Assessment and learning outcomes: the evaluation of deep learning in an on-line course

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Assessment and Learning Outcomes: The Evaluation of Deep Learning in an On-line Course

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ABSTRACT

Using an online learning environment, students from European countries collaborated and communicated to carry out problem based learning in occupational therapy. The effectiveness of this approach was evaluated by means of the final assessments and published learning outcomes. In particular, transcripts from peer-to-peer sessions of synchronous communication were analysed. The SOLO taxonomy was used and the development of deep learning was studied week by week. This allowed the quality of the course to be appraised and showed, to a certain extent, the impact of this online international course on the learning strategies of the students. Results indicate that deep learning can be supported by synchronous communication and online meetings between course participants.

Keywords

Quality Assurance issues, Impact on learning strategies, Synchronous communications, SOLO taxonomy, Deep learning, Occupational therapy

INTRODUCTION

Synchronous communication is little-used in on-line courses at present, owing to real-time communications not being sufficiently reliable and the greater bandwidth requirement compared with email-based courses such as those based on FirstClass or Blackboard.com. When Internet Chat facilities are available, they are simple add-ons and are not integrated into the course structure. However, future improvements in communications will make it possible for courses to use synchronous communications systematically. It is recognised that synchronous communications promote motivation and group cohesion, as well as providing good feedback, supporting consensus and decision making, and assisting pacing - encouraging people to keep up to date and providing discipline (Mason, 1998). However, it is more difficult to schedule group meetings, and synchronous tutorials are relatively more expensive as the optimum group size is so much smaller. Synchronous working meetings follow face-to-face groups in typically having less than ten participants, compared with asynchronous groups of twenty or more. Given these disadvantages, it is important to establish what aspects of synchronous courses lead to the effective development of deep learning, and the factors that promote a successful outcome. The Occupational Therapy Internet School (OTIS) pilot course has provided an opportunity to study the development of deep learning in a ten-week course with a substantial degree of synchronous communication.

Synchronous communication was a key requirement for the OTIS pilot course, entitled *"High level assistive technology in European occupational therapy"* (Armitt et al., 2001). The course

was collaboratively developed and run by four higher education institutions in Liverpool (UK), Amsterdam (Netherlands), Kortrijk (Belgium) and Linköping (Sweden) during January - March 2001. Students were divided into four tutorial groups of mixed nationalities, each group solving a different case study. The course was designed to promote specialist skills in occupational therapy, while also developing generic core skills. Embedded within this latter skill set is the essential ability to communicate effectively and collaborate with a wide range of clients and allied professionals. In the case of OTIS, the course sought to stimulate synchronous communication and collaboration within international online student groups, and also with 'patients' (tutors in role-play) and experts such as health care specialists or representatives of companies marketing assistive technology devices.

The aim of this paper is to report the qualitative evaluation of this course, which took place after the course was completed. Analysis, using the SOLO (Structure of the Observed Learning Outcomes) taxonomy (Biggs & Collis, 1982, 1989), was carried out on the transcripts of students' synchronous communications. This was supported by an evaluation of the final assignment.

THE SOLO TAXONOMY

The SOLO taxonomy is a well-established technique for establishing the presence of deep learning, and is becoming widely used in education, including:

- allocating a cognitive level to individual course objectives (Australian National University, 2000)
- helping students analyse their own work and see how to improve it (University of Alberta, 2001; University of Bradford, 2001)
- explanation of assignment grades (University of Sydney, 2001)
- assessment (Hoddinott, 1998)
- predictor of potential (Crowley & Tall, 2001)
- research into education (Anderson & Walker, 1997)

The SOLO taxonomy identifies the complexity of thought processes in the statements, based on a classification into prestructural, unistructural, multistructural, relational and extended abstract, the levels being derived from the work of Piaget and his stages of cognitive development. Statements are expected to show a continuum of learning from initial recognition to reflection and complex understanding (Hewson & Hughes, 1998). As with Piaget's stages, once a student has reached a particular level in SOLO regarding a concept, s/he is now capable of continuing to operate at that level with regard to that concept. However, a student may not always show evidence of being at that level consistently, since SOLO levels are used to "describe a particular performance at a particular time" (Biggs & Collis, 1982; p.23) and not to indicate a student's ability.

