therefore this project has demonstrated that a research *through* design methodology can be applied to produce knowledge *for* design, in the two meanings of the term: for Design as a discipline, and for designing.

As described in 8.5.1, designing and researching through design involves a degree of subjective interpretation of the data which will vary according to the designer/researcher's understanding and vision, yet it is this situated understanding that constitutes the rigour (see 2.8.5). Even though this research was systematic, knowledge directed, and communicable, the design-led nature of this research (i.e. to produce outcomes that are implemented in the real world) led to contributions to knowledge that also reflect a degree of subjectivity. In relation to 8.4.6, an alternative approach would have been to lead many workshops such as those conducted in UCE1

(e.g. co-design activities), in a multitude of schools or environments, with the same age group, with the aim conducting individual studies that did not seek to advance the design of the game. More data could have been generated, which might have generated stronger and more reliable findings, yet whether those results would be applicable and relevant for designing a game in context is uncertain. In such a scenario, knowledge might be claimed with more confidence, yet with less certainty that this knowledge would actually be useful (to promote PA through games). There therefore seems to be a tension at the start of a research project between:

- Researching to produce reliable results without producing any outcome that can be implemented in the real word; and
- Researching to design outcomes that can be implemented in the real world while producing associated knowledge that may be more tentative.

In order to claim the validity of outcome(s) produced with an RtD methodology, there seems to be a trade-off to make at the start of a research project for the design researchers and their team as to what extent the final design outcomes is given primary importance. In this research project, this trade-off seemed valuable since a game (tested in context) as well as a technique about how designers can contribute to health were created. Yet it is important to recognise that this is not the only option.

It seems worth highlighting that this trade-off is similar to arguments regarding the relative value of quantitative or qualitative approaches (which may also be viewed as a contrast between reductionist or holistic perspectives). Both approaches were adopted in this research. For instance an initial survey was given in UCE1 (i.e. questionnaires to fill) to find out more about this age group. The designer/researcher tried to make it meaningful to them by applying careful graphic design, however the questionnaire approach did not work. UCE2 also aimed at being meaningful, and this why a series of micro-experiments were chosen to face the challenge of being meaningful and engaging (as described in 4.5.1). Similarly, it is also unsure how meaningful the ACTIVIO system would have been if the card game (in Workshop 3 in 4.5.4) had not been created. Therefore, whilst the holistic approach may limit the generalisability of the findings (as described in 8.5.1) it might also be a way to make

the research activities meaningful for participants, which seems important when working with young people and exploring sensitive topics.

The trade-off made in this design-led research seems particularly appropriate for addressing wicked problem such as obesity. As mentioned in 2.8.1, adopting a holistic approach to problems is actually what allows design to deal with wicked problems (Cross, 2007). Even though the final intended outcome did not show any increase in PA, a response (i.e. the game) was formulated. This is a way to make progress and develop understanding about the wicked problem since every solution to a wicked problem is a 'one-shot operation' (Rittel & Webber, 1973).

## **8.6 STRENGTHS OF THIS METHODOLOGY**

This section discusses the strengths of the methodology undertaken.

### ***8.6.1 Iterations to Create & Develop Innovative Outcomes***

The main aim of this research was to create, develop and refine an engaging game(s) to promote PA among adolescents aged 11-12 years. This was possible only through conducting tests in context in an iterative process, which is a main characteristic when designing (i.e. conducting Design practice). This is why this alternation of DREs/UCEs seems appropriate, especially for this Design-led research. It is important to highlight as well that within this iteration, the designer/researcher also undertakes other cycles of iteration during DREs. DRE2 & DRE3 illustrate well this iterative cycle within a cycle, since the activities in those DREs both looked at developing and refining respectively the game concept and the game themselves (e.g. rules, components...) – this process is what was described in the sections found in the in Appendix 1.A and 1.C. In these enquiries, especially DRE3, the designer/researcher conducted many tests in iteration with diverse users (who are not necessarily representative of the future end-users). Each test led to concrete insights for refining further the outcome (i.e. the game) which were then directly applied to the revised/new version of the prototype to test again in the next series of tests. The rapidity of execution between two tests is a characteristic inherent to Design and contrast with the Sciences. The

designer/researcher is not interested at abstracting the data to come up with a general truth, but to look for possibilities to implement his/her vision while creating an appropriate response that will ultimately be effective and adopted by the future end-users.

### 8.6.2 Handling & Analysing the Data

Reflection *in* practice is inherent to the designer's practice and it is advocated to reflect *on* practice to generate knowledge (Swann, 2002). Therefore if the game is a contribution (as demonstrated in 7.1), then reflection *in* practice becomes a method of knowledge generation, even though it is not made explicit. Yet this relates to the Picasso example described in 3.2.2, which could not be established as research since the process did not meet the criteria presented by Archer (1995) in 3.2.3.

Yet as explained in 3.3.1.3, the aim of the research project was to create, develop and refine engaging game(s) to promote PA among adolescents aged 11-12 years. A designed methodology was therefore chosen to ensure the outcome being 'real' (Fallman, 2008). Therefore the reflection phases *on* practice conducted after each UCE were useful to develop understanding and knowledge but these were used to primarily develop the game (i.e. focused onto being 'real' more than 'true'). Yet the knowledge was somehow made explicit: either by producing a new prototype of the game and/or by analysing data (e.g. through the 'Designerly broad brush thematic analysis' or the 'data trawling' that led to creating a framework). However these initial findings have not always been claimed as knowledge even though it informed the next iteration of the game's prototype (e.g. credit card idea).

Reflection *in* practice and *on* practice in this research has shown producing knowledge that was made explicit through the process however it is only by organising the data collected along the way at the end of the project that it was possible to claim knowledge with confidence (i.e. through repetition and link to literature).

Some might wonder whether doing a reflection *on* practice to claim/generate knowledge at the same time as the outcome is being (re)-designed would be a better practice (i.e. conducting more reflection *on* practice in between UCEs). Yet it is thought

as a researcher that conducting the research in a way that is similar to the one presented here seemed more appropriate since it made the knowledge:

1. Less subjective and stronger: going through this reflective process at the end only (DRE4) provides an opportunity to draw out some knowledge that was tacit for the designer and that might have not been possible to articulate and/or to make a reliable case for it if reviewed during the study. This way the created knowledge comes from repeated observations, which helps to establish validity and reliability (e.g. the theme 'Real-World Based / Replicating Adult's Behaviour' – coming from the credit card ideas as described in 5.2.3.1 – seemed important at the time but was not possible to claim as knowledge in the end). Furthermore, more objectivity is shown since the designer/researcher retain some distance from the study to figure out what works (as a designer) rather than trying to support or validate a theory (as a researcher).
2. More appropriate in relation to the research aims since refining the design of the game was the focus at the time. This point echoes with Bowen et al. (2014) who posit that the designer removing him/herself from the designing activity to produce knowledge (under the researcher hat) might actually reduce the quality of the outcome being designed. This is why in their approach, Bowen et al. conducted interviews after each user-centred intervention with qualitative researchers external to the project. However, such a strategy is costly and beyond the resources of this PhD project. A more thorough analysis could have been done after each enquiry in an attempt to verify the validity of the knowledge/hypotheses identified (i.e. assessing whether the themes used to create the framework were engaging) however the outcome of the research (i.e. the game) would have not been as developed. Actually a qualitative analysis was conducted after UCE1, yet as a designer this was experienced as slowing down the process of designing (i.e. prototyping, testing, modifying and testing again in iteration).

Even though there seems to be merits in conducting such data analysis at the end of a research project, it is important to stress that doing so might also be limited in the way that:

1. It is a significant over head in time and effort. It was time consuming to go back through all the data from the entire duration of the project to create the chronological timeline and visual map (respectively figures 25 & 26).
2. It might somehow undermine the validity of the findings. Even though data was collected in a systematic way along the process and notes were carefully categorised (as described in 3.3.4), conducting an analysis at the end (in DRE4) about data that was generated a long time ago might not be as accurate as doing it straight after a UCE.

There is therefore a tension in design and research where it is expected to make and produce a thing at the end of project since it is the skill set that a designer brings, yet there is a need for the designer/researcher to conduct research in a way that can be recognised by others. The design researcher does adopt and adapt methods from other disciplines such as ethnographers, qualitative researchers, yet he/she does not have such deep skills in these methods. The researcher through Design is a T-shaped skill individual (as described by Brown, 2005), capable to understand and integrate other researchers' skills and knowledge to produce a language through making.

## **8.7 REFLECTIONS ABOUT THE BENEFITS OF USING RTD**

Building on the contribution to knowledge presented in the previous chapter as well as some of the discussions presented in this chapter, a reflection is put forward as to demonstrating the benefits of using an RtD methodology within a multi-disciplinary context.

### **8.7.1 Can Bring Innovation in the Domain**

This RtD approach was chosen to create, develop and refine engaging game(s) to promote PA among adolescents aged 11-12 years. This produced two types of results:

1) the creation of the game 'Boost Up!' V4 which is an original outcome that distinguishes itself from other exergames (as described in 7.1); and 2) the creation of knowledge (i.e. a list of factors that promote engagement in young people). Both the game and the knowledge created are useful in the area of games/exergames since together they allow:

- Playing the games with an evolving currency making every game an unique experience (see 7.1.5);
- Promoting PA as a means to an end throughout the whole day, as part of a lifestyle (see 7.1.2);
- Brainstorming ideas to create games based upon a list of factors identified as engaging (see 7.2).

All of the points above seem particularly useful for game designers or other researchers involved into finding new ways to create and develop engaging (exer)games.

### ***8.7.2 Might Challenge Behaviour Change Theories/Models***

Section 7.1 describes the originality of 'Boost Up!' V4, implying that undertaking a RtD methodology contributed to developing the field of exergames in a particular way. Yet there were even instances in both UCE2 (when playing the game with the ACTIVIO system) and UCE3 (through the Health cards/challenges) where PA was undertaken in a way that seemed engaging and different from what was found in the behaviour change literature. These are presented below and described from a behavioural change lens.

Observations made through UCE2 (when testing V2 in Workshop 5 with the ACTIVIO system) suggested the engagement generated by 'Boost Up!' might come from the fact that it provided a way of exercising that didn't lecture about the benefits of PA and/or the dangers of a sedentary lifestyle. It seems that theories and models in psychology of behaviour change tend to begin with awareness raising to point out the benefits/disadvantages of a behaviour to create a cognitive dissonance and to promote 'Action' (Stage 3 of the TTM) however this might be limited in the context of

young people. Instead, 'Boost Up!' begins with 'Action' and being active is used as a means to an end (e.g. to gain game currency) through utilising instant rewards. It is then hoped that through acting repeatedly, players might develop new habits &/or perceive the benefits of adopting the behaviour. 'Boost Up!' also included an element of 'challenge' and whilst there were sometimes complaints about the difficulty of the challenge(s) set, by the end of the workshop, participants were asking to play more. Observations made during the workshops and the game club in UCE3 seem to support the view that challenges are an important part of engagement for young people. In this instance challenge was promoted through the 'Health Cards' (similar to those played with ACTIVIO yet optional with more choice of the type of PA to execute – see Appendix 2.B to compare the two types of challenges). These challenges aim to provide enjoyable experiences of PA, with alternatives, personal investment, social interactions and support, which are all important for increasing PA levels in youth and long term health outcomes (Weiss, 2000).

As well as acting as a means to an end in 'Boost Up!', the use of PA as game currency could also be argued to have acted as an awareness raising tool for the participants. Consistent with the processes of change of the TTM, raising awareness is a key first step of changing behaviour and so the monitoring and providing feedback aspect of the game seemed important in this regard, so too did the system of rewards via a gaming framework to motivate an increase in PA behaviour – all of which are common strategies to promote behaviour change (Abraham & Michie, 2012).

The role of social norms is also worthy of brief consideration. 'Boost Up!' offered opportunity for social comparison and norming both from fellow participants but also from the researcher. Moreover, this social comparison became explicit when playing the game (e.g. in the amount of currency received). It is consistent with the Theory of Planned Behaviour (Ajzen, 1995) to suggest that the opinion of others, especially those valued in the social circle (i.e. the researcher) could have been an influential factor for ensuring execution of the PA challenges, rather than the nature of the challenges or the game play itself and this is a limitation worth noting. It is also important to stress that the discussion here regarding the mechanisms for behaviour change are based on limited evidence (i.e. observational enquiries in UCE2 and a pre & post questionnaire

evaluating attitude, norm and self-efficacy in UCE3 that did not reveal much change). Therefore caution should be applied and further more in-depth research is required to fully understand ‘how’ and by ‘what mechanism’ games like ‘Boost Up!’ to promote ‘Action’ (i.e. PA). However it seems that adopting an RtD approach might offer alternatives for promoting behaviour change and/or challenge what is known in the psychological theories/models (e.g. about what is known of the TTM).

### ***8.7.3 Can Create Tools to Communicate in an Engaging Way***

Communication in Design is essential especially when the designer is the researcher, who is also at the centre of a multi-disciplinary team as it was the case in this research project. Indeed the designer/researcher becomes almost like a third party, integrating knowledge from others’ disciplines, translating it into his own language (i.e. through making) to communicate with end-users, and reporting this communication/interactions back to the team. In this research project the designer/researcher created different means of communication based on the different audiences (i.e. to the supervisory team/other researchers or to the end-users).

1. In communicating with the supervisory team/other researchers, understanding how the data is generated and where it comes from is crucial in research to generate knowledge, especially when different ways of approaching a research question are brought together in multi-disciplinary context. This is what led to the creation of the ‘Annotated Design History’ visuals in this research project (see 4.8.4). The visuals and maps (e.g. chronological timeline and visual map presented in 4.8.2) were found useful to communicate within the multi-disciplinary team, which was also composed of different nationalities.
2. In communicating with the end-users, tools that promote engagement such as dice (Figure 58) were created to ensure participants were pro-active during the workshops. Yet the idea of using dice was used for different purposes: for participants to create games (UCE1W4 – bottom line in Figure 58), to gather feedback as well as developing creative stimuli (UCE2W5), and to provoke a discussion (UCE3W6 – top line in Figure 58).



Figure 58 – Dice used to create games, develop inspiration, and gather feedback

The first point above shows that even though the main methodology adopted for this research was RtD, one outcome of the research was the creation of a new design research technique using ‘Annotated Design History’ visuals to communicate and report the findings in an engaging and transparent way (see 7.3). Therefore this point demonstrates that using a research *through* design methodology can generate knowledge useful to designers in two ways: to inform the design activity (i.e. gathering research for the purpose of designing a game – like the Picasso example) and to improve the research activity (i.e. to report research findings in a transparent way). Therefore applying a research *through* design methodology might also be a way to research *for* design.

The second point above refers to the use of engaging design research techniques to explore and communicate with the future end-users. This is particularly relevant to this research project which involved vulnerable users (i.e. adolescents) to research around a sensitive topic (obesity). Yet it is thought that applying design research techniques can be extended to a wider health context of a sensitive nature, involving other types

of future end-users (e.g. visually or hearing impaired) yet in which their engagement in the project remains crucial.

Combined together, those two points demonstrate the potential for design being at the centre of the multi-disciplinary team since the designer/researcher becomes an intermediary used as a translator to communicate between the team and the participants.

#### ***8.7.4 Can Create Knowledge in a Range of Disciplines***

The contribution to knowledge is multi-fold and multi-disciplinary since this can be of use for those working in the field of Design (demonstrating a new way to report findings through the 'Annotated Design History' visuals), Games (new exergame concept introduced in 7.1.1) and Health behaviour change (insights and guidance to reconsider ways to promote PA as described in 8.7.2 and 8.7.3).

However the knowledge created goes beyond Design, Games and Health. Following the ideas that 'Boost Up!' might promote PA as part of a lifestyle and that PA is a means to an end seemed to engage young people in doing PA, it is imagined that schools' curriculum could be reshaped. For instance, PE lessons could be re-thought to promote PA outside the curriculum, as part of the pupils' everyday life and use PE lessons to play games (for which the currency is awarded based on individuals' daily levels of PA). Re-designing PE lessons seems appropriate given that Ofsted inspectors reported there is not enough VPA during PE lessons (Richardson, 2013). Yet extra-curricular activities could also be created since participants reported as a negative aspect having to miss PE, identified by Simons et al. (2013) as one important reason for 10-12 years old participants to increase PA along with having more energy to do homework. This is consistent with BHF (2014) which reports the success of combining additional PE lessons with before/after school programmes/activities and teaching self-regulatory behaviour skills (i.e. goal setting and self-monitoring). As a conclusion, offering this age-group the opportunity to do PA as part of daily living tasks might be more appropriate or at least more in line with their preferences and values.

Therefore a RtD methodology could be used to redesign the PE curriculum with the aim of making it more suitable while engaging the pupils' tastes and lifestyle. An RtD methodology could also be applied to re-thinking the entire curriculum, for example to create cross-curriculum activities. It is imagined that pupils could create a game as part of their Design & Technology course, play it during PE lessons, and explore their behaviour through being involved in Mathematics or Science activities for which their content would be based onto the pupils' individual data picked up by their device measuring PA (e.g. a bead = 3min VPA). As a consequence, cross-curriculum activities might also provide a blending experience (as defined in 2.6) since they might be a way to represent the abstract notion of 'behaviour' and which might also increase the pupils' self-awareness about their behaviour. On the same token, school playground activities might also be redefined (e.g. make them more fun/as part of the game(s)).

#### ***8.7.5 Seems Useful at the Centre of a Multi-Disciplinary Context***

Design research and more especially RtD was the driver in this research. Being at the centre of the project, as outlined in 8.7.4, seemed useful in the following ways:

- Allows communicating to all stakeholders involved in a project (i.e. research team and participants) in an engaging way, which might facilitates or improve discussions;
- Leads to the creation of a new method to report the data to the team and to other researchers in an engaging and transparent way (through using 'Annotated Design History' visuals).

Through 'making things' as a main method of enquiry (see 2.8.4), designers create their own language (sketches, story boards, 3D models, films/animation movies...) that provide alternative and tangible modes of engagement with people. This point is shared by Kelley (2012) who explains the value of 'making' to spark reactions and emotions that are instant, spontaneous and real. Therefore adopting an RtD approach and applying design research techniques seems particularly useful when working in a multi-disciplinary team and in a sensitive context. Therefore RtD seems particularly relevant for exploring Health topics that involve users that might be challenging to

communicate with (e.g. hearing/visually impaired) and/or working with vulnerable people (e.g. children/adolescents, elderly). Engagement in this research also seemed to be increased through adopting a playful approach such as using dice to gather feedback.

### **8.8 A VISION OF DESIGN RESEARCH WITHIN A HEALTH CONTEXT**

The processes and techniques used in Design contrast with those used in Health research and reveal things in a particular way that might contribute to the innovation process. As presented in 2.8.3, Sanders (2002) explains that involving participants in different activities (say/do/make) can reveal different types of knowledge (explicit/observable/tacit). Yet the type of knowledge produced when adopting a RtD/design-led methodology does not replace those produced in Health research, since the latter was used to guide the project development.

Furthermore, even though 'Boost Up!' was not fully developed, the design-led methodology intended to create and develop games that are 'real' as described by Fallman (2008) – see 3.3.1. This question of implementation is crucial for Matheson et al. (2013) to ensure outcome(s) being beneficial to health services, who posit that true innovation is only possible through implementation. As explained previously, designers create their own language and will implement theory in tangible solutions. Since Design uses an iterative and practice-based approach to develop outcome(s), implementation may be less challenging since already tested in context with users. However it is questioned whether an outcome developed in one context or for one population remain valid elsewhere.

Therefore when conducting a research project that aims to produce Health outcomes (i.e. that are often submitted to quantitative requirements when evaluated), it seems important to adopt a RtD/design-led approach at the start of creating the Health intervention, which belongs to the left hand side in the Figure 59 of Campbell et al. (2000).

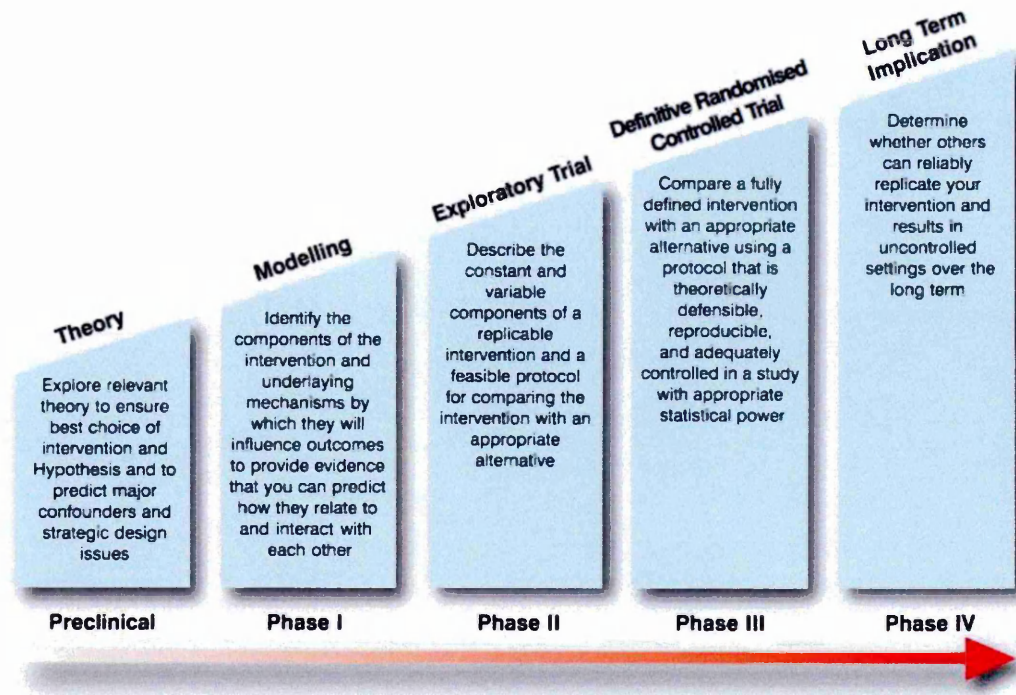


Figure 59 – Evaluation of Complex Interventions (Campbell et al., 2000)

It is during these early phases of the creation of an intervention that Design and Health collaborate (i.e. 'Preclinical' and 'Phase I & II') to ensure together:

- Understanding the concrete needs of the end-users;
- Setting out appropriate directions to follow;
- Creating and Implementing through the process of making / testing / and modifying again to test again iteratively.

Design and Health can work together in the early phases of the evaluations of the intervention but as the intervention is developed, refined and implemented, it then starts following the process led in Health research, where verifying the health measures/benefits becomes the priority. The role of the design researcher might then be less relevant and his/her involvement less required, or at least not as leader (e.g. in 'Phase III' and onwards in Figure 59). Yet there is a need for non-design researchers to accept the lead and/or the use of other methods that are not necessarily quantitative, especially at the start of a project. It is clear that objective measurements are required when assessing Health related outcomes however there is a need to create the intervention to assess first. This is why the design-led methodology created for this

research adopted a mixed-method approach emphasizing qualitative aspects at the start of the research to progressively adding quantitative methods as the intervention became more developed and refined. There is potential following this research project that more pilot study(ies) could be conducted to increase the game's engagement until the games can be shown to work (i.e. shows signs of increase in PA levels) before conducting a final evaluation that would follow the criteria of validity set in health (e.g. an RCT).

Health research & Design research are therefore complementary and a combination of knowledge and methods used in Health with those used in Design is what might facilitate implementation and drive innovation through reaching a balance between theory and practice, as suggested by Matheson et al. (2013). Hence establishing an iterative integration of Design and Health disciplines seems worthwhile, recognising the value of contribution early in the research (i.e. design researcher should be involved early in the process) until the intervention is replicable. Building a multi-disciplinary team from the start of a research project (i.e. setting the research question together) was also recommended in Kato (2012b).

## *Chapter IX- Conclusion*

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As presented in Chapter VII, the RtD methodology used in this research has produced contributions to knowledge in the areas of Games, Health and Design. The type of knowledge generated when applying a RtD methodology is different from traditional methodologies, which, as discussed in Chapter VIII, might facilitate implementation of the outcome(s). It therefore seems beneficial to adopt such a design research methodology within a Health context.

Each contribution is summarised below:

- 'Boost Up!' is a novel approach to engage young people in PA adopting the principles of games/gamification;
- A list of factors has emerged from this research that provides insight into how to engage an audience of 11-12 years old in PA behaviour;
- The development of a new design research technique to show transparency when reporting the field-based data through the use of visuals: this is the 'Annotated Design History', which can be inserted in posters and/or illustrated using tables to show traceability of a research or design outcome (design idea and/or knowledge).

The way 'Boost Up!' was evaluated in UCE3 suggested ways that the V4 prototypes could be modified again to increase engagement. This combined with the discussions presented in the previous chapter suggests some directions for further work.

This thesis has demonstrated how RtD can deliver distinctive research contributions that can be of use to other domains such as Health behaviour change. This is due to the specificity that design research techniques and methodology bring to the research process. An RtD methodology which used 'making' as a main way of enquiring, led to outcomes and knowledge that can be of use to designers, but also to those wanting to create engaging (exer)games or to promote PA among young people aged 11-12. Yet

the knowledge (i.e. list of factors) and understanding of what is engaging and acceptable to young people goes far beyond the three disciplines of Design, Games and Health since it could be applied when developing education curriculum via creating games for education, educational environments or leisure environments or similar (e.g. designing a new product, space, service for 11-12 years old). Central to the production of this knowledge was the method applied to make it explicit. With this in mind, this research demonstrates the benefits of undertaking a RtD/Design-led methodology that is practice-based and iterative, and applying it to 'wicked problems' in a health context.

The potential for using a RtD/Design-led methodology to solve problems in a Health context appears to offer much promise, particularly in young people as shown here. 'Design for Health & Well-being' is a growing field and this research adds to the growing body of knowledge, which faces similar challenges, especially in terms of recognition of Design research methodologies as a way to generate knowledge. There seems to be a tendency nowadays around conducting co-design activities within a participatory context, which questions the role of the designer. It seems worth highlighting that the involvement of the future end-users in the process is crucial to better understand their needs and explore what is feasible, yet the holistic vision combined with iterative tests that ('T-shaped') designers bring to the research process seems unique and promising. Besides, bringing designers into the process adds tangibility in the outcome since ideas and knowledge are synthesised into physical things (e.g. prototypes, artefacts). Therefore even if involving users in the process, developing prototypes and conducting iterative tests might imply a high level of resources (in time and money), there seems value to do so since it has produces original contributions to the body of knowledge.

Yet it is important to mention that if RtD can generate different types of insights and knowledge, this was only possible by relying on existing knowledge developed with more traditional methods of investigation like those used in Health. Therefore both ways of researching remain valid since they produce two types of knowledge that are useful to both disciplines (i.e. they inform each other). It becomes clear that Design and Health are two distinct disciplines that can be complementary. Health and Design

researchers would benefit from working together, especially at the start of a research project, in the conception phases of developing the intervention, and even before, to set up together the scope and approach of the research project.

## **X- Bibliography**

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Aarts, H., Paulussen, T., & Schaalma, H. (1997). Physical exercise habit: on the conceptualization and formation of habitual health behaviours. *Health education research*, 12(3), 363–74.

Adams, J., & White, M. (2005). Why don't stage-based activity promotion interventions work? *Health Education Research*, 20(2), 237-243. doi: 10.1093/her/cyg105.

Adriaanse, A. A., De Ridder, D. T. D., De Wit, J. B. F. (2009). Finding the critical cue: implementation intentions to change one's diet work best when tailored to personally relevant reasons for unhealthy eating. *Personality and Social Psychology Bulletin*, 35 (1), 60-71.

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*. (50), 179–211, Academic Press, Inc.

Archer, B. (1995). The nature of research. *Co-design, interdisciplinary journal of design*, January: 6-13.

Aveyard, P., Massey, L., Parsons, A., Manaseki, S., Griffin, C. (2009). The effect of Transtheoretical Model based interventions on smoking cessation. *Social Science & Medicine*, 68(3):397-403.

Aznar-Lain, S., & Webster, T. (2012). Physical Activity and Health in Children and Adolescents. A Guide for all Adults Involved in Educating Young People. *Ministry of Health & Ministry of Education and Science*. Retrieved from [www.msc.es/en/ciudadanos/proteccionSalud/adultos/actiFisica/docs/actividadFisicaSaludIngles.pdf](http://www.msc.es/en/ciudadanos/proteccionSalud/adultos/actiFisica/docs/actividadFisicaSaludIngles.pdf)

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

- Bandura, A., (1997), *Self-efficacy: The exercise of control*. New York: Freeman.
- Baranowski, T. Baranowski, J., Thompson, D., & Buday, R. (2011). Behavioral Science in Video Games for Children's Diet and Physical Activity Change: Key Research Needs. *Journal of Diabetes Science and Technology*, 5(2), 229–233.
- Baranowski, T., Buday, R., Thompson, D. I., Baranowski J. (2008). *American Journal of Preventive Medicine*, 34(1), 74-82.e10, Elsevier Inc.
- Baranowski, T., Lieberman, D. A., Buday, R., Peng, W., Zimmerli, L., Wiederhold, B., & Kato, P.M. (2013). Videogame Mechanics in Health. *Games for Health Journal*, 2(4), 194–204.
- Barnett, A., Cerin, E., & Baranowski, T. (2011). Active video games for youth: a systematic review. *Journal of physical activity & health*, 8(5), 724–37. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/21734319>.
- Bec, R. (2011). Designing “Gener-G”, the Human Energy Trading Game. *Proceedings of D4H*. Sheffield, UK. Available at: <http://design4health.org.uk/2011-official-proceedings>
- Bernhardt, J. M., Chaney, J. D., Chaney, B. H., & Hall, A. K. (2013). New media for health education: a revolution in progress. *Health education & behavior: the official publication of the Society for Public Health Education*, 40(2), 129–32. doi:10.1177/1090198113483140
- British Heart Foundation. (2012). *Sedentary behaviour Costs of physical inactivity* (pp. 1–16). British Heart Foundation Health Promotion Research Group Department of Public Health, University of Oxford.
- British Heart Foundation (b). (2012). *Physical activity statistics* (pp. 1–131). British Heart Foundation Health Promotion Research Group Department of Public Health, University of Oxford. ISBN 978-1-899088-07-2

British Heart Foundation (c). (2012). *Exergaming, An Evidence Briefing on Active Video Games* (pp. 1–12).

British Heart Foundation. (2014). *Young people : Practical strategies for promoting physical activity* (pp. 1–12).

Bhave, S., Saxena, A., Saini, S., Saxena, A., & Goyal, N. (2011). 156. Peer Pressure Among Adolescent School Children in India. *Journal of Adolescent Health, 48*(2), S98–S99. doi:10.1016/j.jadohealth.2010.11.204.

Biddis, E., & Irwin, J. (2010). Active Video Games to Promote Physical Activity in Children and Youth: A Systematic Review. *American Medical Association, 164*(7), 664–672.

Biddle S. J. H. & Nigg C. R. (2000). Theories of exercise behaviour. *International Journal of Psychology, 31*, 290-304.

Björk, S. & Holopainen, J. *Patterns in Game Design. (2005)*. Charles River Media, Boston, MA.

Bogost, I. (2007). Persuasive Games: The Missing Social Rituals of Exergames. Article from Gamasutra. Last accessed on 5 May 2010 at: [http://www.bogost.com/writing/the\\_missing\\_rituals\\_of\\_exergam.shtml](http://www.bogost.com/writing/the_missing_rituals_of_exergam.shtml)

Bowen, S., Dearden, A., & Dexter, M. (2014). Wearing Two Hats: Reflecting Alongside Authentic Designing Authentic Design Practice. Design Research Society Conference, 1–13. Retrieved from <http://www.drs2014.org/en/>

Brandt, E. (2006). Designing Exploratory Design Games: A Framework for Participation in Participatory Design? *Proceedings of the 9th Participatory Design Conference*. New York, New York: ACM Press.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. doi:10.1191/1478088706qp063oa

- Breuer, J., & Bente, G. (2010). Why so serious ? On the Relation of Serious Games and Learning, 4(1), 7–24.
- Brown, T. (2008). Design thinking. *Harvard Business Review*, 86(6), 84–92, 141. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/18605031>
- Brug, J., Oenema, A., & Ferreira, I. (2005). Theory, evidence and Intervention Mapping to improve behavior nutrition and physical activity interventions. *The International Journal of Behavioral Nutrition and Physical Activity*, 2(2). doi:10.1186/1479-5868-2-2
- Foresight - 'Tackling Obesities: Future Choices – Project Report ', 2<sup>nd</sup> Edition, (2007). Full Obesity Map System. Government Office for Science & Department of Health. Department of Innovation Universities and Skills. Last accessed on 20 May 2014 at: [http://www.noo.org.uk?NOO\\_about\\_obesity/causes](http://www.noo.org.uk?NOO_about_obesity/causes)
- Campbell, M., Fitzpatrick, R., Haines, a, Kin outh, A., Sandercock, P., Spiegelhalter, D., & Tyrer, P. (2000). Framework for design and evaluation of complex interventions to improve health. *Bmj*, 321(September), 694–696. doi:10.1136/bmj.321.7262.694
- Cairns R. B., Cairns B. D., Neckerman J. J., (1989). Early school dropout: Configurations and determinants, *Child Development*, 60, 1437-1452.
- Carroll, J. M., & Rosson, M. B. (2007). Participatory design in community informatics. *Design Studies*, 28(3), 243–261. doi:10.1016/j.destud.2007.02.007
- Cavill, N., & Bauman, A. (2004). Changing the way people think about health-enhancing physical activity: do mass media campaigns have a role? *Journal of sports sciences*, 22(8), 771–90. doi:10.1080/02640410410001712467
- Chin, A., Paw, M. J., Jacobs, W. M., Vaessen, E. P., Titze, S., Van Mechelen, W. (2008). The motivation of children to play an active video game. *Journal of Science and Medicine in Sport*; 11(2):163–166.

- Colley, R. C., Janssen, I., & Tremblay, M. S. (2012). Daily step target to measure adherence to physical activity guidelines in children. *Medicine and science in sports and exercise*, 44(5), 977–82. doi:10.1249/MSS.0b013e31823f23b1
- Craig, P., Dieppe, P., Macintyre, S., Health, P., Unit, S., Michie, S., Nazareth, I., et al. (2008). *Developing and evaluating complex interventions : new guidance* (pp. 1–39). Medical Research Council Framework. Retrieved from <http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC004871>
- Crimmins, E. M., & Saito, Y. (2001). Trends in healthy life expectancy in the United States, 1970-1990: gender, racial, and educational differences. *Social science & medicine*, 52(11), 1629–41. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11327137>
- Cross, N. (2007). *Designerly ways of knowing*. Basel : Birkhäuser, c2007. Originally published: London: Springer, 2006. ISBN: 9783764384845.
- Cugelman, B. (2013). Gamification: What It Is and Why It Matters to Digital Health Behavior Change Developers. *JMIR Serious Games*, 1(1), e3. doi:10.2196/games.3139
- Daley, A. J. (2009). Can exergaming contribute to improving physical activity levels and health outcomes in children? *Pediatrics*, 124(2), 763–71. doi:10.1542/peds.2008-2357
- Dalsgaard, P., & Halskov, K. (2012). Reflective Design Documentation. *Proceedings of DIS2012* (pp. 428–437). Newcastle-Upon-Tyne, UK.
- De Kort, Y. A. W., & Ijsselstein, W. A. (2008). People , Places , and Play : Player Experience in a Socio-Spatial Context. *ACM Computers in Entertainment*, 6(2; Article 18), 1–11. doi:10.1145/1371216.1371221

Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research*. Rochester, NY: University of Rochester Press.

Department of Environment, Transport and the Regions (1999), *National Travel Survey, 1996–98 Update*. London: DETR.

Department of Health. (2011). *Start Active, Stay Active - A report on physical activity for health from the four home countries' Chief Medical Officers. Chief Medical Officers*, (pp. 1–59). Retrieved from <http://www.bhfactive.org.uk/userfiles/Documents/startactvestayactive.pdf>

Dishman, R. K., Motl, R. W., Saunders, R., Felton, G., Ward, D. S., Dowda, M., & Pate, R. R. (2004). Self-efficacy partially mediates the effect of a school-based physical-activity intervention among adolescent girls. *Preventive medicine, 38*(5), 628–36. doi:10.1016/j.ypmed.2003.12.007

Dishman, R. K., Motl, R. W., Sallis, J. F., Dunn, A. L., Birnbaum, A. S., Welk, G. J., Bedimo-Rung, A. L., et al. (2005). Self-management strategies mediate self-efficacy and physical activity. *American journal of preventive medicine, 29*(1), 10–8. doi:10.1016/j.amepre.2005.03.012

Dishman, R. K., Saunders, R. P., Felton, G., Ward, D. S., Dowda, M., & Pate, R. R. (2006). Goals and intentions mediate efficacy beliefs and declining physical activity in high school girls. *American journal of preventive medicine, 31*(6), 475–83. doi:10.1016/j.amepre.2006.08.002

Djaouti, D., Alvarez, J., Jessel, J-P., Rampnoux, O. (2011). "Origins of Serious Games", in Minhua Ma, Andrea Oikonomou, Lakhmi C. Jain (eds.), *"Serious Games and Edutainment Applications"*, Springer, pp.25-43, 2011. Available at [http://www.ludoscience.com/files/ressources/origins\\_of\\_serious\\_games.pdf](http://www.ludoscience.com/files/ressources/origins_of_serious_games.pdf)

- Djaouti, D., Alvarez, J., Jessel, J-P. (b). (2011). "Classifying Serious Games: The G/P/S Model", in Patrick Felicia (ed), "Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches", IGI Global, 2011. Available at [http://www.ludoscience.com/files/ressources/classifying\\_serious\\_games.pdf](http://www.ludoscience.com/files/ressources/classifying_serious_games.pdf)
- Duncan, M. J., Birch, S., Woodfield, L., & Hankey, J. (2011). Physical Activity Levels During a 6-Week, School-Based, Active Videogaming Intervention Using the Gamercize Power Stepper in British Children. *Medicina Sportiva*, 15(2), 81–87. doi:10.2478/v10036-011-0014-0
- Duncan, M. J., & Dick, S. (2012). Energy Expenditure and Enjoyment of Exergaming: a Comparison of the Nintendo Wii and the Gamercize Power Stepper in Young Adults. *Medicina Sportiva*, 16(3), 92–98. doi:10.5604/17342260.1011386
- Ehn, P., & Kyng, M., (1991). Cardboard Computers: Mocking-it-up or Hands-on the Future, pp. 169 – 196 in Design at Work: Cooperative design of Computer Sysetms, Greenbaum & Kyng, Lawrence Erlbaum Associates, Hillsdale NJ., USA.
- Ekblom-Bak, E., Hellénus, M-L., Ekblom, B. (2010). Are we facing a new paradigm of inactivity physiology? *British Journal of Sports Medicine*, 44 (12), 834-835.
- Fallman, D. (2007). Why Research-Oriented Design Isn't Design-Oriented Research: On the Tensions Between Design and Research in an Implicit Design Discipline. *Knowledge, Technology & Policy*, 20(3), 193–200. doi:10.1007/s12130-007-9022-8
- Fallman, D. (2008). The Interaction Design Research Triangle of Design Practice , Design Studies , and Design Exploration, 24(3), 1–15.
- Fallman, D., & Stolterman, E. (2010). Establishing criteria of rigour and relevance in interaction design research. *Digital Creativity*, 21(4), 265–272. doi:10.1080/14626268.2010.548869

- Fishbein, M., & Capella, J. N., (2006), The role of theory in developing effective health, communications, *Journal of Communication*, 56, S1-S17.
- Floyd, C. (1984). A Systematic Look at Prototyping. Retrieved from In R. Budde et al., eds. Approaches to Prototyping. London: Springer Verlag, pp. 1-18. Available at: [http://www.daimi.au.dk/DIS/materialer/Floyd\\_Systematic.pdf](http://www.daimi.au.dk/DIS/materialer/Floyd_Systematic.pdf).
- Fogg B. J., (2002), Persuasive Technology: Using Computers to Change What We Think and Do, Morgan Kaufmann.
- Frayling, C. (1993). Research in Art & Design. *Royal College of Art Research Papers*, 1(1), 1–5.
- Frémeaux, E., Mallam, K. M., Metcalf, B. S., Hosking, J., Voss, L. D., & Wilkin, T. J. (2011). The impact of school-time activity on total physical activity: the activystat hypothesis (EarlyBird 46). *International journal of obesity*, 35(10), 1277–83. doi:10.1038/ijo.2011.52
- Gaver, B., & Bowers, J. (2012). Annotated portfolios. *Interactions*, 19(4), 40. doi:10.1145/2212877.2212889
- Gaver, W. W., (2012). What should we expect from research through design? *Proceedings of CHI 2012* (pp. 937–946). doi:10.1145/2208516.2208538
- Gaver, W. W., Boucher, A., Pennington, S., & Walker, B. (2004). Cultural probes and the value of uncertainty. *Interactions*, 11(5), 53–56. Retrieved from <http://doi.acm.org/10.1145/1015530.1015555>
- Glasemann, M., & Kanstrup, A. M. (2008). Evoking creativity : Young diabetics design their own mobile diabetes supporter.
- Goldfield, G. S., Cameron, J. D., & Chaput, J.-P. (2014). Is Exergaming a Viable Tool in the Fight against Childhood Obesity? *Journal of Obesity*, Article ID, 1–2. doi:10.1155/2014/304521

- Gollwitzer P. M., (1993), Goal achievement: The role of intentions, *European Review of Social Psychology*, 4, 141-185.
- Gollwitzer P.M., Bayer, U., McCullouch K., (2005), The control of the unwanted, *The new unconscious* (pp. 485-515). Oxford: Oxford University Press.
- Graves, L., Stratton, G., Ridgers, N. D., & Cable, N. T. (2007). Comparison of energy expenditure in adolescents when playing new generation and sedentary computer games: cross sectional study. *BMJ (Clinical research ed.)*, 335(7633), 1282–4. doi:10.1136/bmj.39415.632951.80
- Gray, C., Hunt, K., Mutrie, N., Anderson, A., Leishman, J., Dalgarno, L., Wyke, S. (2013). Football fans in training: the development and optimization of an intervention delivered through professional sports clubs to help men lose weight, become more active and adopt healthier eating habits, *BioMed Central journal*, 13:232.
- Green, K. (2006). Physical Education and ' the Couch Potato Society ' - Part One. *European Journal of Physical Education*, (February 2012), 7:2, pp95–107.
- Habgood, M. P. J., & Ainsworth, S. E. (2011). Motivating Children to Learn Effectively: Exploring the Value of Intrinsic Integration in Educational Games. *Journal of the Learning Sciences*, 20(2), 169–206. doi:10.1080/10508406.2010.508029
- Hager, R. L., Hardy, A., Aldana, S. G., & George, J. D. (2002). Evaluation of an Internet, Stage-Based Physical Activity Intervention. *American Journal of Health Education*, 33(6), 329–337. doi:10.1080/19325037.2002.10604755
- Hamm J., (2000), Do birds of a feather flock together? The variable bases for African American and European American adolescents' selection of similar friends. *Developmental Psychology*, 36, 209-219.
- Hausenblas H. A., Nigg C. R., Dannecke, E. A., Downs, D. S., Gardner R. E., Fallon E. A., et al., (2002), Perceptions of exercise stages, barrier self-efficacy, and decisional

balance for middlelevel school students, *Journal of Early Adolescence*, 22, 436-454.

Hillman, M., Adams, J. and Whitelegg, J. (1991), *One False Move: A Study of Children's Independent Mobility*. London: Policy Studies Institute.

Houde, S., & Hill, C. (1997). What do Prototypes Prototype ? In M. G. Helander, T. K. Landauer, & P. V. Prabhu, eds. *Handbook of Human-Computer Interaction*. Amsterdam, The Netherlands: Elsevier Science B.V. (pp. 367–381).

Hutchison A. J., Breckon J. D., Johnston L. H., (2008), Physical Activity Behavior Change Interventions Based on the Transtheoretical Model: A Systematic Review, *Health Education & Behavior*, doi:10.1177/1090198108318491

Jago, R., Baranowski, T., Baranowski, J., Thomspon, D., Cullen, K., Watson, K., & Liu, Y. (2006). Fit for Life Boy Scout Badge: Outcome evalauation of a troop and Internet intervention. *Preventive Medicine*, 42, 181–187.

Kato, P. M. (2010). Video games in health care: Closing the gap. *Review of General Psychology*, 14(2), 113–121. doi:10.1037/a0019441

Kato, P. M. (2012a). Evaluating Efficacy and Validating Games for Health. *Games for Health Journal*. February 2012, Vol. 1, No. 1: 74-76, 1.

Kato, P. M. (2012b). The Role of the Researcher in Making Serious Games for Health. *Serious Games for Healthcare: Applications and Implications*. Hershey, PA: IGI-Global. S. Arnab, I. Dunwell & K. Debattista (Eds.).

Kato, P. M., Cole, S. W., Bradlyn, A. S., & Pollock, B. H. (2008). A video game improves behavioral outcomes in adolescents and young adults with cancer: a randomized trial. *Pediatrics*, 122(2), e305–17. doi:10.1542/peds.2007-3134.

Kelley D., (2012), IDEO founder. Video last retrieved on 11/05/2015 on <http://vimeo.com/36608732>

- Keytel, L. R., Goedecke, J. H., Noakes, T. D., Hiiloskorpi, H., Laukkanen, R., van der Merwe, L., & Lambert, E. V. (2005). Prediction of energy expenditure from heart rate monitoring during submaximal exercise. *Journal of sports sciences*, 23(3), 289–97. doi:10.1080/02640410470001730089
- Klopfer, E., Osterweil, S., & Salen, K. (2009). *Moving Learning Games Forward*. Massachusetts Institute of Technology, USA: The Education Arcade.
- Koskinen, I., Binder, T., & Redström, J. (2008). *Lab , Field , Gallery , and Beyond*, (1).
- Koskinen, I., Zimmerman, J., Binder, T., Redström, J., & Wensveen, S. (2011). *Design Research through Practice, From the Lab, Field, and Showroom*. Elsevier Inc.
- Lamboglia, C. M. G. F., Da Silva, V. T. B. L., De Vasconcelos Filho, J. E., Pinheiro, M. H. N. P., Munguba, M. C. D. S., Silva Júnior, F. V. I., De Paula, F. A. R., et al. (2013). Exergaming as a strategic tool in the fight against childhood obesity: a systematic review. *Journal of obesity*, Article ID, 1–8. doi:10.1155/2013/438364
- Lee, Y. (2008). Design participation tactics: the challenges and new roles for designers in the co-design process. *CoDesign*, 4(1), 31–50. doi:10.1080/15710880701875613
- Lieberman, D. A. (1997). Interactive video games for health promotion: Effects on knowledge, self-efficacy, social support, and health, in R. L. Street, W. R. Gold & T. Manning (Eds.), *Health promotion and interactive technology* (pp. 103-120). Mahwah, NJ: Lawrence Erlbaum Associates.
- Lieberman, D. A. (2006). What can we Learn from Playing Interactive Games? In P. Vorderer & J. Bryant (Eds.), *Playing video games motives, responses, and consequences* (pp. 379–397). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Lieberman, D.A. (2012). Digital games for health behavior change: Research, design, and future directions. Chapter in S.M. Noar & N.G. Harrington (Eds.), *eHealth*

applications: Promising strategies for behavior change. New York: Routledge, pp. 110-127.

Lieberman, D. A. (2013). Designing digital games, social networks, and mobile technologies to motivate and support health behavior change. Chapter in R.E. Rice & C.K. Atkin (Eds.), *Public communication campaigns* (4th Edition). Thousand Oaks, CA: Sage Publications, pp. 273-287.

Lieberman, D. A., Chamberlin, B., Medina, E., Franklin, B. A., Sanner, B. M., & Vafiadis, D. K. (2011). The power of play: Innovations in Getting Active Summit 2011: a science panel proceedings report from the American Heart Association. *Circulation*, 123(21), 2507–2516. doi:10.1161/CIR.0b013e318219661d.

Lu, A. S., Baranowski, T., Thompson, D., & Buday, R. (2012). Story Immersion of Videogames for Youth Health Promotion : A Review of Literature. *Games for Health Journal*, 1(3), 199–204. doi:10.1089/g4h.2011.0012

Lu, A. S., Kharrazi, H., Gharghabi, F., & Thompson, D. (2013). A Systematic Review of Health Videogames on Childhood Obesity Prevention and Intervention. *Games for Health Journal*, 2(3), 131–141. doi:10.1089/g4h.2013.0025

Maddison, R., Foley, L., Mhurchu, C. N., Jiang, Y., Jull, A., Prapavessis, H., Hohepa, M., et al. (2011). Effects of active video games on body composition : a randomized. *The American Journal of Clinical Nutrition*, (94), 156–163. USA, American Society for Nutrition. doi:10.3945/ajcn.110.009142.

Malhotra A., Noakes T., Phineey S. (2015). It is time to bust the myth of physical inactivity and obesity: you cannot outrun a bad diet. *Br J Sports Med* 0:1–2. doi:10.1136/bjsports-2015-094911

Malone, T. W., & Lepper, M. R. (1987). Making learning fun: A taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, Learning and Instruction III: Conative and affective process analyses* (pp. 223-253). Hillsdale, NJ: Erlbaum.

- Maloney, A. E., Bethea, T. C., Kelsey, K. S., Marks, J. T., Paez, S., Rosenberg, A. M., Catellier, D. J., et al. (2008). A pilot of a video game (DDR) to promote physical activity and decrease sedentary screen time. *Obesity (Silver Spring, Md.)*, 16(9), 2074–80. doi:10.1038/oby.2008.295
- Matheson, G. O., Klügl, M., Engebretsen, L., Bendiksen, F., Blair, S. N., Börjesson, M., Budgett, R., et al. (2013). Prevention and Management of Non-Communicable Disease: The IOC Consensus Statement, Lausanne 2013. *Sports medicine (Auckland, N.Z.)*, 43(11), 1075–1088. doi:10.1007/s40279-013-0104-3
- Michael, D. & Chen, S. (2006) Serious games: Games that educate, train, and inform. Boston, MA.: Thomson Course Technology.
- Michie S., Ashford S, Sniehotta F., Dombrowski S., Bishop A., French P., (2011a), A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy behaviours: The CALO-RE taxonomy, *Psychology & Health*, 26:11, 14779-1498.
- Michie, S., Van Stralen, M. M., & West, R. (2011b). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science*, 6(April), 42. doi:10.1186/1748-5908-6-42
- Mønsted, T., & Onarheim, B. (2010). Segmentation of users in PD for healthcare. *Proceedings of the 11th Biennial Participatory Design Conference on - PDC '10* (pp. 159–162). New York, New York, USA: ACM Press. Retrieved from <http://dl.acm.org/citation.cfm?id=1900441.1900465>
- Mueller, F. F., Agamanolis, S., Vetere, F., & Gibbs, M. R. (2009). A Framework for Exertion Interactions over a Distance, 1(212), 143–150.
- Munson, S. A., & Consolvo, S. (2012). and Sharing to Motivate Physical Activity. *6th International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth)* (pp. 25–32). San Diego, CA. doi:978-1-4673-1483-1

Nader, P., Bradley, R. H., Houts, R. M., McRitchie, S. L., & O' Brien, M. (2008). Moderate-to-Vigorous Physical Activity, from Ages 9 to 15 Years. *American Medical Association*, 300(3), 295–305.

