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Abstract. Bring Your Own Device (BYOD) has been heralded by many in academia and industry as a means of integrating new technology into existing processes, thus enhancing the learning experience but without the need for significant capital outlay or resources. One potential benefit of BYOD is an improvement in student engagement in the classroom. This research paper shall seek to identify if this is the case and if so by which means should this be applied. As education is an increasingly global enterprise the research shall be conducted from an international perspective to assess the impact of mobile technology across different countries. What can be alluded to from these findings is that from a student's perspective there are surprisingly few differences between the reasons why and how they use their mobile devices in the classroom, just that they want to. What is notable however is the variation from an institutions outlook; those countries with more established HE provision are less receptive to the ideas of using mobile technology in their classrooms than their less established counterparts.

Keywords: Learning Environment, BYOD, Higher Education, Personalised Learning, e-Learning

1 Introduction

Mobile devices have experienced exponential growth across the globe with many countries now having reached a plateau in terms of device ownership; in many developed economies it is common for households to have more mobile devices than people and in fact, globally more people own a mobile phone than a flushing toilet [1]. As Kraut, Brynin, & Kiesler concluded the pervasive use of technology has become the norm and society now expects an element of technology to be involved in all aspects of their life [2]. This growth, however has not been replicated in higher education. Yes, there has been the introduction of mobile devices to enhance the learning experience but they have not truly been embedded into the learning processes officially, rather it is seen as a latter addition. Institutions are too cautious, they are fearful of students using their devices in class for inappropriate uses and combined with limited empirical evidence they are merely using IT to enhance existing teaching rather than using it to transform how teaching is designed and delivered [3].

This research paper investigates the infrastructure and learning environments of higher education institutions across five different countries: Australia, China, Kazakhstan, UK, and the USA. By analysing the varying degrees of mobile device use the researchers intend to ascertain the extent to which mobile technology can facilitate student engagement. Specific reference to how institutions in each of these countries use mobile devices to support their students will be compared from both an academic and student perspective. The study shall look beyond the typical research of technology use in terms of academic achievement and instead assess the impact on the individuals, specifically in terms of how they are able to access education, combine it with family commitments and overcome barriers to learning. Given the increasing pressures on graduates across the world due to increased competition for graduate jobs, financial strains of tuition fees and changing cultural patterns more people now take alternative paths into HE. The researchers shall investigate how mobile devices can help support students through their learning journey and overcome these barriers.

2 Comparative Studies

There are countless published papers that have validated the benefits of using technology within the HE sector from an academics perspective, although only a select few have taken a student's perspective. Eun oh and Gwizdka who researched HE students use of tablets in a classroom are one such exception [4]. Their study of American students found unexpected technology uses that can be explained by the characteristics of the student group, the Net generation, namely, their impatient multi-tasking and opportunistic behaviour. Their research found that students liked using laptops to take notes during class discussions but tablets were seen as inconvenient for note taking due to the difficulties typing on the screen and limited functionality.

Taking advantage of learning opportunities was also a theme within Dorit and Currie's work; their comparative study showed that there is no one size fits all solution, some student's preferred email and Dropbox whereas others preferred messaging apps and social media [5]. True collaborative communities used a range of tools to suit the circumstances and different tools worked for different students. Ultimately though the result was the same; greater connectedness, collaboration and more intense relationships that resulted in higher quality outcomes for the Australian students they had researched.

Using mobile devices to facilitate student engagement and create a collaborative, technology driven learning environment has been central to the findings of Romero. According to their research technology promotes collaboration and facilities round the clock access to materials on Virtual Learning Environments (VLE's) to cater for those who work unusual shift patterns [6]. When working in dispersed locations as many students now do, particularly so given the increase in HE students attending university in conjunction with their employer through newly developed degree apprenticeships,

the need for electronic communication is immeasurable. Whilst still quite niche Virtual Reality (VR) is becoming more mainstream and opens up opportunities for truly virtual learning environments with students creating their own virtual personas to interact with their peers [3].

The fundamental constraint behind so many of these good intentions is either the lack of imagination at course planning level or any true understanding of the costing and resource implications [3]. A wide range of tools and techniques are required to truly integrate mobile technology into the classroom and facilitate student engagement; however the systems and infrastructure often cannot fully support this due to insufficient wireless access points, power outlets or network configurations that do not permit easy access to remote drives [7].