DEEP LEARNING

It is important for all health care professionals to experience deep learning in their professional training programmes. This not only ensures quality learning but is also a safeguard for the future, in that such health care professionals will display a holistic approach to their clients, with emphasis on quality of care. Clinical education has been shown to be effective in facilitating deep learning (Coles, 1989, 1990) and for students in the academic environment realistic case

studies explored via a stimulating problem-solving approach, can form a close approximation to learning from real life.

Educators suggest that students who are personally involved in learning from real life situations are the ones who are most likely to experience deep learning. McAllister et al (1997) suggest that "deep approaches to learning are found in students who are affectively involved in searching for personal meaning and understanding (their own personal practical knowledge), seeing the whole picture or person - not just the isolated features or disembodied problems - drawing on their personal experience to make sense of new ideas and experiences and relating evidence to conclusions. These deep learning approaches are in marked contrast to surface approaches exhibited by students who seek only to memorise and reproduce information or skills, see only the discrete "bits", expect the educator to be in control of their learning, and are largely motivated by the external imperative to pass an assignment or gain their qualification."

The stimulation of reflection is essential for deep learning, as the reflective process includes synthesis of knowledge through re-evaluation of the experience by undertaking association, integration, validation and appropriation (Boud et al., 1985). Reflection may be facilitated through interaction with peers or tutors, or alone through writing (Lincoln et al., 1997). Synchronous on-line courses must answer the question of whether real-time communication with peers and tutors is effective in promoting reflection.

THE PILOT COURSE

The OTIS course was concerned with the application of high-level assistive technologies (e.g. computer applications, intelligent monitoring of homes) to patient need. The course employed a problem-solving approach, in which students tackled one of four case studies in collaborative international groups of three to six undergraduate and post-graduate occupational therapy students. Although the case studies were in different areas of occupational therapy (e.g. partial paralysis, speech difficulties), all four case studies required students to follow the same general approach of (1) analysing the patient's circumstances, (2) identifying the patient's needs and expressing those needs as characteristics of assistive technology devices, and (3) selecting appropriate technologies to match those needs.

The students were based in their own countries and all communication between them was solely online. The eighteen students who completed the course were divided into four tutorial groups, such that the different student nationalities were spread as evenly as possible between the groups. The language of the course was English, and all students spoke and wrote English well, even though English was a second language for the Dutch and Swedish students and a third language for the Belgians. Although much time was spent in advance of the course in discussion of the philosophy and concepts of problem based learning, no detailed guidance was given to tutors and differences emerged in the way in which each group was managed.

METHOD

The Data:

Since the problem-solving approach requires synchronous communication it was appropriate to evaluate evidence of deep learning using the students' own statements in the communication sessions. The OTIS software allowed logging of all user activities, including all communications using the 'Talk' and 'Page' Internet Chat facilities. 'Talk' allows a user to broadcast to everyone present in the same 'meeting room', and 'Page' enables a user to make a private comment to one

or more selected users. When registering to use the OTIS system, all users gave their written consent to their personal data being used anonymously for research purposes, including establishing patterns of activity. There was no specific intention until after the course had finished of using primary data from transcripts for evaluation of the course, so the behaviour of participants is unlikely to have been affected by the data collection.
An additional source of data was the final assignment submitted by each student at the end of the course. This comprised a essay evaluating the learning experience on the course and reflecting upon the student's personal development and experience.

Initial data extraction:

The transcripts provided several hundred pages of data, concerning not only the solution of the case study, but also the process of preparing the assignments, social interactions and discussion of how to use the OTIS system and various technical problems. A decision was made to focus on the following published learning outcome for the OTIS course:

> *Upon successful completion of this course participants who have reached the required educational level will have:*
>
> - *displayed expertise in following a problem-solving process to match technology to individual client need.*

A preliminary extraction was performed, in which all statements where students discuss the solution of the case study were extracted, plus intermediate 'linking' statements required to understand the flow of the conversation. Throughout this study, a statement has been defined as a sentence or group of sentences that the student sends or broadcasts as a unit (statements from tutors, clients and experts were ignored). At this stage it was established that the client and expert session data largely consisted of students questioning the clients and experts. Such data was largely excluded from the following analysis, except where the students were actively discussing the case solution.