National Association for Sport and Physical Education. (2004). Physical Activity for children: A statement of guidelines for children ages 5-12. Reston, VA: Author.

National Health And Nutrition Examination Survey, (2002), U.S. Department of Health and Human Services. Available online at [http://aspe.hhs.gov/health/reports/child\\_obesity/](http://aspe.hhs.gov/health/reports/child_obesity/)

NICE Public Health Guidance 6. (2007). Behaviour change at population, community and individual levels. Retrieved from <http://www.nice.org.uk/PH006>

National Obesity Forum. (2014). Article available at: <http://metro.co.uk/2014/01/13/obesity-crisis-more-than-half-of-british-population-set-to-be-obese-by-2040-4260431/>

O'Connor, T. M., Jago, R., Baranowski, T. (2009). Engaging parents to increase youth physical activity a systematic review. *American Journal of Preventive Medicine*, 37 (2):141–9.

Oh, Y., & Yang, S. (2010). Defining Exergames & Exergaming. *Meaningful Play Conference* (pp. 1–17).

Omidyar, P., (2012), *Zamzee Research Results*. Paper presented at the Obesity Society, San Antonio, TX. Available at <http://www.slideshare.net/fullscreen/hopelab/zamzee-research-results/1>

Overbeeke, K. C. J., & Wensveen, S. S. A. G. (2003). From perception to experience, from affordances to irresistibles. *Proceedings of the 2003 international conference on Designing pleasurable products and interfaces - DPPI '03*, 92. doi:10.1145/782915.782919

- Pate, R. E. (2010). Assessing the level of physical activity in children. In Bouchard C. & Katzmarzyk P. (Eds), *Physical Activity and Obesity, Second Edition*. Louisiana ISBN-13: 9780736076357
- Peng, W., Crouse, J. C., & Lin, J.-H. (2013). Using active video games for physical activity promotion: a systematic review of the current state of research. *Health education & behavior: the official publication of the Society for Public Health Education*, 40(2), 171–92. doi:10.1177/1090198112444956
- Prensky, M. (2007). Digital game-based learning. St. Paul, MN: Paragon House.
- Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Connor Gorber, S., & Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *The international journal of behavioral nutrition and physical activity*, 5(56), 1–24. doi:10.1186/1479-5868-5-56
- Prochaska, J. O. & Di Clemente, C. C. (1983), Stages and processes of self-change in smoking: Toward an integrative model of change. *Journal of Consulting & Clinical Psychology*, 5, 390-395.
- Prochaska J. O. & Norcross J. C., (1999), Comparative conclusions: toward a transtheoretical therapy. *Systems of Psychotherapy: A Transtheoretical Analysis*, Brooks/Cole, Pacific Grove, CA, pp.487-528.
- Randall, J. M., Morris, B. A., Wetzel, C. D., & Whitehill, B. V. (1992). The effectiveness of games for educational purposes: a review of recent research. *Simulation & Gaming*, 23, 261-276. doi:10.1177/1046878192233001
- Rhodes, R. E., Warburton, D. E. R., & Bredin, S. S. D. (2009). Predicting the effect of interactive video bikes on exercise adherence: An efficacy trial. *Psychology, health & medicine*, 14(6), 631–40. doi:10.1080/13548500903281088.
- Ricci, K. E., Salas, E., Cannon-Bowers, J. A. (1996). Do computer-based games facilitate knowledge acquisition and retention? *Military Psychology*, 8 (4), 295-307.

- Richardson, H. (2013). 'Not enough strenuous activity' in school PE, BBC News [Online]. Retrieved from: <http://www.bbc.co.uk/news/education-21449610>
- Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). *Generation M2, Media in the Lives of 8- to 18-Year-Olds, A Kaiser Family Foundation Study*. Henry J. Kaiser Family Foundation, Menlo Park, Cal.
- Rittel, Horst W.J. & Webber, M. M. (1973). Dilemmas in a General Theory of Planning. *Policy Sciences*, (4), 155–169.
- Roberts, D.F., Foehr, U., & Rideout, V. (2005). *Generation M: Media in the Lives of 8-to-18-year-olds*. Menlo Park, CA: Kaiser Family Foundation.
- Ryan, A. (2000). Peer groups as a context for the socialization of adolescents' motivation, engagement, and achievement in school, *Educational Psychologist*, 35, 101-111.
- Ryan, R. M., Patrick, H., Deci, E. L., & Williams, G. C. (2008). Facilitating health behaviour change and its maintenance: Interventions based on Self-Determination Theory, 10.
- Salen K. & Zimmerman E., (2004), *Rules Of Play, Game Design Fundamentals*, The MIT Press, Cambridge, Massachusetts, USA.
- Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annual review of public health*, 27, 297–322. doi:10.1146/annurev.publhealth.27.021405.102100
- Sallis, J. F., & Glanz, K. (2009). Physical activity and food environments: solutions to the obesity epidemic. *The Milbank quarterly*, 87(1), 123–54. doi:10.1111/j.1468-0009.2009.00550.x
- Sanders, E. B.-N. (2002). From User-Centered to Participatory Design Approaches. *In Design and the Social Sciences, J.Frascara (Ed.)*, Taylor & Francis Books Limited, ISBN: 0415273765., 1–7.

- Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *CoDesign*, 4(1), 5–18. doi:10.1080/15710880701875068.
- Sawyer B. & Smith P., (2008), Serious Games Taxonomy [Online]. Retrieved from: [http://www.seriousgames.org/presentations/serious-games-taxonomy-2008\\_web.pdf](http://www.seriousgames.org/presentations/serious-games-taxonomy-2008_web.pdf)[http://www.seriousgames.org/presentations/serious-games-taxonomy-2008\\_web.pdf](http://www.seriousgames.org/presentations/serious-games-taxonomy-2008_web.pdf)
- Schell, J., (2010), Game invade real life, talk. Retrieved [online] from TED: [http://www.ted.com/talks/jesse\\_schell\\_when\\_games\\_invalidate\\_real\\_life.html](http://www.ted.com/talks/jesse_schell_when_games_invalidate_real_life.html)
- Serious Games Classification, created by Djaouti & colleagues. (2013). Last accessed on 2013/12: <http://serious.gameclassification.com/EN/about/bricks.html>
- Sheeran P., (2002), Intention-behaviour relations: A conceptual and empirical review. *European review of social psychology* (Vol. 12, pp. 1–36), Chichester, England: Wiley.
- Sheeran, P., & Orbell, S. (1999). Implementation intentions and repeated behaviour : augmenting the predictive validity of the theory of planned behaviour, 369(April 1998), 349–369.
- Slater M. D. & Rouner D., (2002), Entertainment-education and elaboration likelihood: Understanding the processing of narrative persuasion, *Communication Theory*, 12, 173-191.
- Spencer L., Adams T.B., Malone S., Roy L., Yost E. (2006), Applying the Transtheoretical Model to Exercise: A Systematic and Comprehensive, Review of Literature, Health Promotion Practice, doi:10.1177/1524839905278900.
- Stolterman, E. (2008). The Nature of Design Practice and Implications for Interaction Design Research. *International Journal of Design*, 2(1), p55–65.

- Street R. L. & Rimal R. N., (1997), Health promotion and interactive technology: A conceptual foundation. In R. Street, W. Gold & T. Manning (Eds.), Health promotion and interactive technology: Theoretical applications and future directions (pp. 1-18). Mahwah, NJ: Lawrence Erlbaum Associates.
- Shayne, R. K., Fogel, V. A., Miltenberger, R. G., & Koehler, S. (2012). The effects of exergaming on physical activity in a third-grade physical education class. *Journal of applied behavior analysis*, 45(1), 211–5. doi:10.1901/jaba.2012.45-211
- Shiomi, M., Kanda, T., Koizumi, S., Ishiguro, H., & Hagita, N. (2007). Group attention control for communication robots with wizard of OZ approach. *Proceeding of the ACM/IEEE international conference on Human-robot interaction - HRI '07*, 121–129. doi:10.1145/1228716.1228733
- Shirazi, A., Stünkel, S., & Schmidt, A. (n.d.). Exploring Context-Aware Mobile Games. Retrieved from [http://www.pervasive.wiwi.uni-due.de/uploads/tx\\_itochairt3/publications/camera-ready\\_01.pdf](http://www.pervasive.wiwi.uni-due.de/uploads/tx_itochairt3/publications/camera-ready_01.pdf)
- Simons, M., Baranowski, J., Thompson, D., Buday, R., Abdelsamad, D., & Baranowski, T. (2013). Child Goal Setting of Dietary and Physical Activity in a Serious Videogame. *Games for Health Journal*, 2(3), 150–157. doi:10.1089/g4h.2013.0009
- Stach, T. B. (2012). *Heart rate balancing for multiplayer exergames*.
- Street, R. L., & Rimal, R. N. (1997). Health promotion and interactive technology: A conceptual foundation. In R. Street, W. Gold & T. Manning (Eds.), Health promotion and interactive technology: Theoretical applications and future directions (pp. 1-18). Mahwah, NJ: Lawrence Erlbaum Associates.
- Summerbell C., Waters E, Edmunds L., Kelly S, Brown T, Campbell K., (2005). Interventions for preventing obesity in children. *Cochrane Database Syst Rev*;(3):CD001871.

- Susi, T., Johansson, M. and Backlund, P. (2007) *Serious Games - An Overview* (Technical Report). Skövde, Sweden: University of Skövde.
- Sutton, S. (1998). Predicting and Explaining Intentions and Behavior : How Well Are We Doing ? *Journal of Applied Social Psychology*, 28(15), 1317–1338. V. H. Winston & Son, Inc.
- Swann, C. (2002). Action research and the practice of design. *Design Issues*, 18(1), 49–61.
- Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: a systematic review. *The international journal of behavioral nutrition and physical activity*, 9(1), 78. doi:10.1186/1479-5868-9-78
- Thai, A. M., Lowenstein, D., Ching, D., & Rejeski, D. (2009). *Game changer: Investing in digital play to advance children's learning and health* (pp. 1–64).
- Triggle N. (2015). Exercise 'not key to obesity fight'. Last retrieved on 12/05/2015 on <http://www.bbc.co.uk/news/health-32417699>
- Tudor-Locke, C., Craig, C. L., Beets, M. W., Belton, S., Cardon, G. M., Duncan, S., Hatano, Y., et al. (2011). How many steps/day are enough? for children and adolescents. *The international journal of behavioral nutrition and physical activity*, 8(1), 78. doi:10.1186/1479-5868-8-78.
- UK Design Council. (2005). The 'double diamond' design process model. More info [online]: [http://www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons\\_Design\\_Council%20\(2\).pdf](http://www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_Design_Council%20(2).pdf)
- US Department of Health and Human Services. (2008). Physical activity guidelines advisory committee report, Washington, DC.

Van Den Hoogen, W., Ijsselstein, W., & Kort, Y. D. (2009). Yes Wii Can ! Retrieved from [http://www.gamexplab.nl/includes/pages/publications/abstracts/vdHoogen\\_Ijsselstein\\_deKort\\_VirRehab2009.pdf](http://www.gamexplab.nl/includes/pages/publications/abstracts/vdHoogen_Ijsselstein_deKort_VirRehab2009.pdf)

Van Teijlingen, E., & Hundley, V. (1998). The importance of pilot studies. *Nursing standard (Royal College of Nursing (Great Britain): 1987)*, 16(40), 33–36. doi:10.7748/ns2002.06.16.40.33.c3214

Verloigne, M., Van Lippevelde, W., Maes, L., Yildirim, M., Chinapaw, M., Manios, Y., Androutsos, O., et al. (2012). Levels of Physical Activity and Sedentary Time among 10 to 12 year-old Boys and Girls across 5 European countries using Accelerometers: an Observational Study within the ENERGY Project. *The International Journal of Behavioral Nutrition and Physical Activity*, 9(1), 34. doi:10.1186/1479-5868-9-34

Weiler, R., Stamatakis, E., & Blair, S. (2010). Should health policy focus on physical activity rather than obesity? Yes. *British Medical Journal*, 340:, c2603. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/20501586>

Weinberg, R. S., & Gould, D. (2006). Foundations of Sport and Exercise Psychology, *Human Kinetics*.

West R. (2005), Time for a change: putting the Transtheoretical (Stages of Change) Model to rest, *Addiction* 2005 Aug, 100 (8):1036-9.

World Health Organization, (2013), Obesity & Overweight, Fact sheet N°311, last retrieved on 2013/09/15 from <http://www.who.int/mediacentre/factsheets/fs311/en/index.html>

Wilkin, T. J., Mallam, K. M., Metcalf, B. S., Jeffery, a N., & Voss, L. D. (2006). Variation in physical activity lies with the child, not his environment: evidence for an “activitystat” in young children (EarlyBird 16). *International journal of obesity (2005)*, 30(7), 1050–5. doi:10.1038/sj.ijo.0803331

Weight-control Information Network. (2008). *Understanding Adult Obesity*, (pp. No. 06–3680, 1–8). NIH Publication No. 06–3680. National Institute of Diabetes and Digestive and Kidney Diseases. Retrieved from <http://www.win.niddk.nih.gov>.

Zimmerman, J., Stolterman, E., & Forlizzi, J. (2010). An analysis and critique of Research through Design. *Proceedings of the 8th ACM Conference on Designing Interactive Systems - DIS '10* (pp. 310–319). New York, New York, USA: ACM Press. doi:10.1145/1858171.1858228

Zyda, M. (2005). From Visual Simulation to Virtual Reality to Games, (September), 25–32.

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**REFERENCE**

***UTILISING GAMES AND DESIGN-RESEARCH  
METHODOLOGY TO PROMOTE PHYSICAL ACTIVITY  
AMONG ADOLESCENTS***

***VOLUME 2 – APPENDICES***

***BEC.R.***

***PH.D.***

***2015***

This paper presents independent research by the National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care South Yorkshire (NIHR CLAHRC SY). The views and opinions expressed are those of the authors, and not necessarily those of the NHS, the NIHR or the Department of Health.

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## ***Appendix 1- 'Boost Up!' Design Development***

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### ***1.A DRE2b : BRAINSTORMING IDEAS OF EXERGAMES THAT EXPLORE DAILY GAMING***

This section presents the brainstorming activity and the main ideas generated during DRE2b, based on the framework created from the knowledge and data generated through DRE1 and UCE1.

#### ***1.A.1 Advent Calendar, a First Concept***

This exergame is composed of a series of sub-games (identified as being a way to sustain engagement) and is based on the idea of the advent calendar (Figure 1A) as a direction to promote continuous gaming and daily play through daily challenges.



> This concept has the opportunity to promote daily challenges to encourage players to execute the given PA task (idea of goal proximity).

> This idea of an advent calendar style game veiling the idea of daily PA was well received by the supervisory team and other ideas of exergames were then developed based onto this idea of daily PA habits/lifestyle.

### 1.A.2 'Conquest' – A Game Played over a Few Days/Weeks

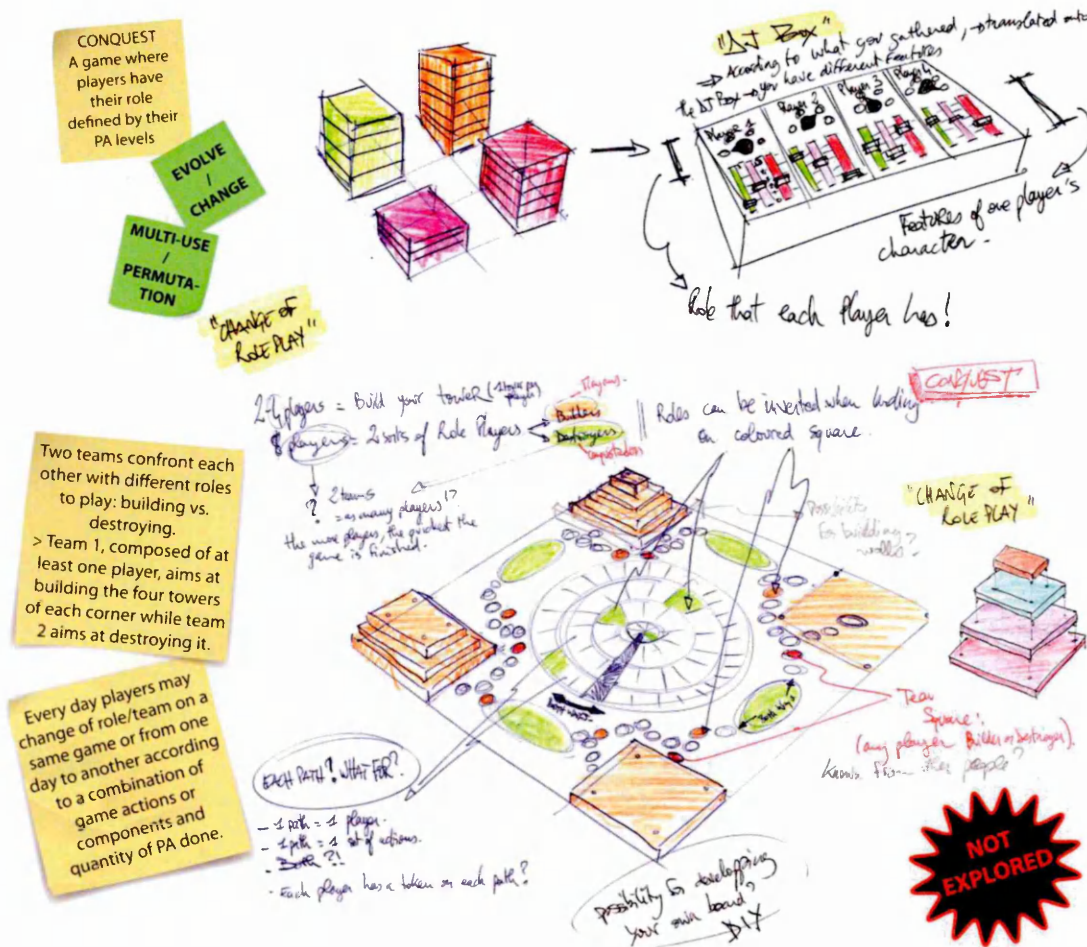


Figure 1B – Conquest, an exergame for which a game is played over many days/weeks

> 'Conquest' is a board game for which the game play is interrupted every day, although the same game is played every day.

> 'Conquest' was not developed further as it was seen as too difficult to implement the evaluation of such a game, especially in comparison to the other

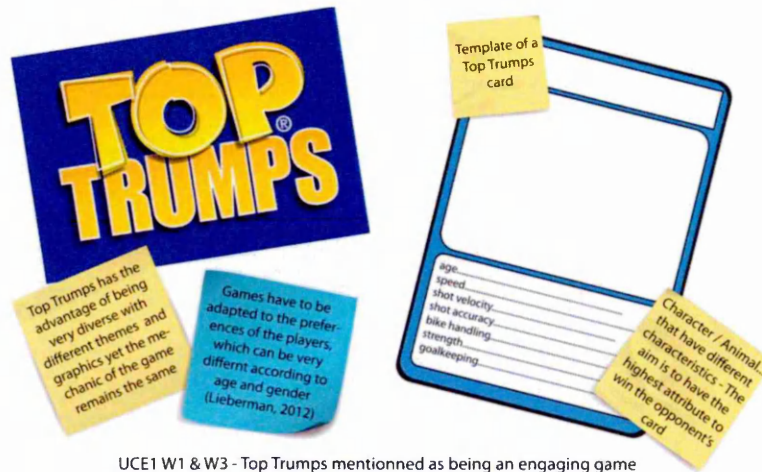
ideas generated (Evolution and Boost). This was mainly due to the fact that the winning of the game may take a very long time (days/weeks). In order to evaluate the level of engagement of the play of the game, the game play should be reduced to a reasonable time which would change the dynamics of the game.

### ***1.A.3 'Evolution' – Top Trumps Type, Orienteering & Board Game***

'Evolution' is based on a Two-Stage concept: it is a combination of a card game with a board game to play afterwards (Figure 1C). The card game that is played first was inspired by the popular themed card game Top Trumps®, a registered trademark of Winning Moves UK Limited.



### 1.A.3.1 Top Trumps®, an existing game



UCE1 W1 & W3 - Top Trumps mentioned as being an engaging game

Figure 1D – Top Trumps card game

> Top Trumps® was chosen among the list of potentially engaging games (5.1.1.7) since there are many versions of the game with a high diversity of themes that have the potential of suiting to both genders, which include the implementation of heroes/characters.

> Each card is composed of different features.

### 1.A.3.2 Evolution, the general concept

The idea in Evolution is to alternate stages of PA (Stage 1) and play (Stage 2). PA in Stage 1 is encouraged through an orienteering game, and Stage 2 encompasses two games; both are played with the same themed cards.

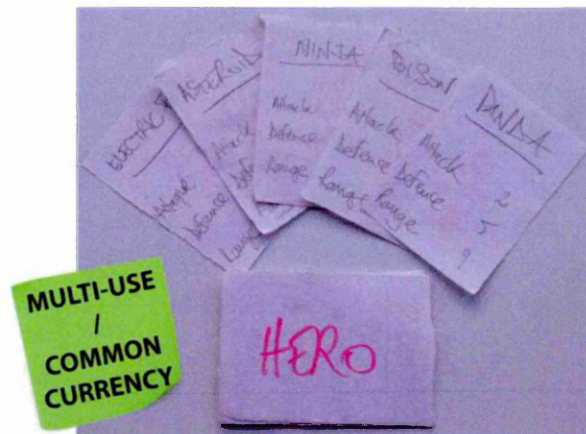


Figure 1E – Character/Hero Cards for an adapted version of Top Trumps

> Evolution themed cards are made of character cards presenting heroes that are composed of three main features or features going from 1-10: 'Attack', 'Defence', 'Range'.

- Evolution A: The Themed Card Game

The play of Evolution themed card is spread over a few days yet its game play is different every day as elements are added.

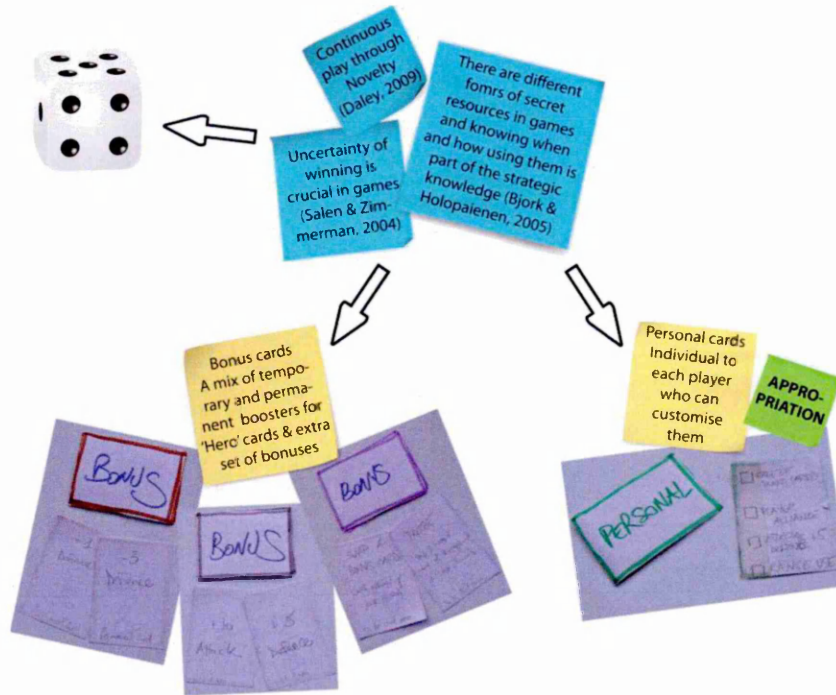


Figure 1F – Boosters are combined with the hero cards to increase the hero's features

> On day 1 players start playing Evolution themed card in the exact same way as the existing game but when playing it from day 2, boosters are introduced to increase the values of the characters' features to get more chances to win the round. Boosters are a form of currency given to the players according to their PA levels that are evolving/changing from one day to another. On day 2, players use dice as boosters (more PA in Stage 1 for that day = more throws of dice in Stage 2), on day 3 a temporary booster card, on day 4 a permanent one, on day 5 a personal card... Personal cards are customisable and illustrate the idea of customisation/appropriation/personalisation.

> When playing the existing Top Trumps® a certain number of times, players learn the values of the character's features and make the game easier for the player starting a round. Adding boosters in Stage 2 of Evolution themed card is a way to bring novelty to the game by modifying the amount of currency used to play the game (features' values are not fixed anymore), as well as rewarding players for their PA done in Stage 1.

- Evolution B: A Board Game

After a specific time, the same hero cards are used to play a board game afterwards. Using these character/hero cards for both games becomes a common component that illustrates 'multi-use', a potentially engaging property identified in UCE1.

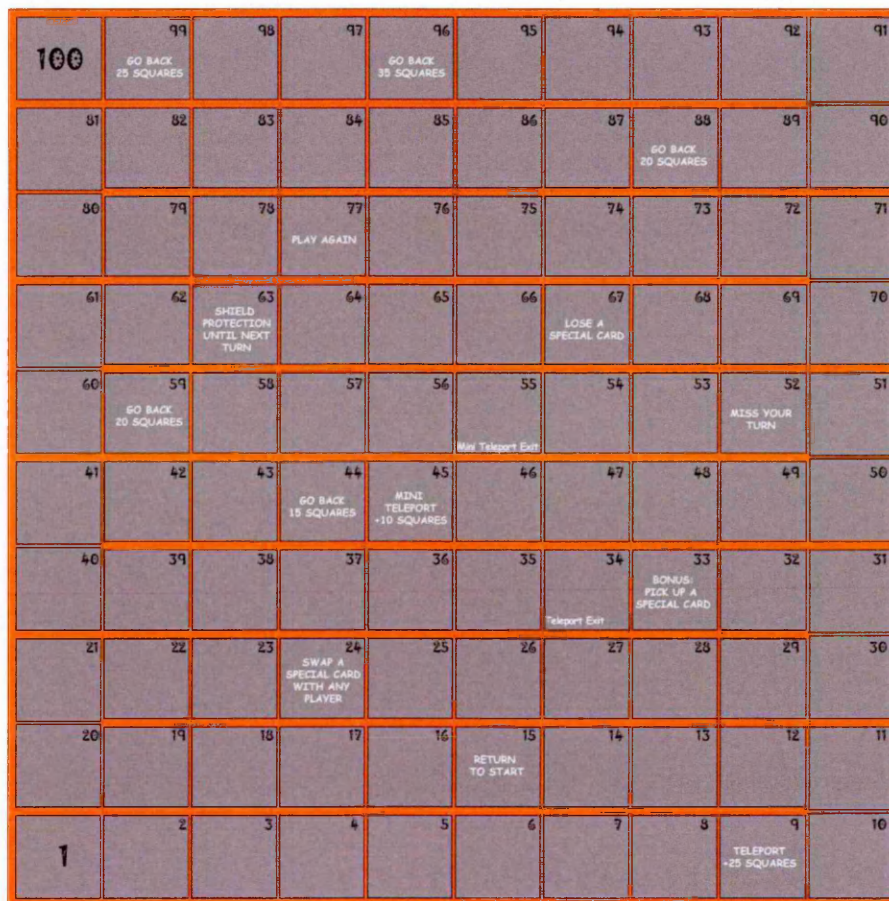


Figure 1G – The Board Game grid

> Board game principle: the board contains 100 squares and the first player reaching the 100<sup>th</sup> square wins. Each player chooses a character from amongst

the set of character cards and play with it on the hero-based board game. Again, according to their PA levels players develop advantages to increase their chances of winning the board game by choosing first the character card to play with, earning more chance cards, an extra throw at dice...

> Board game rules: players can attack each other to send an opponent 25 squares backwards if the attack is successful. For a successful attack, the 'Attack' value of the player attacking must be higher than the 'Defence' of the attacked player. To attack, players must be behind another player (a player can not attack backwards) and they must be within the 'Range' of the character played with. To ensure successful attacks, boosters are distributed randomly through the chance cards that boost a character's 'Attack'.

#### ***1.A.4 'Boost' – Avatar/Hero to Create & Used to Play a Board Game***

'Boost' is in the continuity of 'Evolution' however instead of providing hero cards, players build their 'own hero/character card' over 9 days. The character is composed of the same features (Attack, Defence, Range) and each feature is built based upon the players' PA levels. After the 9 days, players are ready to play using the character they created to play with it on a board game.

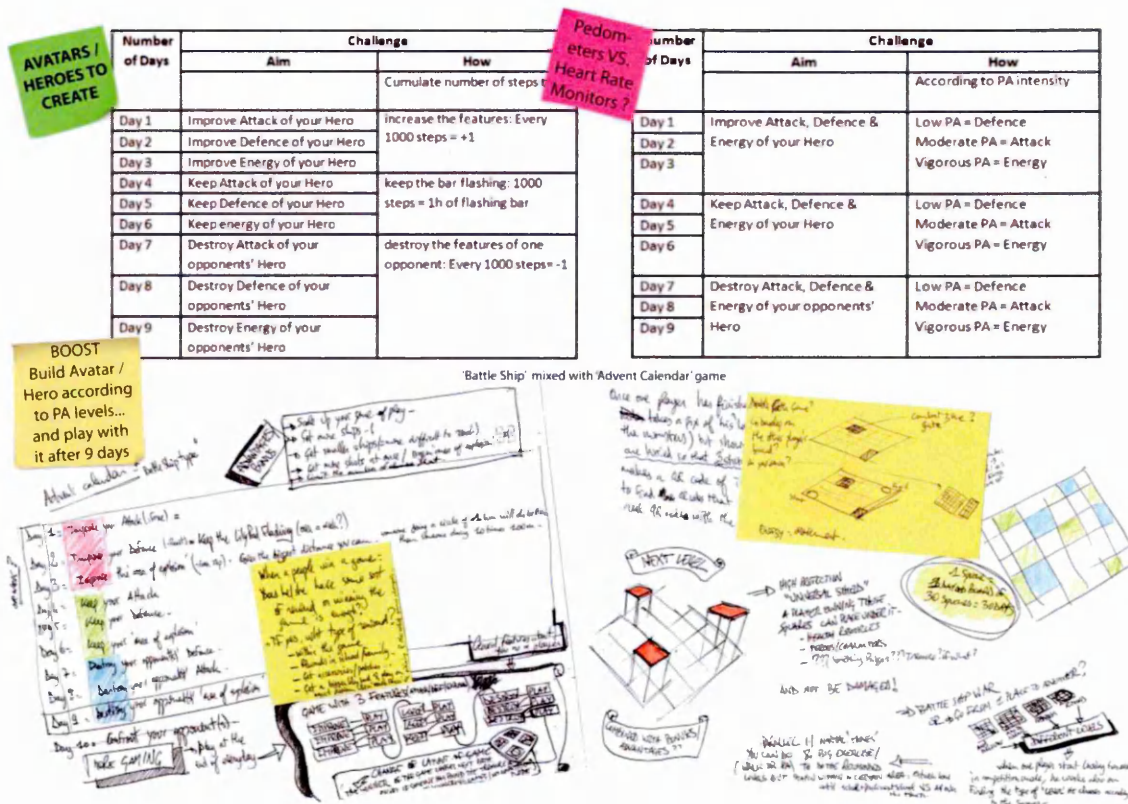


Figure 1H – 'Boost', a linear concept: build you character/hero, used to play with on a board game

> The nine days during which the character's features are built can be split in three sub-phases, each taking place every three days. The first one is about improving one's character's features by accumulating PA: to build one's Attack on day 1; to build its Defence on day 2; and Range on day 3. The second sub-phase is about defending the features built in the first sub-phase, still through doing PA: the features deteriorate/go down/diminish if not active enough (again day 4 is relates to the Attack; day 5 to Defence, day 6 to Range). The third sub-phase is a way to PA to destroy other players' character and features (to destroy the Attack on day 7, Defence day 8, Range in day 9).

> After nine days, all the features of the hero/character are built which is then used to play the board game – this is similar to the one used in 'Evolution'. The players who have been the most active during this first phase have a stronger character and can also gain advantages when playing the board game: they earn game components (e.g. extra bonus card/boosters giving more chances to

succeed when attacking) and can define a 'cease fire' zone to be protected against attacks.

> Issues around the first phase (building character) also remain to ensure the viability of the game for players who may miss a day or more of PA among the nine days (e.g. illness).

> Questions around the type of device to use (heart rate monitors vs. pedometers) emerged to best promote engagement.

### 1.A.5 Reducing the Distinction between the Two Stages

Ideas were modified and redesigned to bring PA into gaming and gaming into PA.

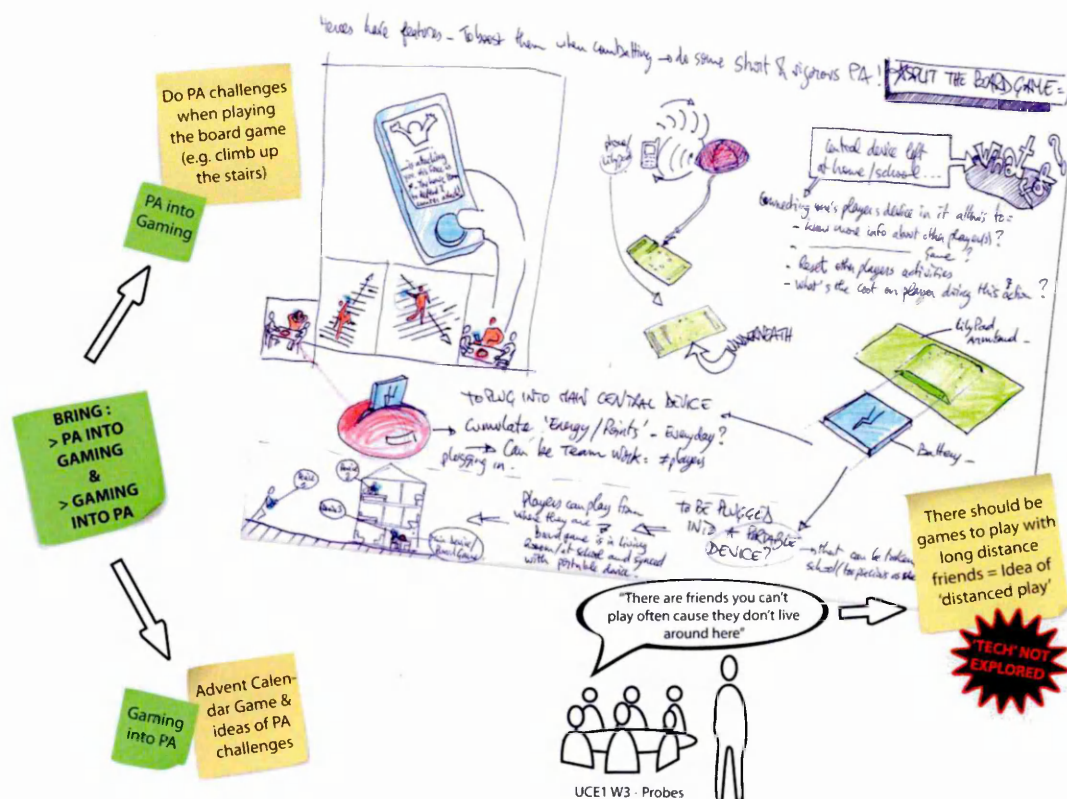


Figure 11 – Bringing 'PA into Gaming' and 'Gaming into PA'

> 'Gaming into PA' – The idea of daily challenges from the advent calendar game was modified and redesigned to 'spice up' PA (Stage 1): players received challenges to execute at different moments throughout the day. According to the players' preferences, attitudes, self-efficacy/perceived-behaviour-control

some might be less inclined to do PA in a group/in front of others. Therefore the PA challenges could be thrown either from a computer-data base (to compete with themselves) or from other players involved in the game.

> 'PA into gaming' – This idea of PA challenges was also applied to Stage 2, when playing the games (e.g. card asking to 'climb the stairs'). Yet there was uncertainty whether it would be a way to maintain a status while playing the game (e.g. 'energy bar' to keep flashing to attack when playing the board game), to accumulate enough PA to do something in the game (e.g. gain points to earn cards, pass a level), to affect other players (e.g. damage the opponent)... Offering the possibility of throwing challenges to each other from a device as shown in Figure 1I (in blue) was a way to give the choice to play the game from any location, wherever the other players are. Also, playing remotely seemed also important as it is a way for some pupils of this age to play with their (best) friends who they do not necessarily see often but that their interaction can be motivational to engage in some activity, whether it is about playing or doing PA. However this daily challenges idea was not developed at this stage as technology-based ideas were discarded.

## 1.B UCE2 - CREATING 'BOOST UP!' V2

A summary of the findings for each of the four first workshops and how it has influenced the design of V2 is described in this section.

### 1.B.1 Workshop 1

#### 1.B.1.1 Two-Stage Concept

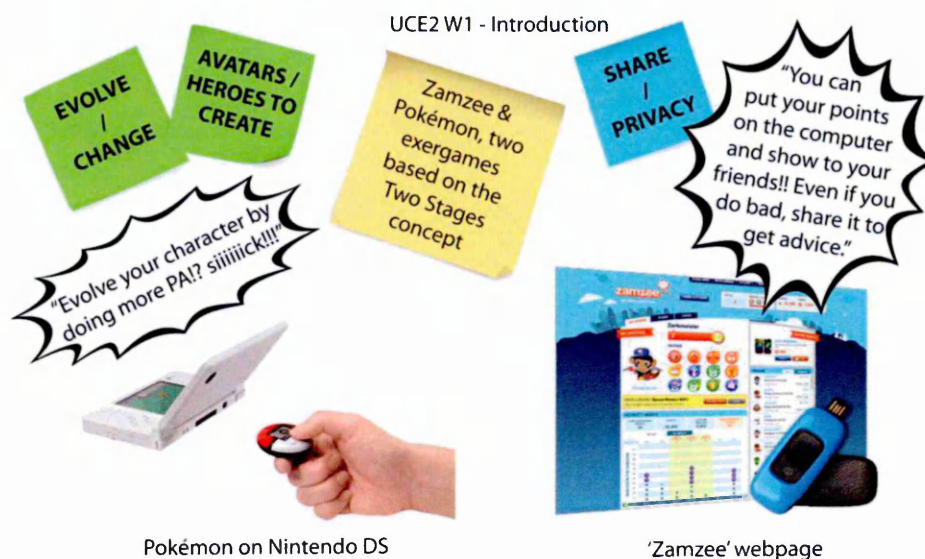


Figure 1J – Participants reactions to the Zamzee & Pokémon

- > Players really enjoyed the concept behind Zamzee and Pokémon that are both Two-Stage based.
- > Creating an exer/game in which a character/hero evolves seemed engaging to both genders.
- > Being able to share a performance around PA (e.g. on a social network) is a way to seek for advice and support to develop motivation.

#### 1.B.1.2 The Device Measuring PA

Insights about what the device measuring players' PA should be were gained through two activities: criticising existing pedometers (Figure 1K) and creating their own device could be (Figure 1L).



Figure 1K – Criticising the given examples

- > Device should be graphically attractive (e.g. flashy colours), simple (e.g. no buttons), affordable, and compatible with the end-users lifestyle (technology and look/feel).
- > Visual representation of PA levels was mentioned which raised more questions about the best way to visualise it.

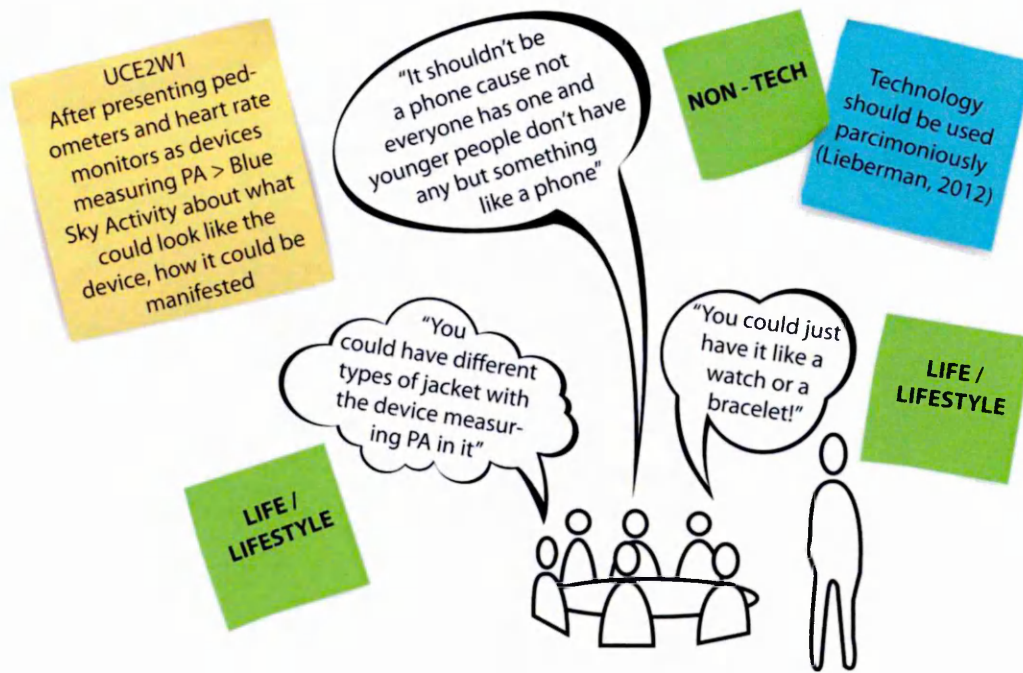


Figure 1L – 'Imagine what the device could be' activity

> A device that is incorporated into daily accessories (e.g. watch) seemed an attractive way to increase its acceptability among these people yet it must be compatible with their lifestyle (e.g. cannot use phones at school).

### 1.B.1.3 Types of Rewards

Virtual versus real world rewards were also discussed based on 'Zamzee' which offers two types of rewards players can choose from: virtual rewards to buy accessories to customise their avatar or real-world rewards (i.e. charity vouchers, 'angry bird' slippers, Xbox...). Real world rewards were appreciated, especially for girls, although it is difficult to implement them for cost issues.

### 1.B.2 Workshop 2

A mixed-gender group played Top Trumps® during the whole Workshop 2, confirming the idea that emerged in UCE1 positing it is an attractive game. Out of the three versions of Top Trumps presented to the participants, boys chose the 'Superheroes' version, girls the 'Baby Animals', and 'Wonders of the World' when both genders played together.

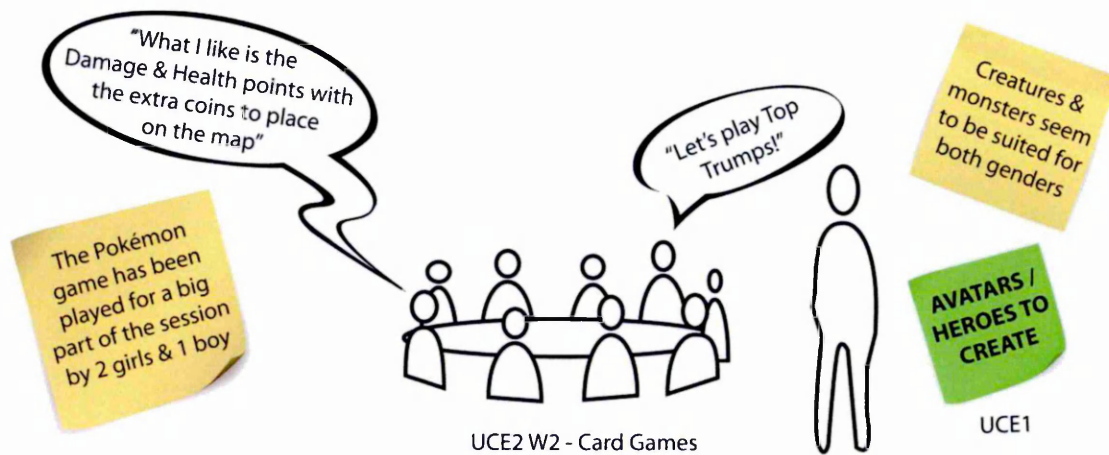


Figure 1M – Combining Cute Creatures and Monsters

- > The rest of the group (two girls and a boy) spent most of the session playing Pokémon, suggesting fantasy world featuring monsters and cute creatures with life/death scenarios might be a theme attracting both girls and boys. Giving life to characters/avatars was identified as potentially engaging in UCE1.
- > Participants highlighted that cards should be customisable and should have a higher variation in scores.

### 1.B.3 Workshop 3

#### 1.B.3.1 Pedometers vs. Heart Rate Monitors

Heart rate monitors were introduced in Workshop 1 but it is in Workshop 3 that participants experienced them with the ACTIVIO system/game. By Workshop 3, two weeks had passed during which participants experienced the pedometer given at the start. This allowed participants to compare the two types of devices and are reported in Figure 1N and 1O.

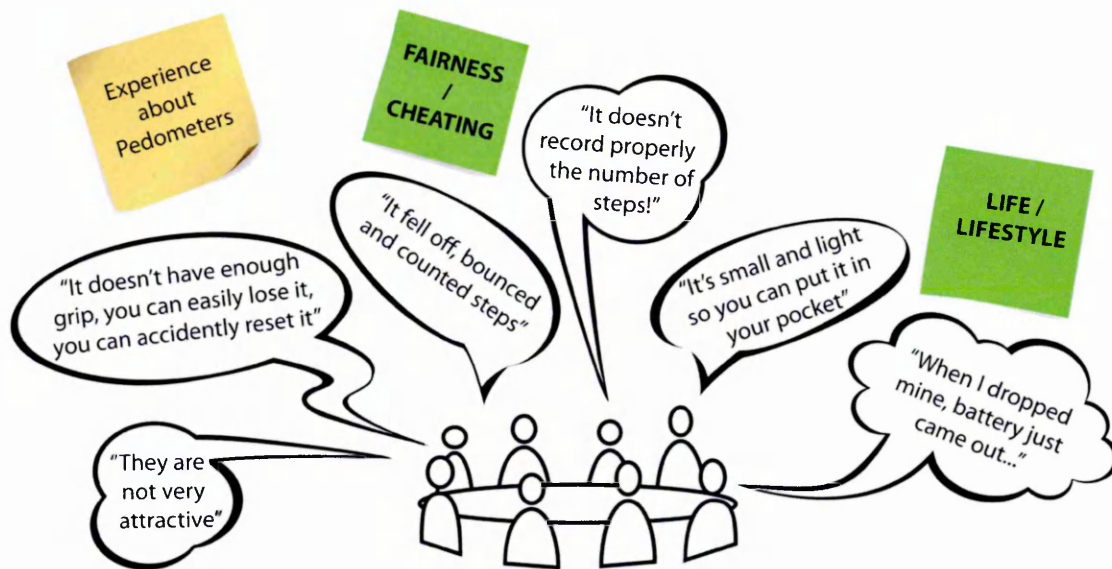


Figure 1N – Pedometers Feedbacks

> Pedometers were generally found not functional (e.g. falling down, buttons might be accidentally pressed), not visually appealing, and not fair, however their size seemed to be convenient.

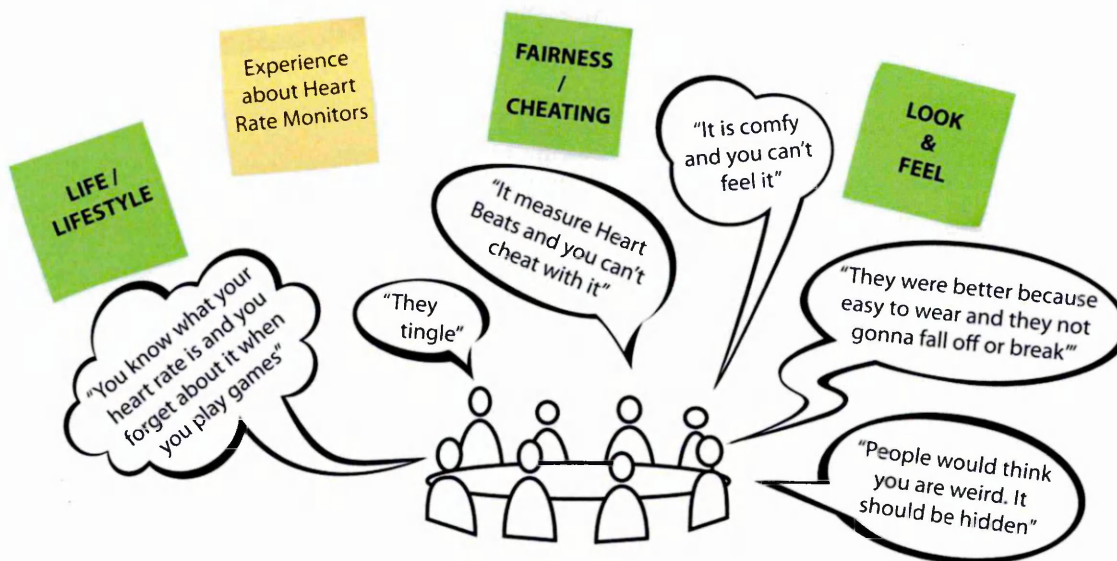


Figure 1O – Heart Rate Monitors Feedbacks

> Heart rate monitors were found to promote fairness, to be adjustable and discreet even though not always comfortable to wear or attractive. However some found it could be stigmatising and would fear the look of other pupils if having to wear this all day long however being able to hide it was appreciated.

### 1.B.3.2 PA Challenges to Explore 'Gaming into PA'

In Workshop 3, a card game was created where players had to draw a 'PA Challenge' card (see the different types of challenges in Figure 1P) to execute using the ACTIVIO system.

<b>PA Challenges Cards</b> - Star Jumps (25 pts) - Push Ups (20 pts) - Sprint (15 pts) - Abdominals (10 pts) - Jump on one foot (5 pts)	<b>Time Metric</b> - For 10 sec (x1) - For 30 sec (x2) - For 1min (x3)
<b>Low Chance Cards</b> - 50/50: Choose a player to split the challenge in half & get the full amount of points - Extra 30 seconds on the time limit - Challenge not accepted	<b>High Chance Cards</b> - Change of challenge but keep the scoring system of the original activity - Pick up another challenge - Gamble Time
<b>Gamble Dice</b> 1 = Lose your hand 2 = Triple points for next challenge 3 = Lose 100 points	4 = Win 100 points 5 = Reduce half the points cumulated of a player of your choice during his next challenge 6 = Exit & lose the points used to gamble

Figure 1P – Rules of the invented card game to be played with the ACTIVIO system

> Rules: There are three different types of cards ('Challenge', 'Low Chance', 'High Chance'). Players draw a 'challenge' card they must execute for as long as they can (up to 1 min) to accumulate a maximum of points. Points are a combination of the difficulty of the challenge by the time they managed to do it for; the winner is the one accumulating the most points.

By the end of the session participants wanted to keep playing the game and gave positive feedbacks about the ACTIVIO experience (through discussion, questionnaires and rating cards).



Figure 1Q – Group peer pressure to promote PA

> Real time feedback when using the ACTIVIO system was reported and observed being a real incentive for this population who were focused onto their own performance rather than the one of their peers.