Despite these barriers enforced by an institutions culture where research is often prioritised over teaching [3] many external organisations are continuing to invest in these areas. Microsoft has been keen to develop the research capabilities at Chinese universities, supporting students with new technology to support their studies and research efforts [8]. The continued growth of China's economy by 10% per annum since the 1970's through to the early 2000's has been driven in part by the significant growth in technology led positions and highly-skilled workers who have integrated new technological advancements into increasing elements of society and the workplace [9]. None more so than within universities where they have strived to develop integrated curriculums that utilise the most advanced technologies so that their students have the necessary skills to contribute to this economic growth.

Previous research into Chinese HE institutions found a correlation between the teachers' positive attitude towards ICT and the success of students in their class. These findings are similar to those made by Vidacek-Hains who found that university students have demonstrated a direct link between the use of ICT for learning activities and improvements in their learning outcomes [10]. Even after investigating different countries, Australia and Eurasia, both Bower and Ali concluded that cultural and procedural difficulties of developing quality learning materials using new technology is what holds back many new initiatives [11] and [3]. Having a clear and coherent governance structure would, according to Ali, ensure that technology was properly integrated into the curriculum for the benefit of academics and students alike.

Currently HE institutions are costly and ineffective; they have not sufficiently adapted to cater for the massification of HE, simply adding extra tutorial groups or running lectures in ever larger lecture theatres does not provide the same student experience as a cohort half the size [3]. Technology can drive cost benefits and improve student satisfaction scores if applied correctly [15]. Where technology has been proactively applied in higher education there are significant cost benefits to be realised. Previous research by the Arizona State University showed how by using digital technology to reduce costs they were able to offer annual fees of $10000 against the average annual fees of US universities of $31000 [12].

3 Methodology

To truly investigate the cultural, political and geographical differences of BYOD on student engagement in HE it was necessary to conduct research across as many continents as possible. As such students from Sheffield Hallam University, UK; Nazarbayev University, Kazakhstan; University of Illinois at Chicago, USA; The University of Western Australia, Perth and Wuhan University, China have been involved. Prior to the main research activity, a small-scale study of current undergraduate students from Sheffield Hallam University was undertaken. This enabled the questions to be finalised and any problems or uncertainties resolved before the main research activity was conducted.

Participants at their respective institutions were invited to participate in the study by completing an online questionnaire during one of their taught sessions. The selection criteria was that they must be over the age of 18 and a current student of a HE institution, either in an undergraduate or post-graduate capacity. Participants were all informed before any data was gathered that the information would be held securely and no reference would be made to them individually as part of the study, at all times participants were free to leave the study. Gender and other personally identifiable information were not requested as analysis on these factors would have been outside of the scope of this research. A total of 174 students chose to be involved and completed the questionnaire.

4 Results and Discussion

Unsurprisingly the proportion of students who use a mobile device as part of their studies is similar to the overall penetration of mobile device usage in their respective countries. What was unexpected was the comparatively low use of mobile devices by Australian students and the higher than anticipated use by students from Kazakhstan.

Table 1. Mobile device use by institution.

Institution	Proportion of students who use a mobile device as part of their studies
Sheffield Hallam University, UK	95%
Nazarbayev University, Kazakhstan	82%
University of Illinois at Chicago, USA	97%
The University of Western Australia, Perth	84%
Wuhan University, China	100%

The most notable differences can be seen in figure 1 which shows a clear variation in the participants preferred mobile device dependent on their country.

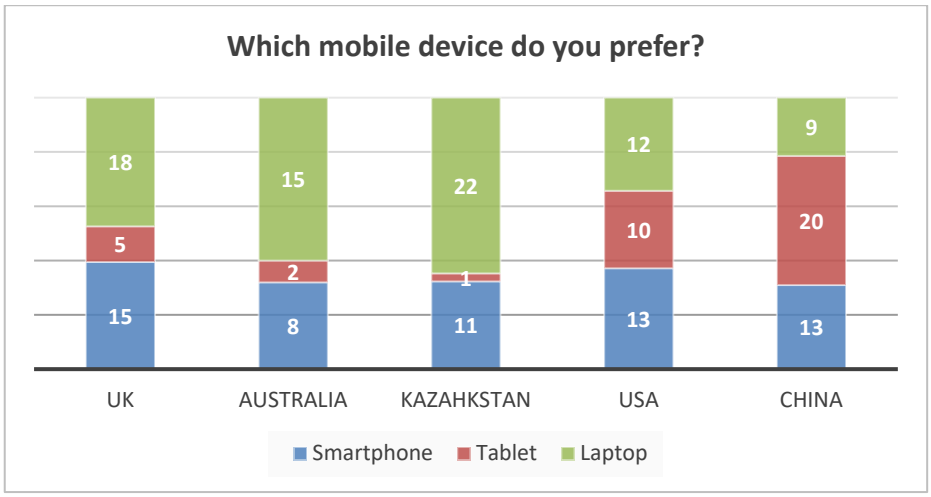

Fig. 1. Mobile device preference

When plotting this data against mobile device use there is a clear correlation, see figure 2, particularly so when the preference for that device is a Smartphone and conversely so when that device is a laptop. The higher the proportion of students using a mobile device as part of their studies then there is a greater likelihood of that device being a Smartphone or tablet.