The SOLO Taxonomy:

Analysis of the transcript data from the preliminary extraction was carried out using the SOLO taxonomy, focusing solely on the statements directly concerned with the learning outcome. The first step was to specify the meaning of each level in the SOLO taxonomy in terms of the selected OTIS learning outcome on matching technology to client need. This method allows the learning outcome to be evaluated in a qualitative way by describing the student's points of learning in a specific task. The levels from 'unistructural' to 'relational' are seen to be the "target mode" (Biggs & Collis, 1989; p.152) of the learning outcome, whereas 'prestructural' indicates that the student has not yet achieved the target mode and 'extended abstract' shows that the target mode has been overshot.

To illustrate the use of this technique with the learning outcome defined above, Figure 1 defines each level in the SOLO taxonomy and gives an example from the OTIS transcripts.

Figure 1: Structural levels in learning. Examples are from the 'Esther' case study, concerning a teenage girl with learning and speech disabilities.	
SOLO Level	**Example**
Prestructural	The statement ignores the client, the client's need and the technology.
Unistructural	The statement focuses on one relevant aspect: the client, the need or the technology. *e.g. "that is the problem; we don't really know what the [Esther's] cognitive level is"*
Multistructural	The statement identifies more than one aspect about the client, the need or the technology, but does not integrate them. *e.g. "f.e. [for example] (i think) Tellus [an assistive technology aid], you can put it instead of the wheelchair table, so you can eat, write,… on it, and if you want to communicate, you put the raster on it"*
Relational	The statement makes a coherent link between the issues related to the client, their need and technology. *e.g. "the thing is that her coputerized [computerised] comm. [communication] aid has to be rather small and not wheigh [weigh] too much and be easy to handle for Esther, but maybe it's possible with a very small laptop to combine her speech and education."*
Extended abstract	The statement explores issues relating to the client's needs and technologies in general, beyond the scope of the case studies. *e.g. "i guess every centre has got several aid[s], so more than one kid can use the computer with an other aid, you just have to change the aid when an other kid uses the pc."* (based on the student's experience of adapting an aid to Esther's circumstances)

RESULTS

Initial Data Extraction:

The simple procedure of performing an initial data extraction of all material concerning the solution of the case study proved a powerful tool in evaluating the course. This showed examples of students interacting with each other as they engaged in reflection and synthesis of knowledge (Figure 2).

Figure 2: example of student interaction (names changed) **Week 5, tutorial group B**
Ingrid asks "there are some amazing things you can do to adapt the pc, for example running it with infrared light so you just have to be able to move your head slightly etc, have you tried that?"
Dirk says, "i did once"
Gerhard asks, "me neither, is it easy to do so regarding to Esthers problem?"
Ingrid says "I don't hink the infrared is a solution for Esther since she might have some problems in focusing and keep the balance with her head, maybe scanning would be something for her, or pointng as she do now"
Dirk says, "that is why i asked to mr vandyk [Esther's father] how she can use her head, he answerd that it s difficult when she is tyred, and i don't know if that is very good for the spastic patern "
Dirk says, "i agree with that ingrid"

The data revealed marked differences between the tutorial groups, concerning:

- the relative amount of time spent discussing the solution to the case study (the "content"), compared with establishing administrative/mechanical details (what to do and when to do it, the "process").
- when discussion of the case study takes place (in tutorials or in peer group meetings).

Figure 3 shows the pattern of extracted data by week of the course and tutorial group during weeks 2-7 when the case study was solved. Tutorial group A spent much more time than the other groups in discussing case study solutions during tutorials. In the other groups, most of the tutorial time was spent on the process rather than the content. Even in group A, the amount of time spent discussing the process during tutorials increased as the course proceeded. However, group A was the only group not to meet outside the tutorial session to discuss the case solution. The other groups undertook the majority of their discussion of content in the peer booked meetings, peer ad-hoc meetings being predominantly social.

Figure 3: occurrences of data concerning content (number of relevant student statements in brackets)

Week	**Tutorial Group A**	**Tutorial Group B**	**Tutorial Group C**	**Tutorial Group D**
Number of students	6	3	5	4
Week 2	After tutorial (37)	Tutorial (4) Extra tutorial (4)	-	-
Week 3	Before tutorial (26) Tutorial (84) After tutorial (18) Peer ad-hoc meeting (19)	Client session (32) Tutorial (15)	Peer ad-hoc meeting (6) Peer ad-hoc meeting (9)	-
Week 4	Before client session (13)	-	-	-
Week 5	Before tutorial (6) Tutorial (24)	Client session (25) After tutorial (12) Peer booked meeting (90)	Peer booked meeting (56)	Peer booked meeting (40)
Week 6	Expert session (70)	Peer booked meeting (69)	Tutorial (4) Peer booked meeting (69)	Expert session (8)
Week 7	Tutorial (30)	Expert session (10)	-	Peer ad-hoc meeting (16)