### 1.B.4 Workshop 4

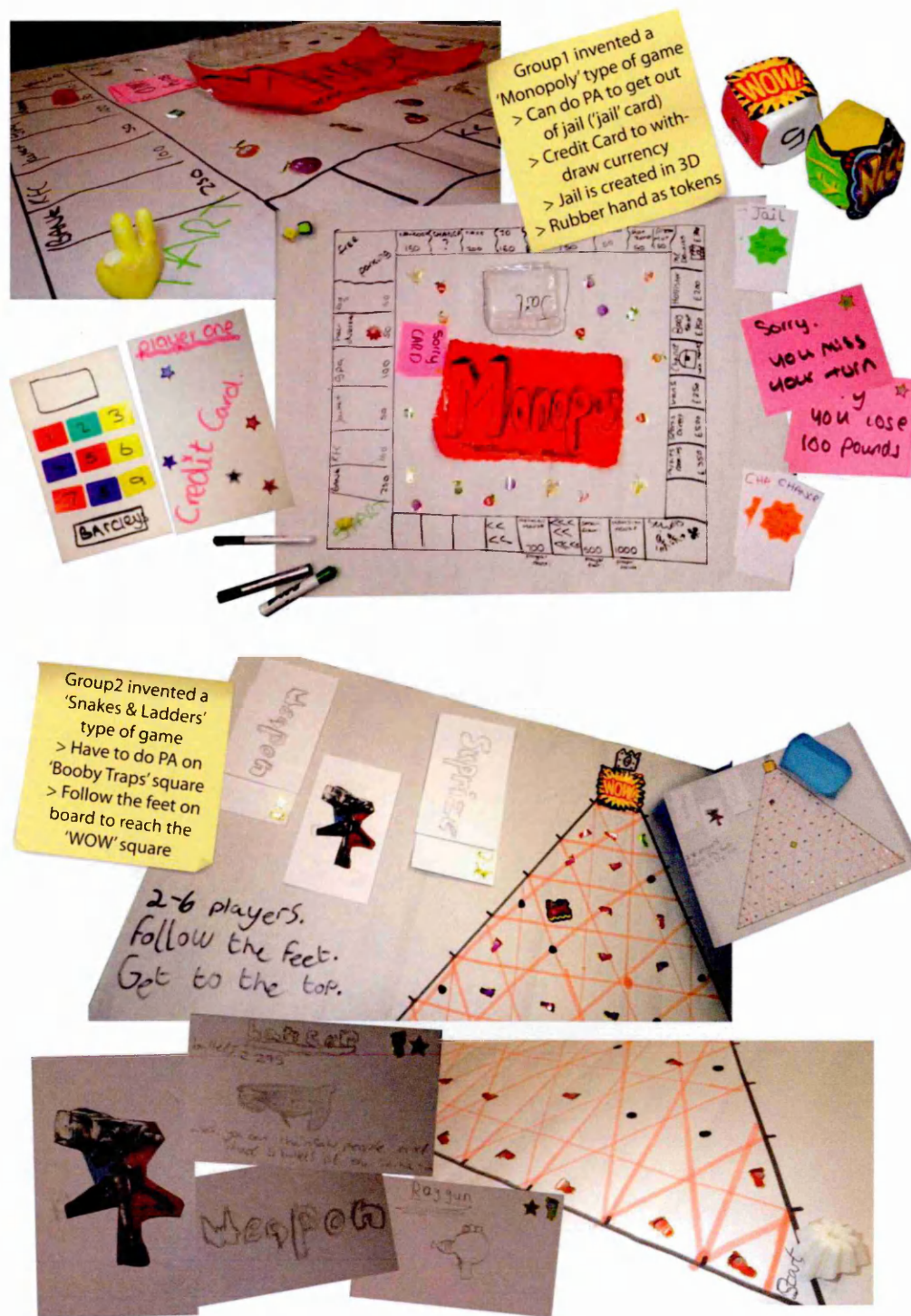


Figure 1R – The two board games created by the two groups of participants in Workshop 4

> The board games participants created allowed gaining insights about the type of games participants were into as well as creating stimuli about how to bring PA into gaming and how tokens can be used to shorten the length of the games.

#### 1.B.4.1 Exploring 'PA into Gaming'

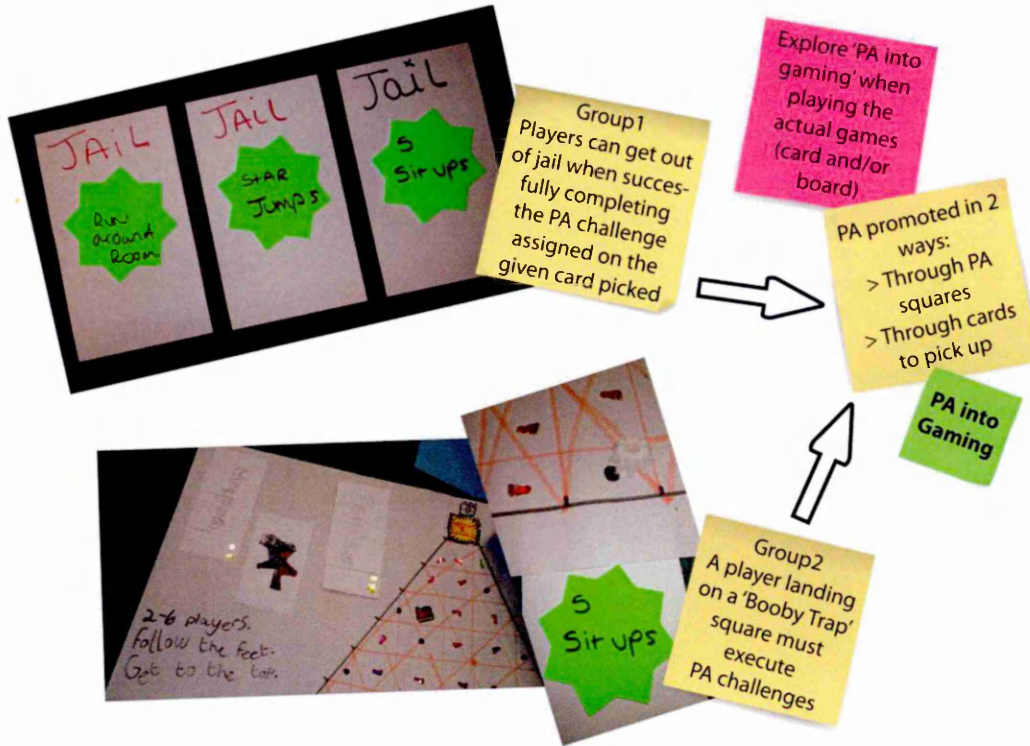


Figure 1S – Bringing 'PA into Gaming' in two ways

> In the 'Monopoly' version of the game, doing PA has a positive connotation since players can do PA to get out of jail. Whereas in the other game PA is seen as a penalty since players have to do PA when landing on a 'Booby Trap' square.

> Yet in both games, PA takes the shape of challenges delivered through picking up cards.

#### 1.B.4.2 Insights: What in Board Games Might Attract and/or Engage

Generally speaking, games should be competitive (e.g. chasing other players), simple, and fast to play, suggesting 'Boost Up!' board game, which has a start and finish points, may be engaging. Yet clear graphics and readability of squares matter, which can be emphasized by adding colours, text, icons or 3D, a highly rated feature.

Uncertainty of winning, which was identified as an engaging feature in the literature review was illustrated through 3D: in Mouse Trap, one aspect described by the participants as engaging is to not know whether the trap is going to work.

#### 1.B.4.3 Tokens with Lives

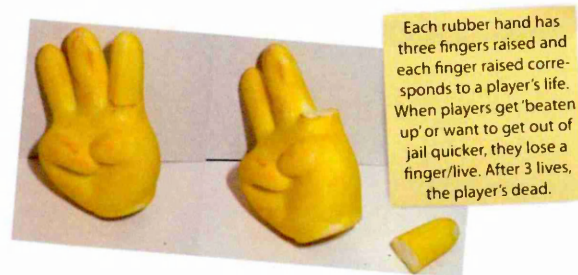


Figure 1T – Token on the Monopoly's version

> To shorten the length of time on the Monopoly version created by Group 1 where players go in round (i.e. a game can last a long time), participants introduced three lives per player, simulated by the fingers on the rubber hand.

### 1.C DRE3 : ITERATIVE TESTING & PROTOTYPING

To develop further 'Boost Up!' V2 card and board games, a series of iterative testing and prototyping led away from the end-users was conducted based on the V3 concept. Physical prototypes of the currency dispenser (presented in 5.3.4.2) were built to start playing the games. At that time, the 'Boost Up!' idea was that players were given an amount of a unique currency that each player would break down among the three features of their character ('Attack', 'Defence', 'Energy') according to the strategy they wanted to adopt. The designer/researcher simulated the players' PA levels to award the currency and gave amounts with high variations to test the uncertainty of winning. This was a way to represent better the whole spectrum of individuals playing 'Boost Up!', with players being quite active (with a big amount of currency) or not really active (with a low amount of currency). Hence the amount given per player varied a lot and was attributed to players randomly, which was consistent with all the iterative tests to come.



Figure 1U – Graphic exploration for the characters to create (through the main currency)

> The main currency was used to create a player's character's features and replaced the character cards used for V2. This was a permanent currency that

illustrated the ideas of creating avatars as well as customisation to promote appropriation of the game.



Figure 1V – Graphic exploration for the two temporary boosters per player (second currency)

> The second currency was given through two boosters that were used for one turn only. Both boosters were also used for a limited number of times: it was defined that Booster 1 can be used only twice and Booster 2 five times. To simulate the used/non-used boosters, pegs were inserted at the top of the boosters. Hence there were only two pegs for Booster 1 and five for Booster 2.

### 1.C.1 Iterative Tests : Currency & Card Game Development

This section presents the development of the card game in parallel to the currency dispenser since the first informed the design of the second.

#### 1.C.1.1 The Card Game Concept

Even though the card game's rules were not decided, the concept was clearly defined (as presented in 'Evolution' in 1.A.3): PA gives a currency that increases the value of the character cards' features. The aim of the Boost Up!™ themed card remained the same as the existing Top Trumps®: winning all the cards of the game.

Boost Up!<sup>TM</sup> themed card starts exactly in the same way as Top Trumps®: all the character cards are distributed to the players who place them on a pile in front of them. Players then pick up the first card on the top of their character cards pile that remains hidden from other players. Then the player starting the game (most active) calls a feature thought to be the highest (going from 1-10) since the highest value of the called feature among the character card of all the players wins the cards for this round. However once a feature is called, this is when Boost Up!<sup>TM</sup> themed card starts differing: players can use the currency earned through the amount of PA done to increase the value of their character card's feature they hold in hands to increase chances of winning the cards for the round. Therefore each player has an opportunity to 'bet' and this is what the tests around the different scenarios described in 5.4.1.1 aimed at defining.

#### 1.C.1.2 Testing the Currency

- First Test

To increase the character cards' features, players used the prototypes presented in Figures 1U and 1V. The main currency is a permanent booster applied at all time to any character cards picked by a player whereas the two boosters are valid for one round only (and only one booster can be used per round). Each player receives 3 sets of figures at the start of a game (one for the permanent currency and one for each booster) that each had to be broken down into three (for the 'Attack', 'Defence', and 'Energy') according to the player's choice or strategy they wanted to adopt. The person with the highest numbers of the three sets of figures accumulated (most active) starts the game by calling a feature and decides whether it is worth spending an extra booster to increase the feature of the character card picked. Let's take an example:

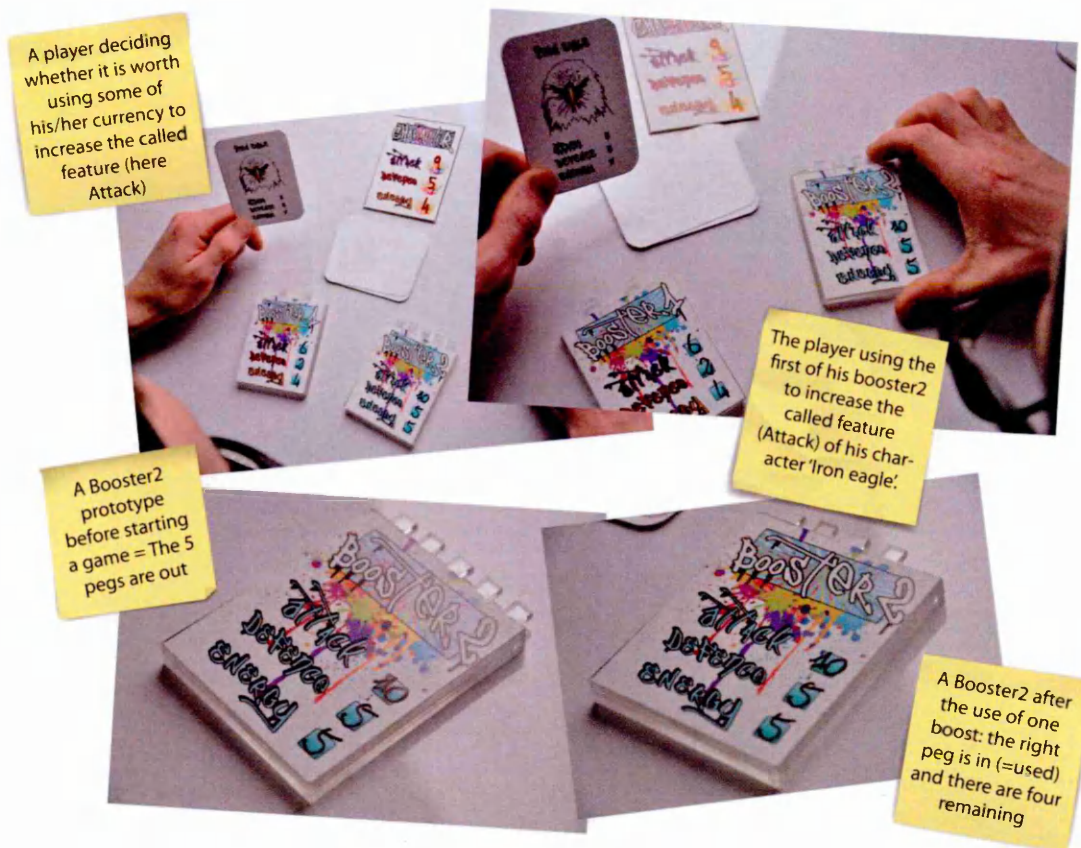


Figure 1W – Player 1 using the permanent and a temporary booster to increase his character's feature

> Player 1 received 18 points credit for the main currency that was broken down as follow: Attack=9 / Defence=5 / Energy=4. That player received 12 for Booster 1 (6/2/4), and 20 for Booster 2 (10/5/5). This player's strategy is around the 'Attack': therefore if the 'Attack' feature is called, this player is likely to win the round except if he picks up a character card with a very low 'Attack' feature, in which case he can pass his turn.

> Player 1 starts the game by picking up the character card and then works out what is the highest feature, which for 'Iron Eagle' is either Attack or Defence (both of 8). Since his permanent booster has a strong Attack (9) and a weaker Defence (5), he decides to call 'Attack'. He then chooses whether to use one of the two boosters to increase that feature for that round but he does not have to. Since other players have a permanent booster lower than his, he does not really need to use a booster to increase the Attack value. However 'Iron Eagle'

is a pretty good card and he wants to secure the win of this card. He will hence burn one of his Booster 2 which has an Attack of 10, bringing the overall Attack to 27 (8+9+10 = character card + main currency + Booster 2).

Then it is the round of the second player (on the left of player 1).



Figure 1X – Player 2 passes his turn

> Since player 2's character card 'Zen Master' has an Attack of 1 and his permanent booster is of 3 only for that feature, he has little chances to win against 27 and passes his turn despite not knowing the value of player 1's character. However although he decided not to increase the Zen Master's Attack, he is still in the game and the character card picked has to be revealed at the end of a round.

Once all players have played (i.e. decided to 'bet' or not), all players reveal their card. The winner of that round is the one with the highest called feature (here 'Attack') and wins all the character cards played in that run (even those who passed their turn) and put them back under his/her pile. All the players then pick the next character card on the top of their pile and the winner of the previous round chooses a feature to call (it can be the same one from one round to another).

During this game testing session feedback included that:

1. There were too many components to play with (three devices for the currency plus the character cards).

2. A permanent currency combined with two temporary boosters that each has a figure for each feature was complex and sometimes confusing.

There was generally a need to simplify the way the currency is given and reduce the number of components to facilitate understanding and play.

- Second Test



Figure 1Y – The currency dispenser gathering permanent and temporary currencies

> Another prototype of the currency dispenser was developed, gathering the main and secondary currencies into one device while still exploring the graphic to facilitate reading and play.

Another test was undertaken with these prototypes of the currency dispenser and was played with the same rules described previously. Players hence were again attributed with three numbers although only the permanent currency was broken down into

three figures for each feature. The amount awarded to the boosters went from 0 to 10 and could be applied to any feature played.

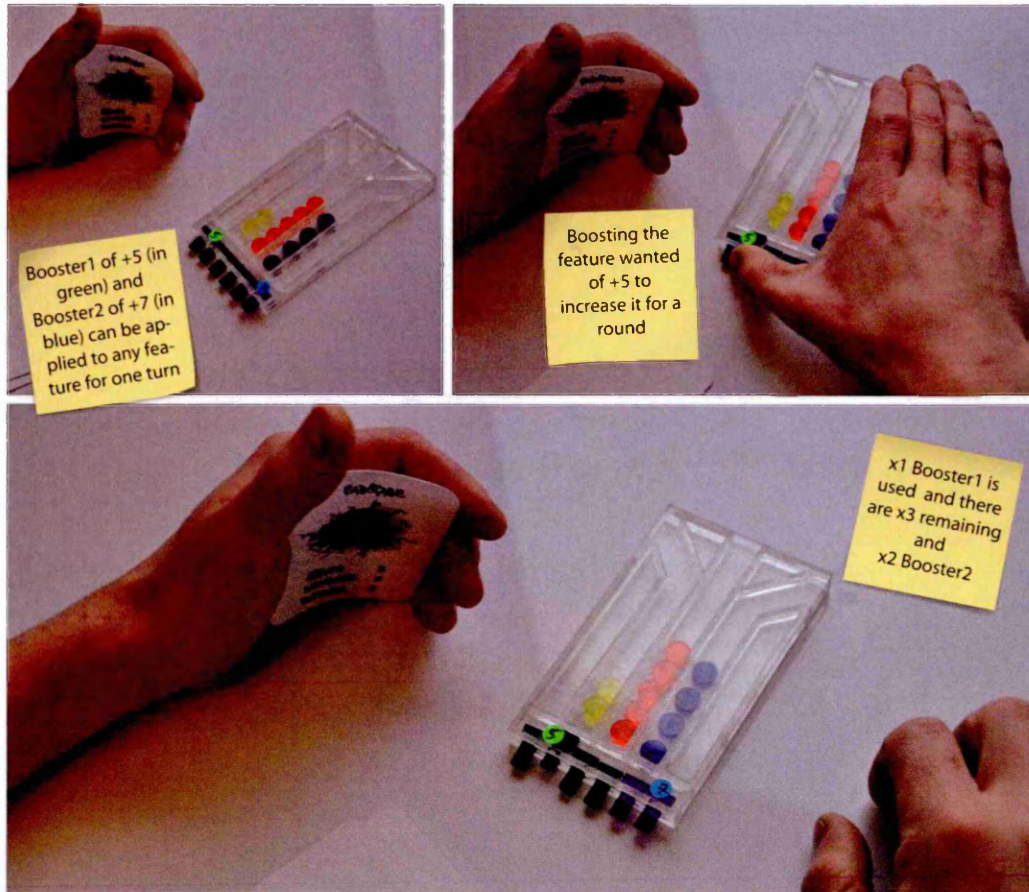


Figure 1Z – The currency dispenser & the use of a Booster 1

- > The main currency was broken down with counters.
- > The boosters consisted in two numbers written on a sticker (Booster 1 in green and Booster 2 in Purple). Every time a player uses a booster he/she presses a peg of the booster in question.

Simplifying the boosters was much better however some complexity and confusion remained. The way the currency was awarded should:

1. Inform better: it was asked why/how the main currency and the boosters are based upon MVPA averages.

2. Be simpler: it was not understood how players would break down appropriately the main currency to decide which figure to choose for which feature (i.e. need to see other players' break down first).
3. Be fairer: even though the boosters were not mistaken anymore due to a simplification of the numbers, the combination of permanent booster applied every round with the temporary ones did not leave much chance for those with the least currency to win. More uncertainty of winning was needed.

This feedback suggested that breaking down the main currency to create the character's features was confusing. Therefore there was a need to generate a currency for each feature more appropriately, which resulted in the creation of a framework to convert an intensity of PA into a given feature. Furthermore, a mix of permanent and temporary boosters being complex and confusing to use, it was realised all the currency generated for that game had to be spent/burnt. This was a way to contrast with the board game since Boost Up!<sup>TM</sup> themed card would therefore be quick, fast and playable anywhere (e.g. have one or more game in the morning break at school). Finally, the second currency (so far the temporary boosters) did not seem to promote enough uncertainty of winning and other game components were hence explored.

#### 1.C.1.3 Tests around a Common Second Currency

- Using the Board Game Chance Cards

Avoiding confusion was also explored by giving players cards as a second currency. Since UCE2 revealed that a currency common across games was appreciated by the participants (with the character cards at the time), more exploration around the common currency took place. Since the game play of the board game was more developed, the chance cards were borrowed and applied to the card game to see if uncertainty of winning could be increased and how.



Figure 1AA – Adapting chance cards of board game V2 to play the card game

> The tests started by using chance cards from both categories (see 5.2.2.3), which were adapted to the card game play by writing over the new meaning of the card. For instance, the 'Freeze' card was not used to miss a player's turn but to avoid opponents boosting their character card's features. The 'Galactic Attack' card made a player lose -5 on any feature for one turn instead of sending all players back 20 squares...

> Inserting all the chance cards created conflict in the card game play. Yet chance cards from the second category seemed to create an interesting dynamic around the game play. This was mainly due to the fact that the first category of chance cards implied actions that affected opponents. However the cards belonging to the second category, which consisted of boosting one's feature (+10 Attack, +10 Defence, +25 Energy) seemed to work better since their action remained personal without interfering with another player's card.

#### ○ Using Chance Cards from the Second Category Only

This idea of having cards affecting one's feature only was explored further and new cards were created. Since players use these cards for their own good they shall only be positive to the players. This is how the idea of bonus cards came up as a second currency on top of the main currency. Hence the chance cards' were renamed 'bonus cards'.



Figure 1AB – More tests took place with the new ‘bonus cards’

> The tests that took place with these new bonus cards led to a much more fluid game play, with no conflicts between the cards and the players’ action. However there was still a need to increase the uncertainty of winning since the tests showed that players with a large amount of currency at the start were winning too often.

#### 1.C.1.4 Betting the Currency: Hidden vs. Visible

One way to increase the uncertainty of winning was to hide the game currency, or part of it. Various tests therefore took place to explore whether the main currency (counters) and/or the secondary currency (bonus cards) should be hidden too.



Figure 1AC – The process of ‘betting’ (with counters and/or cards)

> It appeared the game play was more interesting and uncertain when players hid both currencies (counters and cards). A mix between Poker and Top Trumps® emerged, where players boost the character card’s feature by choosing counters (main currency) and/or a bonus card (second currency).

> Therefore players pick up the top card on the character cards pile and do not show it to other players. Then the player starting calls the feature thought to be the strongest value and decides whether to boost the called feature. Once the (hidden) 'bet' is done it is player 2's turn.

Combining counters and cards allowed developing an interesting and uncertain game play, since the cards can lead to high variations in the amount 'bet' that is unknown to other players. This allows players to adopt many strategies and to 'bluff' and it is therefore through the combination of luck (i.e. not knowing the value of a character card or the bet) and strategy (i.e. judging to boost or not in Stage 2 but also in Stage 1 since the currency is given according to one's levels of PA) that uncertainty of winning was enhanced in the card game.

#### 1.C.1.5 Tests to Adjust the Game Play

The latest tests of the card game rules showed an engaging game play, enhanced by making a few adjustments at different levels.

- A Limit when 'Betting'

To give more chances to the players with less currency winning a round (and potentially a game) it was realised it was important to limit the amount bet. The 'bet' was fixed to a maximum of three counters that can be combined with maximum one bonus card. In addition, the bonus card should not boost a character's feature more than +5 to balance with the number of counters allowed.

- Adjusting the Character Cards' Values

It was also realised there should be more extremes among the values of the character cards with better/stronger bonus cards and worst/weaker ones.

Character (x26)	Attack	Defence	Energy
Sabotage	8	3	2
Meteorite	7	5	9
Mars Lighting	9	1	6
Ninja Robot	7	5	4
Guerrilla Machine	3	6	5
Super Spy	4	4	1
Zen Master	1	9	10
Colonel Criminal	6	4	3
Pharaoh Mummy	9	7	3
Fragmentation Knife	5	7	6
Dark Ship	8	5	5
Shuriken	6	3	5
Supernova	8	8	4
Black Hole	3	6	10
Nasty Netty	2	6	7
Space Tornado	5	8	8
Spiky Nebula	4	9	6
Green Yeti	5	2	2
Acid Lizard	2	1	3
Radioactive	6	8	7
Electric Spider	2	2	1
Iron Eagle	10	9	9
Frost Dragon	10	10	8
Evil Knight	7	10	7
Magic Rocket	4	7	8
Poison Gas	9	3	6
> 5 (5= Average)	14 times	14 times	14 times
Total	150	148	145

Figure 1AD – The character cards' values

> All the values of the character cards were gathered in a table to compare and create more extremes in the cards.

> White boxes correspond to the cards that are below the average (of 5) and the green ones to the cards above, which include the best cards of the game (in yellow).

- Graphic Readability

Even if the 'Ninjas' graphic was appreciated by adults, the readability of the character cards could be improved. For instance the Attack, Defence and Energy font on the character cards needed to relate more to the currency dispenser to avoid mistakes when betting (i.e. choosing the right counters in relation to the called feature should be facilitated by the visuals).

### 1.C.1.6 Test in a Family

An extra test took place with a family as a way to get informal feedback with players of an age similar to the future end-users as it had never been played by this age group. A pack was given to a family of parents with two children.

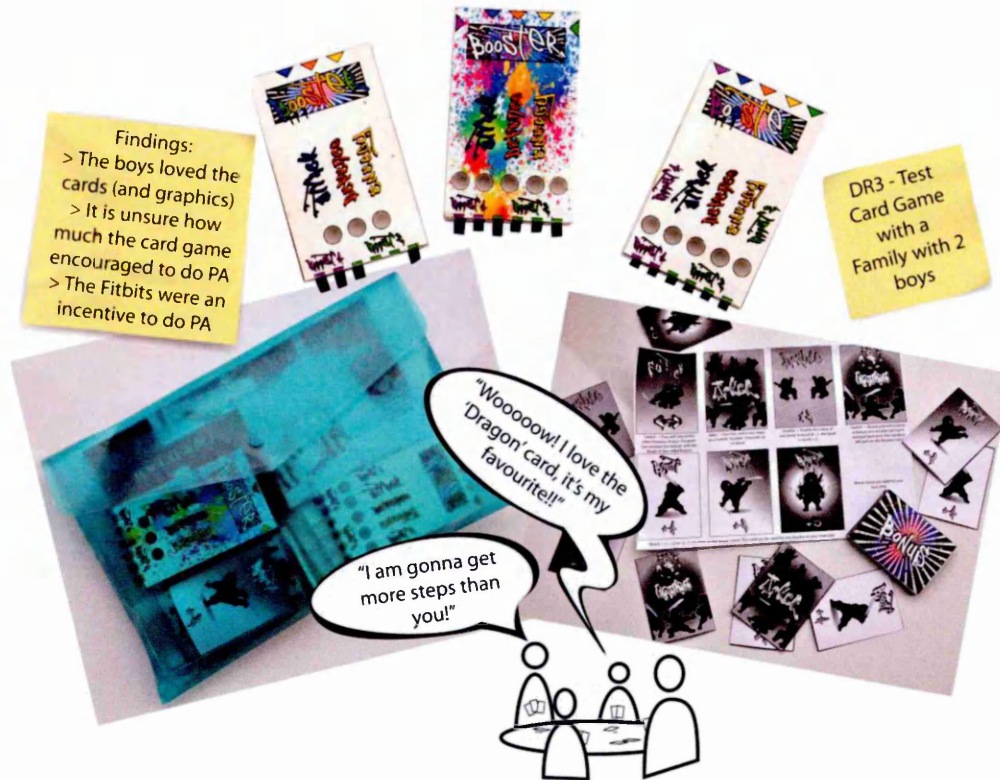


Figure 1AE – The pack given to a family for informal testing

- > The pack contained four pedometers, four currency dispensers (used to insert the counters only – no use of the boosters/pegs), the main currency (counters), a set of character cards, and a set of bonus cards with their meaning.
- > The experience engaged especially the boys rather than the whole family. The pedometers were very engaging: the boys wanted to beat each other on the raw numbers displayed on the screen of the pedometer. They even went out in the rain to play football because they did not have enough MPA for that day. Even if MPA was a way to earn currency for playing the game, it was reported that the pedometer seemed more engaging than the actual card game.

### **1.C.2 Iterative Tests: Currency & Board Game Development**

The board game rules and the fluidity of its play were quite developed after UCE2. The game testing sessions for the board game started when exploring the common currency, and they were led alternately with the card game. Even though UCE2 gave guidance regarding the modifications to the board game, V2 prototype was used again in these tests. These iterative tests, which always ensure promoting uncertainty of winning so that the least active players (with low currency) can still have chances to win the game, consisted of:

- Developing a currency common to the board and card games
- Bringing 'PA into gaming'
- Creating engaging visuals/themes

These points are developed in more details below.

#### **1.C.2.1 Setting the Common Currency**

Unlike the card game, the main currency is not burnt but permanent (i.e. it defines one character/player's features for the whole game and cannot be affected). Hence this idea relates directly to the V1 concept since players do PA to create their own character's features to play with it on the board game.

Following the exploration of the common currency done when testing the card game (see 5.3.4.1), bonus cards were created as a second currency (to replace the temporary boosters). These bonus cards, which allow affecting one's character's feature, came from tests done with the second category of the chance cards.

Although all the chance cards were originally mixed in the board game (see 5.2.2.3), keeping both categories of chance cards separate was applied to the board game. As with the card game, the second category chance cards (Attack +10; Defence +10; Energy +25) were used as bonus cards, and this is why the value of the 'Energy' card was dropped to +10 to create more consistency when betting in the card game.

### 1.C.2.2 Testing 'PA into Gaming'

Bringing PA into gaming was explored in UCE2 through the 'PA squares' created on the board game (see 5.2.2.3). Since all the players enjoyed taking a challenge (see 5.2.3.2), it seemed worth exploring this idea further when developing the games.

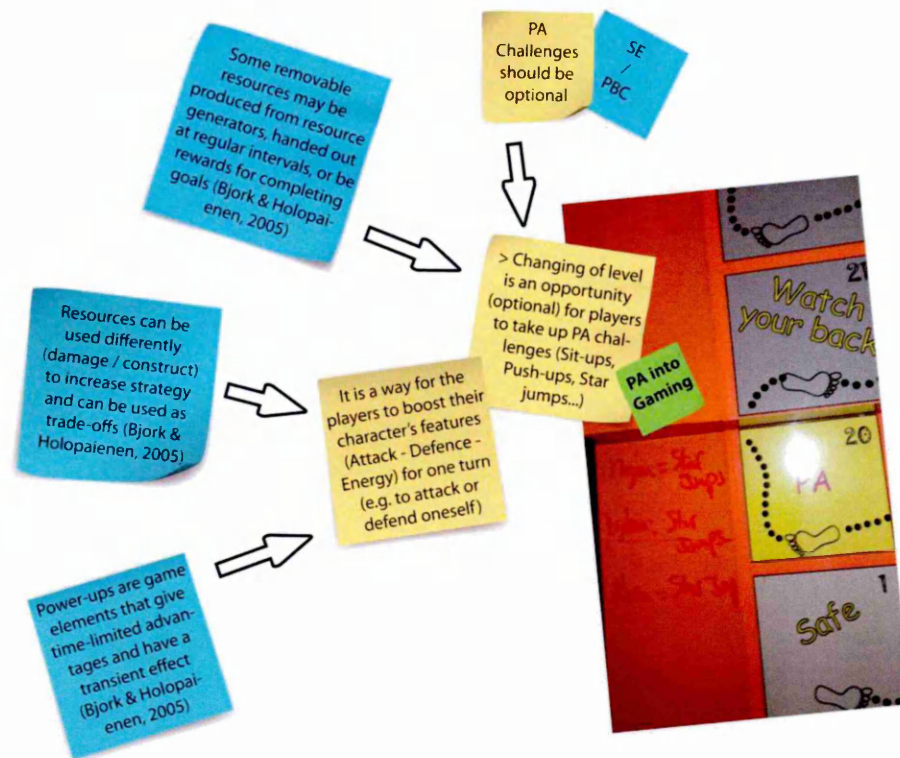


Figure 1AF – Exploring the purpose and implementation of PA into gaming

- > Like in V2, PA challenges remained optional in case players with low levels of self-efficacy may be reticent to do PA in front of other players.
- > In this version, PA challenges (e.g. Push-Ups, Pull ups...) were used again to simulate a change of level however in this case players completing the challenges with success were rewarded with a temporary booster used to increase their character's features.
- > For instance when a player lands on square 20 or passes it, he/she can choose to do a PA challenge but does not have to (a player being on square 19 cannot take the challenge yet). To do so, the player in question picks up a card among the 'PA challenges' cards and executes what is written on the card (e.g. 'You

have 30 seconds to do as many star-jumps as you can'). When players successfully execute a challenge the 'PA challenge' card is earned, enabling them to increase any feature of their character for one turn only (e.g. +5 to attack or defend against opponent's attacks). Hence these 'PA Challenges' cards come in addition to the bonus cards.

- Giving More Choice in the Type of Challenge

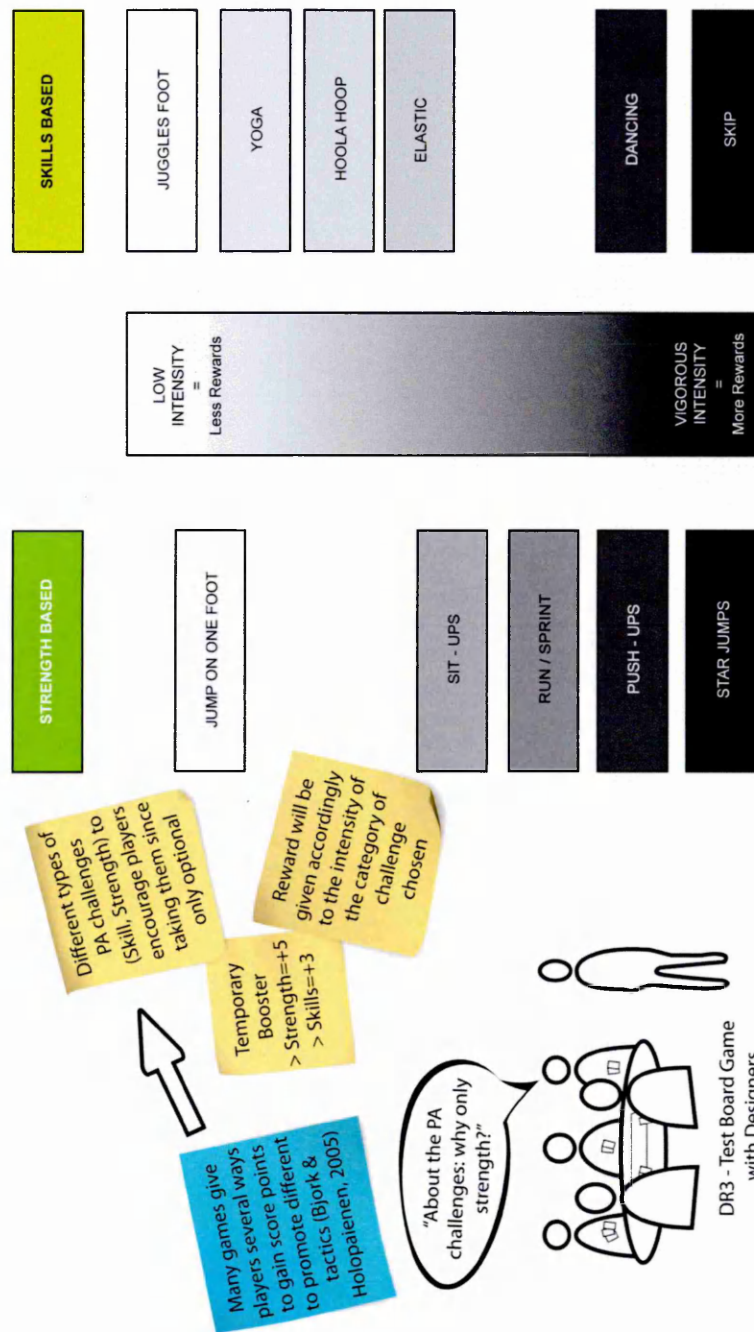


Figure 1AG – Different types of 'Health Challenges'

- > PA challenges were appreciated when tested among designers, however a colleague in the group reported some girls might not feel comfortable doing this type of rather strength-based challenges and suggested doing juggling instead. Hence a skill-based category of challenges were added, which offered more choices and which might be an incentive to take a challenge and get moving.
- > To further encourage players taking challenges, a card rewarding them for taking a challenge but which did not ask to execute any challenges at all (i.e. only 'congratulations for taking a challenge') was created in both categories.
- > The idea between creating another category was to offer challenges with different levels of intensities yet they should be rewarded accordingly. Hence there was a need to adjust the intensity of the challenge created with the value of the reward (e.g. 'jump on one foot' should belong to the skill-based category).
- > Adding ways to increase one's character's features within the game may offer more tactics but also may increase the uncertainty of winning.
- Giving More Opportunities to Do PA

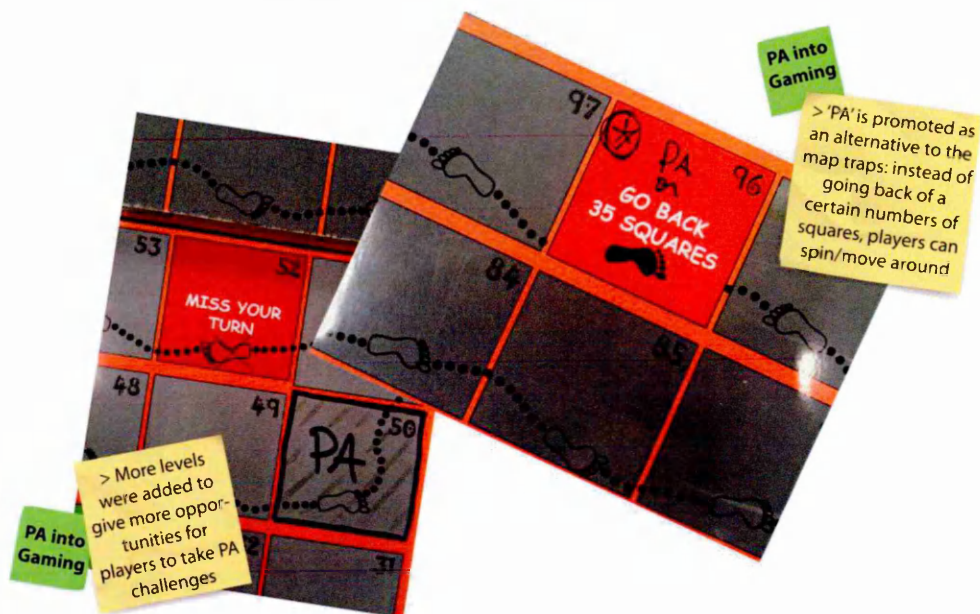


Figure 1AH – Another way to implement PA into gaming

> In addition to the two 'PA squares' created for V2 (squares 20 & 60), two more squares were added (50 & 90) yet they all remained optional. Originally the levels were a way to define the zones (see 5.2.3.2). However adding 'PA squares' increased the number of levels which no longer corresponded to the number of zones.

> The other way created by the participants to promote PA into gaming was through landing on a specific square. This idea was combined with the map traps placed across the board: hence 'spinning around' became an alternative to avoid some of these traps (e.g. on square 96 players choose to go back 35 squares or to 'spin around' for 20 seconds). This PA might not be of a high intensity, yet it is a way to get the players moving while having fun, which tackles sedentary behaviour.

> These forms of PA into gaming allow boosting players' character's features and/or avoiding map traps. They therefore convey the idea that PA is beneficial by showing a positive result for undertaking them, and is part of what defined a blending experience (see 2.6.2). Since they affect the character or player's health, those 'PA challenge' cards were renamed 'Health' cards and PA squares 'Health' squares.

Based on these modifications, more tests were undertaken, revealing the game was fun to play with chances for players with a lower currency to win. However there was a need to balance the rewards by adjusting the values of the health cards in comparison to the amount given through the main currency to each player. Furthermore, there was confusion about the rules for attacking opponents (e.g. which/how many cards can be used) since there were then different cards to play with: health challenges, bonus, and chance cards. The game play involved 3 to 6 players and lasted from 20 to 50 minutes.

### 1.C.2.3 Theme & Graphic of the Board



Figure 1AI – New graphic of the board game inspired by the ones identified as engaging in UCE2

- > A game featuring a landscape with land and rivers seemed to attract both genders in UCE2 and was therefore used as a basis for creating the final graphic of the board game.
- > The V2 character cards graphic were also found attractive to both genders in UCE2 and were hence inserted into the story taking place through the squares on the board (e.g. use of the yeti that looks rather scary to illustrate the square 'lose a chance card'). This was also a way to enhance the common aspects set

throughout the games played in 'Boost Up!' (i.e. not only a common currency but also common graphic).

> To enhance the 3D when changing level, the landscape and its graphic evolved from one level to another, starting on the beach and finishing in space.

### ***1.C.3 Converting PA into Games Currency***

This section presents the theoretical background that influenced the creation of the main and second currency.

#### **1.C.3.1 Generating a Main Currency**

In the second test of the card game, questions were raised about why/how the currency was based upon MVPA averages. Those tests showed the game worked better with a main currency split in three distinct strands (Attack, Defence, Energy), and where players do not have to break it down. Yet there was a need to justify the way those sub-currencies were awarded, which was informed by the health reports. This led to the creation of a framework:

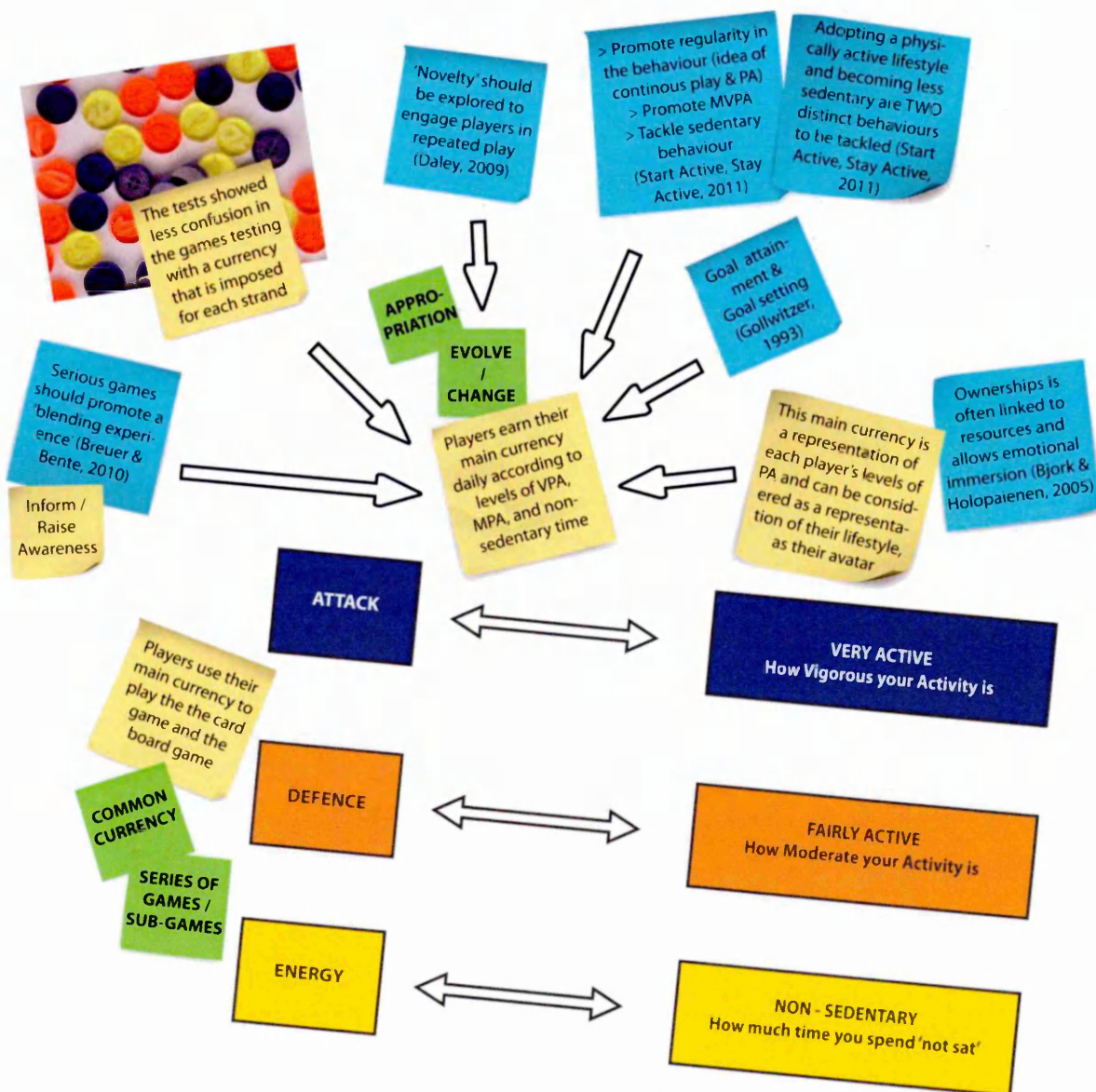


Figure 1AJ – Framework for converting PA into games' sub-currencies (for the main currency only)

> PA should be promoted on a daily basis and should be part of a lifestyle, which varies through people's lives (DH, 2011). The importance of promoting PA through a lifestyle to prevent obesity was echoed by Lieberman (2013).

> Since 'Boost Up!' aims to implement the health recommendations, promoting PA as part of a daily lifestyle is crucial. This implies that the different intensities undertaken within a player's day should be taken into account to generate a currency.

> Aznar-Lain & Webster (2012) reported that the PA to promote should be a combination of factors following the F.I.T.T. principle which stands for Frequency (how often), Intensity (how hard), Time (how long), Type (e.g. running, swimming). According to the Start Active, Stay Active report (DH, 2011) there are two distinct behaviours to promote: physically active and non-sedentary behaviours (as explained in 2.1.3).

> We saw in 2.6.3 that one aspect to provide a blending experience is to inform or raise awareness about one's behaviour.

> The health recommendations about the various intensities of PA to promote (MPA, VPA, and non-sedentary) seemed to fit nicely with the three strands of currency: VPA is a way to build the Attack of one's character (increasing the heart activity is synonymous of having a powerful heart); MPA to build the Defence; Non-Sedentary behaviour to build the Energy (someone always standing up and/or moving out and about spends energy). Therefore to have a strong Attack, players must do PA in a vigorous way. The more moderate PA undertaken, the bigger the Defence of the character will be. Finally the less time spent sedentary/sat, the more Energy that character will get.

> Hence every day players can find out what their intensities of PA are (from sedentary to VPA), which raises awareness of their behaviour and builds towards providing a blending experience. Besides, since each strand of the main currency is associated with a feature of a character, this latter can be seen as a form of avatar representing how active a player is, which illustrates the idea of appropriation identified in UCE1 as engaging. Furthermore, since the currency is awarded on a daily basis and that it is likely that players' PA levels change from one day to another, players' currency will change every day, which is a way to bring novelty to the games as well as to develop strategy and tactics from Stage 1 (e.g. doing a lot of VPA to surprise other players with a strong attack). Finally, since this framework of converting PA into games currency is individual, PA goals can be tailored to the individual to maintain motivation through setting goals that are achievable.

### 1.C.3.2 Generating a Second Currency

Since this system of rewarding currency is tailored to individuals and hence allows setting achievable goals, it was thought that the most active players would be disadvantaged. Therefore a fairer system (crucial feature for the participants in UCE2) needed to be created to somehow reward the most active players. Besides, 'Boost Up!' looks at promoting the health recommendations set in 2.1.3. This led to the idea of bonus cards mentioned earlier in this chapter.

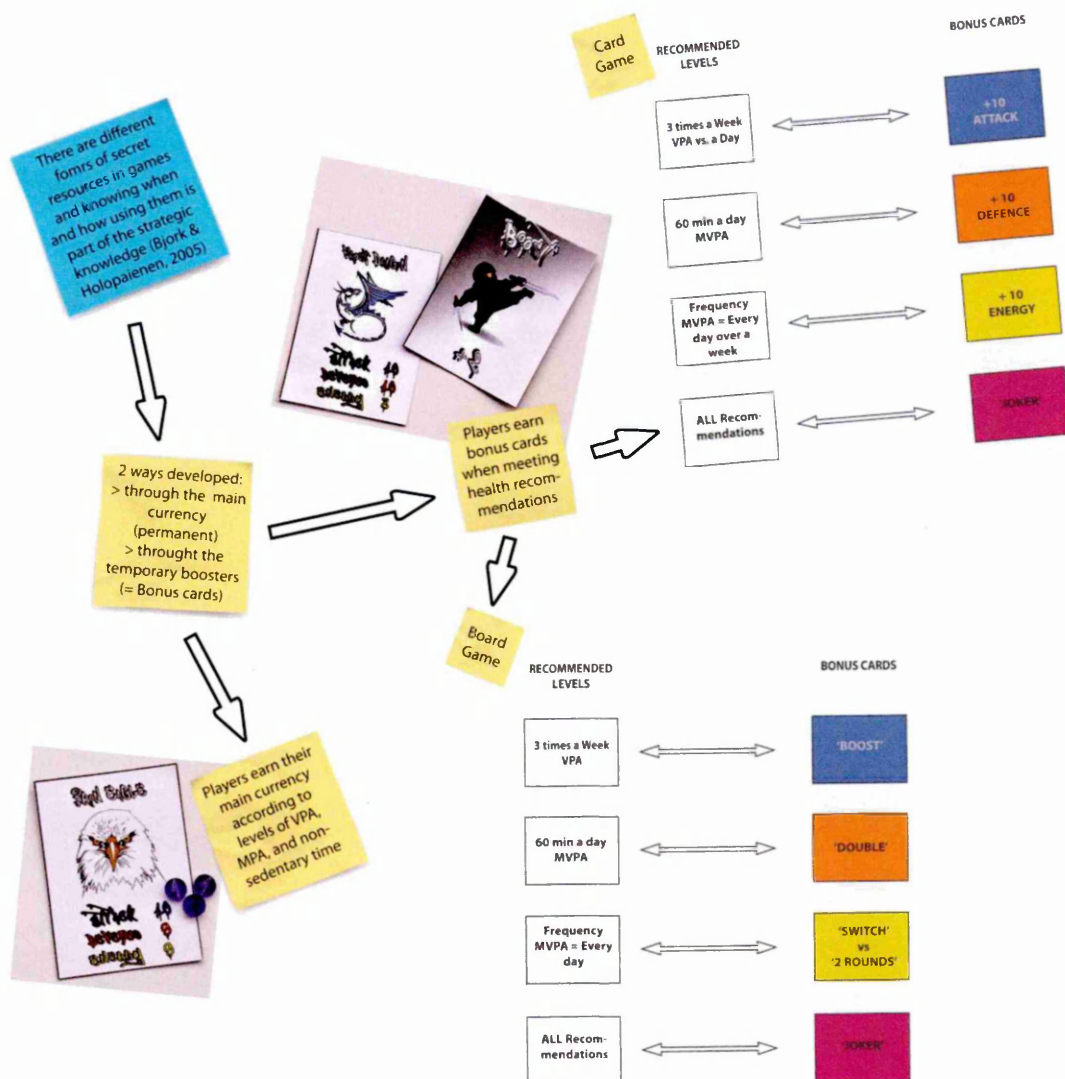


Figure 1AK – Earning currencies and bonus cards in 'Boost Up!'