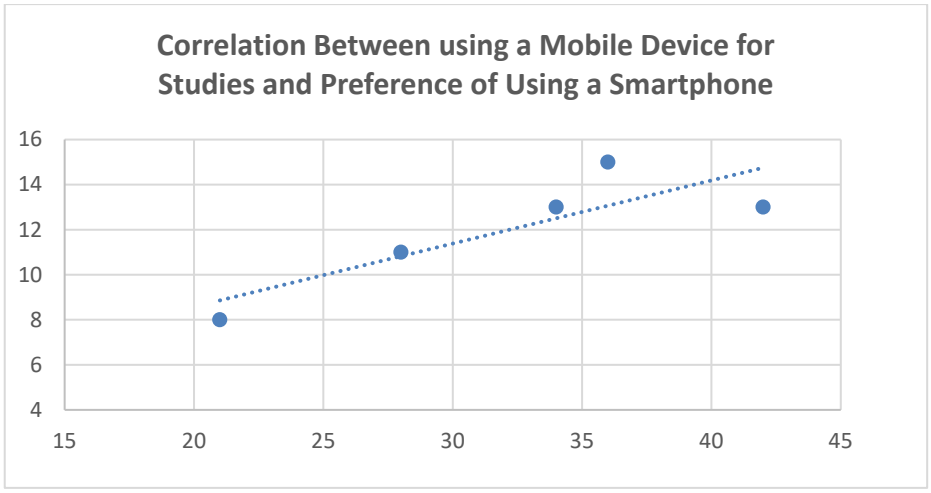

Fig. 2. Mobile device correlation

Undertaking regression analysis on these data values then the coefficient of determination can be calculated as follows.

Table 2. Regression analysis.

Preferred Device	R^2 Value
Laptop	0.25595
Smartphone	0.72096
Tablet	0.68778

An R^2 of 0.72 for any human behaviour is clearly of viable intent and when analysing the data in more detail it is apparent that those students where mobile device ownership is ubiquitous, such as China, the UK or USA, then the student's preference for their device of choice changes to what could be viewed as more up to date technology in the form of a smartphone or tablet. Whereas those economies where mobile technology ownership has yet to reach critical mass the preference for mobile device is much more conservative and traditional in the form of laptops. By using this information academics and course planners can plan teaching activities accordingly based on their student's preference for mobile device.

These findings concur with those of Eun Oh and Gwizdka who concluded that 94% of students agreed that using technology during classroom sessions was beneficial and increased interaction between academic staff and students [4]. They did find an interesting positive effect of the use of tablet computers in the classroom, whilst some students using laptops were engaged in non-course related activities those using a tablet were just using them for course related activities. They concluded that the difficulty of hiding what you are doing on a tablet screen was why those using a tablet remained focused on the task.

Whilst a significant proportion of students do use their mobile devices for their studies there is still a selection who don't and only by investigating these in more detail could we find potential solutions that would benefit all. Figure 3 shows that the ownership status of a mobile device is not of concern, rather the individual preference for using a desktop computer instead of a mobile device was the primary reason. Such a positive outcome is testament to the desire for students to use some form of technology to enhance their studies and it is merely the limiting factors of these devices that influence their choice. A facility to enable students to access specialist software remotely on their own device or the option to hire a range of mobile technologies could encourage students to engage with classroom sessions by making an active contribution.