Further to this transcript data, the role of the tutor and the pattern of social exchange (discussing personal matters outside the course or their impressions and feelings about the course) within the groups were examined. This established that:

- Tutor A held "text book" problem-based learning sessions in the early weeks, and did not believe in being proscriptive in directing the students' learning. The fervent hope was that students would collaborate outside the tutorials, but in practice this did not happen except in the peri-tutorial period, when either the tutor arrived to start the session, then 'disappeared' for a period, or after the tutorial (weeks 2 & 3). In week 5, the tutor advised students to send each other emails if they did not meet on-line.

- Tutor B strongly encouraged students (weeks 2 & 3) in general terms to meet each other without the tutor being present. They met socially for 64 and 55 minutes in each of weeks 4 & 5, before the working sessions in weeks 5 & 6 recorded above as “peer booked meetings”. This student group also used email extensively from week 5, to pass round information acquired on assistive technology devices.
- Tutor C strongly encouraged students during the week 5 tutorial to meet to discuss the case study, following a more general comment in week 3: “It is good to show collaboration throughout, rather than just as a conclusion". The group booked working sessions in weeks 5 & 6. Up to this point, they had had little interaction outside the tutorials.
- Tutor D strongly encouraged students to share their findings by email (tutor statements in weeks 2, 3 & 5). The email data is not available to the research team. The students booked a peer group meeting in week 5, in which they mostly exchanged information about their individual approaches to the case study (listing references or websites), rather than discussing the outcome of the case study.

Application of the SOLO Taxonomy:

Figure 4 shows the results of applying the SOLO taxonomy to the statements concerning the selected course outcome, by group and week, for the weeks during which the case study was ‘solved’ (weeks 2-7). Statements were only included if there was sufficient information relevant to the learning outcome for them to be categorised to the appropriate SOLO level.

Figure 4: breakdown of raw data by group and week

Tutorial Group A:

SOLO Level	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Week 7**
Prestructural						
Unistructural	4	24			1	
Multistructural	3	13	1	1	2	
Relational		4		1	1	
Extended abstract						

Tutorial Group B:

Prestructural						
Unistructural	4	7		13		1
Multistructural		5		7	8	1
Relational		6		24	5	1
Extended abstract				2	1	2

Tutorial Group C:

Prestructural						
Unistructural		3		10	3	
Multistructural		1		3	6	
Relational		1			17	
Extended abstract						

Tutorial Group D:

Prestructural						
Unistructural				11		
Multistructural				1	2	2
Relational				2	1	6
Extended abstract						

Looking at all the groups, the SOLO results offer the following indications:

- the lack of prestructural statements shows that students were aware of the problem domain and were already working in the appropriate mode of the learning cycle.
- the decreasing number of unistructural statements show that students were, in the early weeks, establishing the ground for their task.
- the highest number of multistructural statements were found in the middle weeks of the course and show that students were exploring more than one aspect of the task, but not yet making links.
- most relational statements were also found in the middle weeks of the course when students were linking together the issues of the learning outcome; i.e. the client, the client's need and the assistive technology.
- extended abstracts emerged from week 5 onwards. This shows that students were taking the issues of the learning outcome, abstracting and generalising them beyond the confines of the case study.

DISCUSSION

Application of the SOLO Taxonomy

This study has offered a unique opportunity to use the SOLO taxonomy on transcripts derived from synchronous communications. We believe that this method has not been reported before. Since the method used here is a qualitative approach to the analysis of a case study, the results cannot be generalised to other studies. However, some of the issues identified in this work may be extrapolated into other similar studies.

There have been limitations in the application of SOLO. Firstly, synchronous communications favour relatively short statements so that the sender can avoid the conversational thread being diverted by other participants. This means that a thought may be transmitted as two or more statements, which, while connected in the sender's mind, would score relatively lowly under SOLO. Also, when established groups communicated, they sometimes did so in a type of 'shorthand', which had an underlying assumption that the others knew what they meant. A question late in the course "What about using Tellus?" (an assistive technology device) actually

meant in the context of the discussion, “What about using Tellus for Esther? We’ve all agreed on Esther’s needs and capabilities, and Tellus seems to have the right features to match her need. Do you agree?” (relational). The same question early in the course would be information-seeking (unistructural). This meant that SOLO was particularly difficult to apply to statements late in the course, when students were working at a higher conceptual level. This may partially account for the relatively low number of classified statements later in the course.