> Players in 'Boost Up!' can earn four bonus cards when meeting the recommended levels:

- No recommendations were found about the amount of VPA to do, only that it should be done at least three times a week; therefore a first bonus card was given when VPA was done three times a week.
  - When players reach the 60 minutes of MVPA recommended, another bonus card was earned.
  - The notion of regularity being important, if players maintained regularity in their MVPA levels from one day to another (or one week to another) they earned a third bonus card.
  - When meeting all the recommendations, players were given an extra card, the 'Joker', allowing them to use it as any of the bonus cards presented previously.
- > The bonus cards become a way to increase players' chances of winning the games. This might be another way to provide a blending experience since it might allow players to be more conscious about PA, and turn the health recommendations into a goal. However the right balance needs to be found to ensure uncertainty of winning so that the least active players, who might have the same amount of counters but fewer or no bonus cards, still have chances to win a game.

#### ***1.C.4 Storing the Currency***

Within the resources of this research (time and budget), it was not possible to develop the game to a point where the 'credit card' system and the 'interactive kiosk' to withdraw the currency would actually work (as presented in V3 in 5.3.3.2). Therefore evaluating 'Boost Up!' with end-users will not be supported by any technology except from the device measuring the PA levels.

##### ***1.C.4.1 Design Exploration***

A range of concepts around the currency dispenser was brainstormed as the framework converting PA into games currency along with the games play and rules were being developed.



Figure 1AL – Exploration around the currency dispenser

#### 1.C.4.2 Setting a 'Boost Up!' Evaluation with End-users



Figure 1AM – Questions about the implementation of the games during the latest tests

- > Since there was no 'interactive kiosk' to withdraw the currency, the designer/researcher would be the banker to award the daily currency.
- > Since the currency is physical and not digital, a system had to be found to avoid cheating once participants are awarded their currency for the day.

In order to evaluate 'Boost Up!' appropriately, each player has to carry around the currency dispenser, which should contain:

- The main currency (counters) compatible especially with the play of the card game, which consists of hiding the currency before revealing it and 'burning' it.
- The second currency that is earned when meeting health recommendations (up to four cards).
- The 'Boost Up!' themed card game (character cards) to promote pervasive play (anywhere/anytime).

### 1.C.4.3 A Working Prototype



Figure 1AN – The currency dispenser rapid-prototyped

> The design of the currency dispenser was based on the game play of the card game since the board game used a main currency that was permanent and revealed to other players. Conversely the card game used a main currency that remained hidden. Therefore the currency dispenser had to store all the currency (up to 10 beads per strand), reveal the 'bet' to other players, and 'burn' the currency.

- Concept Suitable: Players Must Be Able to Carry their Currencies

> The prototype contained two layers of 'storage'. The first layer was used to store the bonus cards (in yellow in Figure 1AN) given for the day as well as 'Boost Up!' themed card game (i.e. character cards). The card game was given to the players as it aimed to be played everywhere, at anytime (e.g. during morning break). Hence each player had to receive one deck of themed cards.

> The second layer of the dispenser was used to store the main currency with the three strands of the main currency (Attack, Defence, Energy) which turned out to be beads to facilitate the transition from one compartment to another when 'betting' in the card game.

- Game Suitable: the Box Must be Compatible with the Play of the Card Game

> The second layer, containing the beads (most bottom right image) was split into three compartments: the top one corresponded to the currency available to use, the middle to the currency bet, and the bottom one to the currency burnt. The beads passed from one compartment to another by pressing the buttons placed between each compartment. To hide the currency left, one side of the box was covered with a card to ensure not revealing the amount left when showing a 'bet' to other players. When a game was finished, to avoid players having to pass all the beads from one side of the device to the other (from 'burnt currency' to 'currency left'), both compartments located at the ends of the box were hidden. This allowed players finishing a game to return the box to start a new one. The two extreme compartments are visible on Figure 1AN yet a card could be inserted to cover them so that players do not

know the amount of currency left/burnt, regardless of how the dispenser is held.

> The board game using the main currency in a permanent way, players just placed their beads in the middle section ('bet' section of the card game).

> The layer containing the beads had a clear acrylic lid to allow 'locking' with an Allen key, which did not completely avoid cheating but which might reduce it.

> The holes visible on the extreme right picture in the middle line of Figure 1AN were a way to keep track of the currency given: the number of bonus cards (for both games) and beads given to each player was engraved on a piece of acrylic that was inserted into these holes. Hence this was also a way to limit cheating (e.g. in case a player would keep one or more bonus card(s) from one day to another).

## 1.D UCE3 : EVALUATING 'BOOST UP!' V4

### 1.D.1 V4 Bonus Cards (DRE3)

The way the Bonus cards were awarded in V4 was based on the recommendations found in the literature. Here below are a more detailed description of what was explained in 5.5.3.

#### 1.D.1.1 Card Game

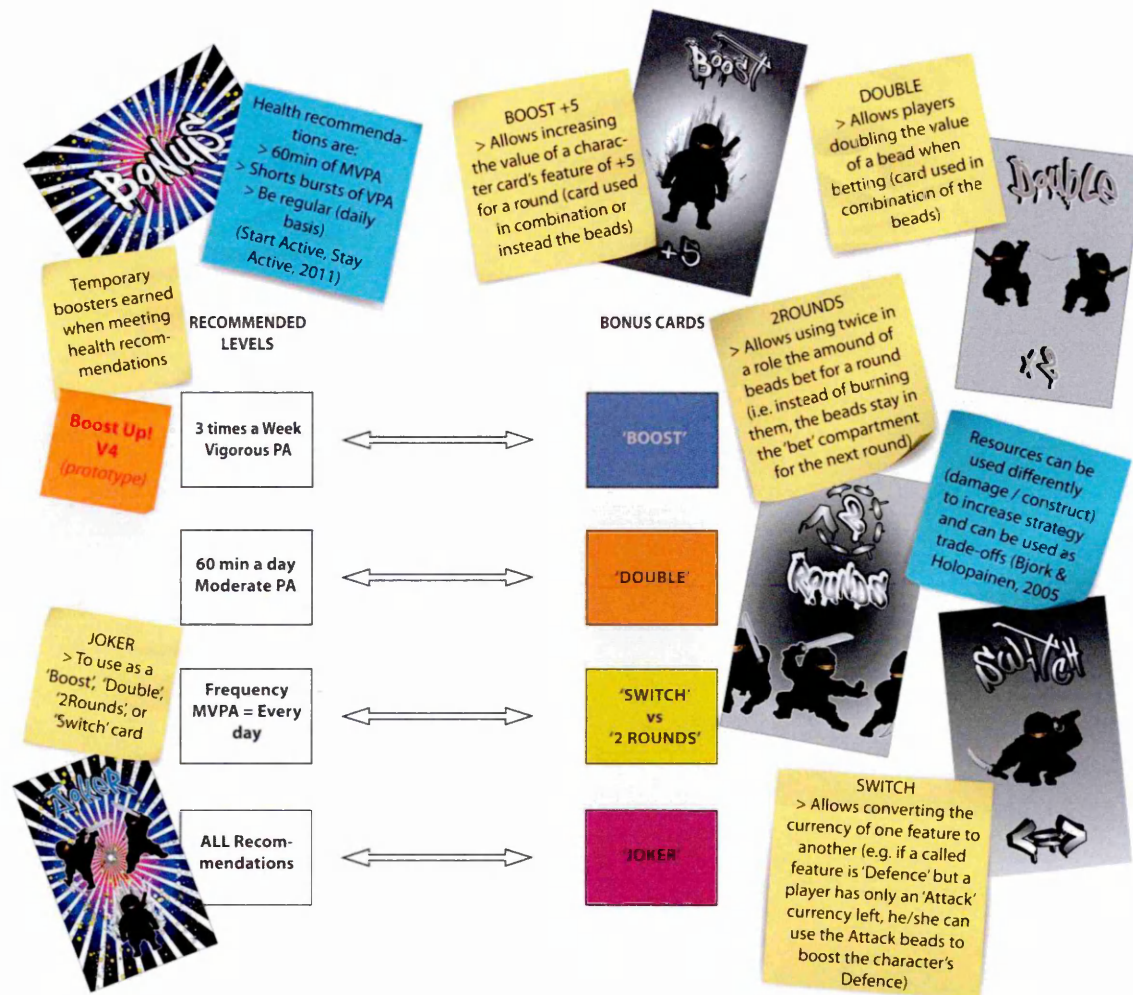


Figure 1AO – Card game's bonus cards

### 1.D.1.2 Board Game

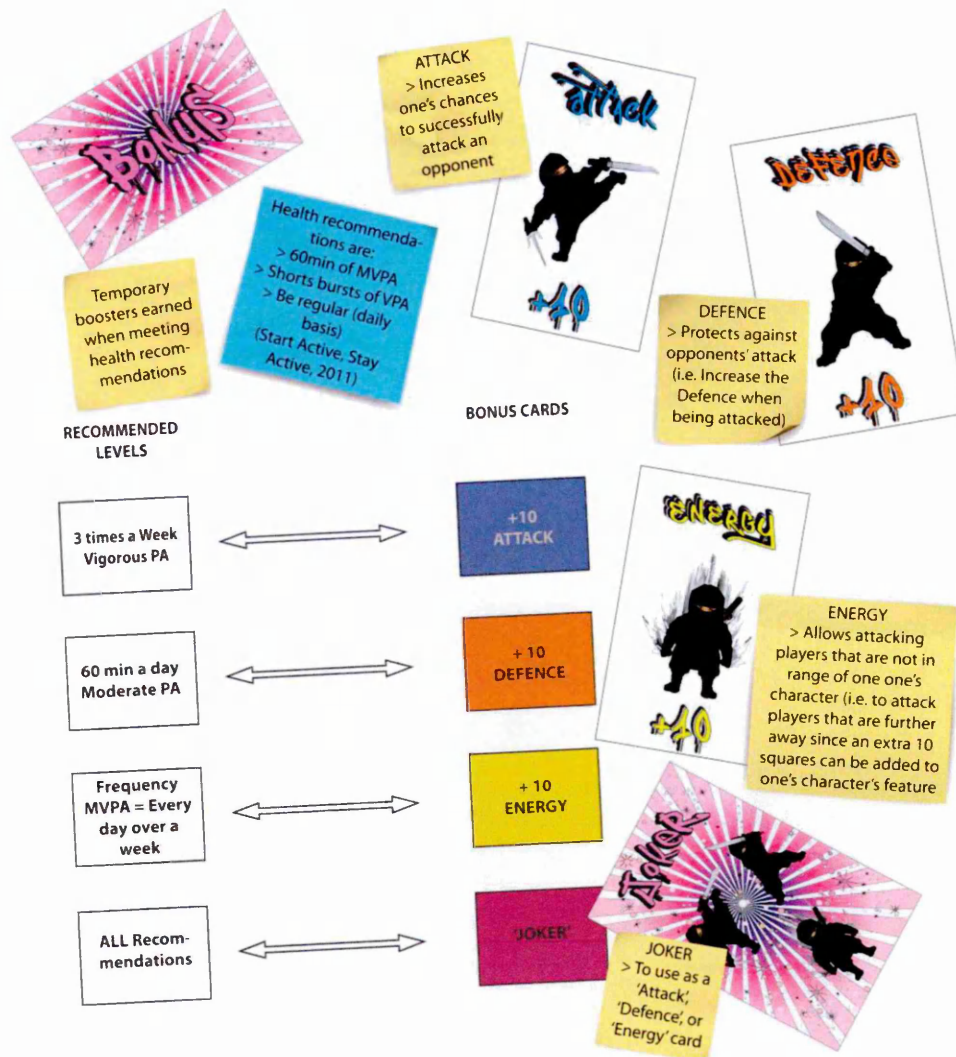


Figure 1AP – Board game's bonus cards

### 1.D.2 V4 Bonus Cards (UCE3)

However as explained in 6.3.3, the way the Bonus cards were awarded to participants was adapted to the sample's levels of PA.

Participants in UCE2 showed enthusiasm and positive feedback about tokens and accessories being interchangeable and Bjork & Holopainen (2005) highlight that resources can be used as trade-offs to increase strategy. Hence cards of a same value became interchangeable as shown in Figure 1AQ and 1AR (e.g. a +5 can be swapped with x2 +2 and x1 +1; a +10 Attack could be swapped with a +10 Defence or +10 Energy).



Figure 1AQ – Bonus cards earned for the card game according to number of steps (x)



Figure 1AR – Bonus cards earned for the board game according to number of steps (x)

### 1.D.3 Trends from Fitbits' Data

In order to have a better understanding whether 'Boost Up!' V4 would have the potential to increase players' PA levels, taking a closer look at a few individuals that seemed to enjoy playing the games might help. Players 7, 8, 10 and 14 were pupils who seemed engaged in 'Boost Up!' since they attended the game club on a regular basis, and they also most often thought of dropping/collecting their bag at the shop, unlike player 3 or 13 for instance who did not seem engage at all.

- Player 7 (girl)

This player was engaged in playing the games, especially the board game but she often forgot the pedometer &/or missed school. Player 7 was often with the same group of friends and therefore came even more often to the game club when it became open to non-participants friends (i.e. from Week 3).

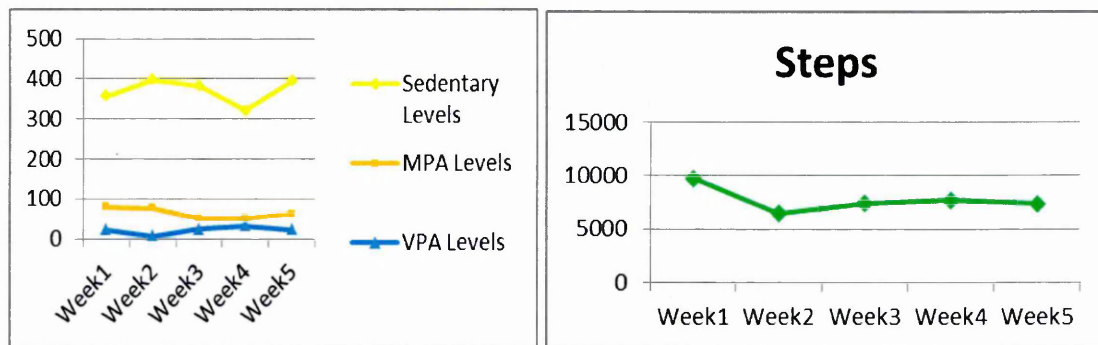


Figure 1AS – Player 7

> The time spent sedentary decreased from Week 3 (i.e. when 'Boost Up' concept was introduced) however it increased again on the last week.

> Even though the time spent sedentary increased considerably in Week 5, the amount of steps, MPA and VPA remained similar, suggesting LPA levels instead increased.

> The 'activitystat' (Frémeaux et al., 2011) can be used to describe this player's profile since her levels of MPA or VPA always decrease when sedentary time decreases too.

- Player 8 (girl)

Player 8 seemed to be quite shy and was less involved with all the girls or boys of the class. Player 8 seemed to enjoy the board game and she came often to the game club for the first two weeks. Both girls did not come much in Week 4 & 5 since they were busy with other occupations (e.g. film club).

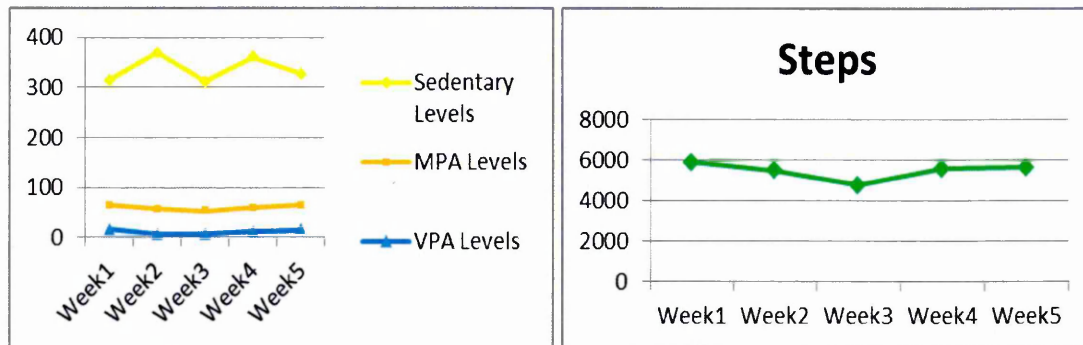


Figure 1AT – Player 8

- > There does not seem to be any pattern visible for this player: time spent sitting was low in Week 1, 3 & 5 and higher in Week 2 & 4 with similar values across both low and high sedentary levels.
- > While the sedentary levels were irregular, MPA & VPA levels remained relatively the same across the five weeks.
- > It also seems for this player that Week 3 was the most inactive week, both in terms of sedentary, MPA and VPA levels.

- Player 14 (boy)

This player generally seemed to be active and was involved in a group of friends who all liked playing football. He was friendly with one other non-participant boy who attended the game club regularly once it was opened to everyone. This player seemed quite competitive and would not really mix with other groups, especially the girls.

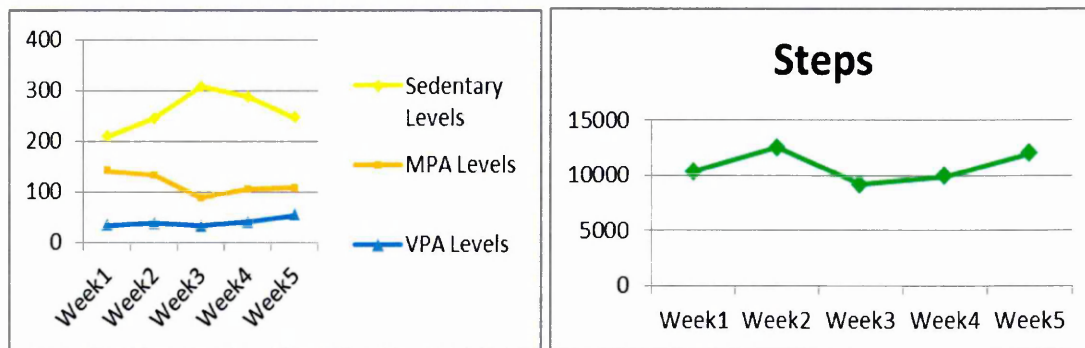


Figure 1AU – Player 14

> No pattern can be detected among this player's activity however Week 3 (i.e. week when 'Boost Up!' concept was presented) was the most inactive week for this player, like it was the case for Player 8: The number of steps and levels of MPA & VPA were at their lowest while the time spent sat at its highest.

> With a general weekly average above 10000 steps, this player is the only one to have earned the 7 bonus cards available.

- Player 4 (girl)

Player 4 did not seem to play the games and never really came to the game club.

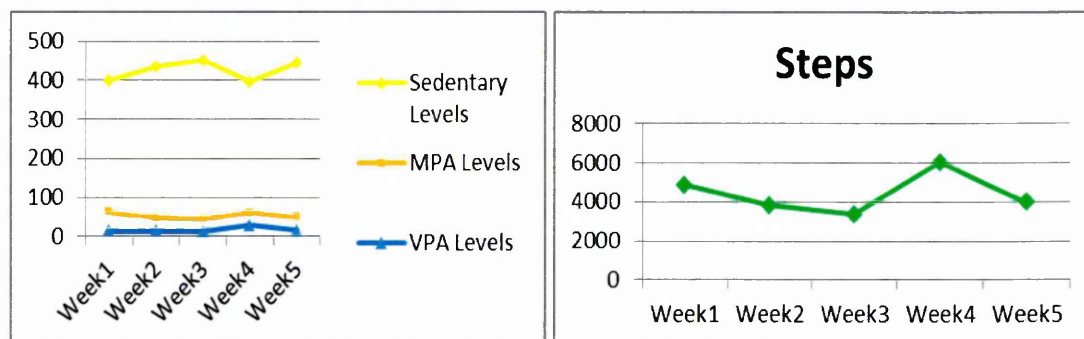


Figure 1AV – Player 4

> We cannot detect any patterns in this player's activity except a very active week in Week 4, where the amount of steps, MPA & VPA were at their highest while sedentary time being at its lowest. It is uncertain why this is.

> What is interesting is that half way through the intervention (i.e at the start of Week 3), this player reported to her PE teacher she wanted to drop out. PE teachers explained the pedometer made her doubt: *"She (...) hasn't got much Self-Esteem and having the pedometer tracking her moves does not make her confident and willing to do more PA"*. Yet she took part in the intervention until the end.

> When talking to her in Week 4, it was reported the pedometer helped a little – she looked at it when being on the treadmill and motivated her – and she felt *"she wasn't active as much before"*.

> Unlike the rest of the intervention, she wore her pedometer every day of the week for the last 10 days of the intervention.

- Player 10 (boy)

Player 10 was really keen in taking part in the intervention: he most often thought of dropping his bag at the shop and of collecting the bag with impatience to find out how much PA (& currency he was awarded for the day). He really seemed to enjoy playing the games, especially the board game and doing the Health challenges. He was the only one reporting playing the card game with his sister at home. He also attended the game club at lunch on a regular basis. This player was less part of an identified group of friends and was not afraid of mixing with a group of girls to play the games during the game club, unlike most of the other boys.

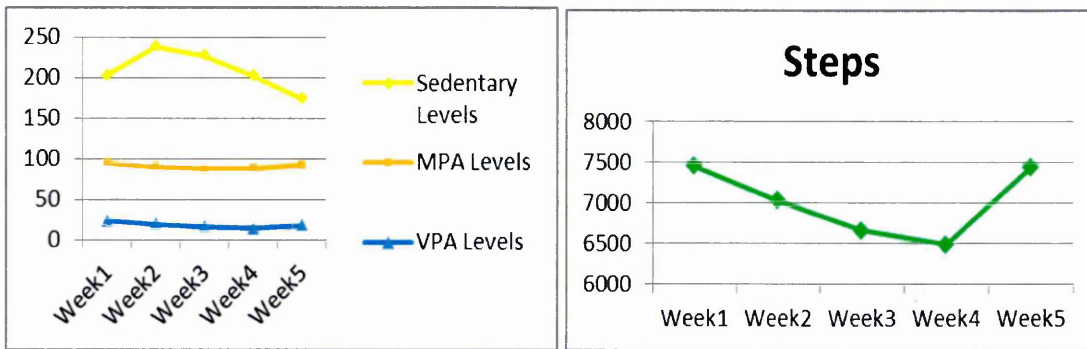


Figure 1AW – Player 10

> We could say this Player 10 have an 'activitystat' since his levels of MPA and VPA slightly reduced over the length of the intervention however the amount of time spent sedentary decreased significantly.

> This suggests LPA levels increased however the number of steps kept decreasing over the intervention (except for Week 5 that has shown lowest amount of time spent sat and highest number of steps).

> It is therefore concluded that for decreasing the time spent sedentary this player spent a lot of time standing up still, without moving (except for Week 5).

This player 10 seemed one of the most engaged since he often thought of dropping/collecting his bag at the shop, played the card game at home, came to the game club regularly to play the board game he reported loving, and always took the health challenge when playing it. Taking a closer look at the amount of steps done might hence be interesting: therefore the same day in the week (i.e. Friday) was chosen to compare the amount of steps done from one Friday to another and observe the potential differences when attending the game club (and play the board game/completed the health challenges) or not.



Figure 1AX – Player 10's steps done every Friday

- > On Fridays where this player attended the game club at lunch time, the amount of steps seemed higher than on Fridays where he did not attend. This seems to be explained by the fact that this player engaged with the Health challenges every time he had the opportunity.
- > Therefore it seems the activities usually undertaken outside the game club are less active than the play of the board game.

From comparing the graphs in Figure 1AX, we can say the play of the board game did promote PA in comparison to both the recreational play when not attending the game club as well as other traditional board games. The play of this board game therefore seems to be more effective to increase PA levels compared to traditional school lunch breaks, which differs from the findings of Duncan et al. (2011). In this study, participants aged 10-11 used the Gamercize stepper exergame over a six week period. Duncan et al. (2011) reported that PA levels done on the exergames were similar to those executed in traditional school breaks. These results suggest the potential of traditional games (e.g. board games) and hybrid games (e.g. 'Gener-G') might increase 11-12 year's old levels of PA.

## ***Appendix 2- Reflective Narrative's Data***

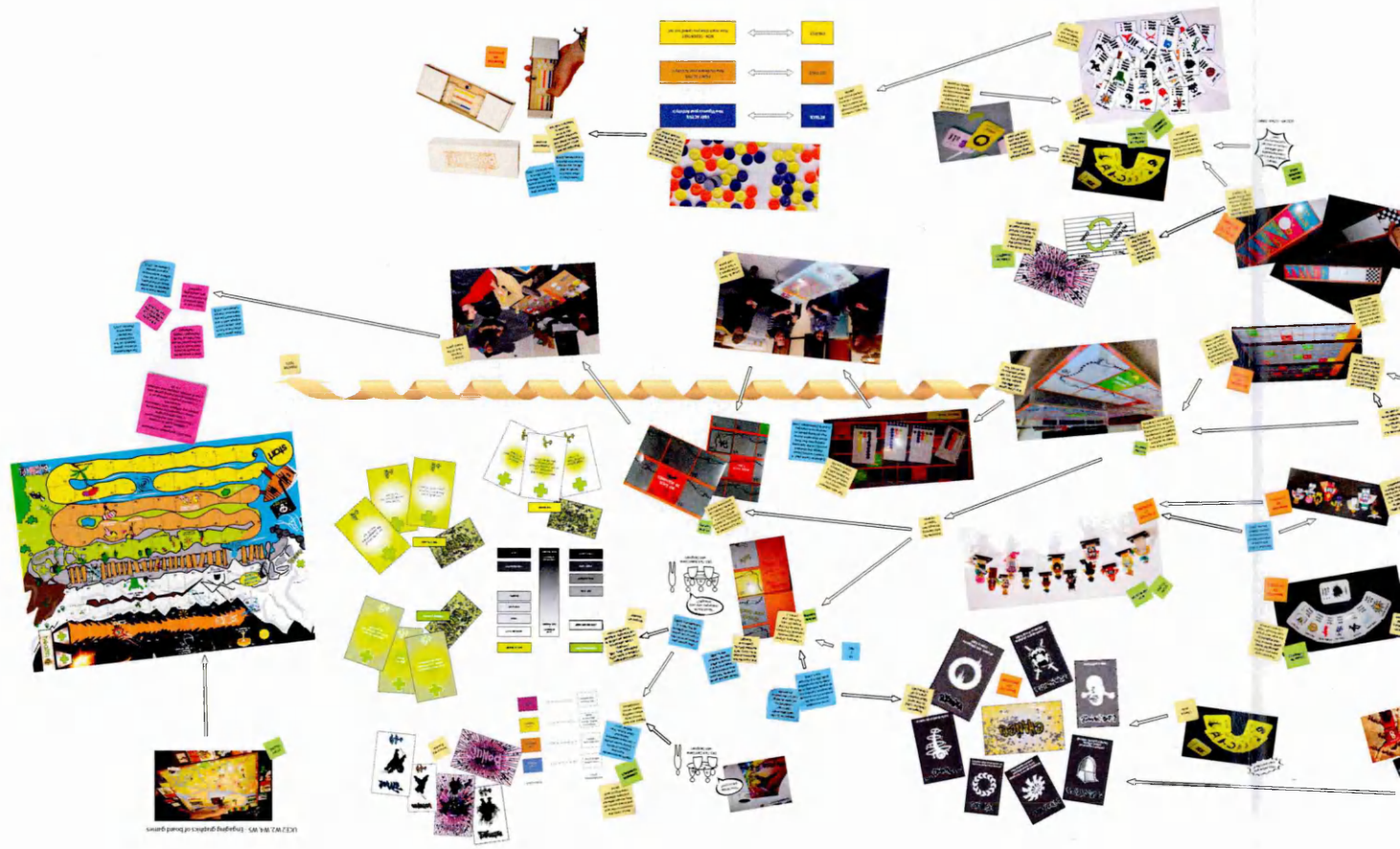
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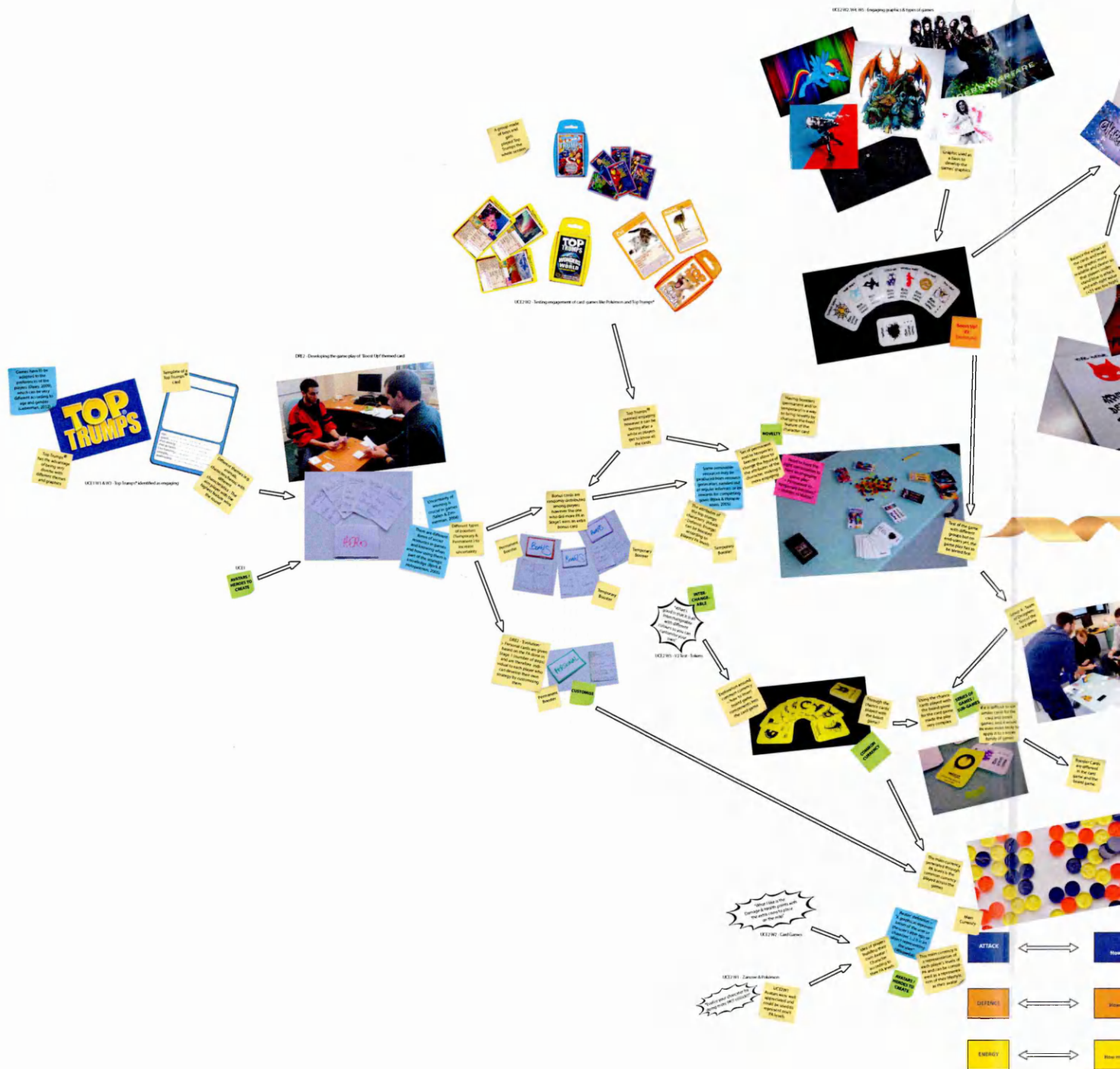
This appendix presents in details the 'reflective narrative' analysis conducted in DRE4 (already presented in 6.5) that led to creating visual maps about the design development of the game as well as about the creation of knowledge. This appendix first presents the timeline about the design development process of 'Boost Up!' (under the 'designer hat') and subsequently reports the themes that were identified as engaging (under the 'researcher hat') to promote repeated play and PA among the 11-12 years old participants that were involved in the overall research (i.e. all UCEs).

### ***2.A 'BOOST UP!' DESIGN DEVELOPMENT***

Following the creation of the Chronological Research Timeline, a series of posters summarising the key events that informed the creation and development of 'Boost Up!' were created and can be found below. These present the:

- Board game (on p306)
- Card game (on p307)
- Currency dispenser (on p308)





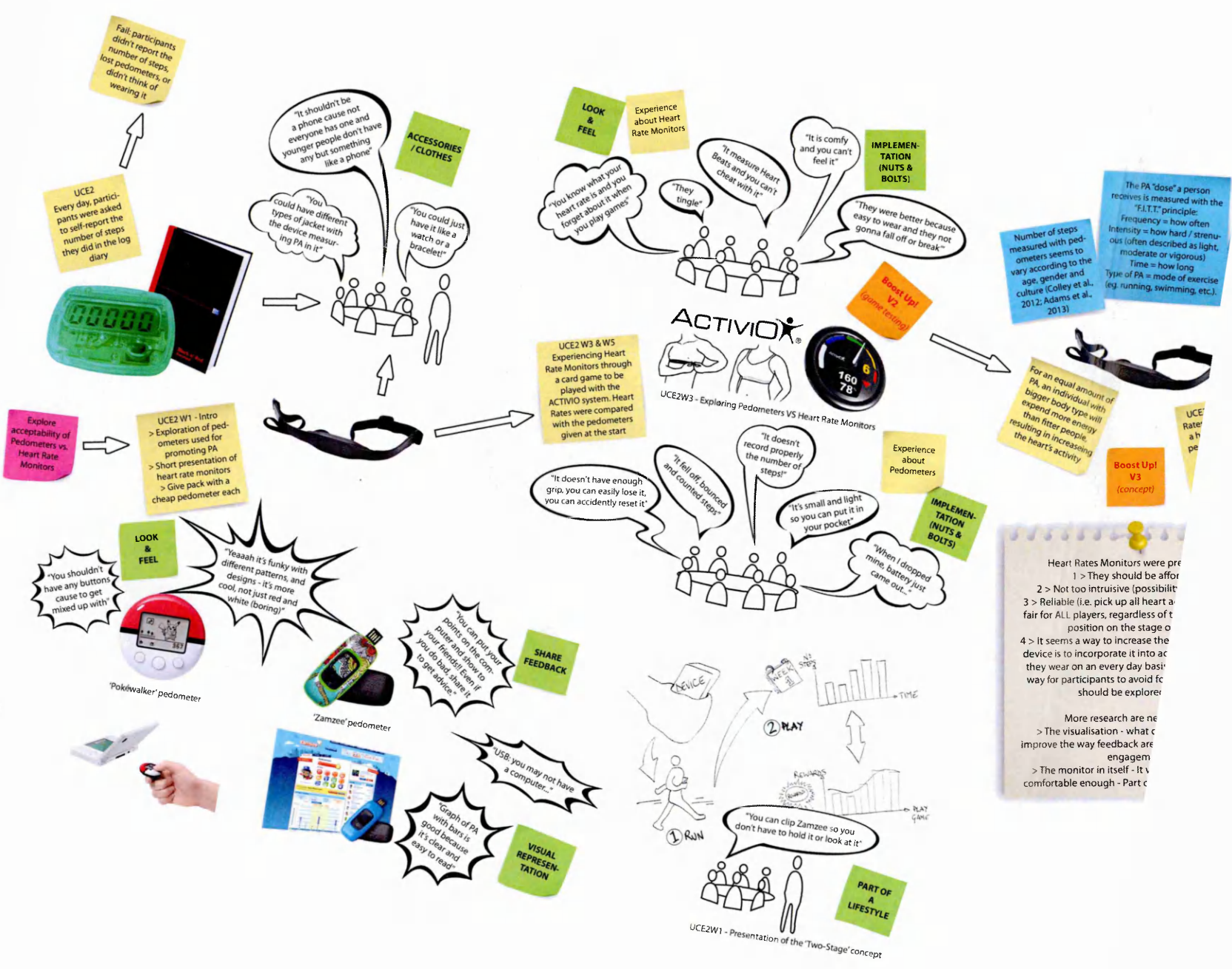


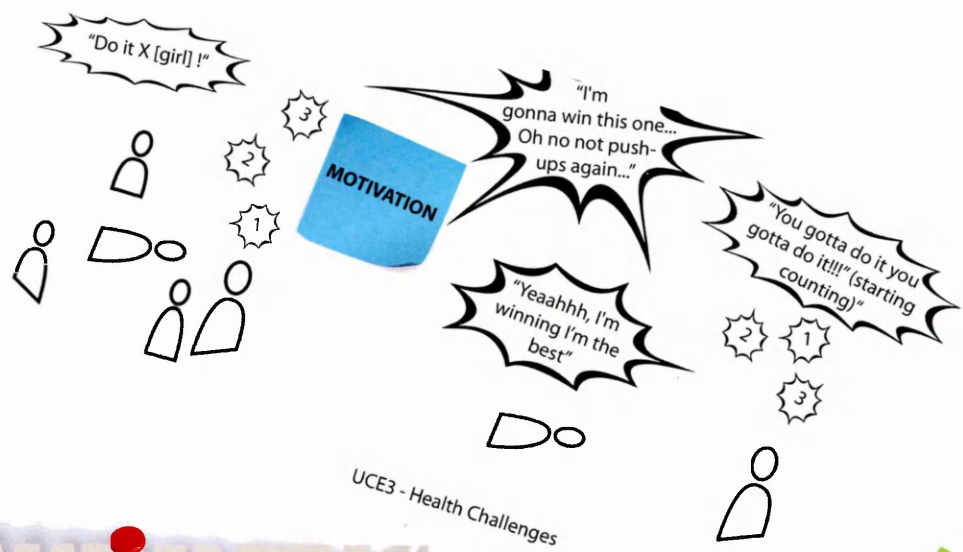
## **2.B KNOWLEDGE CREATION**

This section presents the data that led to generating the knowledge presented in 5.6.2.

### **2.B.1 Knowledge through Comparison**

Based on a comparison of successful events for engaging pupils in doing PA, two other posters were compiled. The first one presents the data was gathered around the acceptability of pedometers against heart rate monitors (see p310). The second poster compares the two games played during UCE2 and UCE3 that promoted engagement (respectively the PA challenges played with ACTIVIO and the Health Cards played with the board game) – see p311.





challenge picked some players not want to execute the challenge by fearing not being able to complete it however it has always been 'accomplished' (with more or less success)

"Sir can I please change as I can't do push-ups at all"

UCE3 - Health Challenges

**PEER PRESSURE**

PA challenges (UCE2) were:

- 1 > Gathering pupils with different corpulence and the challenges were done in a group, with feed-back about heart rate activity in real time
- 2 > Imposed; once a 'challenge' card picked, they have to execute it (except if one has a bonus card) = No choice about difficulty
- 3 > Time limit to choose (up to 1min)
- 4 > Seen as 'positive'; as a way to earn points to get game rewards
- 5 > Instant Reward: Points gained for in 'PA stage' are converted straight after into a game currency to be used instantly
- 6 > 'Informal referee' = for each challenge executed, full points were given if the exercise wasn't done 'properly' however for each set of challenges a bonus was given to the person reaching the highest heart beat.

This is something that seems to be worth exploring further - how the number (and/or quality?) of the challenge can affect the amount of the reward

Both games tested in UCE2 (PA challenges) and UCE3 (Health challenges) promoted engagement and were compared to understand what factors engaged the participants to do PA

**INSTANT REWARD / FEEDBACK**

"It didn't encourage me much to do more PA because I wasn't doing as many steps as I thought I would"

UCE3 - Chat at the Shop

"The more push ups the higher card"

UCE3 - Health challenges

"Or if you do 5 push ups you get 5 in Attack or Defence"

"I did 50 star jumps!!!"

"The number of star jumps doesn't count..."

"I don't care I am still proud"

UCE2 - ACTIVIO and PA challenges

"There were more activity cards in the board game"

"The card game wasn't really active (...) it wasn't something like 'Tag'"

UCE3 - Health challenges

"We didn't do a lot of activity on the thing"

A participant who hasn't been really engaged in playing the games was playing ever checking the number of beads she was earning daily

"I got 6 cards! That's the best I ever did!!"

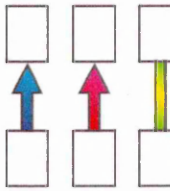
UCE3 - Experience w

### ***2.B.2 Knowledge through Repetition***

This section presents snippets of data under the form of Annotated Design History that were repeated throughout the UCEs and that led to identifying the themes considered as engaging. As explained in 5.6.3, the data for each theme was compiled into tables, which are a way to show the provenance of a theme in question (i.e. what data led to identify the theme and in which enquiry the data is from). The tables allow understanding which category of artefact a theme was embedded in (i.e. in the game concept, components, or in the device measuring PA) and how this artefact emerged (i.e. whether it is the designer/researcher embedding into artefact, the participants' creation, whether it was found in the literature, or a combination of one or more of them).

This section presents the tables that were made for each identified theme. For each theme, the table is presented first and followed by a discussion about the relevance of the theme that is illustrated by the Annotated Design History.

Abbreviations				
Themes		Attributing Data to X number of Participants		Other
Theme Category	How the Theme Emerged	Number of participants	Coding	
1 = Game concept that seemed engaging	D/R = The theme was embedded into a design response produced by the Designer/Researcher	1	*	DRE = Designer / Researcher Enquiry UCE = User-Centred Enquiry W = Workshop within an UCE
2 = Game Content or Components that seemed engaging	P = The theme emerged from analysing the participants' feedback or creation	2<x<4	**	V1 = First concept of 'Boost Up!'
3 = Elements about the Device that seemed engaging	L = a- Theme identified in the Literature as engaging / worth exploring b- The theme seemed useful in relation to what the literature suggests	5<x<8	***	V2 = First prototype of 'Boost Up!'
		Focus Group Discussion/Activity	****	V3 = Second concept of 'Boost Up!'
				V4 = Second prototype of 'Boost Up!'
				PA = Physical Activity MPA = Moderate Physical Activity VPA = Vigorous Physical Activity MVPA = Moderate-to-Vigorous PA HRM = Heart Rate Monitors SE = Self-Efficacy



How an activity informed by participant(s), literature, designer/researcher leads to 'Designing' (i.e. embed knowledge into a prototype)

How participants react to testing this 'Design' / Prototype

Similarities of the findings across activities (around the emerging theme)

Figure 2F – Caption for the tables/themes presented below

- 'Multi-Use' theme

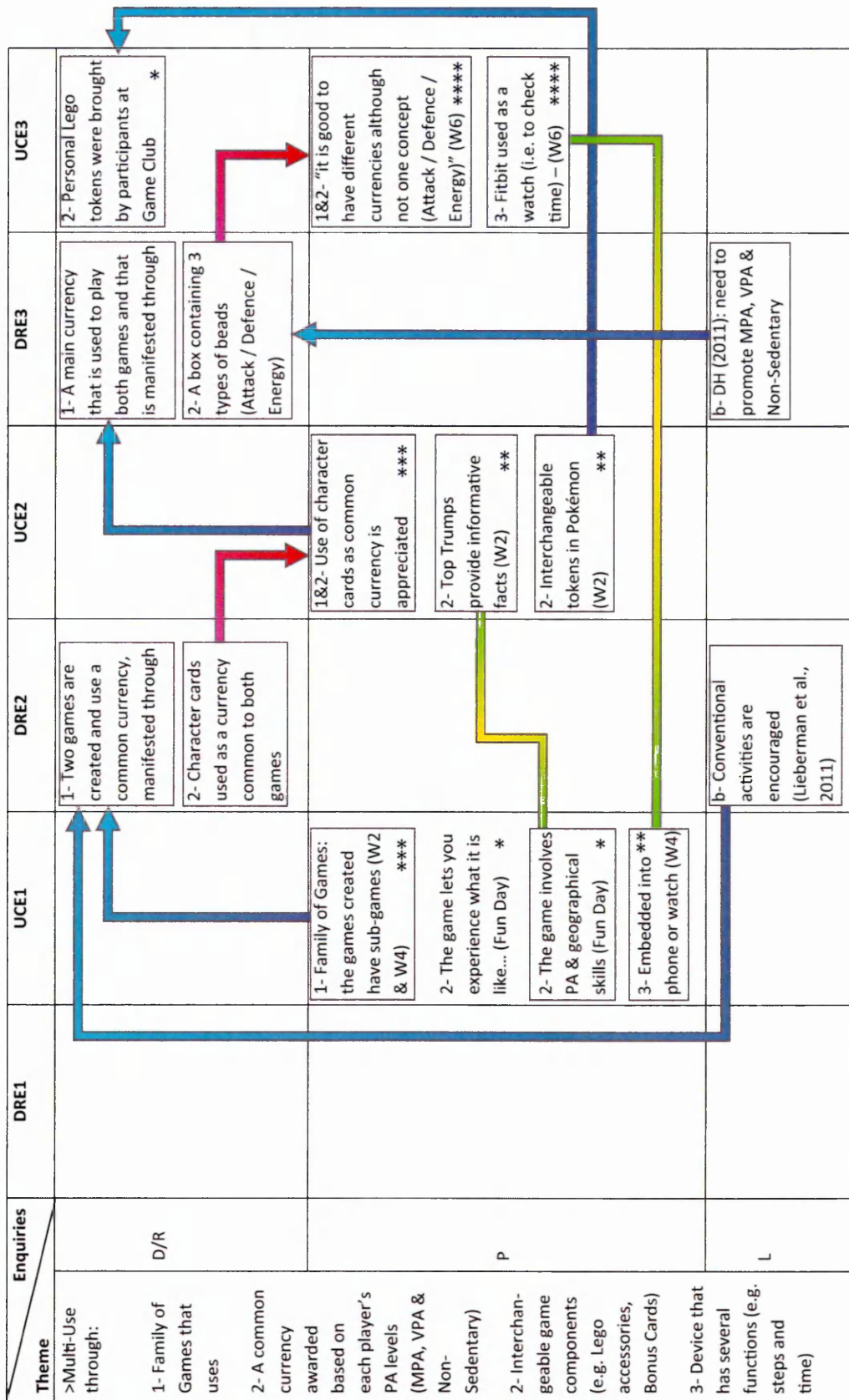


Figure 2G – 'Multi-Use' theme

Giving different uses to a design seemed to be a source of engagement for these people. Three ways to implement the idea of multi-use were found: through the game concept of creating a family of games that are played through a common currency; through the game components that might be interchangeable or that might provide educational or informative messages; and through the device measuring PA that might display the PA performance as well as other information or messages.

'Multi-Use' was already manifested in different ways in UCE1: through the creation of games composed of sub-games and also through the game or the device measuring PA being informative/educational on top of what it is designed for (as explained in 5.1.1.6).

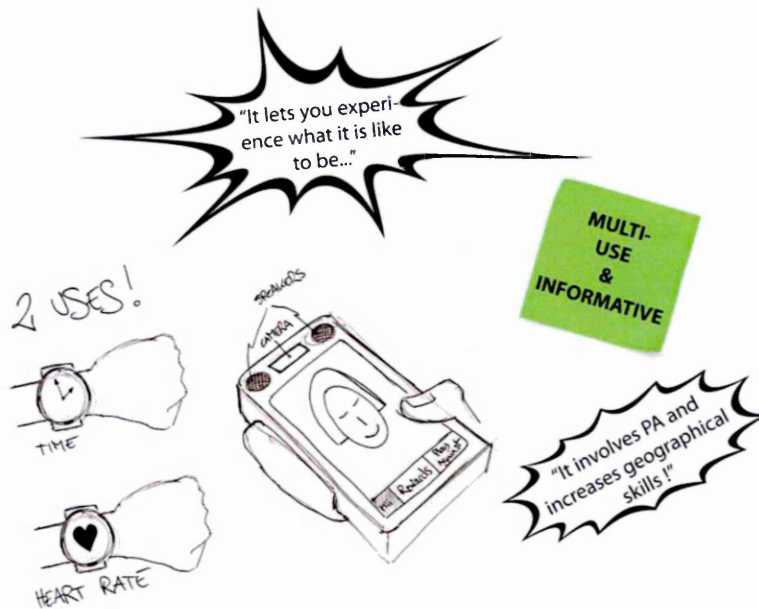


Figure 2H – Multi-Use seemed to be a source of engagement

'Multi-Use' subsequently inspired the creation of 'Boost Up!' V1 which used a common theme (i.e. Hero & Fantasy) and currency across the sub-games invented. The idea behind V1 common currency was to use the various intensities of PA done throughout the day, which include the conventional activities as suggested by Lieberman et al. (2011), to play the games. During the first phase of the game (i.e. play of the card game), an avatar is created and used to play the board game in the second phase of the game.

Since participants did not engage in wearing the pedometers in UCE2, building the avatar based on PA levels was not possible (see 4.2.4.4). Therefore the character cards, originally created to play the card game, were used to play the board game. As reported in the 'Multi-Use' section in 5.2.3.1, using these cards as a common currency across games when testing V2 in UCE2 was reported being an incentive. Top Trumps® 'Wonder of the World' (which provided informative facts) and using Lego figurines as tokens (which allowed players to interchange body parts and accessories) were also appreciated.

Since this idea of 'Multi-Use' and common currency seemed to be engaging, it was further developed in DRE3 and combined to the health recommendations (DH, 2011) suggesting promoting MPA, VPA, and non-sedentary behaviours (see 5.3.4.1). This led to the creation of a common currency composed of two sub-currencies. The main currency, made of three strands (Attack/Defence/Energy) is awarded the same way for both games (i.e. it corresponds to beads given based on the amount of the intensity of PA – see 5.4.2.2) but used in differently. The secondary currency is different from the card game to the board game (i.e. different cards) yet awarded the same way, when meeting the health recommendations (see 5.4.2.3).

Yet V4 tests in UCE3 suggested that developing games based on those three strands only did not suit everyone's tastes.

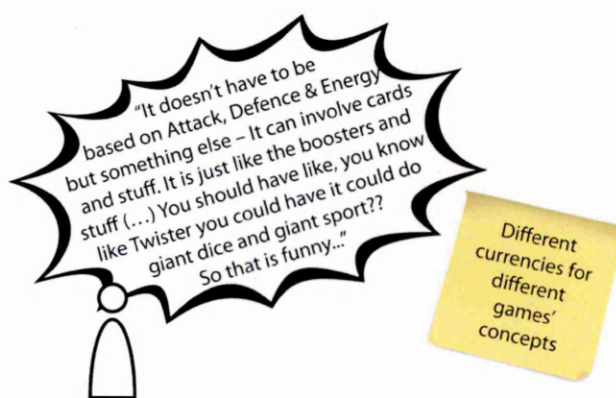


Figure 2I – More currency and game concept

> A set of common currency could be attributed in a similar way (through VPA, MPA, and non-sedentary levels) although not necessarily all relating to a

character's features. Converting PA into a currency to play existing games as imagined in V3 (see 5.3.3.1) might hence be worth exploring further.