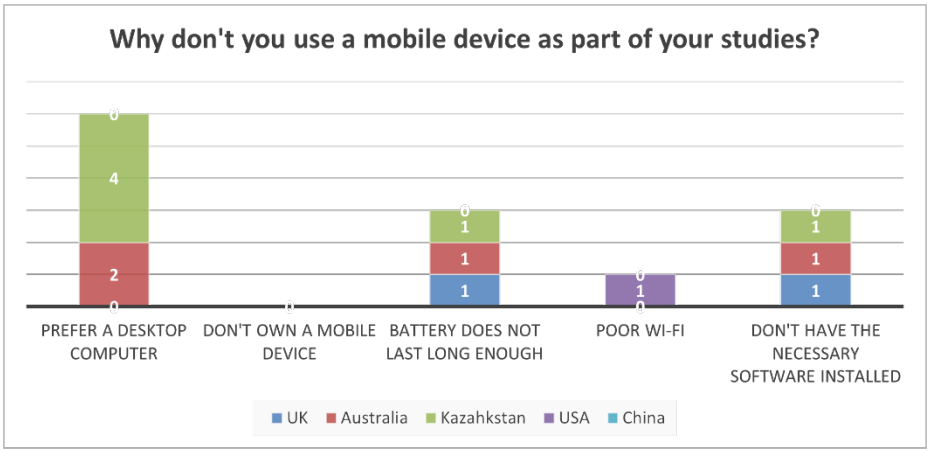

Fig. 3. Reasons for not using a mobile device

Given that there is so little variation in the reasons behind why students don't use a mobile device as part of their studies this is in stark contrast to the reasons why student do use a mobile device for their studies (figure 4). For American students the social element of learning is a key priority, having social connectivity and being able to share ideas was vital to their learning experience. This is the opposite for Australian, British and Chinese students who see completing their work as the primary reason for using mobile devices in the classroom, a fact some educators may find hard to comprehend given the impediments some associate with using mobile devices in their classrooms [16].

Chinese students noted that aesthetics were an essential aspect, being seen with the latest technology is vital and the majority of students actually used multiple devices for their learning. A laptop to complete their main tasks, tablet to do secondary research and a smartphone to connect with peers. Despite the cultural differences and variations in prior education, students from those HE institutions researched have a common theme and approach to ICT use as part of their studies, that its role is as important as any other teaching method and a key component for their successful learning.

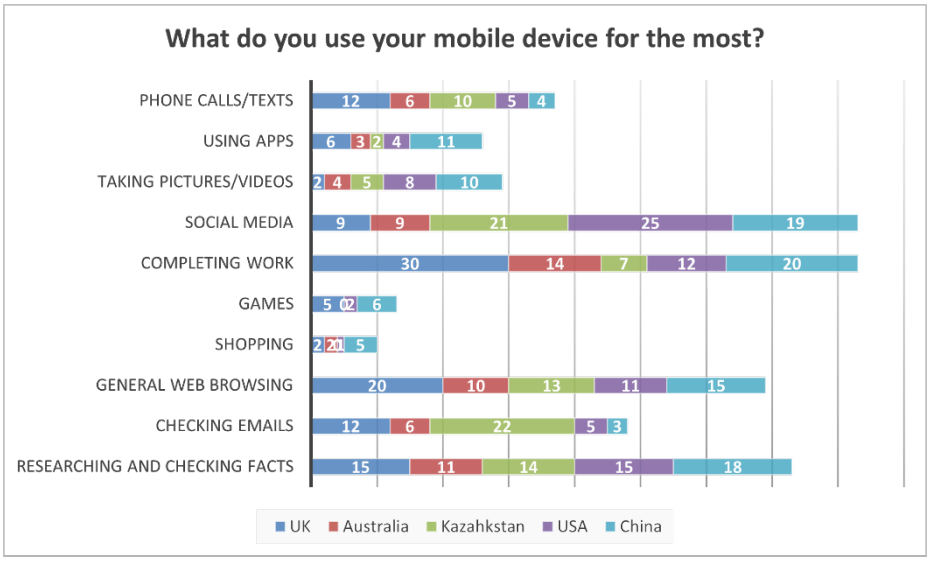

Fig. 4. Mobile device use

The desire is to encourage students from all countries, irrespective of their ability or background to be able to actively engage in classroom activities by using their own mobile devices, the key starting point to this lies within figure 5. By knowing what actual students would like to use their mobile devices for in the classroom then academics and course planners can consider these when designing and delivering their teaching.