Nevertheless, SOLO provides a good indicator of the relative levels attained within the different collaborating groups through the weeks. The low number of relational statements for tutorial group B in week 6 appeared anomalous. Revisiting the transcript showed that this seemed to arise from problems applying SOLO - the group was brainstorming at a highly relational level in a many threaded ‘shorthand’, which proved difficult to analyse.

Synchronous Communication and Reflection

The results from the initial extraction show that high quality synchronous discussions do occur, though collaborative consideration of the course content generally did not happen as often as the course organisers would have liked. A feature of such discussions is that students develop a theme as they reflect on the information and thoughts put forward by other students as well as themselves. In such conversations, the whole is better than the sum of the parts - in other words, synthesis of knowledge is taking place as a direct result of the interaction. Through discussion, students are making cognitive connections between different themes.

It has been generally accepted that synchronous communication is inferior to asynchronous in stimulating reflection, as the student does not have as long to compose a reply (Mason, 1998). We suggest that both types of media are potentially valuable, and this is consistent with Lincoln et al.’s conclusion (1997) that reflection can be stimulated either through interaction with other people (peers, tutors) or alone through personal reading and writing. Students who are used to working in groups, such as health care students undertaking problem-based learning, are used to taking advantage of both means of reflection. For such students, the complementary approaches of synchronous and asynchronous activities mirror their complementary approaches to reflection.

Taken in conjunction with the quoted advantages of synchronous learning - motivation, group cohesion - and the enjoyment of other people’s company, synchronous communications can potentially enrich on-line courses greatly. Synchronous discussion should have the advantage of allowing restructuring, reflection, synthesis, and challenging of ideas in a more dynamic and responsive way than email. One of the criticisms of forum-type discussion groups in wholly asynchronous courses (Chambers, 2000, Cox et al., 2000) is that students can be overwhelmed by emails as a discussion develops. This can lead to shallow reading and a ‘cut and paste’ approach. Synchronous discussions, by comparison, allow immediate clarification and development of thoughts.

Development of Deep Learning During the Course

Although the amount of SOLO data on each individual group is quite small, it does demonstrate very different patterns of learning in the four groups. Apart from group A, where there is insufficient data after week 3, all groups showed the expected advancement from unistructural to relational levels as the course proceeded. There seemed to be an improvement of approximately one SOLO level in each week *in which relevant statements were identified*. There seemed to be no such improvement in weeks without relevant statements, even though students may be

assumed to be working on their own, or may be collaborating by email. This is seen particularly clearly in groups C & D. This suggests that a synchronous element in on-line courses does indeed assist in promoting deep learning.

The point at which relational statements exceeded other types of statements varied considerably (group A: not at all, group B: week 5, group C: week 6, group D: week 7). It appears that the sooner the group starts to make relevant statements, the sooner it reaches the relational level. Many of the higher level SOLO statements arose during long peer group meetings in weeks 5 & 6. In this course, peer group meetings had great value in stimulating reflection, and peer groups, which held more frequent working meetings had a clear developmental advantage over other groups. Given the high cost of tutoring in a synchronous environment, it seems that courses would gain most educational benefit from using this environment mainly for reflective peer group discussions. The peer group meetings seemed also to help with time management, encouraging students to work more evenly through the course, rather than leaving everything to the last minute.

Stimulation of Peer-to-Peer Collaboration

This course confirms earlier work, which show that students who have never met each other do not spontaneously collaborate in peer groups (Chambers, 2000). This study showed that tutors needed to make their expectations for collaboration known. The tutors for groups B & C actively encouraged their students to set up peer group meetings, which subsequently took place. The tutor for group A hoped that students would set up working meetings, but this did not happen. The tutor for group D encouraged the group to collaborate primarily by email, and this was what happened.

This is consistent with the necessity for groups to pass through the third stage of Salmon's Five Stage Model for induction into CMC systems (Salmon & Giles, 1999; Salmon, 2000):

1. Gaining access to the system, logging in, getting started, 'netiquette'
2. Becoming familiar with the on-line environment, finding others with whom to interact
3. Encouragement to seek and give information to each other
4. Interacting in group discussions
5. Looking for other benefits from the system to achieve personal goals

This study also supports earlier work (Wegerif, 1998; Cox et al., 2000) which shows that prior social interaction and bonding is important in groups becoming effective educationally. Group B, which had long social conversations early on, achieved the relational level in SOLO quicker than other groups. The tutor for group B had strongly encouraged students during weeks 2 & 3 to meet informally, and this may have been a factor in the faster development of this group.