The feedback gathered around the Fitbits in Workshop 6 of UCE3 also showed that giving different uses to the device increase its acceptability among this population: a majority of participants reported looking up the information on the pedometers (mainly the steps) however some used it as a watch, to check the time. Besides, the fun and unexpected aspect of the messages displayed on the pedometer's interface (e.g. 'Step Geek') also seemed to be an incentive since it was observed participants engaged in LPA when such messages popped up (i.e. walking around), waiting for new ones to appear.

- 'Choice' theme

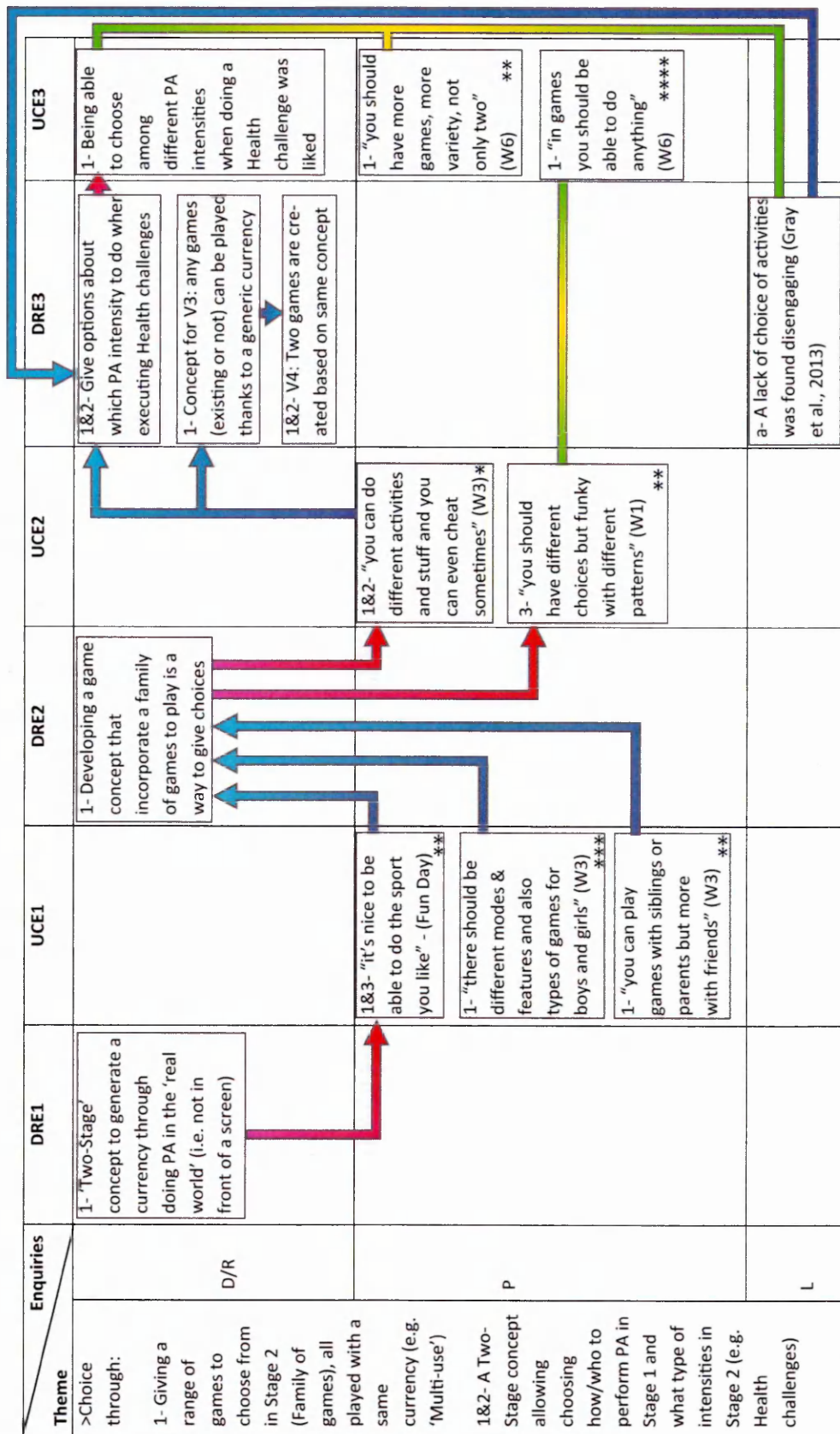


Figure 2J – 'Choice' theme

The notions of freedom, choice and autonomy emerged throughout the three UCEs during which participants enjoyed having alternatives and being able to choose among a variety of possibilities, suggesting having a sense of freedom and control is an important feature for engagement.

The game created prior to this research 'Gener-G' was based on the 'Two-Stage' concept and was part of the 'Two Stages Games' poster presented during the Fun Day event in UCE1. A positive feedback of Gener-G was the variety of choice this game promoted (i.e. being able to do any sports like Football, Cricket, Volley...) since players are not restricted to doing PA 'on the spot' like most of exergames.



Figure 2K – 'Choice' seemed an important property of game

> This echoed the discussion exchanged in Workshop 3 of UCE1 during which participants highlighted the importance of being able to choose what game(s) to play, in the mode they want, and with the right people.

This idea of having a family of games to play strongly influenced the creation of 'Boost Up!' V1, a game composed of a series of games (see 5.1.4).

When testing V1 throughout the 'micro-experiments' in UCE2, offering choices was also found being an incentive. When comparing the Zamzee and Pokéwalker pedometer in Workshop 1 (see 1.B.1.2), participants highlighted the importance of being able to choose among different look of devices that measure PA. Furthermore, a positive aspect of the game tested in Workshop 3 with the ACTIVIO system (see 1.B.3.2) was that a variety of activities could be undertaken.

All of these findings led the designer/researcher to develop 'Boost Up!' V3, in which players can play any games they want, even the existing ones, with a generic currency that is awarded based on their PA levels (see 5.3.3.1). However given the scope of the project, the generic currency for V4 was developed offering players the possibility to choose among a card game and a board game only. Furthermore, it was found that a lack of choice of activities can be disengaging (Gray et al., 2013). This was applied when creating the health squares on the board game to give players the choice of what type of PA challenges to execute (see Health Cards/Challenges in 5.5.5.3).

A list of reasons explaining why V4 games tested in UCE3 did not increase PA was given in 8.1. Not having enough choice of games to play amongst was found disengaging for some participants (i.e. those who never came to the game club or did not engage much in dropping/collecting the bag at the shop and in wearing the pedometer regularly).

Therefore throughout these 3 enquiries, giving the choice to players was identified being manifested in four ways. Through offering:

## 1. A family of games

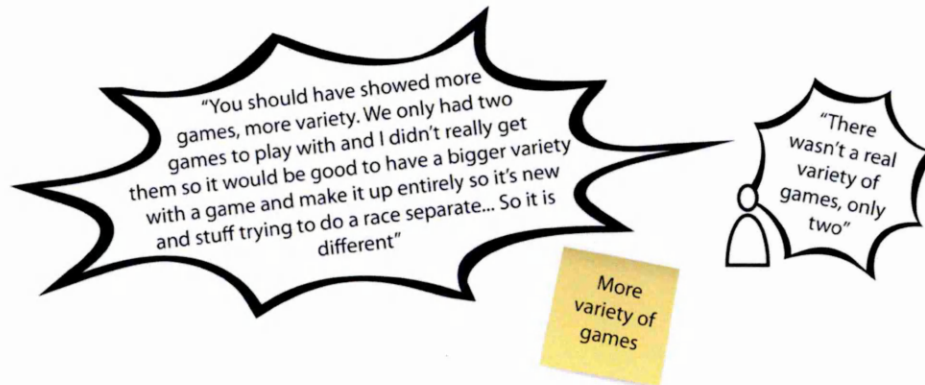


Figure 2L – Choosing among a variety of games is a way to be more inclusive

> 'Boost Up!' was created with the idea of generating a currency common to a range of games to attract a wide range of demographic and genders. Despite the possibility for players to choose among two distinct games (of different formats), it was reported mainly by participants who did not attend the game club that there was not a real variety of games and did not suit all participants' tastes.

## 2. Different currencies for different games concept

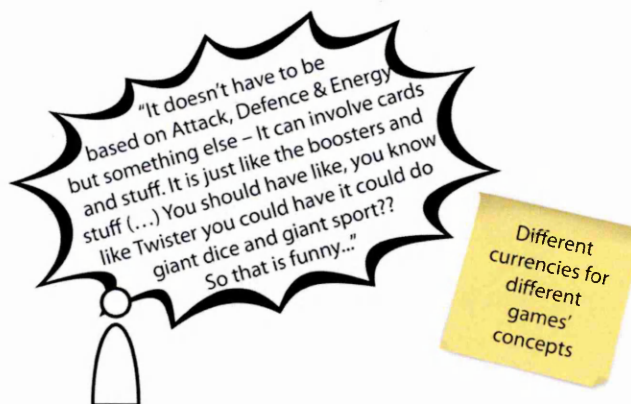


Figure 2M – More currency and game concept

> Creating their own avatar/hero (UCE1) and awarding different currencies (UCE2) that can be interchangeable was identified as engaging and led to the creation of a main currency made of three strands (Attack/Defence/Energy) that is common to both games, but used in different ways. However, developing games based on those three strands only did not suit everyone's tastes. A set of common currency

could be attributed in a similar way (through VPA, MPA, and non-sedentary levels) although not necessarily all relating to a character's features. Converting PA into a currency to play existing games as imagined in V3 (see 5.3.3.1) might hence be worth exploring further.

### 3. Autonomy & choices



Figure 2N – Being to explore freely and having choices within both stages is engaging

- > Graphics on Mine Craft are not of a high quality but players might partly be immersed in the game due to the freedom of doing whatever they want.
- > Being able to choose among different PA intensities when choosing a health challenge was appreciated. These challenges being optional seemed also particularly important since they were executed in front of others. This was confirmed in a study promoting weight loss where a lack of choice of activities was found disengaging (Gray et al., 2013).
- > Being able to use any real-world PA in Stage 1 as a currency for Stage 2 was appreciated (which also occurred in UCE1) however it is still unclear whether

non-structured and self-directed use of exergames can support long term adherence.

#### 4. The type of feedback

Being able to customise the type of feedback to receive or how to share the feedback about the performance might also increase engagement, whether it is based on humour, or randomness.

##### ○ Humour

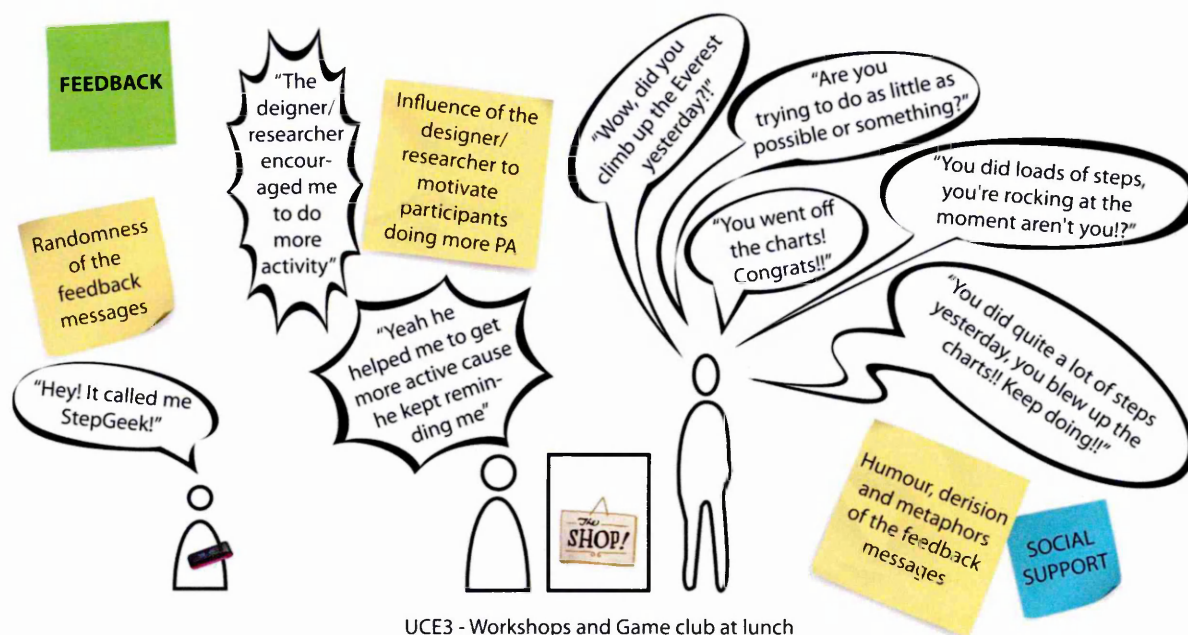


Figure 20 – Unexpected feedback based on humour was an incentive

> In some instances it was observed that feedback based on humour increased PA or decreased sedentary time. Increasing motivation through humour seemed particularly true when PA levels were low.

> This refers to Munson & Consolvo (2012) who highlight that what is posted should catch the readers' attention to increase motivation.

##### ○ Randomness

The randomness of the messages popping up on the pedometer interface (e.g. 'Step Geek') seemed motivational for promoting PA.

Zamzee, which has been successful in promoting PA (Omidyar, 2012), has an option on the website to describe how Zamzee users executed their activity by generating sentences through combining words from a pre-selected list (e.g. doing footie/volunteering at home/dancing with mad skills/on the clouds ...) that other users can 'like'.

This suggests that providing unexpected messages to a player and/or enabling associations of words to describe one's performance might be a fun way to give feedback to increase PA.

- 'Life / Lifestyle' theme

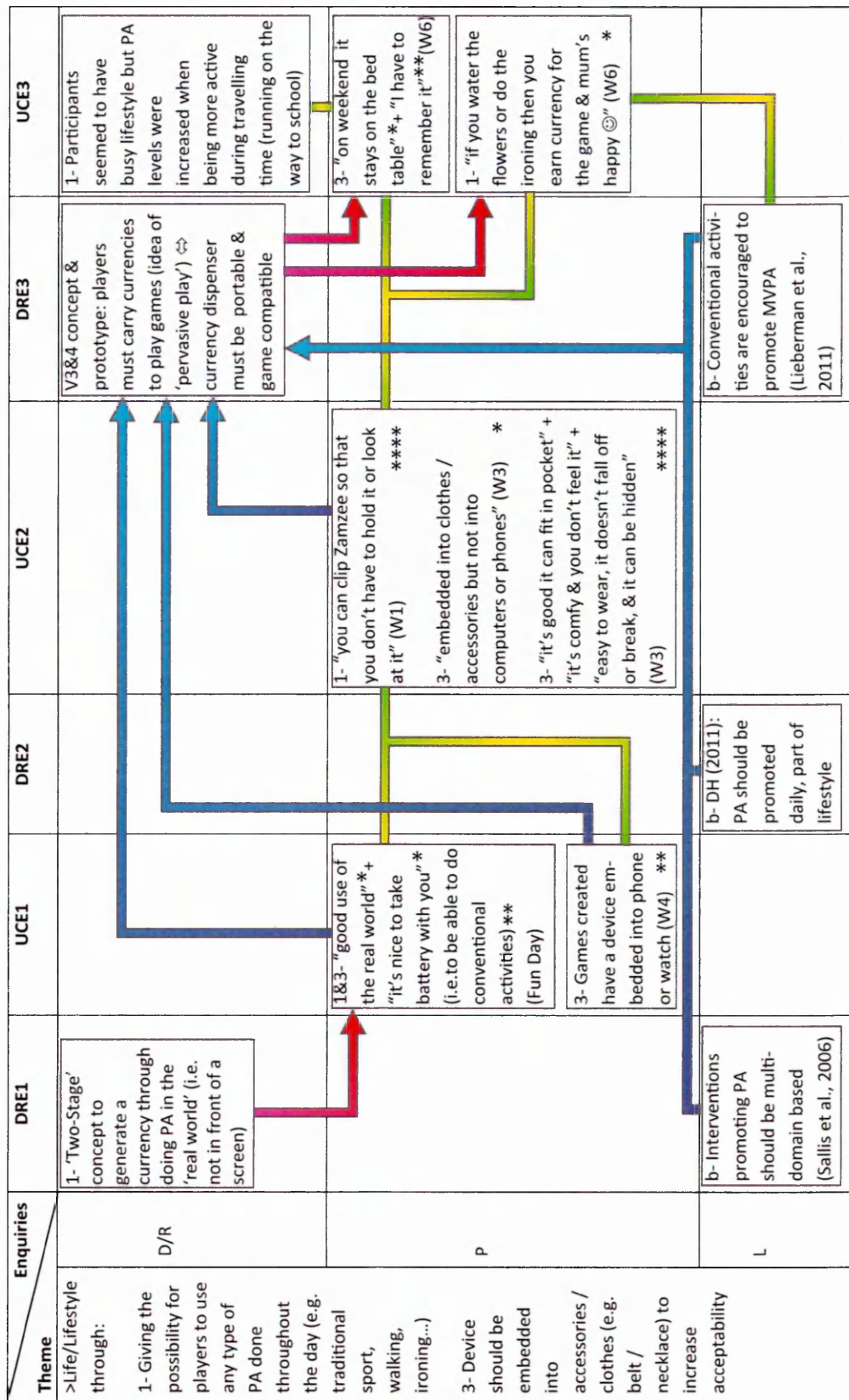


Figure 2P – 'Life/Lifestyle' theme

The 'Life/Lifestyle' theme seemed pretty crucial to engage participants and promote PA throughout two main ways: ensuring that all types of intensity of PA done by an individual are taken into account when awarding the game currency; and embedding the device measuring PA into accessories or clothes that are part of the individual's daily life.

It was imagined in 'Gener-G', the game created prior to this research, that all types of PA done throughout the day were taken into account to increase chances of winning the game. This meant that all types of PA done in the various domains described by Sallis et al. (2006) and presented in 2.1.5 contributing to recharging the battery that each player was taking with them.

Gener-G was presented as part of the 'Two Stages Games' poster during the Fun Day event in UCE1. A positive feedback of Gener-G was the use of the real world (i.e. being able to do any PA that counts towards the game) and the fact that the battery is taken with the players throughout the day. However instead of taking a battery out in the real world to physically recharge it, some participants in Workshop 4 created some games in which the tool to measure PA is embedded into a phone or a watch.

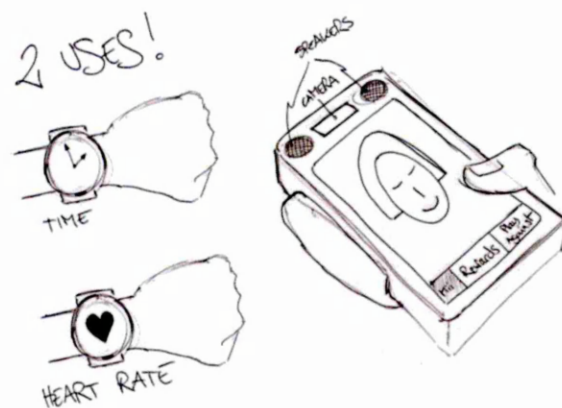


Figure 2Q – Measuring PA is embedded into objects they players take with them

The device that measures PA was explored further in UCE2 throughout Workshop 1 (see 1.B.1.2) and Workshop 3 (see 1.B.3.1). Throughout these workshops, participants enjoyed examples in which the device could be forgotten (e.g. in the pocket so that there is no need to think about it). They also imagine a device that was embedded into clothes or accessories (e.g. hairbands, belt) and experienced heart rate monitors,

which they preferred to pedometers since generally found more comfortable with the possibility of hiding them.

All of this contributed to the creation of 'Boost Up!' V3 in DRE3, during which all types of PA are considered (e.g. conventional activities as suggested by Lieberman et al., 2011), including MPA, VPA, and non-sedentary behaviour. Yet given the scope of the project, the Fitbit pedometer was chosen to measure PA levels as part of UCE3 evaluation (see 5.5.1).



Figure 2R – A device part of the participants' lifestyle

> Participants found that remembering the pedometer all the time was “hard”, “a pain”, “worrying” and it upset them when forgetting to wear it since they could not get rewarded for the activity done.

> To avoid losing or forgetting to wear the instrument measuring PA, it seems the device should be part of something that bridges the worlds of school (week) and home (weekend) that appeared to be clearly distinct and should be part of their lifestyle. Incorporating the instrument of measure into products or fashion designs like a necklace, a phone (however this may not be suited for school use), or a wristwatch may be a way to engage these people wearing it. This way, players could be rewarded for being more active throughout the day (DH, 2011) and for any type of activities undertaken – including conventional

activities (Lieberman et al., 2011) – and without restricting the use of exergames to a limited space but to the real world (see 2.5.3). This means that the entire PA done across various domains (Sallis et al., 2006) could be taken into consideration, which would be more representative of the users' pattern of PA.

- 'Real time / Instant' theme

Theme	Enquiries	DRE1	UCE1	DRE2	UCE2	DRE3	UCE3
<p>&gt;Real Time / Instant (Feedback) through:</p> <p>1,2&amp;3- Creating a concept allowing instant access to PA intensity (especially since here it is the basis to award currency)</p> <p>1&amp;2- Creating more links between the content of a sub-game and PA to do (e.g. storytelling)</p> <p>2- Giving Game rewards (e.g. Health card) to be used straight away / Explore idea of customized rewards</p> <p>3- A device giving instant feedback</p>	D/R		<p>1&amp;2- The games created gave actions &amp;/or access to information about one's PA performance straight away (W4) ***</p> <p>3- The games created have a device embedded into phone or watch (W4) **</p>	<p>1&amp;2- Use of ACTIVIO system</p>	<p>2- Participants had to accept a PA challenge</p> <p>3- Disengagement was noticed when the heart rate performance wasn't showing up (W3+W5) **</p> <p>3- Participants didn't engage in using the pedometers which were cheap &amp; inaccurate</p> <p>3- "you know what your heart rate is &amp; you forget about it when you play games" (W3) *</p>		<p>2- Peer pressure ensured execution of the PA challenges that might have been declined otherwise</p> <p>1,2&amp;3- Participants didn't have access to their PA intensity in real time (only from one day to another)</p> <p>2- Health challenges were a success and provided instant reward (i.e. earning a card) to increase chances to earn the game</p>
			<p>1&amp;2- The games created gave actions &amp;/or access to information about one's PA performance straight away (W4) ***</p> <p>3- The games created have a device embedded into phone or watch (W4) **</p>				<p>1- PA performance done on Fridays, Saturdays &amp; Sundays was averaged but was disengaging: "Why I don't have an extra card I did so much activity on Friday!?" (Shop) *</p> <p>1&amp;2- "we didn't do enough activity on the thing" + "the card game wasn't really active (...) it wasn't something like 'Tag'" + "if you could do it more accurate so you could land on a teleport square then you have to do health challenges or you can't teleport (W6) ****</p>
	L		<p>a- At the age of adolescence, individuals identify their behaviour in their peers and reduce differences with others to be more 'conform' to the group identity (Cairns et al., 1989; Hamm, 2000; Ryan, 2000)</p>		<p>a- Having high SE is important to encourage adoption of behaviour but it can decrease when performing in a group</p>		<p>b- Personalising health education messages at the right time and assessing effectiveness in real time seems to be suited for health promotion/education (Bernhardt et al., 2013)</p> <p>a- Peer pressure was found enjoyable and led to maintain levels of PA effective (Jago et al., 2006)</p>

Figure 2S – 'Real time/Instant' theme

The notion of 'Real Time' emerged throughout the three UCEs during which participants enjoyed having access to instant information, feedback and reward about their PA performance and about its conversion into games currency. The content of this section supports the use of instant feedback when engaging with young people.

Some participants in Workshop 4 (UCE1) imagined how to measure PA so that players can access the information in real time, when doing their PA.

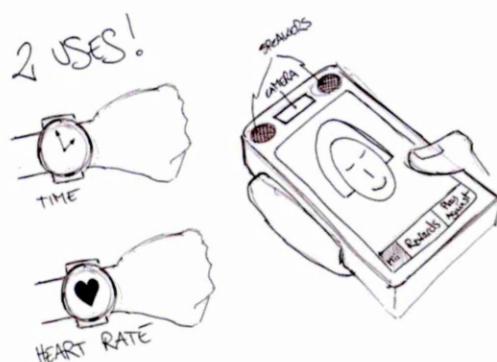


Figure 2T – Measuring PA is embedded into objects they players take with them

> One way to do so is to embed the tool for measuring PA into a watch or a phone.

The idea behind 'Boost Up!' is to promote PA among 11-12 years old, regardless of their attitude, weight, or any other characteristics that might be an obstacle to moving. Trying to promote PA among a whole group might be appropriate when targeting 11-12 years old since individuals at the age of adolescence identify their behaviour in their peers and reduce differences with others to be more 'conform' to the group identity (Cairns et al., 1989; Hamm, 2000; Ryan, 2000). Yet depending on individuals' levels of self-efficacy, performing in a group can be an obstacle to promote a behaviour (i.e. individuals with low levels of self-efficacy might not want to do PA in front of others).

Hence the game created for the ACTIVIO system in Worksop 3 in UCE2 aimed at exploring how these people might react when performing in a group. The ACTIVIO system, combining constant monitoring with real time feedback as well as a detailed record including charts, seemed to breed competition and motivation to win. As reported in 1.B.3.2, peer pressure seemed to be an incentive to do PA however it

might also be attributed to the real time feedback the ACTIVIO system provided since it was noticed participants were quickly disengaged with PA when the heart rate monitors were failing to connect to the system. What was also interesting to see in Workshop 3 & 5 (which both used ACTIVIO) was that participants were focused onto reading their own performance, challenging themselves to beat their own score rather than looking at others'.

It was also observed in UCE3 that participants seemed to engage more in PA when rewards were earned instantly.



Figure 2U – Instant rewards were engaging

> A participant seemed frustrated when realising that the amount of PA done over the week end was averaged to award the currency on Mondays (as explained in 'The Workshops' section in 4.7.4). Conversely, participants in UCE3 were more receptive when doing PA as part of the game rather than from one day to another (left side). This might explain the success of the health challenges which were undertaken every time participants had the opportunity to do so (even though optional). This is confirmed by two suggestions participants gave to promote PA into gaming: by relating the PA to the game narrative/content of the squares and by customising the reward based on the amount of PA done (e.g. 5 push-ups = +5 Attack).

> This concurs with Bernhardt et al. (2013) who posit that personalising health education messages at the right time and assessing effectiveness in real time might be suited for health promotion and education. Real time information is also a way to provide feedback on the players' progress towards their goal to effectively support behaviour change (Lieberman, 2013).

The success of the Health challenges therefore seemed related to the instant reward (a form of feedback) that the board game offered (unlike the card game which was less successful). However peer pressure might have been engaging again in UCE3 to promote PA.



Figure 2V – PA related observations within a group

> Peer pressure was observed being an incentive to involve the adolescents in PA again since a majority of participants chose to take a health challenge when they had the opportunity. Furthermore it was observed that the 'referee' (i.e. player timing the challenge) did not always leave them enough time to decline the challenge they might have declined otherwise.

> Using peer groups to involve adolescents in PA was also reported in Jago et al. (2006) who highlighted the activity was found more enjoyable and led to maintain their level of activity. This is congruent with Cairns et al. (1989), Hamm (2000), and Ryan (2000), who explain adolescents try to reduce

differences with others to be more 'conform' to the group identity. Once a challenge was executed, it was noticed participants were proud of completing it and developed a sense of achievement and mastery.

- 'Novelty' theme

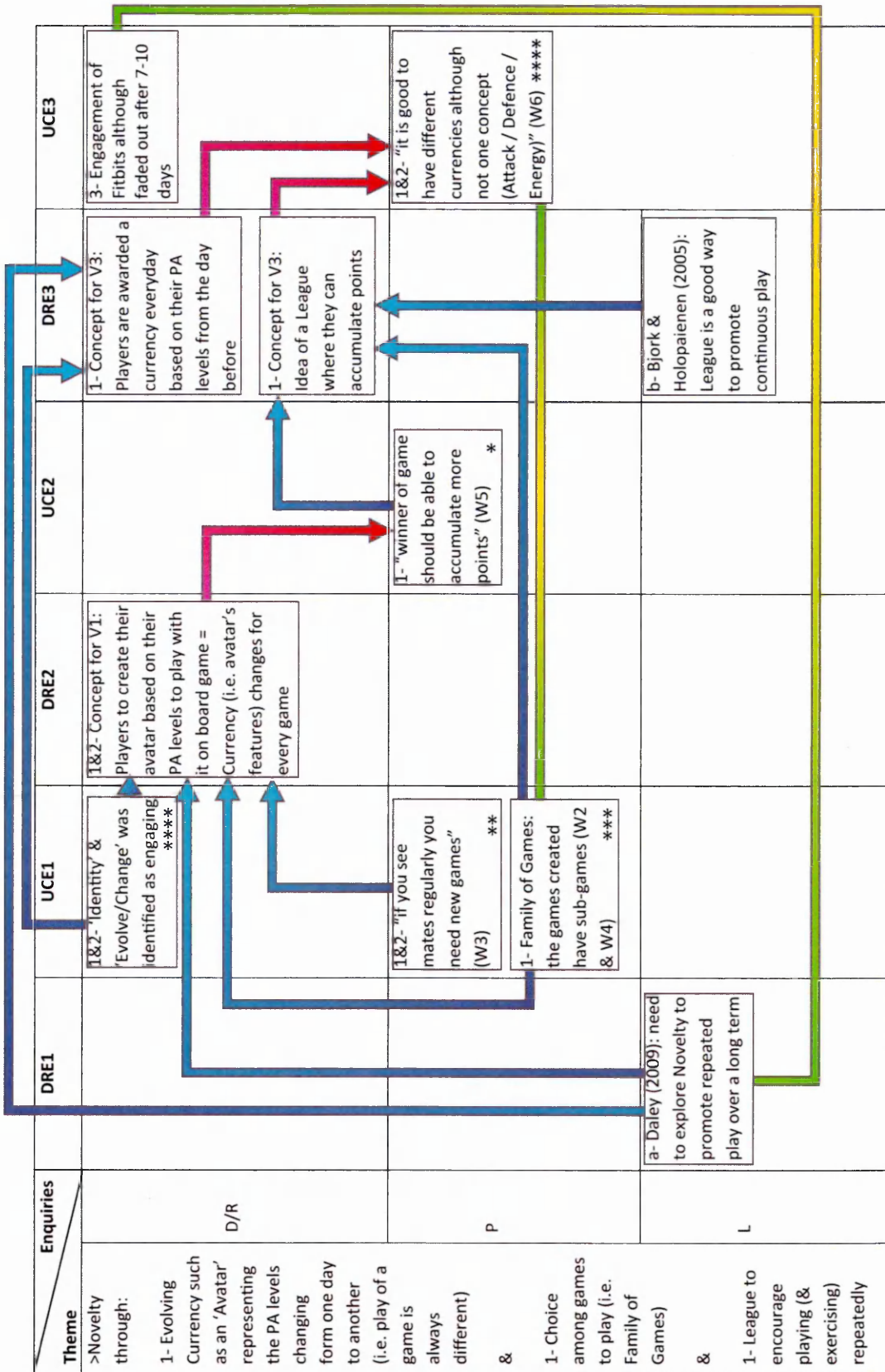


Figure 2W – 'Novelty' theme

The importance of bringing 'Novelty' seemed to be an important factor for engaging these people to play games or to wear the device measuring PA over a long term period. A currency that changes every day, the option to be able to choose different games to play, and a league in which a player's rank can be challenged every day all seemed to be valid ways to bring 'Novelty' to the players' experience.

'Novelty' was already identified in UCE1 in different ways. Firstly, through the discussion conducted in Workshop 3, in which participants highlighted the importance of being able to play new games with friends they see regularly. Secondly, through the games created in Workshop 2 and 4 that are composed of a family of games (as presented in 5.1.1.2). Lastly through the 'Evolve/Change' aspect already presented in 5.1.1.1 and more detailed below.

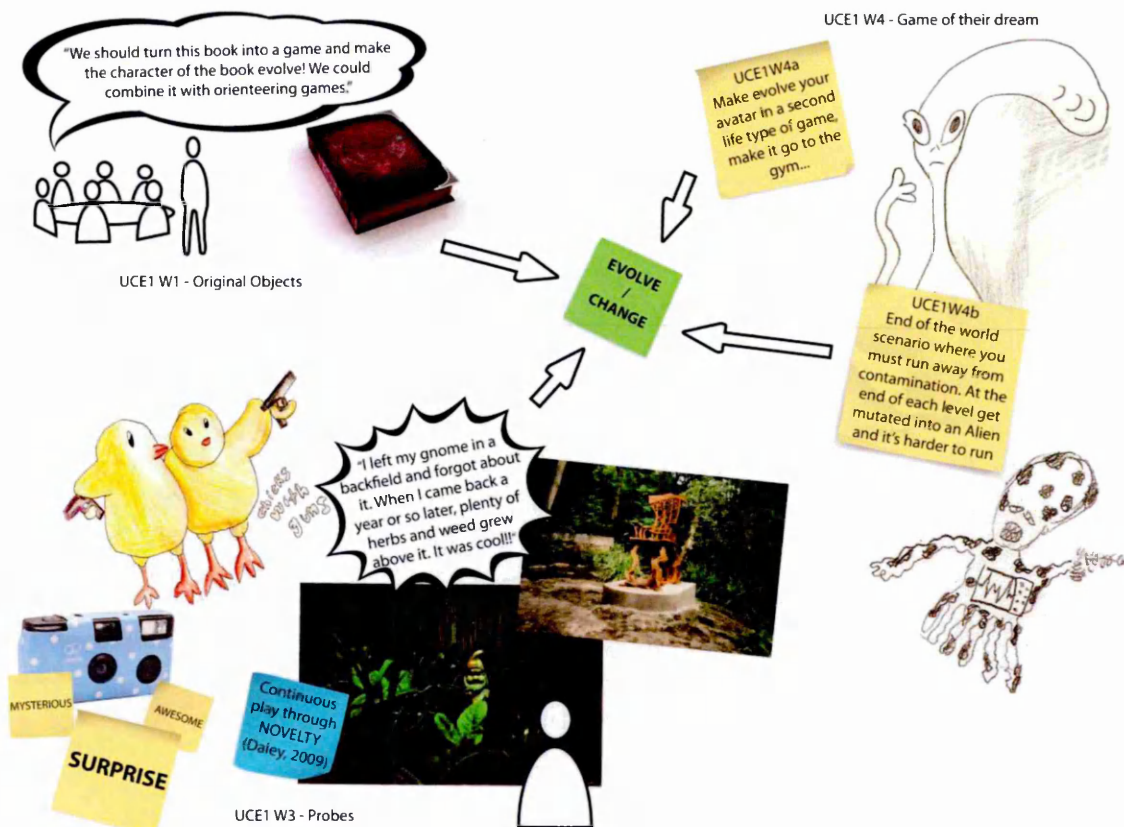


Figure 2X – 'Evolve/Change' came up many times across the intervention

> Evolving/changing seemed important as it occurred many times during UCE1, which was thought being a good way to bring novelty to playing the games.

> Bringing novelty when playing exergames was judged worth exploring for promoting continuous play (Daley, 2009).

'Boost Up!' V1 was invented with this 'Evolve/Change' notion in mind. As presented in 5.1.4, the idea behind this concept was to promote novelty in two ways. Firstly, through a daily currency awarded based upon one's PA levels and which may vary from one day to another (i.e. players earning the game advantages may vary too). The varying amount of currency might also change the tactics players adopt when playing the game. Secondly through offering two games to play and an avatar to create, which may increase the attractiveness of the game to create and sustain engagement.

When testing V2 games in Workshop 5 of UCE2, a participant reported that players should accumulate points towards a league rather than just 'winning the game' (see 5.2.3.3).

This, combined with the data presented above led to the creation of 'Boost Up!' V3 in two main ways. Firstly through creating a league, described by Bjork & Holopainen (2005) as a good way to promote continuous play. In the league invented in V3, players accumulate as many points as they can through winning games and/or doing PA yet doing more PA increases chances to win the games (see 5.3.2.2). Secondly through delivering a daily currency that always changes (as already imagined in V1) and that is therefore unknown from other players (which will hence encourage players to adopt different strategy).

The league concept was not implemented in UCE3 however the card and board games were evaluated. As reported in 6.4, it is unclear how engaging the games and/or the concept of 'Boost Up!' were since there seemed to be uncertainty as to how well the concept of 'doing PA to earn rewards the following day' or the conversion of PA into game currency (i.e. VPA gives beads for the avatar's Attack, MPA for the Defence, and non-sedentary time for the Energy) were understood.

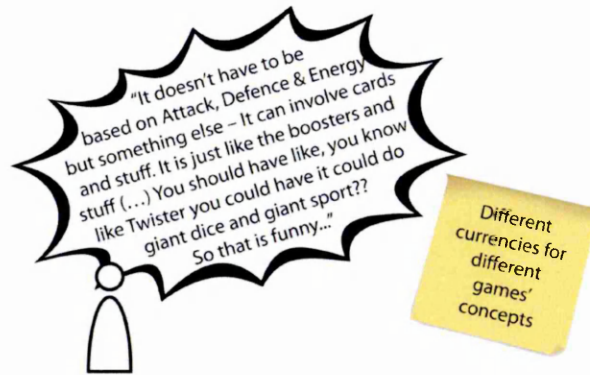


Figure 2Y – More currency and game concept

> Yet the lack of engagement in playing the games was sometimes due to the lack of variety in the games (i.e. participants would like to play games that are not necessarily based onto an avatar featured with Attack, Defence, Energy).

Therefore even though 'Novelty' was promoted through a currency that can vary from one day to another, the games did not suit all the participants' tastes. Furthermore, participants seemed to interact a lot with the pedometers when first handed out, although the novelty seemed to wear off after 7-10 days, especially during weekends: 9/13 wore the pedometer the whole first weekend, although for the second and third, the average dropped to respectively 4.5/13 and 3.5/13. It is important to consider the previously mentioned concern about losing the devices which could also explain why participants were reluctant to wear them.

- 'Social' theme

Theme	Enquiries	DRE1	UCE1	DRE2	UCE2	DRE3	UCE3
>Social through: 1- Creating Multiplayer games (to be played with friends)	D/R				2- Some players didn't want to execute a PA challenge however it has always been accomplished (with more or less success) – (W3) **		1- Increased attendance @ the game club was noticed when opened to non-participants ***
1- A Two-Stage concept allows players to physically interact with each other in Stage 1 (PA) & Stage 2 (play)	P		1- "Katie goes home after a full day of PA and compares it with her friends" (W2) **** 1- "you can play games with siblings or parents but more with friends" (W3) **				1- A participant said being often on her own, at home, connected to remote friends – explore the idea of 'remote play' (at Game Club) *
1- Exploring how digital / hybrid games might allow to play with 'remote friends'			1- "it's really good as you can make new friends" (Fun Day) **				1&2- 'Being with friends' was highly rated by participants ***
1- Providing support (need relatedness)	L	b- Exergames don't support social rituals (Bogost, 2007)	b- There is a need for relatedness – Self Determination Theory	b- Game content interactions are as important as social interactions (De Kort & Jisselstein, 2008)		b- Social support is essential for engaging young people in doing PA (Lieberman, 2013)	b- Social interactions develop intrinsic motivation (Teixera et al., 2012)

Figure 2Z – 'Social' theme

Various aspects throughout the three UCEs suggested the social experience that games can provide might be crucial to engage pupils from this age.

A lot of the data gathered in UCE1 showed the 'Social' aspect seemed important.



Figure 2AA – Importance of Social aspect when playing games

> Social support was reported as essential (through questionnaires and activities) for engaging young people in doing PA. Participants seemed more motivated to play games with their friends and/or maybe siblings rather than parents/guardians.

> A parallel can be made with the need for relatedness to promote behaviour change (Self-Determination Theory presented in 2.2.1.4) however exergames so far failed at promoting social rituals (Bogost, 2007). Nonetheless De Kort & Ijsselstein (2008) posit games should not only promote interactions as much socially as with the game's content.

UCE2 showed that players who did not want to execute a PA challenge when playing the game with ACTIVIO in Workshop 3 always ended up completing it, even though it

was done more or less accurately. This suggests that social support &/or peer pressure might be a way to promote PA.

UCE3 also showed instances suggesting that being in a social context is useful to do PA.

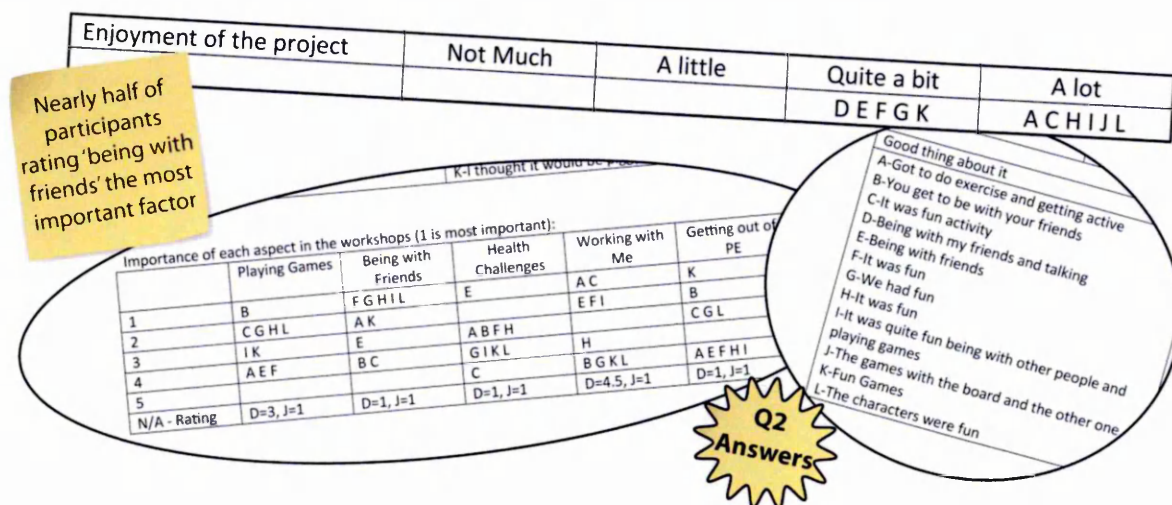


Figure 2AB – Questionnaire answers transcribed from workshop 6

> First, 5/12 participants (F, G, H, I, L) rated 'being with friends' the most important aspect of the workshops. Yet three other participants (B, D, E) described the intervention as positive since social.

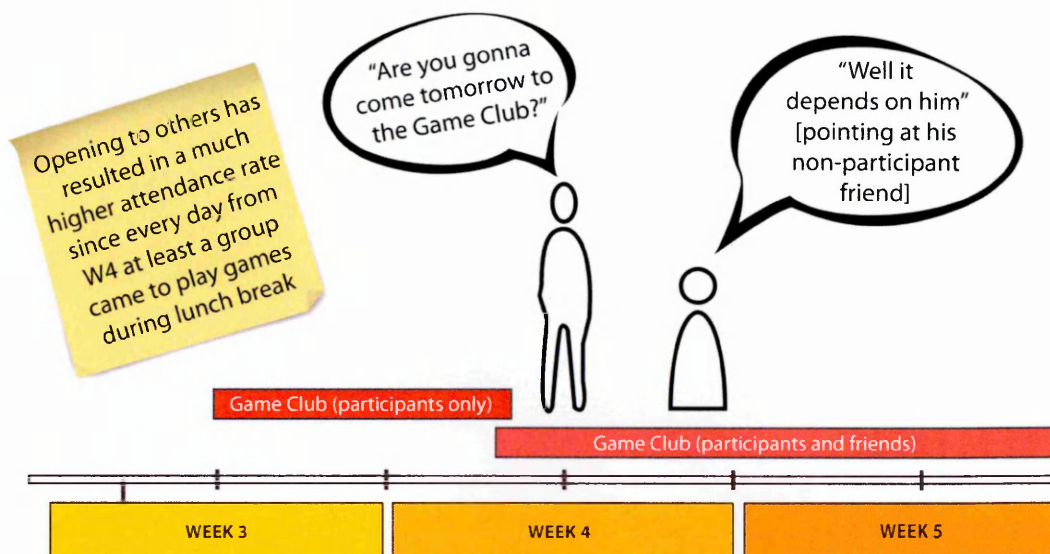


Figure 2AC – Opening the Game Club to non-participating friends increased attendance

> Second, participants attended the game club on a regular basis when accessible to their friends who were not involved in the project (see 6.3.2).

> Third, two stories about two participants suggested participants engaged in activities to be part of a social circle. Story 1: some participants reported a girl did not attend the game club because she preferred being in big groups. This was found in Jago et al. (2006) who reported that a social circle can be for some people the only motivation to join up the activity group. Story 2: a boy who attended the game club a few times did not play the games nonetheless he enjoyed seeing others playing, sometimes gave tactical advice about the game play, and took part in the conversation around the game.

As a conclusion, social interactions seem crucial to promote engagement and has already shown being motivational to develop intrinsic motivation (Teixera et al., 2012) as well as increasing uptake, engagement, and satisfaction (Weinberg & Gould, 2006), which might be important to promote continuous play in exergames (Barnett et al., 2011). Furthermore, social support was identified as essential for engaging young people in doing PA (Lieberman, 2013) since it can lead to better prevention behaviours, treatment adherence and health outcomes (Lieberman, 2012). Social support can be manifested through comparing progress made and sharing stories (Van Den Hoogen et al., 2009).

• 'Appropriation' theme

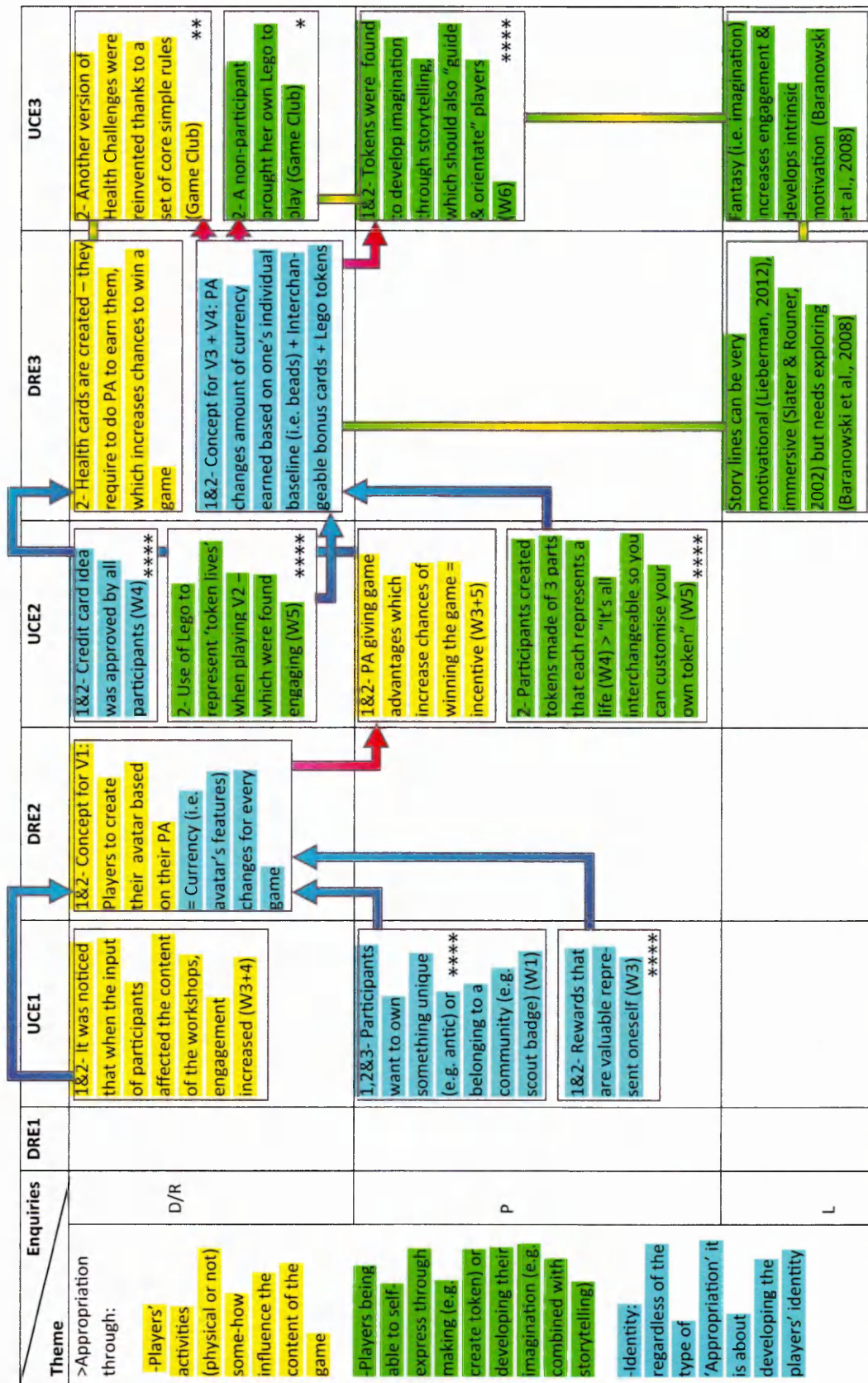


Figure 2AD – 'Appropriation' theme

Throughout the intervention, it was found that 'Appropriation' was a key factor to promote engagement among this population. This was done in two main ways: when players can somehow influence the content of the game and when players can express themselves, either through making (e.g. create their token) or through developing their imagination (e.g. combined with storytelling). In both ways, it seemed that what is important is that players can somehow bring some of their view(s), personality or identity.

#### 1. 'Appropriation' through influencing/affecting the content

As already mentioned in 5.1.1.4, it was observed in UCE1 that participants became much more pro-active when they realised that the words they generated in Workshop 3 were reported onto dice to create their own game in Workshop 4. Participants also appreciated the enjoyment of owning something unique (e.g. there were a lot of enthusiasm for things that are 'antics') or something that reflects their identity (e.g. owning a scout badge was appreciated as it is a sign to belong to a community). This was consistent with Workshop 3, during which participants highlighted the value of rewards representing themselves.

This idea of representing a player's identity (i.e. representing the player's levels of PA) was at the core of the creation of 'Boost Up!' V1: according to the amount of PA done for a day, players will get awarded a different type and amount of currency (i.e. to build the avatar's features), which might change the strategy to adopt when playing the games.

As mentioned in 5.2.3.2, participants during UCE2 showed interest in the principle of earning more game advantages when doing more PA even though more fairness was needed.

Therefore based onto this principle, V3 was developed, which included the creation of Health challenges/cards. As explained in 4.B.4, these Health cards are PA challenges players can choose (though optional) to temporarily increase their avatar's features, which increases chances to win the battle and the game.

Evaluated in UCE3, these Health cards were a real success since every time players could take this (optional) challenge, they were doing so. What is also interesting is that pupils that attended the game club during lunch time created variations of the use of these cards.