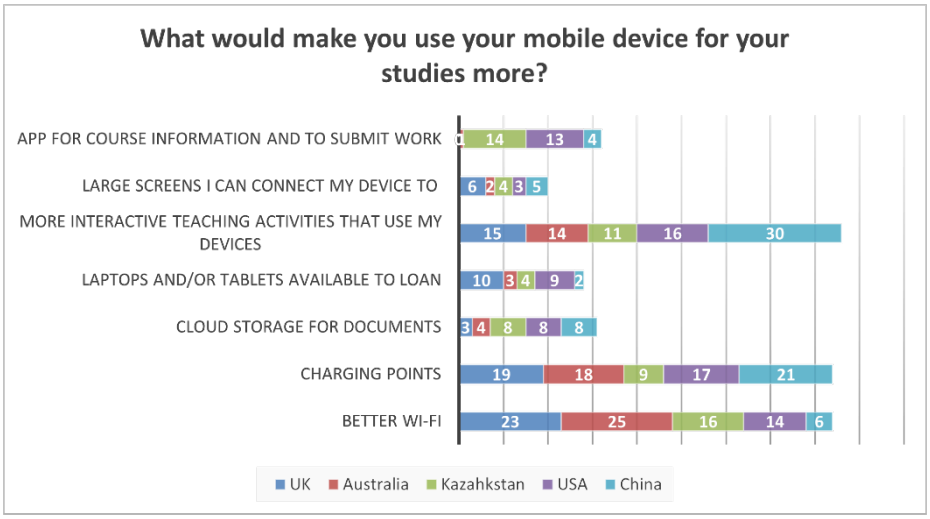

Fig. 5. Increased mobile usage

Overall students want more interactive teaching activities that use the full capability of their devices, rather than just using them to type Word documents or Google a question. However, when analysing the data in more detail there are geographical disparities. Australian students felt that the network and infrastructure was a limiting factor, it didn't really support their devices and American students wanted more access to power outlets so they could charge their devices throughout the day.

5 Conclusion

This research paper had sought to ascertain if mobile device use in the classroom can facilitate student engagement within a HE setting across different international institutions. From the data gathered there is clearly a desire on the part of students to use a range of devices in support of their learning. There are however challenges when using mobile devices in the classroom, one such drawback often cited is the distraction these devices can help to facilitate by encouraging users to multitask [16]. The problem with multitasking is an overall decrease in quality of the individual activities [17]. However, from the students' own comments, they appreciated being able to multi-task, completing several different activities using multiple technologies as being the most convenient. The contradiction of the empirical evidence and the students perception is how many problems arise, as educators we seek to base our practice on evidence without always considering how this may be perceived by the students we are attempting to teach.

Teacher training could be used to help overcome some of these barriers to technology adoption and increase an awareness of student perceptions but this forced training is seen by some members of academia as merely a tick box exercise and is never taken seriously. Despite this it should be noted that the researchers strongly urge academic policy makers and work planners to encourage their academic delivery staff to make adequate provision that would facilitate students to bring their own devices into the classroom. This research has clearly demonstrated that there is a desire by the students for this to happen and any student-led activities are likely to have greater success.

Students from all five countries commented that using mobile devices as part of the classroom enhanced the learning experience rather than diminished or interfered with the learning process. A number were frustrated at the fact that whilst mobile technology had come on in leaps and bounds over the past 10 years, HE had failed to keep pace and there were too many instances of technology being seen as an intrusion, particularly so in those countries where HE is well established. Those countries whose HE institutions are relatively new appear to have a far more open perspective towards the introduction of mobile technology in the classroom and are embracing the possibilities these can bestow.

The limitations to the data set used to form these correlations primarily lie with focusing on a single institution within each of the participating countries. The type

and background of students attending HE vary by institution which could have an impact on the reliability of the findings. However, given the institutions involved incorporated relatively new universities Nazarbayev (founded in 2010) and Sheffield Hallam (university status in 1992) alongside more established institutions Western Australia (founded in 1911) and Illinois (founded in 1859) the similarity of student responses to key questions mitigates any such concerns.

Notwithstanding these limitations it still provides a basis from which Higher education institutions and academics can begin to adapt their teaching resources. They can use this information to ensure they tailor their teaching resources to factor this device preference into their teaching activities. For example, an academic delivering a course in those countries that have a preference for using smartphones should design interactive teaching activities that utilise the gyroscopes and touch screen controls of a modern smartphone. Such examples can be as simple as creating a scavenger hunt using Geocaching to more complex augmented realities. Even so, these need not be expensive, Google cardboard can create a quick and effective Virtual Reality headset with a plethora of content available on YouTube's VR channels.

This research has analysed mobile device use and student engagement within a HE setting but it does so from a social lens which has demonstrated a need for further research into the precise methods and means by which technology can be truly integrated with the curriculum without being viewed as an intrusion. Consequently future research shall seek to design a specific technological intervention that will be designed and implemented by the students themselves. By having the participants for whom the intervention is intended to help at the core of the design stage will create an opportunity to compare a different method of delivery and hopefully overcome some of the pre-conceived limitations.

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