Reflection in learning

The problem-based learning approach in OTIS meant that students had to work together in groups. In order to do this, they had to use synchronous communication to contact their group members in tutorials and peer booked meetings. The comments quoted here come from the students' own reflections on their learning, which they submitted, at the end of the course, as the final assessment. They are, therefore, stated with hindsight.

"Concerning the international teamwork it was very interesting to learn new people. At the beginning cooperation was very laborious but it became better with the time. I think during the

case there rose a fruitable cooperation between us peers and we had the possibilitiy to learn from each other how to work on a problem and also exchange some information regarding assistive technologies." (Student 2C)

It is interesting to see that, although there were some undoubted difficulties, both technical and conceptual, the students felt that they did derive some benefit from the experience of OTIS.
"I think though that one of the most positive things about taking this Otis course is to get to know students/teacher in other countries, and also the great opportunity to practice the English language." (Student 1F)

Collaboration and virtual teamwork developed in the groups as they contacted each other and began to build communities with some element of trust and responsibility for each other.
"Contacts with peers students? That was very nice. We mailed, helped and motivate each other. We were real group. I hope we will keep contact even after this course. That's something that I would really wanted." (Student 4B)
However, the small number of students enrolled on the OTIS course meant that the online learning environment was very sparsely populated, with individual students often being the only one in the environment. It was perceived to be difficult to contact students in other tutorial groups.
"I have some contacts with other peers, but less. That's a pity! I wanted some contacts with other peers but every time I went to OTIS, there wasn't anybody. To book a room on a time is difficult because everyone has his own activities during the week and weekend. I also don't mail to anyone, because I don't feel I needed it." (Student 3C)

The students' own reflections on their experiences in OTIS have supported the evidence provided by the synchronous data samples and the literature of the area.

CONCLUSIONS

We have found that the SOLO taxonomy can be useful in the initial analysis of transcript data. Extraction of transcript data relevant to a particular learning outcome provides immediate pointers to the successes and failures of a course, and these pointers can be confirmed using SOLO, despite difficulties in applying SOLO to short statements in synchronous communications.

Results for the OTIS pilot course show that development of deep learning in synchronous groups does not happen spontaneously throughout the course, but is promoted by online discussion of the course content. Groups which interact more effectively develop cognitively more quickly than other groups as the course proceeds. Where in depth on-line discussions take place, SOLO has shown an immediate benefit in terms of the depth of learning achieved. It is significant that many of these discussions were peer-to-peer in the absence of the tutor, at later stages in the course when the students are becoming autonomous learners within the subject area. While wholly synchronous courses are probably not financially viable owing to the tutoring costs for small groups, this study shows that a synchronous peer-to-peer element can be beneficial in promoting active reflection. We propose that the most effective and educationally advantageous way to deploy synchronous communications is for peer-to-peer meetings later in the course, within courses primarily tutored asynchronously.

Groups do not spontaneously coalesce to undertake effective in-depth synchronous discussions. This study demonstrates the importance of tutors ensuring at an early stage in the course that students understand their expectations regarding when and how to collaborate. More work is

needed into the changing balance of the activities of the student and tutor at different points in the course, taking into account the promotion of the social and collaborative development of the group and the group's developing capabilities as a community of autonomous learners.

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REFERENCES

Anderson, D. & Walker, R. (1997) Quality of learning outcomes amongst teacher education students, *Refereed Proceedings of the 27th Annual Conference of the Australian Teacher Education Association (ATEA)*, Yeppoon, Queensland, Australia, July 1997 [on-line] http://atea.cqu.edu.au/content/soc_base/anderson.html

Armitt, G., Green, S. & Beer, M. (2001) Building a European Internet School: Developing the OTIS Learning Environment, *European Perspectives on Computer-Supported Collaborative Learning, Proceedings of the First European Conference on Computer-Supported Collaborative Learning, March 2001, Maastricht, Netherlands*, 67-74, Maastricht McLuhan Institute.