Figure 2AE – Being able to reframe rules seemed engaging

> By the end of the intervention, players created their own rules when playing the board game (i.e. what card(s) to use for attacking opponents).



Figure 2AF – Being able to develop sub-games seemed engaging

> By the end of the intervention, players did not really play the board game and were instead executing health challenges only, which became a game within the game. This idea of having sub-games, compared by the participants to traditional plain card games, was positively received.

Salen & Zimmerman (2004) highlighted there are different levels of rules within a game. There are rules explicitly written and unwritten rules that are more socially acceptable for instance. Being able to play a game without applying the official rules (i.e. written rules) increased engagement and facilitated the game's appropriation by adjusting them and modifying them to what suits the players best. Furthermore, creating sub-games played independently appeared to be engaging, which might also be more inclusive since it offers people who are not necessarily part of the 'Boost Up!' experience the possibility to play the game. In this case, a new themed card game that used the character cards and the bonus cards was created to enable non-participants who did not wear a pedometer (and therefore could not get awarded currency) playing it.

## 2. 'Appropriation' through making and/or developing imagination

Participants in Workshop 4 of UCE2 used rubber hands as lives (with three fingers each representing a life) which led the designer/researcher to use Lego figurines as tokens (see 1.B.4.3). As mentioned in 5.2.3.1, it was observed participants enjoyed creating their own token/avatar with the Lego tokens, which was also consistent with UCE3 findings.

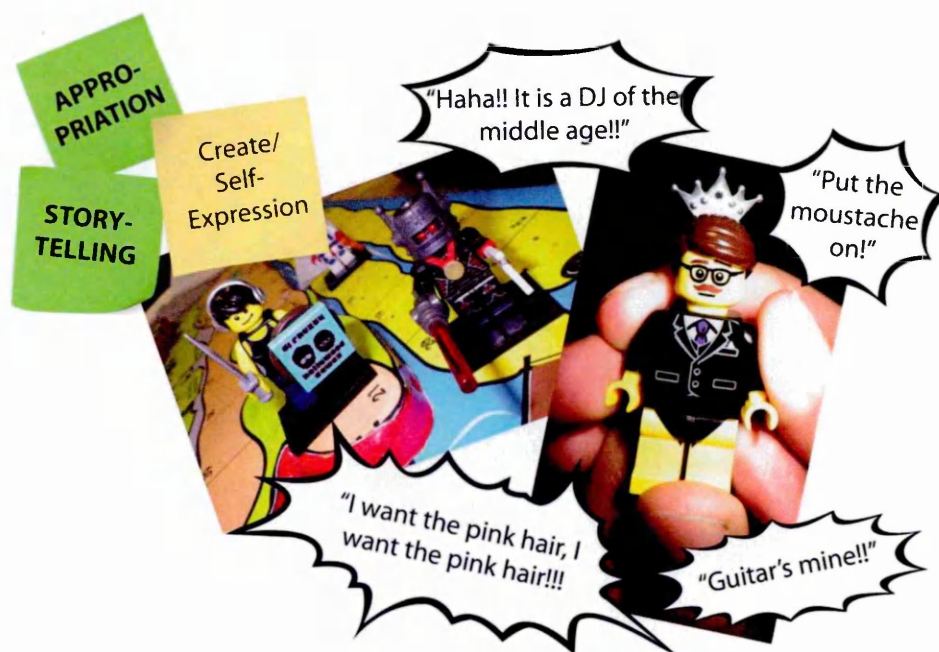


Figure 2AG – Creation/self-expression allows appropriation

> Tokens were well appreciated. One participant did not want to play the games when her token was already used by someone else. Another 'non-participant' at the game club regularly brought her own Lego to play with her favourite character while using some of the accessories provided. Even though Lego tokens were tangible, using characters to immerse players into a compelling story was reported being crucial in Lu et al. (2012).

> Graphics (e.g. cards, board) and game accessories (e.g. Lego tokens) encouraged participants to express themselves and/or develop stories around them. Furthermore, enabling players to produce unexpected scenarios through associating random concepts (i.e. transposing ideas/things into time or places they neither exist nor belong) developed imagination and emotions, and increased engagement. This could be compared to the random associations of words used on Zamzee website to describe PA and associate emotions to it. Fantasy, defined by the use of imagination, was identified as a core element for developing intrinsic motivation and facilitating engagement among youths and adults (Baranowski et al., 2008; Malone and Lepper, 1987).

> Imaginative and compelling story lines with appealing characters and a fantasy theme (i.e. lakes, mountains, haunted environments...) can be very motivational (Lieberman, 2012), immersive (Slater & Rouner, 2002) and can focus attention (Lu et al., 2013) although this needs more research (Baranowski et al., 2011). Stories can create emotions by immersing players into a meaningful life-world, which is useful to change knowledge, attitude and behaviour (Lu et al., 2012), even health related one (Baranowski et al., 2008). Games with stories demonstrated being more engaging with young people than with adults, however it is unclear how the different aspects of story, games components and sub-stories can provoke emotional response and behaviour change (Baranowski et al., 2008). In UCE3, an engaging storytelling seemed to be a way to develop the participants' imagination or to guide them when playing games.

- 'Simple / Simplicity' theme

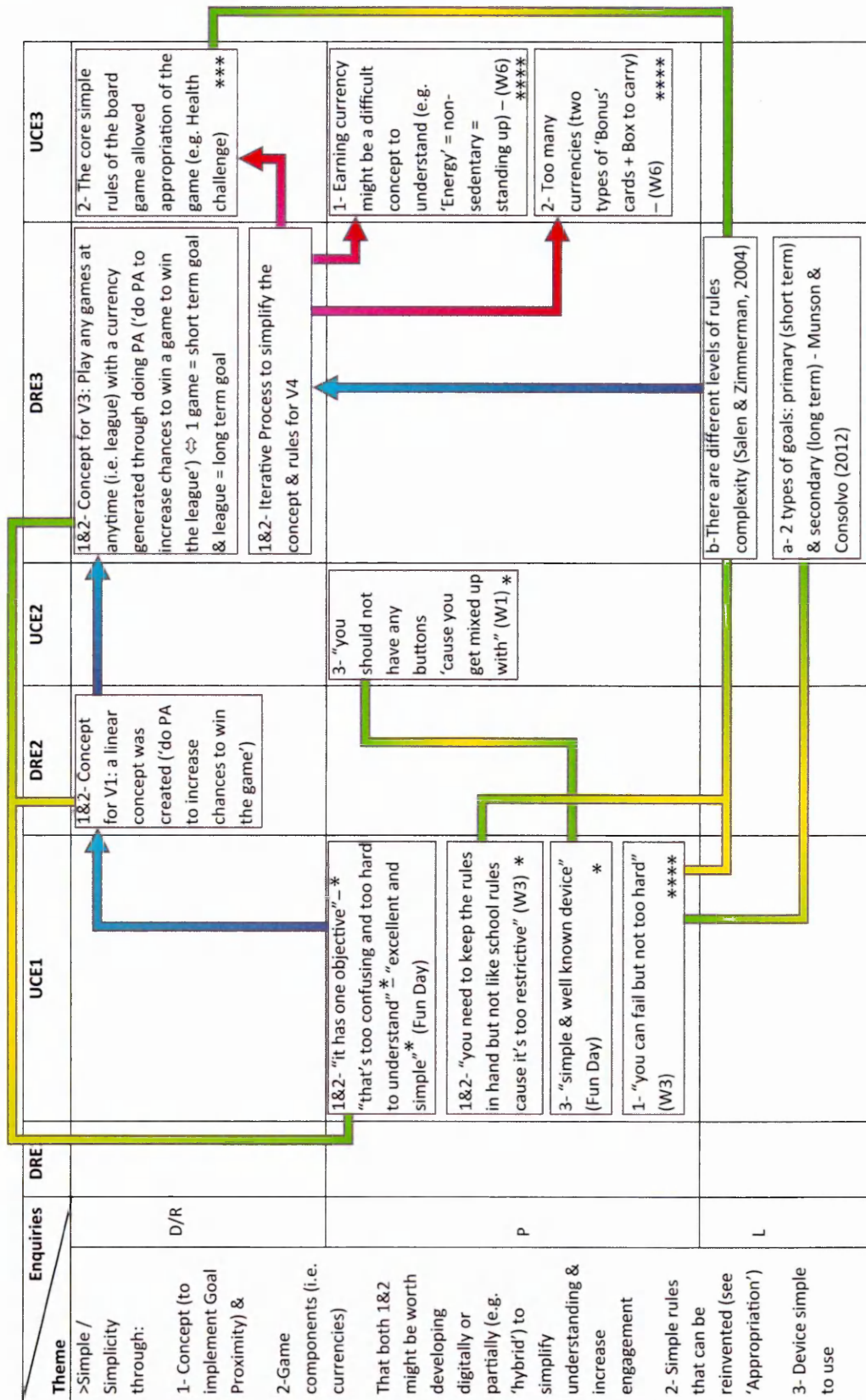


Figure 2AH – 'Simple/Simplicity' theme

Creating a simple game concept with a few game components and with a minimal design about the device measuring PA (e.g. no buttons to confuse) seemed to be an incentive to engage these people. Furthermore, creating hybrid games might be worth exploring further as participants seemed to respond well to this format of game and incorporating a higher level of technology might also facilitate understanding of the game rules.

Already UCE1 data suggested that the simpler the game is the more engaging. Having one simple objective in the game with rules that are clear and direct and not too restrictive seemed engaging since it is easy to understand and it can allow self-expression/variations in the rules of the game.

Participants in UCE2 also explained that no buttons should be added to the device measuring PA as this might bring confusion. The simplicity of the device confirms UCE1 data that the simpler the more engaging.

The iterative tests led in DRE3 aimed at simplifying the games rules and concept which encompass a primary and a secondary goal, as recommended by Munson & Consolvo (2012). The primary goal for players is about winning one or more games (on a daily basis) however the secondary goal is about winning the league (over the long term).

Yet the way 'Boost Up!' V4 was presented and/or conceived for UCE3 might have not been simple enough since confusing in four different ways, about:

## 1. The concept



Figure 2AI – The Two-Stage concept seemed to be a difficult concept to grab

> Feedback gathered in the Workshop 6 showed confusion about earning the main currency (each intensity equals a currency – e.g. Blue = 'Attack' = VPA) and the number of steps to earn the second currency (i.e. bonus cards).

> Doing PA one day to be converted into games currency the following day might not be engaging to this age group who seemed more responsive to instant rewards/feedback.

> It is also unclear to what extent this age-group can understand the concept of being sedentary (i.e. standing up allows accumulating 'non-sedentary' currency = 'Energy') and/or being lightly, moderately and vigorously active (e.g. walking at a slow pace does not give any currency since it is LPA).

## 2. The amount of currency/components

The iterative game testing sessions in DRE3 led to add components to increase uncertainty of winning however it seemed there were too many components to handle.



Figure 2AJ – The games currencies

- > Three different types of cards were offered for the board game (bonus cards, chance cards, and health cards) and some players did not always remember to use them all. Yet it is unclear why this is (e.g. they did not understand their role, health cards were more attractive).
- > The card game contained only two sets of cards (character cards and bonus cards) however it has been reported the card game was not as engaging as the board game and was found too complex to play since there were too much maths/too many calculations to do.

### 3. The concept & rules



Figure 2AK – Being able to reframe rules seemed engaging

> By the end of the intervention, players created their own rules when playing the board game (e.g. redefining what card(s) to use for attacking opponents).

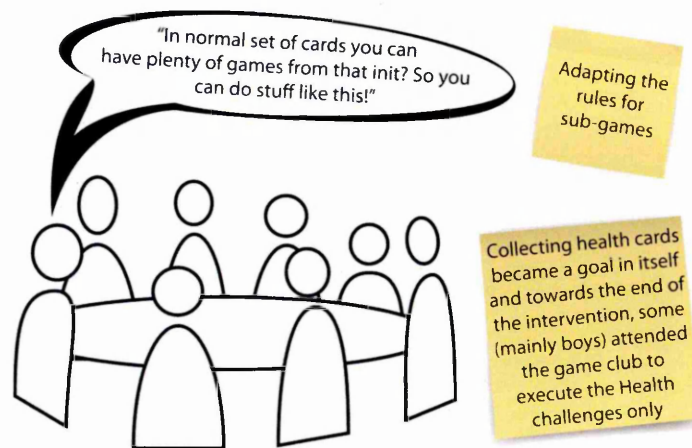


Figure 2AL – Being able to develop sub-games seemed engaging

> By the end of the intervention, players did not really play the board game and were instead executing health challenges only, which became a game within the game. This idea of having sub-games, compared by the participants to traditional plain card games, was positively received.

Salen & Zimmerman (2004) highlighted there are different levels of rules within a game. There are rules explicitly written and unwritten rules that are more socially acceptable for instance. Being able to play a game without applying the official rules (i.e. written rules) increased engagement and facilitated the game's appropriation by adjusting them and modifying them to what suits the players best. Furthermore,

creating sub-games played independently appeared to be engaging, which might also be more inclusive since it offers people who are not necessarily part of the 'Boost Up!' experience the possibility to play the game. In this case, a new themed card game using the character cards and bonus cards was created to enable non-participants playing it.

#### 4. The format of the games

It was generally reported that participants (and non-participants) found traditional games engaging, especially board game that are 3D-based (e.g. Mouse Trap, Rumble in the jungle).

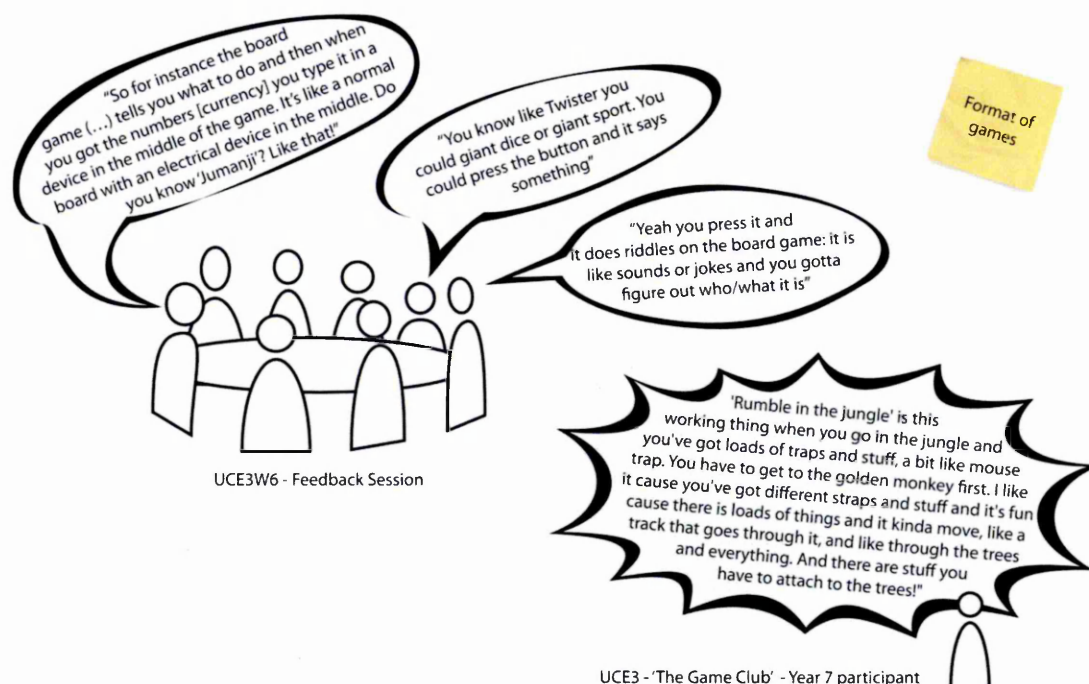


Figure 2AM – Hybrid games seem to be worth developing

- > The board game promoted a form of engagement and the fact that games like 'Rumble in the jungle' are engaging suggest traditional games should not be neglected.
- > Participants suggested developing traditional games that incorporate electronic components (e.g. sound - not only the device measuring PA levels) which seems worth exploring further. This format of game combining

traditional games with electronics, is defined in this research as 'Hybrid' games, and reminds of 'Gener-G', the electronic board game invented prior to this research and based on the Two-Stage concept (Bec, 2011).

It was also reported that the bag was cumbersome, which combined with the number of game components delivered daily might have been an obstacle in the players' engagement. Therefore creating a device or an app that might simplify the game's experience and facilitate understanding might be worth exploring further, like for instance combining it with the tool to measure PA.

- 'Visual Representation' theme

Theme	Enquiries	DRE1	UCE1	DRE2	UCE2	DRE3	UCE3
<p>&gt;Visual Representation (Feedback) is crucial since it was found:</p> <p>3- To be an incentive, not necessarily to satisfy curiosity but to do better / more / or to be active (e.g. Evolving Graphic)</p> <p>2- Tangible representation seemed to be an incentive - Explore fixed vs customised (instant) rewards</p> <p>1,2&amp;3- Numbers might enhance the misperception (i.e. be too brutal) or confusing, which can be disengaging</p> <p>1,2&amp;3- Yet 'privacy' is of concern (i.e. choosing who to share one's performance with)</p>	D/R		<p>1- "Katie goes home after a full day of PA and compares it with her friends" (W2) ****</p> <p>1- Sharing certain info (e.g. where you live) can be sensitive) - (Fun Day) **</p> <p>1- "fail can be funny but you can't fail too hard" + "it can be annoying when you don't success... &amp; you get laughed at" (W3) ****</p> <p>b- Sharing should give the option to approve or disapprove one's behavior (Michie et al., 2011) since it has motivational factors but should be done infrequently (Munson &amp; Consolvo, 2012)</p>		<p>1,2&amp;3- Participants agreed on importance of visually representing PA levels (W1+3) ****</p> <p>1,2&amp;3- "graph of PA with bars is good coz it's clear and easy to read" (W1) ****</p> <p>1,2&amp;3- it's good to know how healthy you are" / "...to improve" / "... to know when to stop" (W3) ****</p> <p>1&amp;2- "watching others' performance is none of your business" (W3) *</p> <p>b- Behaviour change is abstract &amp; representing it visually was found effective (Gray et al., 2013)</p>	<p>1,2&amp;3- What's the best way to represent one's performance? E.g. Mario Kart ghost car as they seemed to be keen on beating their own performance.</p> <p>The 2 boys kept going up and down the stairs to get as many floors as possible on the Fitbit (Family Tests) **</p> <p>b- Making achievements visible (even for one self only) is rewarding (Munson &amp; Consolvo, 2012)</p>	<p>1&amp;2- Using numbers to report the PA performance (i.e. through Individual Framework) could be seen by others &amp; was confusing (W3+6) *</p> <p>1,2&amp;3- Participants thought they were doing more PA than they actually did (Shop) ***</p> <p>3- The number of steps (and the time too) were often checked (W6) ****</p> <p>3- "did it record yeah the flower was on all day long" (Shop) *</p> <p>2- "can I take a look at my beads I did loads of PA last Friday" (Shop) *</p> <p>1&amp;2- "you might do 10 push-ups so you would get +10 bonus card" (Shop) ****</p> <p>b- Evolving graphics was found effective (Munson &amp; Consolvo, 2012)</p> <p>b- Misperception of PA was found in Prince et al (2008) + 'Activity Stat' (Frémeaux, 2011)</p>
	P						
	L						

Figure 2AN – 'Visual Representation' theme

This research concluded that representing one's PA performance is an important factor to promote PA. Many different ways of representing one's PA performance were explored in this research yet further work is needed to understand what the best way to visually represent a behaviour is. This exploration could be done in a way that allows players to have more competition with themselves since beating their own performance was something they were into. This leads to the question of privacy as to displaying information that in certain scenarios might be sensitive but motivational.

### 1. Importance of visually representing behaviour.

The games participants created in Workshop 2 of UCE1 allowed the personas to compare their PA levels done for the day with others (e.g. friends).

This was also found in UCE2 where all participants agreed the importance of visually representing PA levels (e.g. to know how healthy they are, to know when to stop, and/or to improve/beat their own performance).

UCE3 concurred with the effectiveness of visually representing one's PA performance.



Figure 2AO – Visualising the performance is an incentive

> The design of the pedometer and its interface was liked and accessing the number of steps was an incentive.

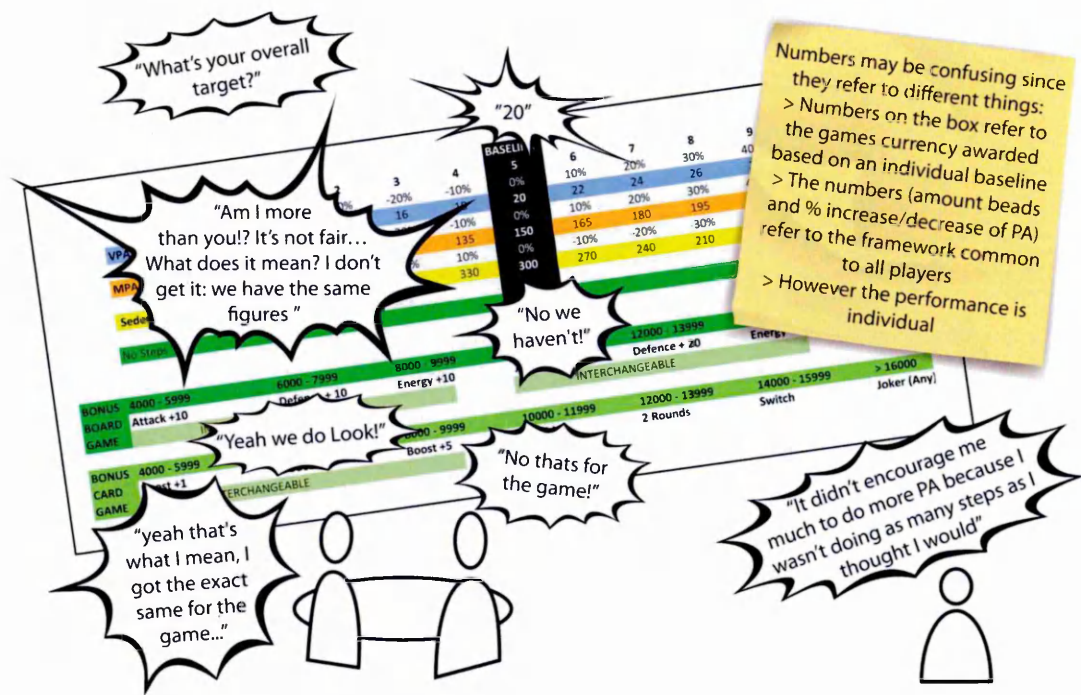
- > Participants looked up their performance, not necessarily to satisfy their curiosity but to do better.
- > The graphical representation of PA in the form of a flower seemed to be a useful incentive and engaged one participant who generally seemed disengaged. The use of 'evolving graphics' (e.g. garden growing over time) has shown to be effective previously (Munson & Consolvo, 2012).
- > Being able to see concrete data of their behaviour through a visual representation seemed to be an incentive and encouraged them to do more activities or just "*to be active*". It is unknown whether providing access to more detailed PA information over and above step count would have increased motivation even further.

## 2. Representing the performance

Even though the visual representation was an incentive, it is questioned what the best way to represent PA is.

The ACTIVIO system in UCE2 used a combination of a gauge with a number yet since it was also reported in Workshop 1 that graphic visuals such as bars (as showed in Zamzee in Appendix 1.B.1.2) were engaging, it is questioned which of the numbers, diagrams or else are the most appealing or engaging.

The majority of participants in UCE3 reported checking regularly the steps on the pedometers however how to best represent PA to increase motivation among young people is questioned, whether it is about using numbers or other forms of representation.



UCE3 - Presenting Individual Performance / Framework

UCE3 - Chat at the Shop

Figure 2AP – Using numbers showed confusion and discouragement

> Using numbers may be a direct way to read and make sense of one's performance however it can also be confusing. This is especially true in this scenario where the games currencies were awarded based on a framework common to all players but referring to a performance set individually (baseline). It is unclear how well participants understood this and therefore numbers read 'out of context' seemed confusing and discouraging.

> It seemed that participants had difficulties self-evaluating how active they were (i.e. they often thought they were doing more than they actually did) and the reality of their behaviour seemed sometimes difficult to accept. Reporting PA levels through numbers might also be a too brutal/direct way of giving feedback, especially when PA is misperceived. Misperception of PA was also reported among adults in Prince et al. (2008), who also had difficulties self-evaluating the intensity of their PA, which might be even truer with young people.

The way 'Boost Up!' V4 was designed enabled giving feedback about one's performance in a different way to using numbers (i.e. game currency/reward and graphics).

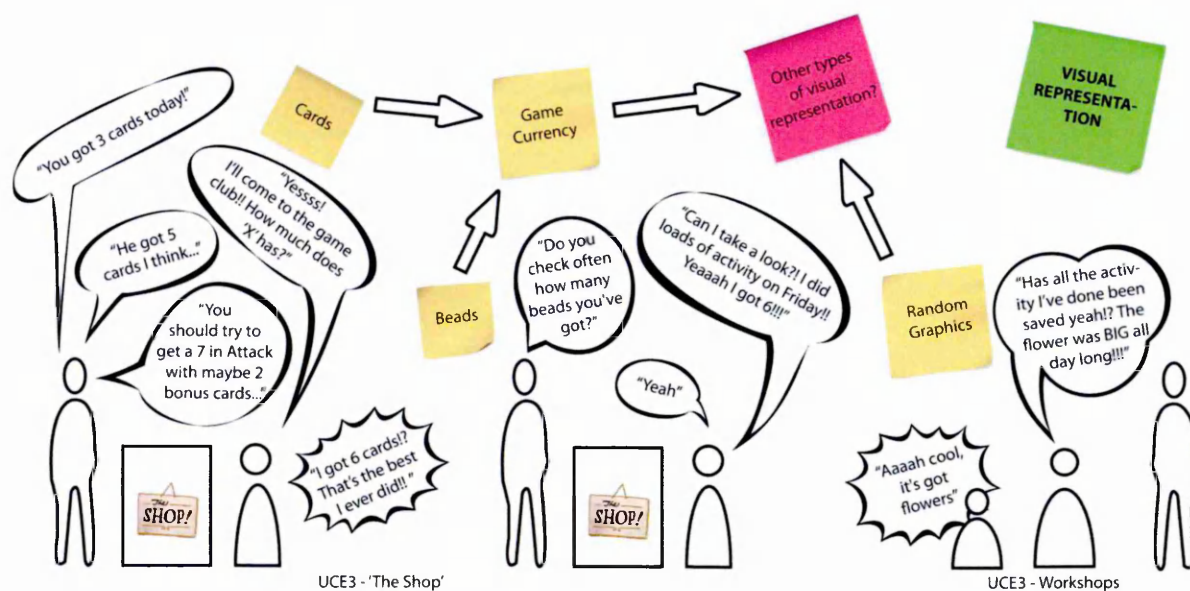


Figure 2AQ – Exploring other ways to visually represent PA

> Beads (middle) in the currency dispenser seemed to be interactive for all participants, even those reporting not playing the games or attending the game club. These individuals were somehow curious to find out how much or how well they were doing, suggesting the element of surprise/suspense, already identified as engaging in UCE1, was enjoyable.

> Earning as many cards as possible (left) also seemed to be an incentive, whether it was from one day to another (to earn bonus cards) or when playing the board game (to earn health cards). When coming to the shop to collect their currency, participants did not seem to be interested in how many minutes they had done and would rather know how many beads or cards they had earned.

> Graphical representation (right) in real time has shown to engage participants difficult to engage. 'Evolving graphics' (e.g. garden growing over time) has shown to be effective previously (Munson & Consolvo, 2012).

The various changes in a behaviour can be very abstract for an individual and representing it physically was found in Gray et al. (2013) to be a powerful incentive for all individuals, whether the progress (in that case weight loss) was light or not. Exploring how to visually represent PA (e.g. through the use of (evolving) graphics, game rewards/currency and/or in a tangible way) seems worth exploring further.

### 3. Beating their own performance

Throughout all the enquiries, it was noticed at various instances that often participants seemed keen in beating their own performance rather than others'.

In UCE2 participants just wanted to increase their heart rate from one PA challenge to another.

In DRE3, the card game was tested among a family (see 1.C.1.6) with two boys who were running up and down the stairs to do better from one day to another (even though competition between the two boys was also reported).<sup>1</sup>

The designer/researcher in UCE3 was able to testify of some participants' reactions who tried to accumulate as much steps or beads as they could (i.e. increase the PA levels of MPA or VPA or decrease sedentary time), or get the flower as big as they could.

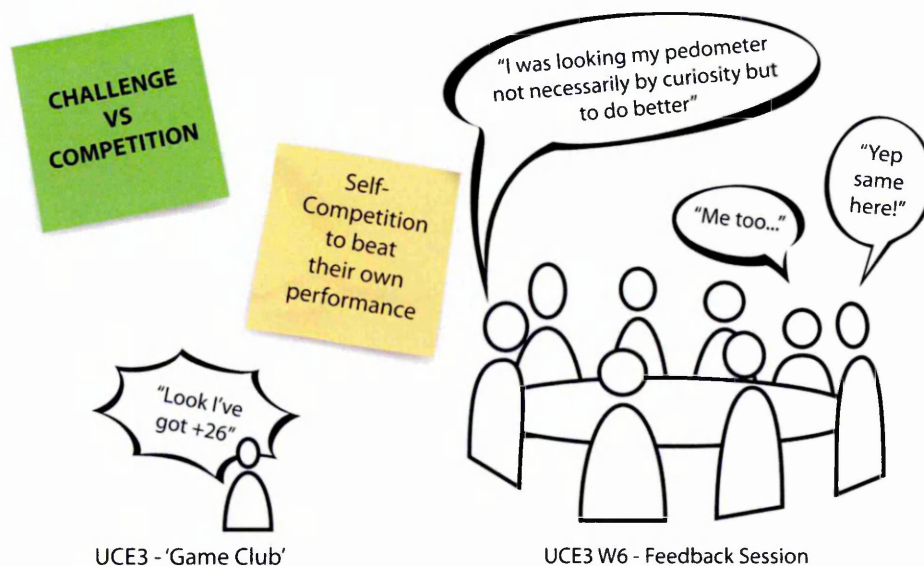


Figure 2AR – Defining Challenge & Competition

> It was also observed in UCE3 that boys were comparing their game currency (number of beads and cards earned) with peers, confirming that boys are more competitive than girls (Schell, 2008).

> Participants from all gender seemed to be keen in having a competition with themselves, to beat their own performance through accumulating the highest scores with the health cards. Some players (girls and boys) developed a sense of achievement when beating their own score through accumulating health cards.

It is therefore imagined that since they were trying to compete with themselves, the best performance of the heart activity for instance could be displayed as an incentive to do more (e.g. the 'Ghost car' in Super Mario to compare the actual performance with the best one reached prior to that play).

#### 4. Privacy when sharing the PA performance

Even though representing and sharing a performance can be a form of motivation and increase engagement, concerns were raised about the privacy of the information to make visible.

Players should be able to post their PA performance to receive support from others for instance when the levels are low or to show progress since the simple fact of making achievements visible was found rewarding (Munson & Consolvo, 2012). Yet sharing certain information can be sensitive for some people therefore the choice of what to share and who with seems crucial. Furthermore, giving the option to approve or disapprove ones' behaviour seems important (Michie et al., 2011) and was found motivational, when done infrequently (Munson & Consolvo, 2012).

- 'Two-Stage' theme

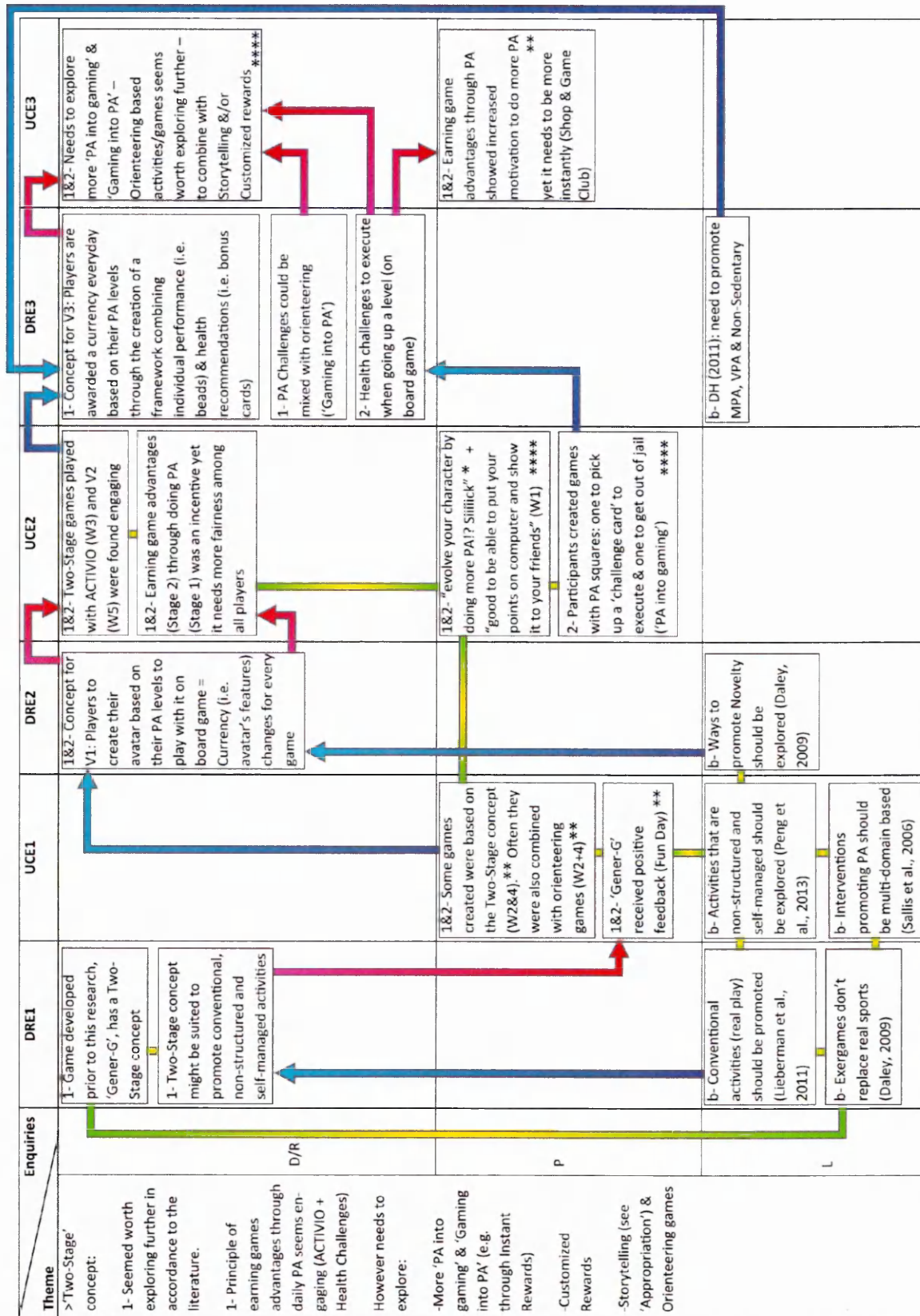


Figure 2AS – 'Two-Stage' theme

The Two-Stage concept, inherent to 'Gener-G' (the game created prior to this research), was appreciated when tested by a family (see 1.2.3) and seemed particularly suited in relation to what the literature suggests (see 2.5.3).

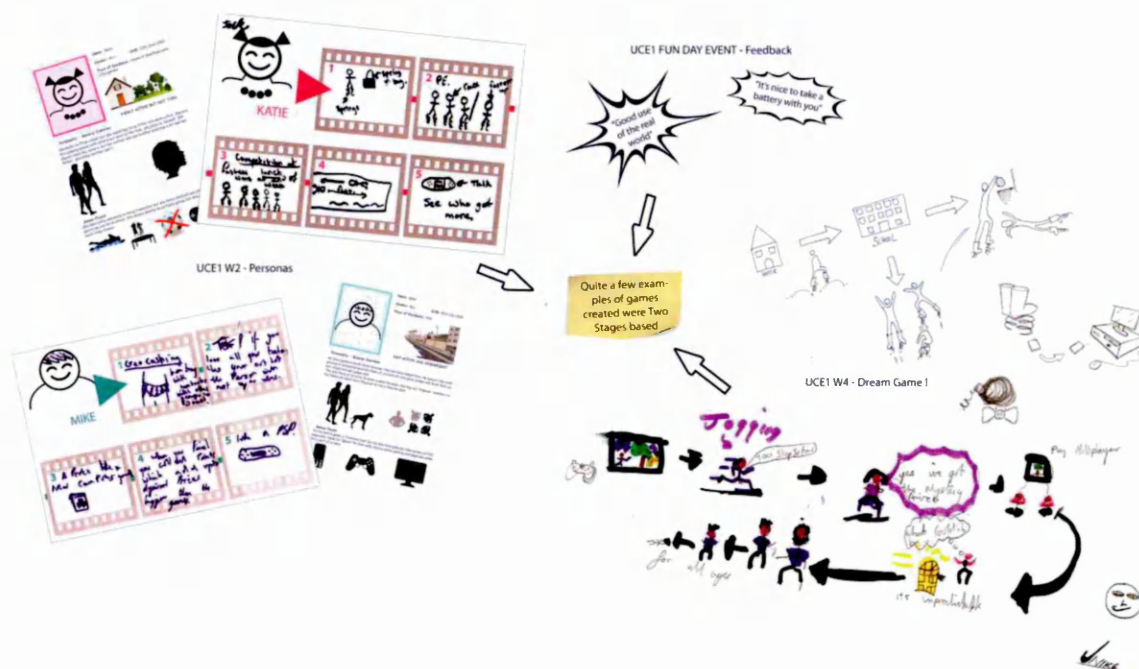


Figure 2AT – Participants creating games based on the Two-Stage concept in UCE1

- > Participants in Workshop 2 & 4 in UCE1 created games based on this concept too, suggesting it might be attractive.
- > Therefore Gener-G was presented as part of the 'Two Stages Games' posters during the Fun Day event in UCE1 (see 5.1.2.2) and received positive feedback.

'Boost Up!' V1, created during DRE2, was hence based onto this concept, which also seemed to be a good way to bring 'Novelty' to the game, presented as an important factor by Daley (2009) to promote repeated play.

It was reported in 4.2.4 that the original plan for testing the 'Two-Stage' principle (i.e. do PA during one week to earn advantages when playing the games during the workshops) could not be tested throughout the whole length of UCE2. However as demonstrated in 5.2.3.2 there were several instances where participants showed interest in this concept. This was concluded through the participants reporting enjoying the Two-Stage games (Pokémon and Zamzee games in Workshop 1, the game

played with ACTIVIO in Workshop 3, and the Two-Stage concept tested in Workshop 5).

UCE2 data gave confidence about the viability of the 'Two-Stage' concept to promote PA in an engaging way and it was hence explored further in DRE3. Yet this enquiry also looked at blurring the Two-Stages by bringing 'PA into gaming' and 'gaming into PA' respectively based on the games created by the participants in Workshop 2 and on the success of the game created for Workshop 3 in UCE2. In both workshops though, the games were based on the idea to do PA to earn games rewards (i.e. points or advantages) instantly, which led to creating the Health challenges in V4 board game (as explained in 1.C.2.2). Furthermore, the type of PA to promote in Stage 1 (i.e. health recommendations) was also combined with the idea of players creating their avatar's features (see 1.C.3.1).

V4 was then tested in UCE3, which also developed insights around the effectiveness of 'Boost Up!' and its Two-Stage concept to promote PA. For a majority of the participants, the intervention was not what they expected but this was not necessarily a bad thing.



Figure 2AU – The games & Two-Stage concept seem to be an incentive to increase PA

> Even though there was no increase in PA or reduction of sedentary behaviour in UCE3, instances showed the Two-Stage principle of doing PA to get more cards to win against opponents when playing in games in Stage 2 was an incentive.

> Even if it is unclear how well the concept of earning currency was understood (see 6.4), playing games for promoting PA seemed to be appropriate for young people, especially when PA is part of the game play (e.g. health challenges).

> Since people from this age seem to value instant feedback/rewards more, the stages of doing PA and playing games should follow each other or be more related/linked. Blurring the two-stages by bringing 'PA into gaming' and 'gaming into PA' seems worth exploring further.

- 'Device Measuring PA' theme

Theme	Enquiries	DRE1	UCE1	DRE2	UCE2	DRE3	UCE3
3- Device - Both Pedometers & HRM were experienced & compared. Even though HRM were not always attractive or comfortable, they were preferred to pedometers. Literature suggest HRM might be more appropriate too	D/R				3- 29% of participants (2/7) were still wearing the pedometer by the end of the study		Researcher insisted on the fact the pedometer given to them for the study was an expensive kit of technology they had to take care of (W1)
					3- Pedometers were found not functional (kept falling, buttons got in the way), not visually appealing, and not fair however their size was convenient – (W3) ****		3- 69% of participants (11/15) were still wearing the FitBit by the end of the study
					3- Heart Rate Monitors were found to promote fairness, adjustable and discreet, however not always comfortable to wear (itchy) or attractive (stigmatising). Being able to hide was judged important (W3+5) ****		3- Design of the FitBit and of its interface was liked and accessing the number of steps was an incentive (Shop+W6) ****
The Device should be: Reliable & Fair when measuring PA / Not intrusive (possibility to hide it / Comfortable (not itchy) / Part of their Lifestyle (into accessories)	P						3- Fitbit used as a watch (i.e. to check time) – (W6) - see 'Multi-use' ****
							3- Pedometer was too small & it should be seen more (e.g. luminous) / It should be waterproof (for swimming) & incorporated into accessories (e.g. bracelet, necklace, belt...) - see 'Lifestyle' ****
							b- PA should be promoted as part of lifestyle: We need to be more active throughout the day (DH, 2011), for any type of activities undertaken (including conventional activities as suggested by Lieberman et al. (2011)), which would encompass the entire PA done across various domains as suggested by Sallis et al. (2006)
	L				b- Recommendations are of 60 minutes of MVPA on most if not all days of the week (NASPE, 2004). This corresponds to 12000 steps (Colley et al., 2012) although variations in the amount of steps between different countries, age groups, and ways of measuring PA (self-report and/or pedometer).		
					b- 60 minutes MVPA is between 10000 & 15000 steps (Tudor-Locke et al., 2011)		
					b- The aim of exergames is to increase the heart rate and respiratory rate to promote MVPA (Lieberman et al., 2011)		

Figure 2AV – 'Device Measuring PA' theme

This section presents the findings around the use of devices to measure PA in an engaging way to ensure its acceptability and reliability. The findings presented here are based onto a comparison of practical tests that took place in UCE2 and UCE3, in which both heart rate monitors and pedometers were discussed and/or tested.

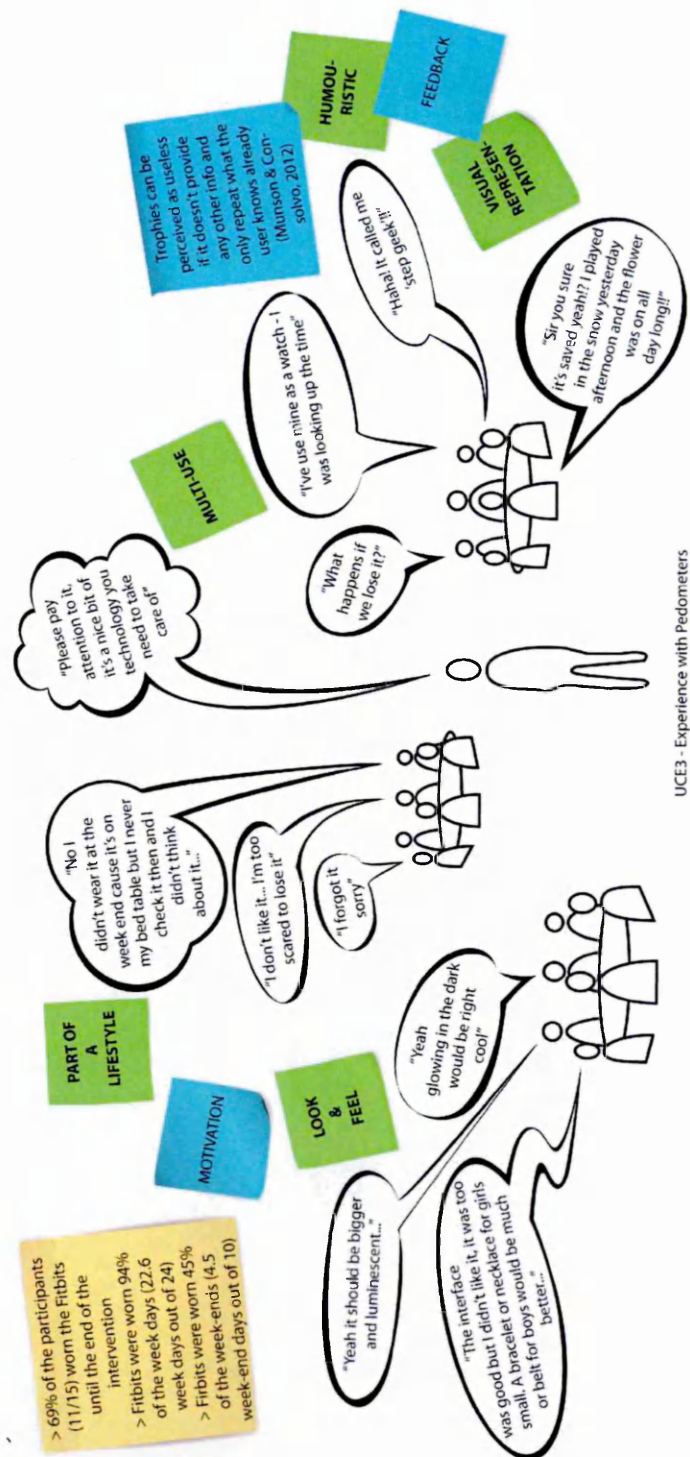


Figure 2AW – Feedbacks & Statistics around the Fitbit pedometers

> By the end of UCE3, 69% of the participants (11/15) were still wearing the Fitbits against 29% (2/7) in UCE2. Yet this does not mean Fitbits were worn every day, especially during weekends, which may be a key point to explain the variations in the data.

> Through questionnaires, observations, chats, and feedback gathered in UCE 3 Workshop 6, it was possible to develop an understanding about the acceptability of the pedometers: what was engaging (right side), what was an obstacle (in the middle) and how this could be overcome (left side).

#### 1. A range of properties found engaging

##### ○ Visualisation



Figure 2AX – Visualising the performance is an incentive

> The design of the pedometer and its interface was liked and accessing the number of steps was an incentive.

> Participants looked up their performance, not necessarily to satisfy their curiosity but to do better.

> The graphical representation of PA in the form of a flower seemed to be a useful incentive and engaged one participant who generally seemed disengaged. The use of 'evolving graphics' (e.g. garden growing over time) has shown to be effective previously (Munson & Consolvo, 2012).

> Being able to see concrete data of their behaviour through a visual representation seemed to be an incentive and encouraged them to do more activities or just *"to be active"*. It is unknown whether providing access to more detailed PA information over and above step count would have increased motivation even further.

- Feedback & Multi-Use

During the discussion in Workshop 6 a majority of participants reported looking up the information on the pedometers (mainly the steps) however some used it as a watch, to check the time (right side in Figure 2AW). Having a device measuring PA that can also be used for something else might be an incentive to wear/use it.

The fun and unexpected aspect of the messages (e.g. 'Step Geek' in Figure 2AW) on the pedometer also seemed to be an incentive since it was observed that participants engaged in LPA when such messages popped up (i.e. walking around), waiting for new ones to appear.

- Novelty

Participants seemed to interact a lot with the pedometers when first handed out, although the novelty seemed to wear off after 7-10 days, especially during weekends: 9/13 wore the pedometer the whole first weekend, although for the second and third, the average dropped to 4.5/13 and 3.5/13 respectively. It is important to consider the previously mentioned concern about losing the devices which could also explain why participants were reluctant to wear them.

## 2. What it should not be

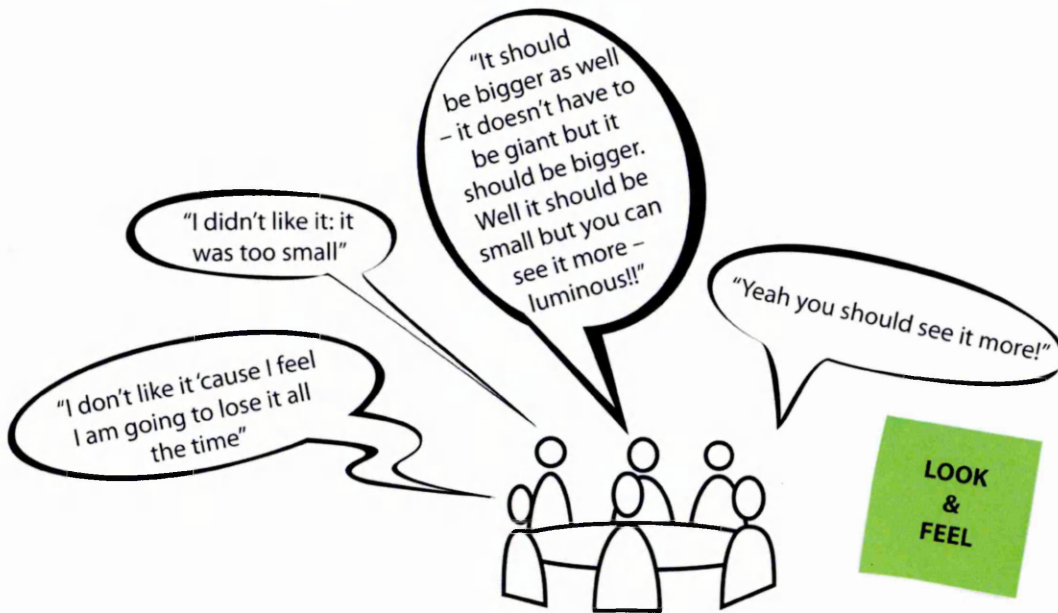


Figure 2AY – The negative aspects of the Fitbits

- > Losing the pedometer was something the participants were scared of. Four pedometers were lost over the length of the intervention.
- > Pedometers were generally found too small which may have been an obstacle to its acceptability.
- > The fear of losing the pedometers may be explained by the fact that participants did not own it and that the designer/researcher insisted on taking care of them while wearing them every day.
- > Alterations were suggested (e.g. luminous pedometer glowing in the dark, choice in size & colour).

### 3. What it seems to rather be

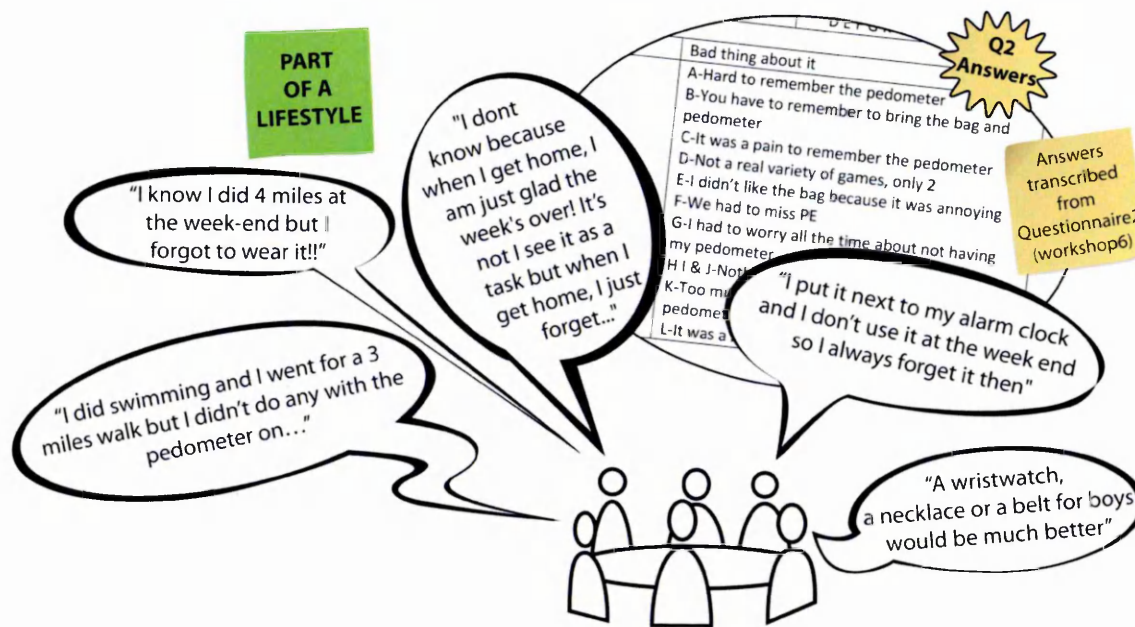


Figure 2AZ – A device part of the participants' lifestyle

> Participants found that remembering the pedometer all the time was “hard”, “a pain”, “worrying” and it upset them when forgetting to wear it since they could not get rewarded for the activity done.

> To avoid losing or forgetting to wear the instrument measuring PA, it seems the device should be part of something that bridges the worlds of school (week) and home (weekend) that appeared to be clearly distinct and should be part of their lifestyle, which confirms the findings of UCE2 (see 5.2.1.1). Incorporating the instrument of measure into products or fashion designs like a necklace, a phone (however this may not be suited for school use), or a wristwatch may be a way to engage these people wearing it. This way, players could be rewarded for being more active throughout the day (DH, 2011) and for any type of activities undertaken, which include conventional activities (Lieberman et al., 2011). This means that the entire PA done across various domains (Sallis et al., 2006) could be taken into consideration, which would be more representative of the users' pattern of PA.

Below is a compilation of various aspects that seem worth exploring and that may be useful integrating in the design of a device measuring PA likely to be engaging.

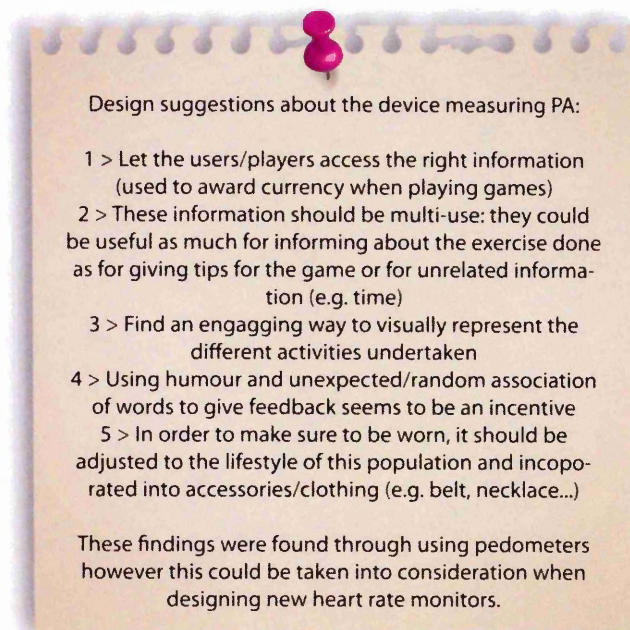


Figure 2AAA – A list of potentially engaging aspects for designing a new device measuring PA

## ***Appendix 3- Boost Up!<sup>TM</sup> Board & Card Game Rules V2***

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Evaluating the V2 board and card games was a way to test the Two-Stage concept. This was carried out in the last workshop of the second user-centred enquiry, which consisted of doing PA with the ACTIVIO system to simulate Stage 1 and reward the most active participants when playing the games in Stage 2. Both games shared a common currency, manifested here through the chance and character cards.

### ***3.A BOOST UP!<sup>TM</sup> BOARD GAME V2***

Boost Up!<sup>TM</sup> board game rules were much more advanced than those of the themed card game.

#### ***3.A.1 Object of the Game***

Players choose a character to play with.

The first player to reach the 'WOW' square (square 100) wins. Players can attack each other in order to take the lead and use chance cards to boost their character's features and increase their chances to successfully win an attack.

#### ***3.A.2. Hardware***

-1x Board (Figure 3C).

-1x Deck of 26 character cards (Figure 3D) where each character card is composed of three features (Attack, Defence, Energy) with a value from 1-10.

-1x Deck of chance cards (encompassing two categories – see 3.A.9).

-7x Lego figurines with accessories used as tokens.

-1x 6 sided dice.

### 3.A.3 Principle of the Game

- Meaning of Character Cards

Each character has 3 features: 'Attack', 'Defence', 'Energy' and each has a different meaning:

- 'Attack' helps a player to attack other players.

- 'Defence' helps protect a player from enemy attacks.

- 'Energy' tells a player how far their attack can reach (=number of squares a character can attack).

- Conditions to enable an Attack

To Attack another player:

- 1) A player's token must be outside the ceasefire zone (outside square 20 – see 3.A.7).
- 2) A player's token must be behind the enemy. A player cannot attack another player who is behind or on the same square.
- 3) A player needs to first roll the dice and then attack only if the player is in front of him/her.

- Succeeding in an attack

For a successful attack:

- 1) The opponent should be within the character's 'Energy' range. For instance if a player reaches square 39 after casting the dice and that the opponent is on square 45, the player's character must have an 'Energy' of 6 or higher to be able to attack.
- 2) A player's 'Attack' must be stronger than the opponent's 'Defence'. It cannot be the same value or lower. If one's character has an 'Attack' of 5, but the opponent's character has a 'Defence' of 5 or above, then the player attacking will fail. To increase the value of their character's feature, players can use the chance cards to boost their

character's features: this is valid for players attacking (by boosting their character's Attack) or defending (by boosting their character's Defence).

A successful attack will force the opponent to move back 20 squares. For example, if that opponent is on square 53, he or she will have to go back to square 33. If the attack fails, the attacker must go back 10 squares. Alternatively, players can also use a life of their token (see 3.A.10) to avoid going backwards, whether the player is attacking or defending

### ***3.A.4 Starting a Game***

Each player receives three chance cards except Player 1, who receives four (see 3.A.5). Players' character cards are revealed to other players, however the chance cards remain hidden.

Once players have chosen their character card, they all place their Lego tokens on the start line. Player 1 starts by throwing the dice.

A player going from one zone to another has the opportunity to do as much PA as possible in 30 seconds (see 3.A.6).

### ***3.A.5 Advantages Earned for the Most Active***

The player finishing first from Stage 1 (with the highest points total) is made Player 1 and earns advantages which increases their chances of winning the game. These advantages consist of:

- First choice of character.
- First choice of token.
- An extra chance card (four instead of three).
- First move when starting the game.

Each player chooses a character card. The player who did the most PA in the previous activity chooses first, then the second, and so on...

### 3.A.6 The Zones on the Board

There are three zones on the game board:

- 'Cease Fire' zone (the first 20 squares: 1-20) = No player can attack another while on a square in the Ceasefire Zone.
- 'No Teleport' zone (the last 40 squares: 61-100) = the 'teleport' chance card cannot be used if a player is on one of the squares in this zone.
- The zone in the middle has not got any particular rules.

### 3.A.7 PA Squares

When landing on one of the two 'PA' squares (number 20 & 60), players have the option to carry out a challenge of their choice (e.g. push-ups, star jumps, sit-ups) in an attempt to reach the highest BPM possible in 30 seconds, using a heart rate monitor as part of the ACTIVIO system to try to earn one or two chance cards, determined by the number of beats per minute reached within those 30 seconds. Once executed, players write down the number of points generated on the side of the board. Shown below are the thresholds that allow chance cards to be won:

	< 170 BPM	171 < x < 190 BPM	> 191 BPM
Number of Cards	0	1	2

Number of cards earned for Stage 2 based on PA (heart beats) done in Stage 1

### 3.A.8 Chance Cards Meaning

The chance cards can be split into in two categories. Category 1 encompasses cards giving all sorts of advantages (e.g. avoiding map traps, players' attack, moving quicker). Cards in Category 2 consist of boosting one feature of a player's character. When playing a game, cards from both categories are mixed together.

- Category1

-Cosmic Shield: Protects against all player attacks (except Galactic Attack).

-Freeze: Choose one opponent to miss a turn.

-Galactic Attack: All opponents go back 10 squares (only Universal shield protects against this).

-Reverse: choose one opponent to move backwards on their next turn.

-Super Freeze: Take 2 extra turns.

-Teleport: Move forward 25 squares. This card can't be used in the 3<sup>rd</sup> zone (dark grey).

-Universal Shield: protects against all opponent attacks and map traps.



Figure 3A – Chance cards from category1

- Second category

-Attack: +10.

-Energy: +25.

-Energy: +50.

-Defence: +10.



Figure 3B – Chance cards from category2

### 3.A.9 Tokens

Each Lego token is made of 3 parts (head, body, legs), which each corresponds to a life for players to use. A life can be used by a player who:

- Fails an attack;
- Was attacked and lost;
- Wants to avoid a map trap.

Instead of going backwards (when attacking/attacked) the player in question sacrifices a life to remain where he/she was. To do so he/she takes off one part of their Lego token.

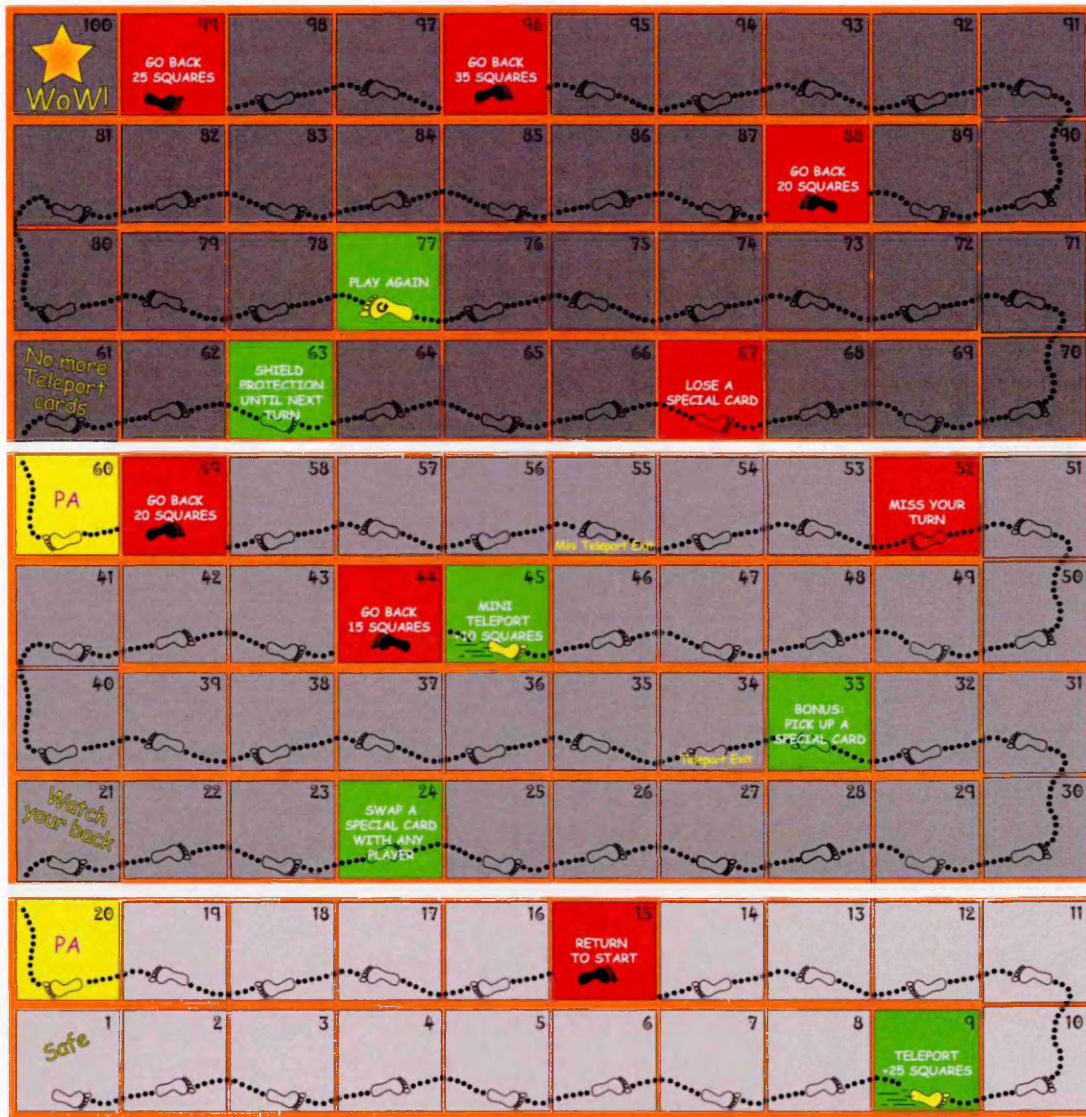


Figure 3C – The Board



Figure 3D – Character cards

### **3.B BOOST UP!<sup>TM</sup> THEMED CARD GAME V2**

At the time, the Boost Up!<sup>TM</sup> themed card game was not as developed as the board game, however a set of core rules was established nonetheless.

#### **3.B.1 Object of the Game**

Players have to collect all the character cards from other players to win the game. To increase their likelihood of winning the cards, players can use chance cards that are distributed at the start of the game.

#### **3.B.2. Hardware**

-1x Deck of 26 character cards. Each character card has three features (Attack, Defence, Energy) with a value from 1-10 (see Figure 3D).

-1x Deck of chance cards (from the second category of the board game only): Attack: +10; Defence: +10; Energy: +25 (see Figure 3E).

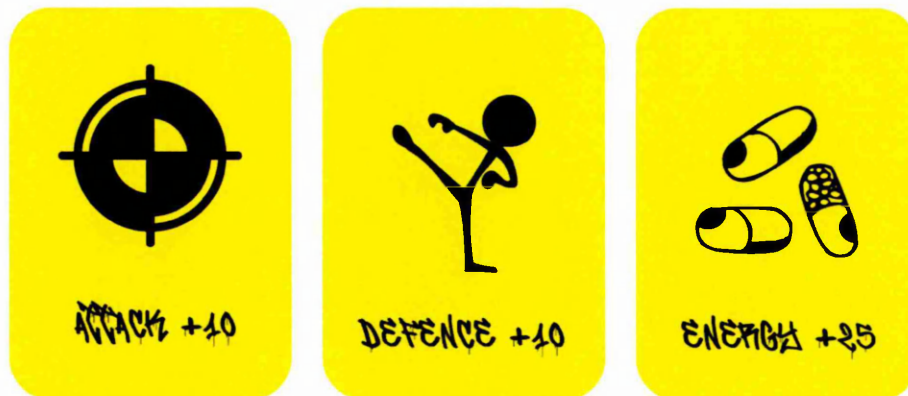


Figure 3E - Chance cards from category2

-7x Lego figurines with accessories.

#### **3.B.3 Starting a Game**

Each player receives three chance cards at the start, except Player 1 who receives four (see 3.B.4).

All the character cards are dealt equally to the players, who then place their character cards pile in front of them face down.

Each player picks the first card on their character pile and holds it, along with their chance cards, so that the other players cannot see their cards.

Player 1 starts the game and chooses one feature (e.g. Attack). Once a feature has been called, Player 1 has the option to boost the chosen feature by using a maximum of one chance card per round. It is then the turn of the second player (clockwise) to choose whether they wish to boost their character card, then the third ... until all the players have had a chance to boost the called feature. Everyone then calls out their total value for the chosen feature. . Whoever has the highest value wins all the character cards, collects them and places them at the bottom of their stack.

Whoever won the cards then chooses any feature to read from their next card, and again whoever has the highest value of the chosen feature on their top card wins all the cards and has the next turn. This continues for as many turns as necessary, and players drop out of the game as they run out of cards. Whoever eventually manages to collect all the cards wins the game.

At any time during the game, players can choose to use a life (see 3.B.5) to try earning a chance card if they carry out enough VPA, as detected by the heart rate monitor used with the ACTIVIO system.

### ***3.B.4 Advantages Earned for the Most Active***

The player who finishes first in Stage 1 (with the highest amount of points) is made Player 1 and earns an advantage which increases their chances of winning a game. These advantages consist of:

- Starting the game (Calling a feature first).
- Getting an extra chance card (four instead of three).
- Choosing first a token to play with.

- Getting the extra character card(s) left, if the cards cannot be distributed evenly.

### **3.B.5 Use a Life**

Each player has a token that represents them. The token is made of 3 parts (Head, Body, Legs), which each correspond to a life for the player to use. A life allows players who have lost a round to keep the card they played with, although the winner of that round keeps the cards of other players.

When one player uses a life, all the players have to do PA for 30 seconds (using the heart rate monitor used with the ACTIVIO system) to try to earn one or two chance cards, determined by the number of beats per minute reached within those 30 seconds. Shown below are the thresholds that allow chance cards to be won:

	<b>&lt; 170 BPM</b>	<b>171 &lt; x &lt; 190 BPM</b>	<b>&gt; 191 BPM</b>
<b>Number of Cards</b>	0	1	2

Number of cards earned for Stage 2 based on PA (heart beats) done in Stage 1

## **Appendix 4- Boost Up!™ Board & Card Game Rules V4**

### **4.A BOOST UP!™ V4**

#### **4.A.1 Brief Idea of the Overall Game**

The players carry out PA one day to generate a primary and secondary currency, which are then used to play games on the following day. The currencies are the same for both the board game and card game but they are used differently in each. Currencies are given to players on a daily basis and they must keep their currencies with them in order to play at any time throughout the day.

#### **4.A.2 Earning Currencies – Personal to Each Player**

This section explains how to earn currencies prior to playing the games.

- Main Currency (Beads)

Players' patterns of PA are used to create a 'character' which has three features: 'Attack', 'Defence' and 'Energy'. Players can earn up to 10 beads for each feature depending on the intensity of their PA (VPA = 'Attack', MPA = 'Defence', Non-Sedentary time='Energy'). When starting 'Boost Up!', each player sets their baseline by measuring their daily average of PA over a certain amount of time. This is then used as a benchmark from which to award the beads, which are kept in the player's personal box. By reaching their baseline, players are awarded 5 beads. Table A below shows an example of how beads are awarded when the baseline is set with: 20 minutes of VPA, 150 minutes of MPA and 300 minutes spent sedentary.

Beads Steps	0 -50%	1 -40%	2 -30%	3 -20%	4 -10%	5 Baseline	6 +10%	7 +20%	8 +30%	9 +40%	10 +50%
VPA	10	12	14	16	18	20	22	24	26	28	30
MPA	75	90	105	120	135	150	165	180	195	210	225
Sedentary	450	420	390	360	330	300	270	240	210	180	150

Table A – PA to beads conversion framework

- Second Currency (bonus cards)

The bonus cards are awarded for the amount of steps made by a player on a day-to-day basis. Table B below is the framework explaining how bonus cards (up to 7) can be earned:

Number of Steps	4000 < x < 5999	6000 < x < 7999	8000 < x < 9999	10000 < x < 11999	12000 < x < 13999	14000 < x < 15999	x > 16000
Number of Cards	1	2	3	4	5	6	7

Table B – Steps to cards conversion framework

## 4.B BOOST UP!<sup>TM</sup> BOARD GAME V4

### 4.B.1 Brief Idea of the Game

Suitable for 2 to 8 players, the aim of this game is to avoid map traps and players' attacks to be the first to reach the 'WOW' square.

In this game the beads awarded determine the strength of the three features of each player's character. 'Attack' is used to attack other players, 'Defence' is used to protect and 'Energy' is used to determine how far one's attack can reach.

Players can temporarily boost the value of their character's features during a game by using their secondary currency (bonus cards) if they earned any that day, or by using health cards earned during a game (see 4.B.4).

Players can also protect themselves against map traps through the use of chance cards that are acquired when playing too (see 4.B.4).

#### **4.B.2 Hardware**

- A box (with up to 30 beads) and a case (with up to 7 bonus cards) that are personal to each player.
- 1x Deck of chance cards.
- 3x Decks of health cards (Fun, Skills and Strength).
- 8x Lego figurines used as tokens with accessories.
- 2x Dice (one 6 sided to play on the board, the other 12 sided to attack/defend other players).
- 1x Timer.

#### **4.B.3 Currencies Earned prior to Playing (Personal to Each Player)**

As explained in 4.A.2, the currencies have different purposes in the game and are awarded for the players' levels of PA: the main currency is permanent (i.e. it defines one character/player's features for the whole game and cannot be affected) and visible to other players (see 4.B.5) whereas the second currency is only valid for one turn and kept hidden from other players.

The bonus cards can boost one's character by +10 or +20 (Figure 4A). Depending on the strategy players want to adopt, a +10 card can be swapped with another card of the same value. For example, a +10 attack can be exchanged for a +10 defence or a +20 card can be exchanged for two +10 cards.

#### **4.B.4 Currencies Accumulated during a Game**

During a game, players may earn health cards and/or chance cards to boost a character's feature in order to attack other players or to get protected against map traps or players' attacks. The cards presented below are only valid for one turn but they can be used at any time during the game.

- Health Cards

A range of health cards can be collected when passing from one level to another. Although it is not compulsory, passing from one level to another is also an opportunity for players to complete a physical challenge (health challenge). Players choose from three categories of health challenges with different degrees of difficulty, which award players according to the intensity of the task (table C). Figures 4B, 4C and 4D show respectively the Fun (+2), Skills (+4) and Strength (+6) health cards.

Health Cards		
Fun +2	Skills +4	Strength +6
-Stand on your hands/head for 10 seconds -Do 5 cartwheels in a Row -Stand on one foot, put your arm under your leg, touch your nose and hold it for 20 seconds -Juggle for 30 seconds (football, balls...) -Congratulations for taking up a challenge	-Hoola Up for 30 seconds -Elastic for 30 seconds -Hop on one leg for 1 minute -Run up and down the stairs for 30 seconds -Run from one end of the corridor to another in less than 30 seconds - Congratulations for taking up a challenge	-Star Jumps -Push Ups -Skip -Jump everywhere -Sit Ups - Congratulations for taking up a challenge

Table C – Three categories of health challenges

Players pick up a card from their chosen category and carry out the challenge immediately. The other player(s) become the referee(s) and if the challenge is judged successful, the player who took the challenge earns the card and keeps it in their hand to use it later on in the game.

Health cards are used to temporarily increase the value of any character's features in order to attack or defend against an opponent's attack. They can also be combined with bonus cards (see 4.B.7).

- Chance Cards

Chance cards can be used at any time. There are 7 chance cards and each has a different meaning (see Figure 4E).

-Cosmic Shield: protects against all player attacks (except Galactic Attack).

-Freeze: choose one player to miss a turn.

-Galactic Attack: all players go back 10 squares (only Universal Shield protects against this).

-Teleport: move forward 25 squares. This card can't be used after square 60 (last two levels).

-Reverse: choose one player to move backwards on their next turn (when they throw the dice).

-Universal Shield: protects against all player attacks and map traps.

-Super Freeze: take 2 extra turns (=throw the 6 sided dice two more time or the 12 sided one once).

#### **4.B.5 Setup**

- The Box

Each player takes out their box (main currency) and the bonus cards they earned for that day. All the players place the beads earned for that day in the middle compartment of their box so they are visible to the other players. To pass the beads from one compartment to another, players press the buttons as many times as necessary to insert all the beads from the three strands in the middle compartment.

- The Board Game

Display the three piles of health cards on the table (Fun, Skills, Strength).

Players choose their token (with accessories) and place them on the 'Start' square.

All the players display their box in front of them.

Each player is dealt three chance cards and the remainder of the pile is placed on the table. The distributed cards remain hidden from other players. When starting a game players will have three chance cards in addition to the bonus cards earned that day.

#### ***4.B.6 Starting a Game***

The player with the most beads starts the game by throwing the 6 sided dice. This dice is used to move on the board and the 12 sided dice is used to attack or defend against the other players (see 4.B.7).

On their turn, players throw the 6 sided dice first, move their token the correct number of spaces, and then decide whether or not to take any actions (e.g. playing a bonus card, taking a health challenge and/or attacking another player). If a player does not attack it is the turn of the next player, on the left. A player wanting to attack an opponent must declare it before the next player throws the dice.

#### ***4.B.7 Attacking other players***

Players can attack each other in order to try to be the first reaching the 'Wow' square. However there are conditions for attacking and not all attacks are successful.

- Conditions to Attack

To attack another player:

- 1) A player's token must be outside the cease fire zone (finishing on square 20 – see 4.B.10).
- 2) A player cannot attack another player if their token is on the same square or behind them.
- 3) A player needs to play the dice first and then attack if the player is in front and within range, which corresponds to the 'Energy' of one's character.

- Successful Attack

For a successful Attack:

1) The opponent (ahead) needs to be within range of the player who is attacking. The range is defined by the 'Energy' of one's character, which determines how many spaces in front a player can attack. For example, if a player reaches square 39 after throwing the dice, and the opponent is on square 45, the character of the player attacking must have an 'Energy' of 6 or above to be able to attack.

2) The player attacking must have a stronger 'Attack' than the opponent's 'Defence'. It cannot be the same value or lower. If one's character has an 'Attack' of 5, but the opponent has a 'Defence' of 5 or above, the attack will fail. To avoid failing, the player attacking can boost their character's features (see 4.B.8).

A successful attack will force the defending player to go back 20 squares. For example, if the player is on square 53, they will have to go back to square 33, which is equal to two rows. The player attacking will then move to the previous position of that player, in this case square 53.

#### ***4.B.8 Boosting a Character's feature***

During an attack, both players can boost their character's 'Attack', 'Defence' or 'Energy' feature for a single turn to successfully attack or defend themselves. This can be done in two ways: relying on luck by throwing the 12 sided dice (boosting from +1 to +12) or by using a bonus card (+10 or +20). Health cards can also be used but they need to be played before throwing the dice or playing a bonus card. Any amount of health cards can be chosen and combined (+2, +4, and/or +6).

The attacking player goes first (dice or card(s)). The defending player then decides how to counter attack according to the number of the player's 'Attack' (value of a character's feature + bonus card OR dice + eventual health card(s)).

#### ***4.B.9 Winning A Game***

The first player reaching the 'Wow' square is the winner. To finish, a player has to find the exact number required when throwing the dice. For example, a player on square 98 needs a '2' to finish.

At the end of the game, the players keep their personal currencies (box and bonus card(s)).

#### **4.B.10 The Board**

The board is presented in Figure 4F.

- Bonuses, Traps, and 'Go Back' Squares

If a player lands on a trap, only the 'Universal Shield' chance card can save them (see 4.B.4 chance cards section). There are also two 'Go Back' squares (59 and 96) on which players can avoid the penalty (i.e. going backwards) by moving or spinning around for 20 seconds.

If a player lands on a bonus square, they can choose whether or not to use the bonus. For example, the players do not have to swap a chance card when landing on square 24.

- Levels

There are 5 levels on the board game that are split into three zones, however only zones 1 and 3 have a meaning:

-Zone 1 is the first level (the 'beach' on Figure 4F) and is a 'Cease Fire' zone (first 20 squares). Players cannot attack between squares 1-20.

-Zone 3 is the last two levels (the 'mountain' and 'space' on Figure 4F) and is a 'No Teleport' zone (last 40 squares). The 'teleport' chance card cannot be used between squares 61-100.



Figure 4A – The 7 bonus cards to earn for playing the board game

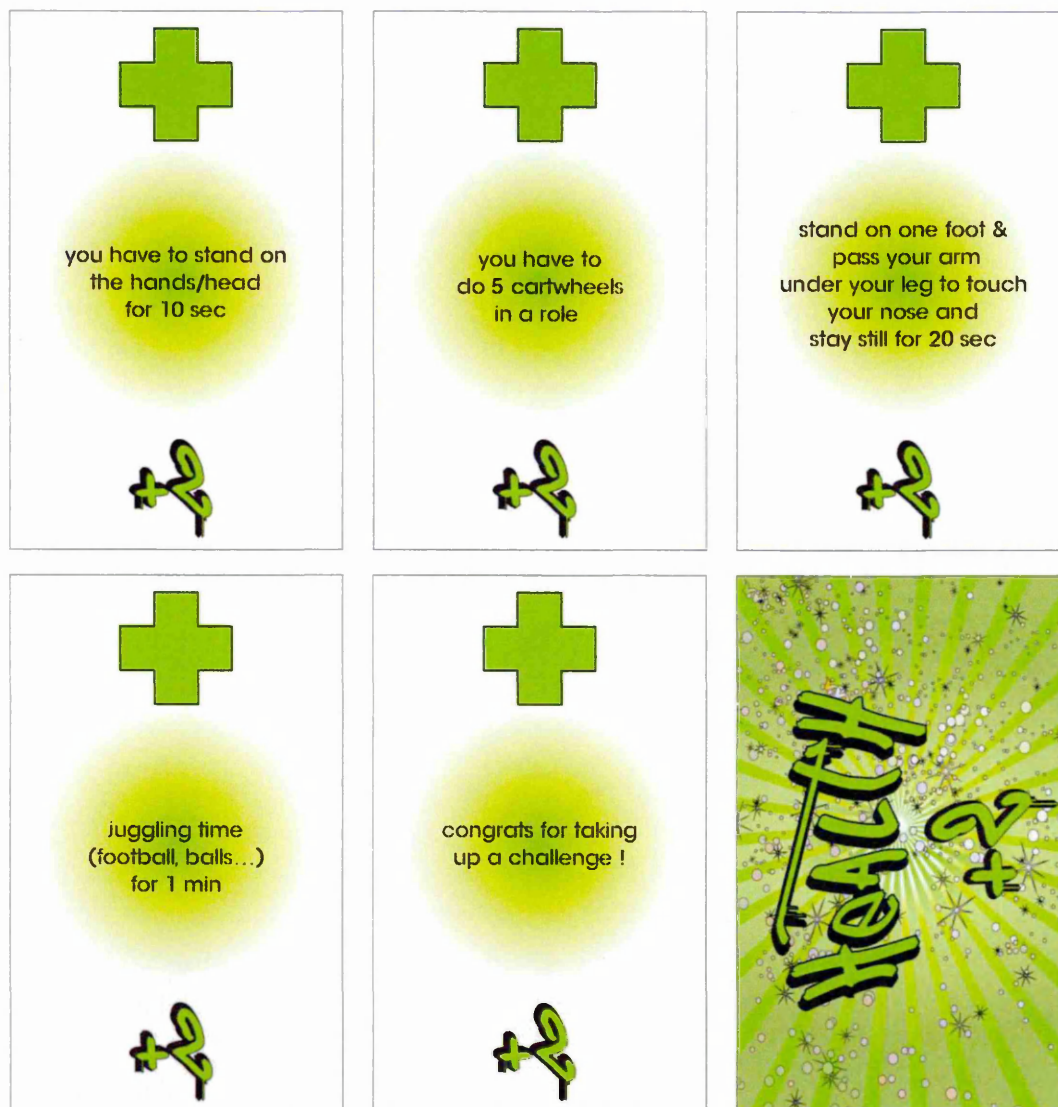


Figure 4B – The challenges to pick among the 'Fun' category of Health cards

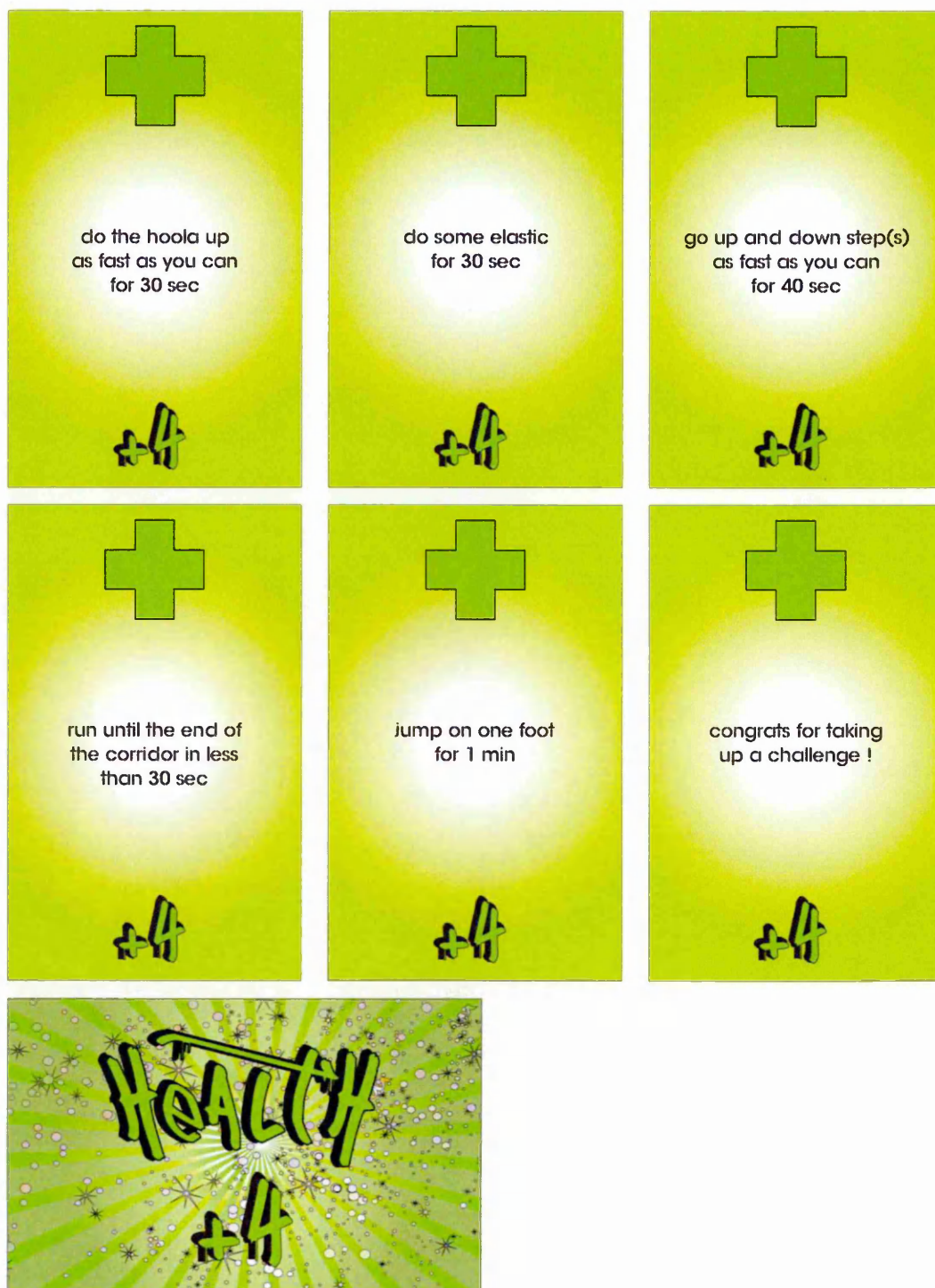


Figure 4C – The challenges to pick among the 'Skills' category of Health cards



Figure 4D – The challenges to pick among the 'Strength' category of Health cards



Figure 4E – Chance cards and their meaning

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## **4.C BOOST UP!™ CARD GAME V4**

### **4.C.1 Brief Idea of the Game**

Suitable for 2 to 6 players, the goal is to win the opponents character cards by comparing their feature values. The first player to collect all the character cards in their hands wins. This game is a bit like Top Trumps® but in addition to the character cards there are also boosters to increase the chances of winning.

In this game, the main and secondary currencies (beads in the box and bonus cards) are also awarded to players based on their levels of PA. However both currencies are only valid for one round and are used to increase the character's features.

### **4.C.2 Hardware**

-A box (of up to 30 beads) and a case (of up to 7 bonus cards) that are personal to each player.

-1x Deck of 26 character cards.

### **4.C.3 Set Up**

Each player takes their box (main currency) and bonus cards earned for that day. The players place their beads into an the left or right hand side of their box (see 4.C.9) but they remain hidden from the other players.

All the character cards are dealt evenly between the players. Each player takes their cards and places them face down in front of them so nobody knows which character cards have been given.

A player's bonus card(s) must also remain hidden from the other players.

### **4.C.4 Starting a Game**

For each turn, the players take the character card from the top of their pile, while still keeping it hidden from the other players.

The player with the most beads is player 1 and they have the advantage of choosing whether to play with the Attack, Defence, or Energy of their character for that round.

After the feature has been called, player 1 decides whether they want to make a 'bet' (i.e. whether it is worth boosting the value of his/her character card). Players do not have to make a bet and can pass their turn. Once player 1 has passed or made a bet (see 4.C.7), it is player 2's turn (on the left of player 1) who decides whether to boost their character's feature, then player 3, until it comes back to player 1.

Once everyone has decided to bet or pass, the total number (see 4.C.8) is shouted out. Whoever has the highest value wins all the character cards, collects them and places them at the bottom of their stack.

The winner of that round then chooses the feature to read from their next card. Whoever has the best value of this feature wins the cards and has the next turn. This continues for as many rounds as necessary. Players drop out of the game as they run out of cards and whoever collects all the cards wins the game.

#### **4.C.5 Character Cards**

The game is played with 26 character cards (see Figure 4G). Each character is defined by 3 features; 'Attack', 'Defence', 'Energy' which are rated from 1 to 10.

#### **4.C.6 Currencies Earned prior to Playing (Personal to Each Player)**

As explained in 4.A.2, the main and secondary currencies are awarded for players' levels of PA. In this game, both currencies remain hidden from the other players when betting and are used to boost a character's value. Both currencies can be combined when betting although players can only use up to 3 beads and/or a single bonus card per round (see 4.C.7).

- The beads

Each bead increases a character's feature of +1 but the bead(s) must relate to the called feature. For example, the beads in the 'Attack' strand cannot be used to boost 'Defence', except when using the 'Switch' card (see below).

- The bonus cards

The bonus cards presented in Figure 4H have different meanings:

-‘Boost’: whether it is +1, +2 or +5, playing one of these cards increases any feature of the character card by the amount indicated on the bonus card. The +2 and +5 cards can be swapped with +1 and/or +2 cards according to the strategy players want to adopt. For example, a player with a +5 card can exchange it for two +2’s and a +1.

-‘Double’: this doubles the value of one bead.

-‘Switch’: enables the use of bead(s) from a different strand. For example, if ‘Attack’ was the feature called but a player does not have any ‘Attack’ beads, they can play the ‘Switch’ card which allows them to use the bead(s) left in one of the other strands

-‘2Rounds’: gives the opportunity to use the same bet twice. Instead of ‘burning’ the beads at the end of a round, the player using this card keeps the bet beads for the following round (see 4.C.9).

-‘Joker’: players can use this card in any way they want: as a ‘Switch’, ‘Double’, ‘2 Rounds’, or a ‘+5 Boost’.

#### ***4.C.7 Boosting a Feature***

Boosting a feature (i.e. making a ‘bet’) can be done using the beads and/or the bonus cards. Players can use up to a maximum of 3 beads and/or one bonus card per round. Players do not have to bet and can decide to pass their turn if they do not wish to boost the called feature. However a player who passes still has to play the picked character card and must place it in front of them, face down.

Once a bet is completed, players place the box and the eventual bonus card(s) along with the character card face down in front of them to make sure the card(s) or the bet is not visible to the other players.

Each player does the same and when it comes back to the player who started the round everyone turns over their character card and their eventual bonus card together, even players who chose not to boost their character’s feature. Only one bet can be played each round.

Once the cards and beads are used, they cannot be used again for this game (except for the '2Rounds' bonus card – see 4.C.6).

#### ***4.C.8 Winning a Round***

The winner of the round is the player with the highest overall number, which is an accumulation of the figures of the: character's feature + eventual bead(s) + eventual bonus card.

If there is a draw between two players, the value of the other characters' features are added (Attack, Defence & Energy). If at this point it is still a draw, all the cards are momentarily left in the middle and all the players start a new round. The player who started the 'drawn round' restarts and the winner of this new round wins all the cards from both rounds.

A player who passed is not out of the game but it means they do not want to use any of their currency to boost their character's feature. Therefore if a player who passed has the highest overall number for that feature they would still win the round.

When a player wins a round, they win all the character cards played in this round (or in the last 2 rounds in the case of a draw). They then put them back face down underneath their character cards so the next round can begin.

#### ***4.C.9 Using the Box***

There are three compartments in the box through which beads from each feature can pass through. All the players place the beads earned for that day in one of the compartments situated at either sides of the box. This is because there are shutters at either side which allow the currencies left/burnt to be hidden from other players. Once the beads have been placed in one extremity of the compartment, place the box vertically so that the compartment with the beads is at the top.

The top compartment becomes the 'currency left' (i.e. the one containing the beads), the middle one is the 'currency bet' (i.e. the one used to boost the feature of the character card for a round), and the bottom one is the 'currency burnt' (i.e. at the end

of a round, all players must burn the bet before starting a new one, except when using the '2Rounds' bonus card – see 4.C.6).

When players want to bet (i.e. to boost the feature of their character card), they have to pass the beads from the upper compartment to the middle one. To do so, they must press the button on the column corresponding to the named feature. A colour code is used across the character card and the box (blue is 'Attack', orange is 'Defence', yellow is 'Energy'). This button can be pressed a maximum of three times per round. Once the bet revealed to the other players, the beads have to be burnt (except when using the '2Rounds' bonus card). Players therefore have to pass all the beads from the middle compartment to the lower one.



Figure 4G – The 26 Character cards

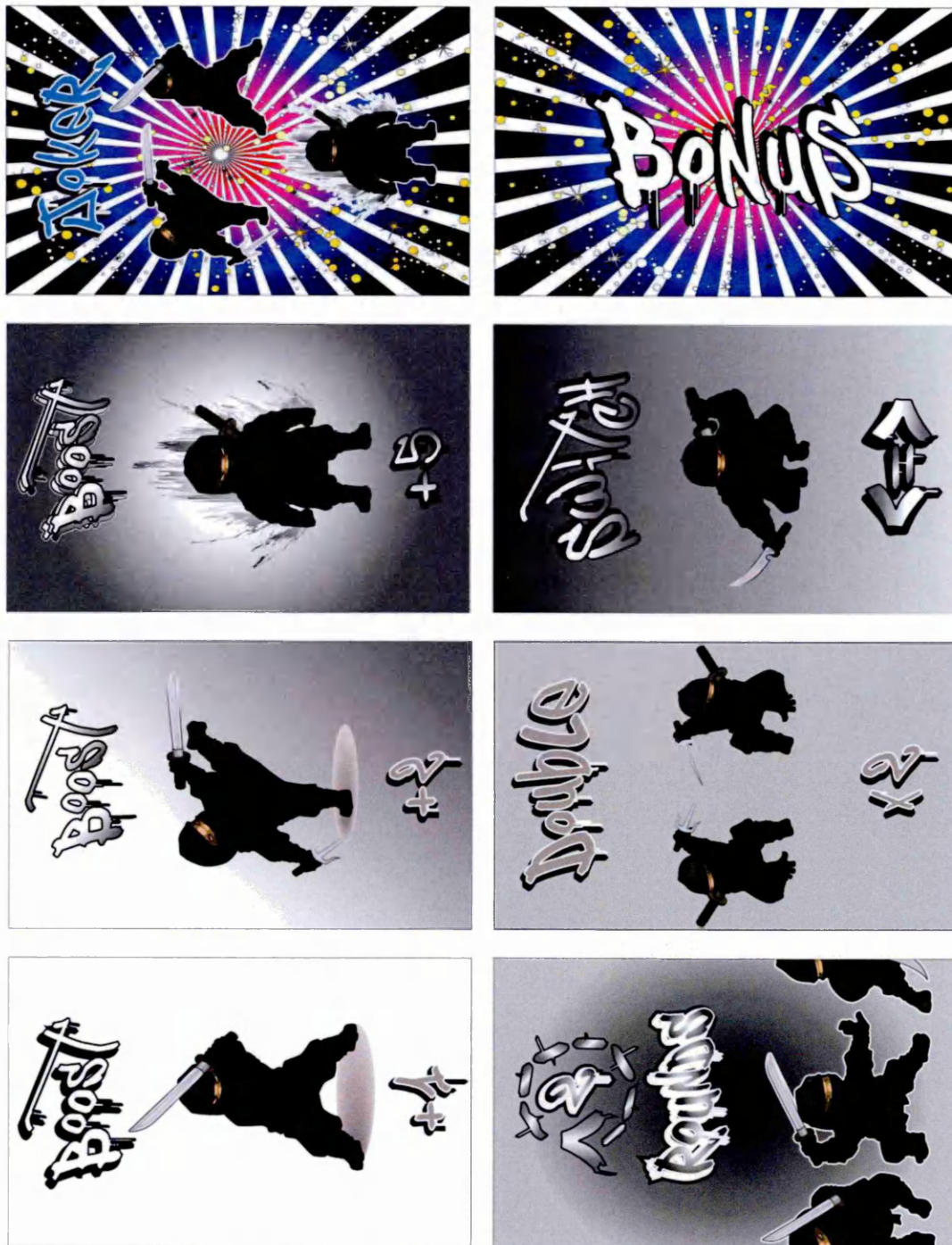


Figure 4H – The 7 bonus cards to earn for playing the card game

## ***Appendix 5- 'Boost Up!' V1, V2, V3 & V4***

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Throughout the entire research, four versions of 'Boost Up!' were created. Even though V1 & V3 were concepts and V2 & V4 'integration prototypes' (Houde & Hill, 1997) that were tested with a sample of future end-users (respectively UCE2 & 3), the boundaries are not that clear. Before being able to build V2 & V4, a series of iterative tests with various stakeholders (e.g. design colleagues, friends) were conducted, during which a range of prototypes was created. This is why some of the rows in the 'Games' column are filled for V1, even though this was only a concept.

Similarly, V2 & V4 games are prototypes created based upon their concept (respectively V1 & V3). Therefore the 'concept' section should not be filled however the evaluations did not quite reflected the plan in mind, even though the general concept remained the same. This is mainly due to participants not engaging with pedometers in UCE2 (making not possible evaluating 'Boost Up!' over the long term but over a workshop lasting two hours only) and to a 'blue sky' concept in DRE3 that required many resources at this stage (time, money, skills) and that was hence difficult to implement.