Australian National University, Department of Computer Science (2000) COMP3100: Software Engineering Group Project [on-line] http://cs.anu.edu.au/Student/2001/COMP3100/

Biggs, J.B. and Collis, K.F. (1982) *Evaluating the quality of learning: the SOLO taxonomy*, Academic Press.

Biggs, J.B. and Collis, K.F. (1989) Towards a model of school-based curriculum development and assessment: using the SOLO taxonomy, *Australian Journal of Education, 33*(2), 151-163.

Boud, D., Keogh, R. & Walker, D. (1985) Promoting reflection in learning: A model. In D. Boud, R. Keogh & D. Walker (eds), *Reflection: Turning experience into learning,* 18-40, London, Kogan Page.

Chambers, E. (2000) Contextualizing the CEFES project: A selective review of the computer conferencing literature. In Baumeister, H-P., Williams, J. & Wilson, K. (eds) *Teaching Across Frontiers: A Handbook for International Online Seminars*, Deutsches Institut für Fernstudienforschung an der Universität Tübingen, 153-166.

Coles, C. (1989) The role of context in elaborated learning. In Balla, J., Gibson, M. & Chang, A. (eds.) *Learning in medical school: A model for the clinical professions.* Hong Kong University Press, Hong Kong.

Coles, C. (1990) Elaborated learning in undergraduate medical education, *Medical Education*, 24, 14-22.

Cox, E.S., Clark, W., Heath, H. & Plumpton, B. (2000) Key Facilitation Skills for Effective On-Line Discussion Groups: Herding Cats through Piccadilly Circus, '*Distance Education: an open question?' Conference Proceedings*, Adelaide, Australia, Sept. 2000 [on-line] http://www.com.unisa.edu.au/cccc/papers/refereed/paper11/Paper11-1.htm

Crowley, L. & Tall, D. (2001) Attainment and Potential: Procedures, Cognitive Kit-Bags and Cognitive Units, submitted to PME25, July 2001 [on-line] http://www.uky.edu/LCC/MATH/Crowley/papers/PME25.pdf

Hewson, L. and Hughes, C. (1998) Templates for online teaching, *ASCILITE'98*, 329-338 [on-line] http://cedir.uow.edu.au/ASCILITE98/asc98-pdf/hewsonhughes.pdf

Hoddinott, J. (1998) Constructive alignment: A pedagogical model applied to a plant physiological ecology subject delivered over the world wide web, *ASCILITE'98 Proceedings Supplement* 21-22
[on-line] http://cedir.uow.edu.au/ASCILITE98/abw_09c.html

Lincoln, M., Stockhausen, L. & Maloney, D. (1997) Learning Processes in Clinical Education. In McAllister, L., Lincoln, M., McLeod, S. & Maloney, D. (eds), *Facilitating Learning in Clinical Settings*, 99-129, Stanley Thornes, Cheltenham

McAllister, L., Lincoln, M., McLeod, S. & Maloney, D. (eds) (1997) *Facilitating Learning in Clinical Settings*, Stanley Thornes, Cheltenham.

Mason, R. (1998) *Globalising Education: Trends and Applications*, Routledge
[on-line] http://iet.open.ac.uk/pp/r.d.mason/globalbook/syncasync.html

Salmon, G. & Giles, K. (1999) Creating and Implementing Successful On-Line Learning Environments: A Practitioner's Perspective. *European Open and Distance Learning Journal*
[on-line] http://kurs.nks.no/eurodl/eurodlen/index.html

Salmon, G. (2000) *E-Moderating: The Key to Teaching and Learning On-Line*, Kogan Page, London

University of Alberta, Department of Biology (2001) Botany 431 - Physiological Plant Ecology. Teaching, Learning and the Development of Student Thinking
[on-line] http://www.biology.ualberta.ca/courses.hp/bot431.hp/thinking.html

University of Bradford, Department of Civil and Environmental Engineering (2001) Communication Skills - First Class Answer [on-line] http://www.brad.ac.uk/acad/civeng/studsupp/fca.htm

University of Sydney (2001) BACH5186 Graduate Skills for Professional Development, Grades Table, Explanation of Assignment Grade [on-line] http://www.cchs.usyd.edu.au/bach/5186/grades_table.htm

Wegerif, R. (1998) The social dimension of asynchronous learning networks, *Journal of Asynchronous Learning Networks vol. 2 no. 1*, 34-49 [on-line] http://www.aln.org/alnweb/journal/vol2_issue1/wegerif.htm