Game Version Characteristic	V1 (created in DRE2)	V2 (created throughout UCE2)	V3 (created in DRE3)	V4 (created in DRE3, for UCE3)
<b>General Idea</b>	Two-Stage idea that PA (in Stage 1) increase chances to win the games (in Stage 2)	Two-Stage idea that PA (in Stage 1) increase chances to win the games (in Stage 2)	Two-Stage idea that PA (in Stage 1) increase chances to win the overall game (in Stage 2) – i.e. the games and the league	Two-Stage idea that PA (in Stage 1) increase chances to win the games (in Stage 2)
<b>Identity</b>	Daily PA levels define the features of the avatar players have to create when playing 'Boost Up!'	PA levels done throughout the 4 first weeks of the intervention define the features of the players' avatar	Daily PA levels define: 1) the features of the avatar players have to create when playing 'Boost Up!' games only; 2) gives game advantages to play existing games	A player's health is represented by an avatar they create based on the intensity of their PA (i.e. VPA = Attack, MPA = Defence, Non-Sedentary = Energy)
<b>Family of Games</b>	A card game and a board game to play, and an avatar to create	A card game and a board game to play, and an avatar to create	Existing games as well as the 'Boost Up!' games (card & board games) are played with the created avatar however existing games can also be played	An avatar to create to play the card game and board games
<b>Type</b>	Linear - Card & board games played one after the other. The card game is played first (while creating an avatar) and then the board game after a specific period of time	N/A - Unsure how the games fitted together (players who could not be active one day (e.g. illness) would miss an opportunity to build the feature(s) of their character)	A league based on PA where any games can be played at any time. Players do PA to accumulate points to win the league. Points can be earned by doing PA or playing games (it costs to play a game but winning gives even more points)	There is no order as to playing the games: both can be played at any time
<b>Use of Avatar</b>	Players create their Avatar over the defined period of time (9 days) & then play the board game with it afterwards. The avatar is composed of 3 features (Attack / Defence / Range)	Players create their Avatar over the defined period of time (here the length of time of the 4 first workshops in UCE2 (4 weeks) & then play the board game with it afterwards. The avatar is composed of 3 features (Attack / Defence / Range)	-The avatar is a currency used to play 'Boost Up!' card & board games only. The values of the avatar's features change daily based on the amount and regularity of PA done.	Every day, an avatar is created based upon the PA levels done the day before. The daily avatar corresponds to the primary currency and it is used to play both card & board games. The avatar is composed of 3 features (Attack / Defence / Energy).
<b>Adaptation to other games</b>	N/A – The common currency across the games is PA since PA is what gives games advantages when playing the card game and what defines the features of the avatar to play with on the board game. Both games involve a character (character	N/A – The common currency across the games is PA again (as it gives more advantages) but 'characters' are also used for playing the card and board games (respectively with the character cards & the built avatar)	The common currency across 'Boost Up!' and existing games is PA again. Players use a credit card to find out what currency was earned. A 'withdraw' of currency is: defining the values of the avatar's features to play 'Boost Up!' games and game	N/A – There is only one currency to play the card and board game only.

		cards with 3 features to play the card game & avatar with same 3 features to play the board game)		advantages to play existing games (e.g. most active players playing Pictionary might earn an extra throw of dice, have extra time...).	
	'Gaming into PA' (in Stage 1)	Players receive PA challenges to execute at different moments throughout the day (e.g. thrown from a computer-data base or from other players)	PA challenges are explored through playing a game to be played with ACTIVIO system; players pick a PA challenge card that they have to execute	Players can throw PA challenges to execute at different moments throughout the day (e.g. thrown from a computer-data base or from other players)	N/A – Not implemented given the resources
	'PA into Gaming' (in Stage 2)	This idea of PA challenges was also applied to Stage 2, when playing the games (e.g. card asking to 'climb the stairs')	This is done through taking up PA challenges. These can be done when passing from one zone to another on the board game or when using a life in the card game	Players can take up PA challenges when playing the board game only	Players can take up PA challenges (i.e. through picking up Health cards) when playing the board game only
	Game Theme	Heroes	Heroes / Fantasy with Cute Creatures & Monsters	Heroes / Fantasy with Cute Creatures & Monsters	Heroes / Fantasy with Cute Creatures & Monsters
ME	Games' Components		Games tested over 2h only		Games tested over 4 weeks
	Card Game	-x1 Set of Character cards (each character made of three features (Attack / Defence / Range) with values going from 1 to 10) -x3 Sets of Booster cards -x1 set of Personal cards -x1 Dice	-x1 Set of Character cards (each character made of three features (Attack / Defence / Range) with values going from 1 to 10) -x1 Set of Chance cards (=grey and purple Booster cards are combined together) -x1 Set of Lego figurines	-x1 Set of Character cards (each character made of three features (Attack / Defence / Energy) with values going from 1 to 10) -A dispenser to 'withdraw' the currency with the credit card = x1 built avatar per player (3 values for each feature, all going from 0-10 units)	-x1 Set of Character cards (each character made of three features (Attack / Defence / Energy) with values going from 1 to 10) -x1 Set of Bonus cards (=grey Booster Cards) -x1 built avatar per player (1 value for each feature, all going from 0-10 beads)
	Board Game	-x1 Board (paper) -x1 Built avatar per player -x1 Set of Chance cards -x1 6 sided Dice (to move tokens) -Tokens -x1 'Carrom Tray' to use as booster	-x1 Board (in 3D) -x1 Set of Character cards (to replace avatar not built) -x1 Set of Chance cards -x1 Set of PA challenges cards -x1 Set of Lego figurines (tokens) -x1 6 sided Dice (to move tokens) -x1 'Carrom Tray' to use as booster	-x1 Board (in 3D) -x1 Set of Chance cards -x1 Set of PA challenges cards to use as booster -x1 Set of Lego figurines (tokens) -x2 6 sided Dice (to move tokens and to use when attacking others) -A dispenser to 'withdraw' the currency with the credit card = x1 Built avatar per player	-x1 Board (in 3D) -x1 Built avatar per player -x1 Set of Bonus cards (= category 2 of the Chance cards) -x1 Set of Chance cards (= category 1 of the Chance cards) -x3 Sets of Health cards to use as booster (=PA challenges cards) -x1 Set of Lego figurines (tokens) -x1 6 sided Dice (to move tokens) -x1 12 sided Dice (to attack others)

Avatar	-Avatar composed of 3 features (Attack, Defence & Range)	N/A – Couldn't test it since participants didn't engage in wearing the pedometers	The avatar's values are given by inserting the credit card into the currency dispenser	The avatar is represented by beads going from 0 to 10) and corresponds to the currency dispenser
Device measuring PA	N/A (Pedometers vs. Heart Rate Monitors)	-Basic Pedometers -ACTIVIO Heart Rate Monitors	Heart rate monitors	Fitbit Fitness Tracker
<b>Core Rules</b>				
Card Game	-Top Trumps type. Players need to get all the character cards to win the game. Players win a round by owning the character card with the highest value. To win a round, players can boost their character card's value by using a Booster or the Permanent card (that are visible from others). For every day during the defined period (set at 9 days), a game component (e.g. Booster) is introduced, making the game different every day	-Top Trumps type. Players need to get all the character cards to win the game. Players win a round by owning the character card with the highest value -To win a round, players can boost their character card's value by using a Chance card (that is hidden from others). -3 Chance cards are distributed to all players (except the most active who gets 4). -Players can also use one of the 3 lives of their token (made of 3 parts) to try earning one or more Chance card(s) by taking up PA challenges > See full rules in 3.B	-Top Trumps type. Players need to get all the character cards to win the game. Players win a round by owning the character card with the highest value -To win a round players boost their character card's value by using the avatar/currency dispenser -The avatar/currency dispenser is used as a permanent currency but also provide a temporary one	-Top Trumps type. Players need to get all the character cards to win the game. Players win a round by owning the character card with the highest value -To win a round players can boost their character card's value by 'betting', which is a combination of 1 Bonus card and/or up to 3 beads (that remain(s) hidden from others) -The avatar/currency dispenser is used as a temporary currency only > See full rules in 4.C
Board Game	-The first player reaching the 100 <sup>th</sup> square wins. Players can attack each other to send one opponent backwards and try to reach square 100 first -When attacking, players can use boosters to increase the value of their avatar's features (i.e. some of the Chance cards and 'Carrom Tray') -3 Chance cards are distributed to all players -There are 3 zones on the board that each corresponds to: 1) a 'cease fire'; 2) Attack others; 3) Attack others and non-use of 1 Chance card ('Teleport')	-The first player reaching the 100 <sup>th</sup> square wins. Players can attack each other to send one opponent backwards and try to reach square 100 first -When attacking, players can use boosters (i.e. some of the Chance cards, 'Carrom Tray') to increase the value of character card's features they are playing with -The most active player (Stage 1) earns games advantages (Stage 2) -3 Chance cards are distributed to all players (except the most active player who gets 4)	-The first player reaching the 100 <sup>th</sup> square wins. Players can attack each other to send one opponent backwards and try to reach square 100 first -When attacking, players can use boosters (i.e. some of the Chance cards, PA challenges) to increase the value of their avatar's features -3 Chance cards are distributed to all players -The 3 zones are in 3D (same prototype): when going from one zone to another, players go up a level and can pick up a PA challenge card	-The first player reaching the 100 <sup>th</sup> square wins. Players can attack each other to send one opponent backwards and try to reach square 100 first -When attacking, players can use boosters (i.e. some of the Chance cards, Health card) to increase the value of their avatar's features allowing each individual -3 Chance cards are distributed to all players -There are 3 zones however 5 levels: when going from one level to another, it is the opportunity for

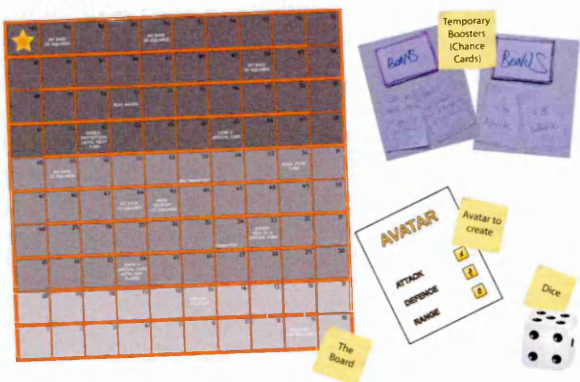

			<p>-Players can also try earning more Chance cards either by using one of the 3 lives of their token or by doing up PA challenges</p> <p>-The Lego tokens made of 3 parts give 3 lives to players who can use them: 1) to avoid going backwards when failing an attack or a defence; 2) to avoid a map trap; 3) to earn Chance cards</p> <p>-The 3 zones are made 3D: when going from one zone to another, players go up a level. It's an opportunity for them to do up to 1min of PA to try earning more Chance cards</p> <p>&gt; See full rules in 3.A</p>	<p>to execute the challenge (optional). PA challenge cards allow players to increase the value of their avatar's features</p> <p>-Legos are used as tokens only</p> <p>-The avatar/currency dispenser is used as a permanent currency but also provide a temporary one</p>	<p>players to try earning a Health card of the category they want</p> <p>-Legos are used as tokens only</p> <p>-The avatar/currency dispenser is used as a permanent currency only</p> <p>&gt; See full rules in 4.B</p>
Avatar	<p>-Avatar created during the defined time (e.g. 9 days)</p> <p>-Avatar then used to play the board game</p>		<p>N/A – Could not test the avatar idea (pedometers not engaging) therefore character cards were used</p>	<p>-The values of the avatar's features change daily based on the amount and regularity of PA done. For each feature, there are 3 columns given based on PA done: 1) since a player joined the game (=baseline), 2) in the last hour before playing (Boost 1); 3) in the past 3 days (Boost 2)</p> <p>-The avatar is composed of 3 features (Attack/ Defence/ Energy). Players get given an overall number every day for each column (i.e. for each booster) that they break down the way they want across each feature</p>	<p>-The values of the avatar's features change daily based on the amount and intensity of PA done: VPA = Attack, MPA = Defence, Non-Sedentary = Energy</p> <p>-The amount of currency changes daily. Players don't get to break down the numbers across features</p>
Device measuring PA	N/A		<p>Game created with ACTIVIO (to explore 'Gaming into PA'). The winner of Stage 1 is the player that reaches the highest heart rate within the given time. This winner earns game advantages to increase</p>	N/A	<p>-A daily currency is awarded every day based on the Fitbits' data. This currency corresponds to beads (main currency = avatar) and to bonus cards (second currency awarded when meeting health</p>

			chances winning the games in Stage 2		recommendations) -A framework that converts PA into game currency was created, allowing players to earn up to 7 Bonus cards (according to the number of steps) and between 0 and 10 beads per feature (total of 30) to build the avatar > See full rules in 4. A
	<b>Boosters</b>				
	Card Game	Boosters increase chances to win a round since they increase the avatar's features temporarily and permanently. 2 out of the 3 boosters (purple and grey) increase a feature for a turn, while the 3 <sup>rd</sup> booster (brown) and the Personal card do so for a full game	Chance cards benefit a player since they increase the value of the character card's features	Each feature (Attack/ Defence/ Energy) on the currency dispenser has 3 columns which correspond to the boosters: left = Baseline; middle = Boost 1; right = Boost 2	Boosters correspond to the main and second currencies that allow players boosting one's avatar's features value or affect the 'bet'
	Board Game	Boosters increase chances to win an attack as they allow increasing the avatar's features	Boosters benefit players as they increase the avatar's features or give game advantages (e.g. avoiding map traps)	There are 3 different boosters: the PA challenges cards, the dice (replacing the 'Carrom Tray') and the avatar/currency dispenser -Each feature (Attack/ Defence/ Energy) on the currency dispenser has 3 columns (left = Baseline; middle = Boost 1; right = Boost 2). Boost 1 can be used up to 2 times (since based on PA done for the past hour). Boost 2 can be used up to 5 times (since based on PA done for the past 3 days)	There are 4 different types of boosters: the second currency (i.e. cards), the Health cards (x3 sets), the Bonus cards (x1 set), and the x12 sided dice
	<b>Temporary Currency (e.g. valid for 1 turn)</b>				
	Card Game	-Grey Bonus cards affect the features of one's character card -Purple Bonus cards protect one against opponent's attacks	-Grey Chance cards are used to boost the value of the features on a player's Character card. -Purple Chance cards gives personal advantages (e.g. Keep a booster for 2	-Boost 1 & 2 on the avatar/ currency dispenser can be used only once per turn & cannot be used twice within a game	-Bonus cards (i.e. second currency) increase one's avatar's features value (+1; +2; +5) or affect the 'bet' (e.g. double it, make it last for another round...)

		turns)		-Beads (i.e. main currency) increase one's avatar's features value (up to +3 = 3 beads)
Board Game	-Two categories of Chance cards are mixed together and have different purposes: 1) to protect against map traps & opponent's attacks; 2) to affect the features of the character card. Only 1 card (of any category) can be used in a turn -A 'Carrom Tray' can also be used to boost for a turn one's feature	-Category 1 of the Chance cards gives player the possibility to avoid map traps & some opponent's attacks -Category 2 of the Chance cards can increase for a turn the value of one's character cards' features	-A PA challenge successfully completed awards the player with a card that can be used to boost one's avatar's features for a turn -Only category 2 of the Chance cards increases one's avatars' features -Category 1 of the Chance cards protects against map traps for a turn -The 12 sided dice can also be used to boost one's avatars' features -Boost 1 & 2 on the avatar/ currency dispenser can be used only once per turn & cannot be used twice within a game	-Bonus cards (i.e. second currency) increase one's avatar's features value (+10; +20) and are interchangeable ( player can have x2 +10 instead of x1 +20 but it has to be of the same feature) -Health cards also increase one's avatar's features value yet the amount is proportional to the intensity of PA to do (Fun = +2; Skills = +4; Strength = +6) -The x12 sided Dice can also increase one's avatar's features
Permanent Currency (e.g. valid for 1 game)				
Card Game	-Brown Bonus cards affect features of the character card for a game -Personal cards allow players choosing for a game to boost one feature or to get protected against opponent's attacks	N/A	The left column on the currency dispenser (Baseline) corresponds to the permanent booster that is added to every character card played (i.e. for every round) and can therefore be combined with Boost 1 or 2.	N/A
Board Game	-The avatar is used as a permanent currency throughout the game	-A chosen Character card is used as a permanent currency throughout the game	-The Baseline in the avatar/ currency dispenser is the permanent currency; it replaces the Character cards	-Players' avatar/currency dispenser (i.e. beads) is used as a permanent currency throughout the game
Graphic / Material				
Card Game	-Pencil & paper torn (B&W)	-Character & Chance cards printed on thick paper	-V2 cards used again and modified (e.g. by writing on it) -Printed paper cards (different versions with different graphics)	-Character & Bonus cards printed on thick paper
Board Game	-Printed paper -3 zones in 3 shades of grey -Rewards & map traps are written on the board	-3D board (i.e. with levels) made of glued acrylic -3 zones in 3 shades of grey -Green & Red squares to show positive (i.e. rewards) & negative (i.e.	-V2 board used again and modified (e.g. by writing on it) -Printed paper cards (different versions with different graphics)	-3D board (i.e. with levels) vacuum casted -'Storytelling' Graphic (i.e. map): 5 different levels of different landscape, starting on the beach

			map traps) -Words were added/written on the board -Use of 'foot prints' to guide -Cards printed on thick paper		(Square 1) to go up the mountain and finish in space (Square 100)
	Avatar	N/A : Not prototyped as a 'non-technologic' direction was chosen	N/A	-A range of prototypes were made of acrylic and/or paper printed	-Box made of a combination of card board, ABS (rapid prototype), acrylic and Plywood -'Boost Up!' logo is represented
	Device measuring PA	N/A	-Semi-translucent pedometers -Chest heart rate monitors	N/A	-Fitbits

- Board Game

Concepts	V1		V3	
				

Prototypes

V2

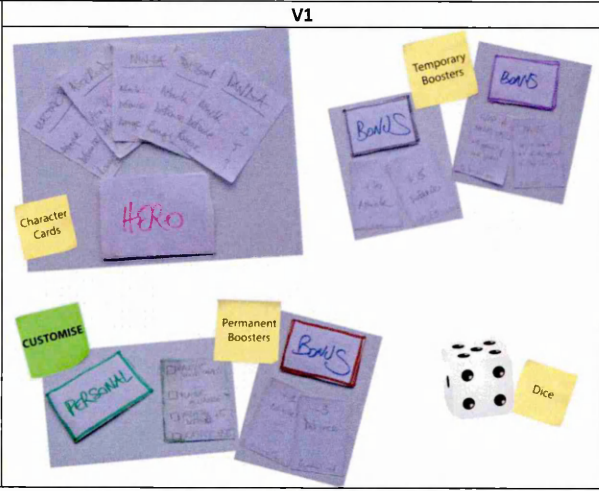


V4



• Card Game

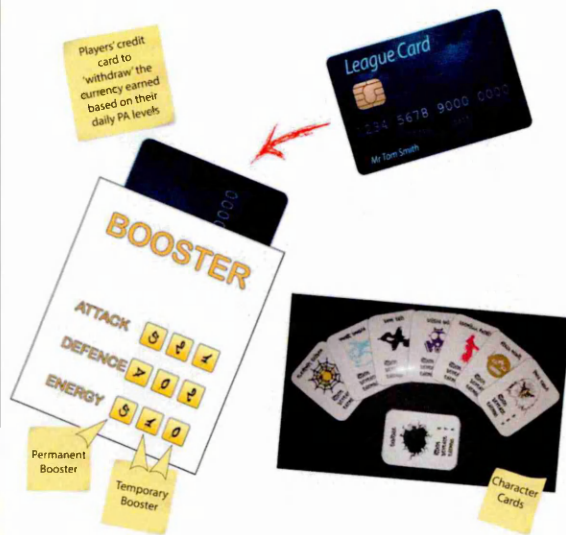
Concepts

V1	V3
	

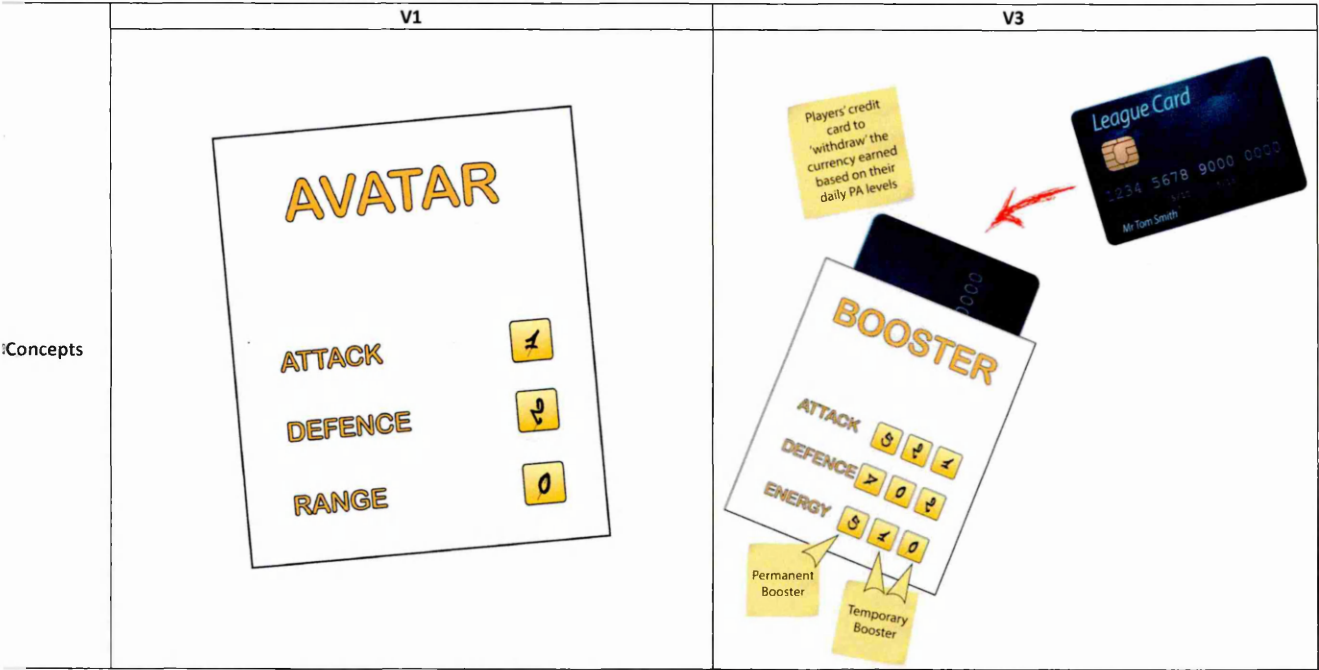
prototypes

V2

V4

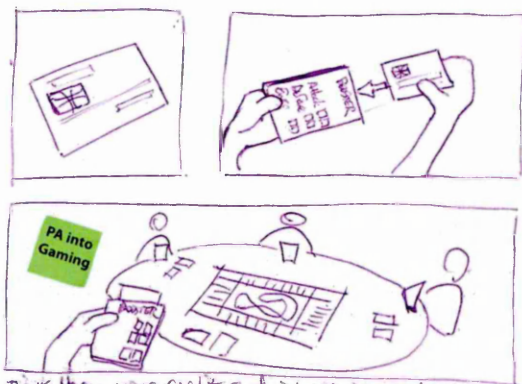


- Avatar / Currency Dispenser



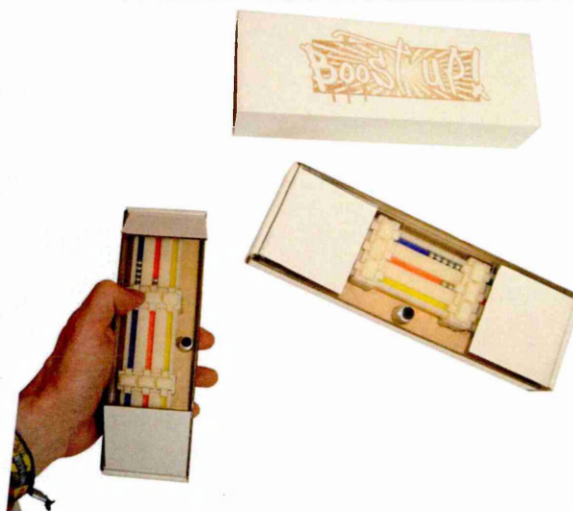
Prototypes

V2



Insert your credit card into the Reader Card & you're ready to play a range of (existing) games.

V4



## ***Appendix 6- Questionnaires***

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### ***6.A USER-CENTRED ENQUIRY 1***

The questionnaire in this enquiry was given in phase 'A' of UCE1 and was twofold: it was a way to get first insights about what the participants were into as much about PA as games but the questionnaires' answers were also used as a basis to build the profiles of the personas in Workshop 3.


## QUESTIONNAIRE

-Please tick the one which applies when you see ☐

-Please rate with a number (1 being the most important) when you see ☐

-Write when you see .....

-Fill in the empty circle when you see the below scale




☐

☐

☐

☐



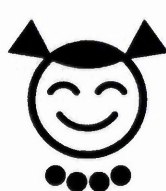
Not Likely

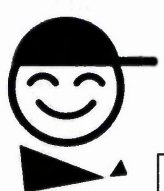
Not Very Likely


Somewhat Likely

Very Likely


## About You!


☐


☐





.....



..... years

-In which year are you?


☐


☐












☐

Figure 6A – Questionnaire p1


## About You and Physical Activity!



Here we mean anything that refers to any activity that gets your heart pumping such as running, cycling, fast walking, and even running upstairs...

### How much physical activity does your family do?

	Mother	 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>  Not Much      A little      Quite a bit      A lot
	Father	 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>  Not Much      A little      Quite a bit      A lot
	Sister(s)	 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>  Not Much      A little      Quite a bit      A lot
	Brother(s)	 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>  Not Much      A little      Quite a bit      A lot

### How much physical activity do your friends do (i.e. running, biking...)?








☐
☐
☐
☐

  
Not Much      A little      Quite a bit      A lot

**Specify** which kind of physical activity in general.....

.....

Figure 6B – Questionnaire p2

Do you consider yourself active?		
		
<input type="checkbox"/> <b>Yes</b> I consider myself as being <b>very active</b> because..... ..... .....  Would you like to change this? ..... ..... .....	<input type="checkbox"/> <b>Yes</b> I consider myself as <b>being active</b> because..... ..... .....  Would you like to change this? ..... ..... .....	<input type="checkbox"/> <b>No</b> I consider myself as being <b>not active</b> because..... ..... .....  Would you like to change this? ..... ..... .....

Were you more physical active when you were younger? Why do you think this is?	
	<input type="checkbox"/> <b>Yes</b> I was <b>more active</b> when I was younger because...  <input type="checkbox"/> <b>No</b> I am the <b>same</b> because...  <input type="checkbox"/> <b>No</b> I am <b>less active</b> now because... because..... ..... ..... .....

Rate from 1 to 5 who do you prefer to do physical activity with, 1 being the most important.				
<b>Parents</b>	<b>Siblings</b>	<b>Friends</b>	<b>By Yourself</b>	<b>Other</b> Who?.....
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Figure 6C – Questionnaire p3

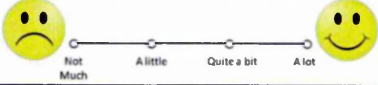
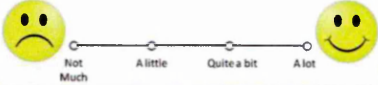

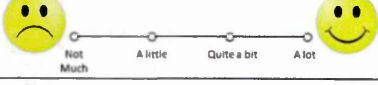
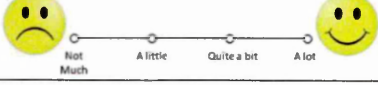
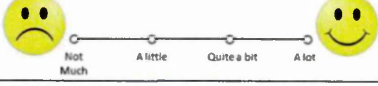
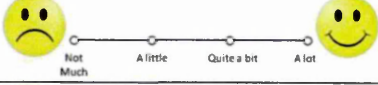







Rate from 1 to 8 which factor is the most important for you to make you do physical activity, 1 being the most important one.		
Factors that could motivate you		Rated factor
<b>Reward – Getting a prize</b> 		<input type="text"/>
<b>Win – Beating your friend(s)</b> 		<input type="text"/>
<b>Recognition – Other people see I am doing well</b> 		<input type="text"/>
<b>Self Accomplishment – I feel good &amp; happy of having done it</b> 		<input type="text"/>
<b>Social - Being with other people (i.e. friends, family...)</b> 		<input type="text"/>
<b>Emotional – Having Fun</b> 		<input type="text"/>
<b>Physical – Getting Fit</b> 		<input type="text"/>
<b>Other.....</b> ..... ..... .....		<input type="text"/>

Figure 6D – Questionnaire p4

## About You and Games!

Here we mean anything that you can play by yourself or with a group with a set of rules like electronic games and also traditional sports such as football, volleyball...

How much you prefer playing games in the below places and explain why.

 <p style="text-align: center;">At school</p> <div style="text-align: center;">  </div> <p><b>What do you like / dislike in this environment?</b></p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	 <p style="text-align: center;">At home</p> <div style="text-align: center;">  </div> <p><b>What do you like / dislike in this environment?</b></p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	 <p style="text-align: center;">Around my home</p> <div style="text-align: center;">  </div> <p><b>What do you like / dislike in this environment?</b></p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>
--	--	---

Name 3 games that you like to play and explain why you don't like them

 <p><b>My most liked game is</b></p> <p><b>because</b>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	 <p><b>My 2<sup>nd</sup> most liked game is</b></p> <p><b>because</b>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	 <p><b>My 3<sup>rd</sup> most liked game is</b></p> <p><b>because</b>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>
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Figure 6E – Questionnaire p5




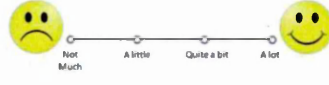

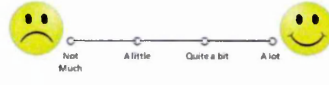


















Do you play this type of game?	What do you like/dislike in it?
<b>Computer Games (i.e. CD-Rom...)</b> 	
<b>Handheld Games (i.e. Nintendo DS, 3DS...)</b> 	
<b>Video Games (i.e. X-box, PS3...)</b> 	
<b>Board Games (i.e. Monopoly, Mouse Trap...)</b> 	
<b>Indoor Games (i.e. Gym, Basketball...)</b> 	
<b>Card Games (i.e. Top Trumps, Magic)</b> 	
<b>Outdoor Games (i.e. Football, Tag, PrisonBall...)</b> 	
<b>Over a Period of Time (i.e. Farmville, Warcraft...)</b> 	

Figure 6F – Questionnaire p6

<b>Games for Physically Exercising (i.e. Wii, Kinect...)</b> 	
<b>Arcade Games (i.e. PacMan...)</b> 	
<b>Phone Games (i.e. Snake, Apps on I phone...)</b> 	
<b>Other</b> ..... ..... ..... ..... 	


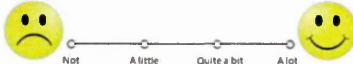

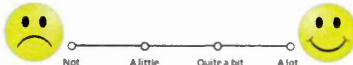

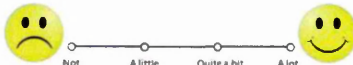
Do you prefer to play a game...	
<b>By yourself</b> 	 because..... .....
<b>As a team effort, all together</b> 	 because..... .....
<b>By yourself, but as part of a team</b> 	 because..... .....

Figure 6H – Questionnaire p7

Rate from 1 to 5 who do you prefer to play games with, and why?				
<b>Parents</b>	<b>Siblings</b>	<b>Friends</b>	<b>By Yourself</b>	<b>Other</b> Who?.....
<div style="border: 1px dashed black; width: 40px; height: 40px; margin: 0 auto;"></div>	<div style="border: 1px dashed black; width: 40px; height: 40px; margin: 0 auto;"></div>	<div style="border: 1px dashed black; width: 40px; height: 40px; margin: 0 auto;"></div>	<div style="border: 1px dashed black; width: 40px; height: 40px; margin: 0 auto;"></div>	<div style="border: 1px dashed black; width: 40px; height: 40px; margin: 0 auto;"></div>


  













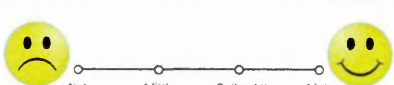

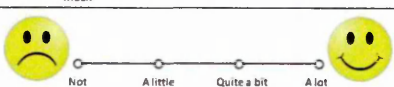

Do your parents like you to play games?	
	<div style="text-align: center; margin-bottom: 10px;"> <span style="display: inline-block; width: 150px; border-bottom: 1px solid black; position: relative; top: -5px;"> <span style="position: absolute; left: 0; top: 50%; transform: translateY(-50%);">Not Much</span> <span style="position: absolute; left: 33%; top: 50%; transform: translateY(-50%);">A little</span> <span style="position: absolute; left: 66%; top: 50%; transform: translateY(-50%);">Quite a bit</span> <span style="position: absolute; left: 100%; top: 50%; transform: translateY(-50%);">A lot</span> </span> </div> <p>because they say it is</p> <p>.....</p> <p>.....</p> <p>.....</p>

What were the last games that you've bought? Where did you get it from?			
	<p>The last games I bought were</p> <p>1-.....</p> <p>2-.....</p> <p>3-.....</p>		
Who bought your last game?			
 <input type="checkbox"/> My friend	 <input type="checkbox"/> My sibling	 <input type="checkbox"/> Parents	<div style="font-size: 40px; margin-bottom: 10px;">?</div> <input type="checkbox"/> Other..... .....
Where from?			
 <input type="checkbox"/> 2 <sup>nd</sup> Hand shop	 <input type="checkbox"/> Online shop	 <input type="checkbox"/> Electronic shop	<div style="font-size: 40px; margin-bottom: 10px;">?</div> <input type="checkbox"/> Other..... .....

Figure 6I – Questionnaire p8

The last game you played...			
	<b>What was it?</b>	<b>Where did you play it?</b>	<b>Who with?</b>
	1.....	1.....	1.....
	2.....	2.....	2.....
	3.....	3.....	3.....

Rate which factor is the most important for you to play games, 1 being the most important one.	
Factors that can motivate you	Rated factor
<b>Reward – Getting a prize</b> 	
<b>Win – Beating your friend(s)</b> 	
<b>Recognition – Other people see I am doing well</b> 	
<b>Self Accomplishment – I feel good &amp; happy of having done it</b> 	
<b>Social - Being with other people (i.e. friends, family...)</b> 	
<b>Emotional – Having Fun</b> 	
<b>Physical – Getting Fit</b> 	
<b>Other.....</b> 	

**Thank you very much for your time!!!**

Figure 6J – Questionnaire p9

## ***6.B USER-CENTRED ENQUIRY 2***



The questionnaire below was given in Workshop 3. Prior to this workshop, participants had experienced the use of the pedometer seen in p1 of this questionnaire (in green). Since the game created for Workshop 3 was based on the ACTIVIO system which uses heart rate monitors, that session was used to compare the two ways of measuring PA. This was through a focus group discussion where participants had to fill a card about a positive and a negative for each of the way of measuring PA. The questionnaire was then given at the end of the workshop in which some of the answers were compiled.

### Workshop 3: Heart Rate Monitor & Games







N A M E .....  
.....

#### ➤ Heart Rate Monitors VS Step Counters!

-Which system of measuring how much exercise you are doing do you prefer?

<input type="checkbox"/> <b>Heart Rate Monitor</b>  Because..... ..... .....	<input type="checkbox"/> <b>Step Counter</b>  Because..... ..... .....
---	--

-Write down 3 things you like the most and 3 things you dislike the most about Hear Rate Monitors

	Like	Dislike
<b>Heart Rate Monitor</b>	1.....  ..... .....	1.....  ..... .....
	2.....  ..... .....	2.....  ..... .....
	3.....  ..... .....	3.....  ..... .....
<b>Any other comments</b>	..... ..... .....	..... ..... .....

-Is it important to see how much exercise you are doing?.....Yes or No?

Why.....  
 .....  
 .....

-If yes, should it be:

Numbers?.....Yes or No

Images?.....Yes or No

Graphs? .....Yes or No

Colours?.....Yes or No

Other (ie Vibrating...) Please specify.....Yes or No

-Should it be hidden (i.e. under clothes) or obvious?.....Yes or No

Why.....

Figure 6K – Questionnaire Workshop 3 p1

➤ **About the real time system**







- Would it be better if other players don't see your score?.....Yes or No
- Is it a good idea that other people can look at you when doing the challenges?.....Yes or No
- Is it better to do the challenges all together or by yourself?.....Yes or No
- Rate how good was the fact you could see in real time the activity of your friends?



- Is it important for you to see in 'real time' how well your friends are doing?  
Yes or No? Why.....

➤ **About the Physically Active challenges**

- Write down 3 things that you liked the most and 3 things that you dislike the most about the Challenges with the card game; explain why.

	Like	Dislike
<b>Physical Activity Challenges</b> <i>Card Game</i>	1..... 	1..... 
	2..... 	2..... 
	3..... 	3..... 
<b>Any other comments</b> <i>ie.advantages / Gamble...</i>	..... ..... ..... .....	..... ..... ..... .....

- Did you see these challenges as being difficult?.....Yes or No
- Would it have been better to be able to choose your challenge?.....Yes or No  
Why.....

- Would you like to do these challenges every day if they increased your chances to win in some other games?.....Yes or No  
Why?.....

- Which card(s) were the most attractive to you?.....  
Why?.....

- Would you have preferred to see this game in another format (i.e. only Dice, board game...)?.....  
Yes or No? Why?.....

- What else could be added to make these challenges better/ more attractive?.....  
.....

Figure 6L – Questionnaire Workshop 3 p2

## **6.C USER-CENTRED ENQUIRY 3**

### **6.C.1 'Pre' & 'Post' Questionnaire**

This questionnaire was given in UCE3 and consisted of measuring the potential change in the participants' behaviour. Hence this questionnaire was completed twice: at the start of the intervention in Workshop 1 and two weeks after the intervention finished. The questionnaire was based on the Theory of Planned Behaviour and incorporated questions about the participants' attitude around PA and games (e.g. I often play games, I enjoy being active) and self-efficacy/perceived-behaviour-control (e.g. I have the ability to be physically active I want to, I could be active every day if I wanted to).

Name: \_\_\_\_\_



I would like to ask you some questions about being active and playing games. Being active can include walking, running, playing and also things like football and other sports. I want you to have fun answering the questions. This is not a test; I just would like to know what you think....

# BEING ACTIVE

For these questions please tick the box that matches what you think.







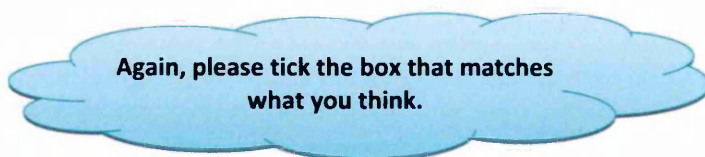






					
	Less than once a month	About once every 2 weeks	Once a week	About 3 times a week	Pretty much every day
<b>For Example: I often go to Old Trafford</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I often do physical activity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I often play Board Games	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I often play Card Games	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I often play Computer Games	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 6M – Q1 page1



					
	Totally disagree	Disagree	Maybe	Agree	Yes!! I agree
<b>For Example: I love Manchester United</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I enjoy being active	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Being active is good for me	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I could be active everyday if I wanted to	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have the ability to be physically active if I wanted to.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have the confidence to take part in physical activity if I wanted to	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I like collaborative physical activities (Dancing, Yoga...)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I like individual physical activities (Cycling, Running, Swimming, Parkour, Skateboarding...)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I like competitive physically active games played individually (Tennis, Squash, Rowing...)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I like competitive physically active team games (Football, Netball, Cricket, Rugby...)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

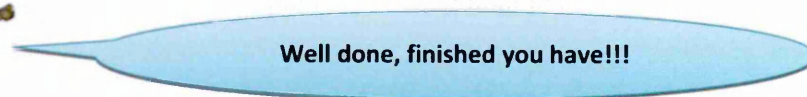


Figure 6N – Q1 page2

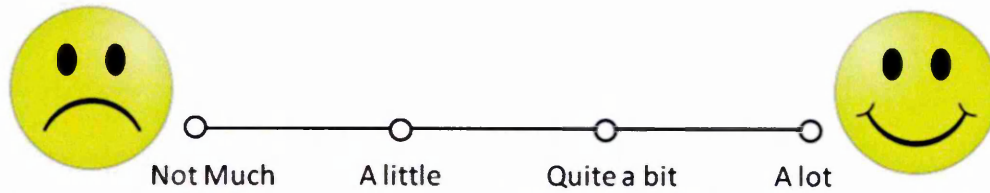
### ***6.C.2 Questionnaire Completed in Workshop 6 (Q2)***

The questionnaire completed in Workshop 6 (Q2) gathered general feedback about the intervention (e.g. was it what they expected and why) and questions around potential variations in their PA levels and the reasons behind it (e.g. self-perceptions, motivating factors).

N<sub>1</sub> A<sub>1</sub> M<sub>3</sub> E<sub>1</sub>

## STUDY

Rate your overall enjoyment of the project



Say one good thing about it



.....

.....

.....

.....

.....

Say one bad thing about it



.....

.....

.....

.....

.....

Was the whole study what you expected? Yes - No



Explain why.....

.....

.....

.....

.....

Rank each aspect you preferred in the workshops / lunch club (1-5), 1 being the most important





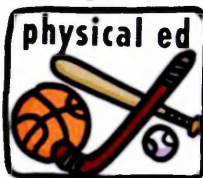
Aspect	Rate	Aspect	Rate	Aspect	Rate
Playing games 	<input type="text"/>	Being with Friends 	<input type="text"/>	health challenges 	<input type="text"/>
Working with Me 	<input type="text"/>	Getting out of PE 	<input type="text"/>	Other (specify) ..... ..... ..... ..... .....	<input type="text"/>

Figure 60 – Q2 page1





















































PHYSICAL ACTIVITY	
<p>Do you think you have now become more active than when you started the study?</p> <div style="text-align: center;">  </div> <div style="text-align: center;">       </div> <p>What makes you think this?.....</p>	
<p>Compared to the time before the study, do you think more often of...</p>	
<p>... spending less time sat down</p> <div style="text-align: center;">  </div> <div style="text-align: center;">       </div>	<p>... moving whilst \out and about</p> <div style="text-align: center;">  </div> <div style="text-align: center;">       </div>
<p>... doing more bursts of sprints</p> <div style="text-align: center;">  </div> <div style="text-align: center;">       </div>	
<p>How much did the following encourage you to do more physical activity and explain in which way...</p>	
<p>The pedometer</p> <div style="text-align: center;">       </div> <p>.....</p>	<p>Myself</p> <div style="text-align: center;">       </div> <p>.....</p>
<p>The card game</p> <div style="text-align: center;">       </div> <p>.....</p>	<p>The board game</p> <div style="text-align: center;">       </div> <p>.....</p>

Figure 6P – Q2 page2

## **Appendix 7- Consent Forms**

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For each user-centred enquiry three documents were handed:

- An information letter with a consent form to sign by the participant
- An information letter with a consent form to sign by the participant's guardian/parent(s) since they were minor.
- A general letter about the project with a deadline for bringing back the consent forms signed off by both the participants and their guardian/parent(s)

The two consent forms (guardian/parent(s) and participant's ones) had to be brought back signed off to the contact from the school in question (PE teacher in UCE1 and principal engagement officer in UCE2 & 3) before the deadline set in the letter otherwise the participants could not take part in the intervention.

This appendix 4 presents the template of the consent forms given to each participant for each user-centred enquiry. Hence only the first bullet point in the list above will be illustrated in this appendix.

## 7.A USER-CENTRED ENQUIRY 1

### Consent Form - Child's Version

## Games for Health

### Who am I?

My name is Rémi Bec, and I am a designer at Sheffield Hallam University. I am working on this research project with Doctor Robert Copeland, Professor Andrew Dearden and Professor Paul Chamberlain from Sheffield Hallam University.

### What do I want to find out?

This is a project that is interested in discovering why young people play games, which features of games are most interesting to you and keep you playing again and again. This is so I can better understand the gaming experience to help design games that might increase physical activity! Therefore, it is really important to make sure that the project works and this is why I would like your opinions.

### How would you be involved?

I would like you to be involved in the study and you can choose your level of involvement. Initially, this would involve filling out a short questionnaire about physical activity and games. The next stage would be to complete a log book during the half-term holiday. Following this, there would be an opportunity to take part in a series of four workshops each lasting about 40mins.

The log book will be given just before half-term holiday in the form of a pack which will contain various tools such as notebook, disposable camera... You will be briefed when the pack is given out so you know what to do with it. The completed pack will be collected during the week after half-term, and it will help me (and maybe you) to better understand your tastes.

Following this, you may also be selected to take part in the four workshops.

The first two workshops will be more focused on discussion around the outcomes of the questionnaire and the probes.

The second two workshops will be more 'participatory', involving the design, development and evaluation of game concept(s) that will encourage young people to be more physically active.

After these four workshops, there will be two further workshops as part of your curriculum with Year 7, 8 & 9 in July and September. The first one will aim to present the work we will have done, and the second one will test the concept(s) of games that seem most attractive to the students.

The workshops will take place at school, during the PE lessons, and will be run by me, Rémi Bec, with the help of the PE teacher, Mr Craig Haslingden. This project will help inform the development of future game(s) and activities for young people and therefore your involvement in this project is very much appreciated.

### Do you need to bring anything with you to the workshop?

No, I will bring everything you need, and I will only want your opinions!

### Will the workshops be recorded?

Yes. The workshops sessions will be audio recorded. The recordings will be used to inform the design aspect of the project which will allow me not to waste time by taking any notes.

Figure 7A – Consent form p1

## Consent Form - Child's Version

### **What about confidentiality?**

I will remove your name from all the work you do and keep your details secret. All information (whether digital or sketches / notes) from the workshops will be stored in a locked cabinet and remain at Sheffield Hallam University. Where this information is digital, it will be stored on an encrypted Hard Disk and kept in the same locked cabinet.

### **How will the results be used?**

The results from this research will be used for my research at Sheffield Hallam University. They might also be used as supporting evidence to plan for future projects. The results might lead to the development of new product for promoting physical activity and healthy lifestyles.

### **Can you withdraw from the project?**

Yes. You can choose not to answer any question(s) and/or withdraw from the study at any time and without reason.

### **What if you have any more questions?**

Please feel free to contact me using the details below.

Many thanks,

Rémi Bec

Room 9220  
Furnival Building  
Sheffield Hallam University,  
153 Arundel Street  
Sheffield  
South Yorkshire  
S1 2NU  
07914985759  
[rbec@my.shu.ac.uk](mailto:rbec@my.shu.ac.uk)

Figure 7B – Consent form p2

## Consent Form - Child's Version

### Consent Form

**TITLE OF STUDY:** Create Games to promote physically active lifestyles among young adolescents.

***Please circle your answers to the questions below and then sign the form.***

- Have you read and understood the information sheet about this study? Yes/No
- Have you been able to ask questions about this study? Yes/No
- Have you received enough information about this study? Yes/No
- Do you understand that you are free to withdraw from this study?
- At any time? Yes/No
  - Without giving a reason for your withdrawal? Yes/No
- Choose the way you agree to take part in this study (choose one answer only)
- I agree to participate in filling in the Questionnaires Yes/No
  - I agree to participate in filling in the Questionnaires & the Probes Yes/No
  - I agree to participate in filling in the Questionnaires & the Probes and in attending the Workshops if I get selected Yes/No
- Will you be up for taking part again at some point in the research in a similar way? Your answer is not definitive and you will be able to change your mind if I contact you in the future Yes/No

Your signature will certify that you have voluntarily decided to take part in this research study having read and understood the information in the sheet for participants. It will also certify that you have had adequate opportunity to discuss the study with an investigator and that all questions have been answered to your satisfaction.

Your name:		Your telephone:	
		Your email address: (optional)	
Signature of Guardian:		Date:	
Remi Bec's signature:		Date:	

**Please keep your copy of the consent form and the information sheet together.**

Figure 7C – Consent form p3

## 7.B USER-CENTRED ENQUIRY 2

### Consent Form - Child's Version

## Games for Health

### Who am I?

My name is Rémi Bec, and I am a designer at Sheffield Hallam University. I am working on this research project with Doctor Robert Copeland, Professor Andrew Dearden and Professor Paul Chamberlain from Sheffield Hallam University.

### What do I want to find out?

I want to find out what it is about a game that makes you come back to play again and again. This is because I'm designing a series of games that will encourage young people to do more physical exercise, and so I need your help to improve the design so that you, your friends or people like you will want to play.

Your opinions are really important to make sure that the project works and this is why I would like your help.

### How would you be involved?

I would like you to be involved in this study which consists in a series of 5 workshops of an hour a week, during your PE lessons. During these workshops you will be able to play a range of existing card and board games as well as new games that I have created. We will also discuss them, what you like or dislike and you will be able to create your own game too.

You will be given a pack that contains various tools like coloured pencils and a log book so that you can report and comment onto the activities that we will do together.

The completed pack will be returned to me at the end of the study and will help me (and maybe you) better understand your tastes and ideas.

The workshops will take place at school, during the PE lessons, and will be run by me, Rémi Bec, with the help of the participation and engagement officer, Ms Jo Robinson. This project will directly inform the development of future games and activities for young people and therefore your involvement in this project is very much appreciated.

### Do you need to bring anything with you to the workshop?

No, I will bring everything you need, and I will only want your opinions!

### Will the workshops be recorded?

Yes. The workshops sessions will be audio recorded. The recordings will be used to inform the design aspect of the project which will allow me not to waste time by taking any notes.

### What about confidentiality?

I will remove your name from all the work you do and keep your details secret. All information (whether digital or sketches / notes) from the workshops will be stored in a locked cabinet and remain at Sheffield Hallam University. Where this information is digital, it will be stored on an encrypted Hard Disk and kept in the same locked cabinet.

### How will the results be used?

The results from this research will be used for my research at Sheffield Hallam University. They might also be used as supporting evidence to plan for future projects. The results might lead to the development of new product for promoting physical activity and healthy lifestyles.

Figure 7D – Consent form p1

## Consent Form - Child's Version

### **Can you withdraw from the project?**

Yes. You can choose not to answer any question(s) and/or withdraw from the study at any time and without reason.

### **What if you have any more questions?**

Please feel free to contact me using the details below.

Many thanks,

Rémi Bec

Room 9220  
Furnival Building  
Sheffield Hallam University,  
153 Arundel Street  
Sheffield  
South Yorkshire  
S1 2NU  
07914985759  
[rbec@my.shu.ac.uk](mailto:rbec@my.shu.ac.uk)

Figure 7E – Consent form p2

## Consent Form - Child's Version

### Consent Form

**TITLE OF STUDY:** Create Games to promote physically active lifestyles among young adolescents.

***Please circle your answers to the questions below and then sign the form.***

Have you read and understood the information sheet about this study? Yes/No

Have you been able to ask questions about this study? Yes/No

Have you received enough information about this study? Yes/No

Do you understand that you are free to withdraw from this study?

- At any time? Yes/No
- Without giving a reason for your withdrawal? Yes/No

Do you agree to take part in this study? Yes/No

Will you be up for taking part again at some point in the research in a similar way? Your answer is not definitive and you will be able to change your mind if I contact you in the future Yes/No

Your signature will certify that you have voluntarily decided to take part in this research study having read and understood the information in the sheet for participants. It will also certify that you have had adequate opportunity to discuss the study with an investigator and that all questions have been answered to your satisfaction.

Your name:		Your telephone:	
		Your email address: (optional)	
Signature of Guardian:		Date:	
Remi Bec's signature:		Date:	

**Please keep your copy of the consent form and the information sheet together.**

Figure 7F – Consent form p3

## 7.C USER-CENTRED ENQUIRY 3

### Consent Form – Participant's Version

#### Use of your data

When you work with me, I may take photographs and make audio or video recordings of the activities. I will store these recordings on secure servers (computers) within Sheffield Hallam University that can only be accessed by the project team using special passwords.

I will use these recordings and notes to help me design healthier services, systems or products. In this scenario, your data will be used by the research team and will remain confidential.

Later, I will want to write and talk about the design and research we have done together to share with researchers working on design and healthcare at school, at the University and in academic papers, professional meetings, presentations and talks.

In these publications and presentations I may want to refer to parts of the recordings I have made, or provide written descriptions of what happened and what was said, to illustrate the activities that took place and the things we have found out together.

My aim will be to share the designing and research that we have done together, and I will try to ensure that your views and ideas are accurately represented. These recordings might be used in the UK and overseas, but it will not be used for profit.

There are two ways that I might want to use the recordings in articles or presentations:

- writing down quotations of things you have said and quoting notes that you have shared with me, or
- Playing the recordings themselves.

It is up to you whether you want to allow me to use the recordings in either of these ways. In either case, I will make every effort to ensure that you are not recognisable from the report (e.g. pixelating faces, not using your real name...).

Figure 7G – Consent form p1

## Consent Form – Participant's Version

### Consent Form

**TITLE OF STUDY: Games promoting physically active lifestyles among young adolescents.**

Please circle your answers to the questions below and then sign the form.

Have you read and understood the information sheet about this study? Yes/No

Have you been able to ask questions about this study? Yes/No

Have you received enough information about this study? Yes/No

Do you understand that you are free to withdraw from this study?

- At any time? Yes/No
- Without giving a reason for your withdrawal? Yes/No

Do you want to be involved in the study? Yes/No

I agree to audio recordings of myself being used:

- Confidentially by the researcher and the project team to inform the research and design of the games Yes/No
- Anonymously in research and professional publications and presentations; Yes/No

I agree to images and video recordings of myself being used:

- Confidentially by the researcher and the project team to inform the research and design of the games Yes/No
- Anonymously in research and professional publications and presentations; Yes/No

I agree to written information taken from recordings of myself being used:

- Anonymously in research and professional publications and presentations; Yes/No

Would you be willing to take part again at some point in the research in a similar way? This answer is not definitive and you will be able to change your mind if I contact you in the future Yes/No

Your name:		Your telephone:	
		Your email address: (optional)	
Signature of Guardian:		Date:	
Remi Bec's signature:		Date:	

**Please keep your copy of the consent form and the information sheet together.**

Figure 7H – Consent form p2

## Appendix 8- Who Is Involved

The table below lists all the stakeholders that took part in the research, giving a detailed description of the type of person(s) involved and what their role was.

Enquiry	Type of person(s) involved	Number	Drop Out	Description of involvement
<b>DRE1</b>	Supervisory team	3	-	To advise externally about the literature review (e.g. enlighten aspects of behavioural change theory, research methodologies in Design and also in Health)
	Design colleagues	3	-	To test early & rough versions of the game to create over a few sessions
<b>UCE1</b>	Participants	13	0	Involved in Phase A, B and C to create and assess ideas of games that promote PA over 8 weeks
	Participants	12	0	Involved in Phase C only (over the Fun Day event only) to assess the ideas of games generated in Phase A, B and C
<b>DRE2</b>	Supervisory team	3	-	To review the overall game concept
	Design colleagues	6	-	To review the game rules by testing out rough prototypes over a few sessions (mainly board game)
<b>UCE2</b>	Participants	8	1	To review existing games (over 4 weeks) as well as 'Boost Up!' V2 (over one session)
<b>DRE3</b>	Supervisory team	3	-	To review the overall game concept
	Design colleagues	8	-	To review the game rules by testing out V3 prototypes in an iterative process over a dozen of sessions (card + board games)
	Friends	4	-	To review the game rules by testing out V3 prototype over a couple of sessions (mainly board game)
	Family	4	-	To assess V4 card game over a week (with fitness trackers) before evaluating it in UCE3
<b>UCE3</b>	Participants	15	1	To assess 'Boost Up!' V4 over 6 weeks
<b>DRE4</b>	Supervisory team	3	-	To guide the writing up of the thesis