### ORIGINAL ARTICLE

MG Gussy RJM Knevel V Sigurdson G Karlberg Theoretical and practical considerations for the development of online international collaborative learning for dental hygiene students

#### Authors' affiliations:

M.G. Gussy, School of Dental Science, The University of Melbourne, Melbourne, Australia *R.J.M. Knevel*, Dental Hygiene Education, University of Professional Education INHOLLAND, Amsterdam, the Netherlands *G. Karlberg, V. Sigurdson*, Karlstad University, Karlstad, Sweden

#### Correspondence to:

M. G. Gussy School of Dental Science The University of Melbourne 720 Swanston Street Melbourne, Vic. 3010 Australia Tel.: +61 3 9341 1499 Fax: +61 3 9341 1599 E-mail: gussy@unimelb.edu.au

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**Abstract:** Globalization and concurrent development in computer and communication technology has increased interest in collaborative online teaching and learning for students in higher education institutions. Many institutions and teachers have introduced computer-supported programmes in areas including dental hygiene. The potential for the use of this technology is exciting; however, its introduction should be careful and considered. We suggest that educators wanting to introduce computer-supported programmes make explicit their pedagogical principles and then select technologies that support and exploit these principles. This paper describes this process as it was applied to the development of an international web-based collaborative learning programme for dental hygiene students.

**Key words:** collaborative approach; computer-supported learning; dental hygiene education; globalization; internationalization

### Introduction

Computer-supported learning and teaching is now the rule rather than the exception in most schools in developed countries. Dental hygiene education programmes around the world have incorporated computer-supported learning to varying degrees (1). This ranges from simple retrieval of information (journal articles and websites) and word processing through bulletin boards, chat rooms and lecture slide access to subjects or programmes which are offered exclusively online (1, 2). However, the degree to which the use of technology in dental hygiene education is congruent with espoused pedagogical principles and assumptions is not always made explicit in reports of such programmes in the literature.

Alongside this explosion in the use of computer technology in higher education has been the development of curriculums that desire to be international in their outlook. It may well be that this movement has resulted from the globalization of information mediated by the development of computer technology.

The benefits of both these trends for students themselves are the potential for the development of respect and increased understanding and tolerance of diversity and a healthy understanding of international differences and issues (3). Additionally, it exposes students to alternative viewpoints and challenges them to consider different solutions to everyday problems.

The development of information and communication technology changes how, what, who, when, where and why we learn. These technologies can now be used to provide asynchronous learning/collaborative learning where individuals can access it at times convenient to them. A study of computerbased distance education conducted in the USA found that asynchronous methods were the approaches most commonly used by dental hygiene programmes (1). However, most studies of computer-based education/collaborative learning show that such approaches are limited to state/country areas (1, 4, 5). We were unable to identify any literature reporting computer-based dental hygiene education/collaborative learning across national borders.

This paper presents a review of literature conducted in preparation for the development of an international online distance course for dental hygiene students around the world. A pilot web-based distance programme entitled 'Oral Health in an International Perspective' (OHIP) was conducted in 2003 involving INHOLLAND University in Amsterdam, The Netherlands, and Karlstad University in Sweden. This programme had a study load of 7.5 ECTS (European Credit Transfer Scheme). The next stage of development is to expand OHIP to allow students outside northern Europe to participate. This will allow exposure of dental hygiene students to more diverse cultures and systems of oral health care. However, language and time zone differences introduce new challenges to the way technology is used in collaborative online learning and teaching.

This review highlights important issues for dental hygiene educators considering developing similar programmes. The

OHIP project development is underpinned by the theory of constructivism (which we will argue sits most comfortably with technology-supported learning) and the theoretical and empirical findings in the field of computer-supported education. It is also guided by the constraints and practicalities of a programme which includes participants from different time zones. This paper considers how constructivist learning theory can be realized in the context of computer-supported learning in dental hygiene education.

# Early applications of technology in teaching and learning

Early research into the use of computer technology in education was based on the transmission model of teaching and learning derived from behaviourist theory (6). This approach to teaching and learning assumes that the teacher (or computer) is the source of information and that the learner's role is to absorb and retain the information in the same format in which it is transmitted. Technology applications arising from this research included drill-and-practice and tutorials both of which have filled applications and limited information environment characteristics. This approach created learning environments that gave learners little control. In many on-line courses, lecture videos are downloaded and viewed by students and then discussed in a space in the bulletin board system (BBS) with the teacher and other students. In existing BBSs, the discussion topics are sorted by date in a linear fashion. Because this structure is not consistent with face-to-face discussions, students often have difficulties in following and adding to the discussion about the contents of the lecture. Further research is required to develop a system for integrating the discussion into the video to create a closer relationship between the video contents and the discussion (7).

### Constructivist learning theory and computer

Recent shifts in the philosophy and psychology of learning to a more constructivist orientation have been accompanied by a corresponding change in the research surrounding computer technology in learning (8). Much has been written about the effects of technology on learning theory and vice versa but it may be that technology research and learning theory have a reciprocal or dialectical relationship (8, 9). It is also suggested that a 'constructivist-driven, open-ended problem-solving and pupil-centred approaches are especially suitable for technology education' (10).

Constructivism is a term that encompasses many cognitive theories of learning and thinking. The common theme

although is the view that effective learning occurs when individuals construct their own understanding through interaction with the environment (11). Rather than simply absorbing information transmitted at them, learners construct their own truth or understanding by applying their existing knowledge to new incoming information. Learning-as-construction thus contrasts with the objectivist view that learning is the 'acquisition and accumulation of a finite set of skills and facts' (12).

Several salient principles of constructivism have been outlined (13):

1 Knowledge and beliefs are formed within the learner.

**2** Learning activities should cause learners to gain access to their experiences, knowledge and beliefs.

**3** Learning is a social activity that is enhanced by shared inquiry.

4 Reflection and metacognition are essential aspects of constructing knowledge and meaning.

From a constructivist viewpoint, learning can be viewed as active construction by individuals through interaction with their environments and through the reorganization of their own cognitive structures. Learners are involved in active learning which necessitates higher order cognitive skills such as analysis, synthesis and evaluation and is more likely to lead to better learning outcomes and student satisfaction (14, 15). This type of learning necessarily occurs in a social context. The four principles identified above will provide a loose framework for considering how computer technology sits with both a constructivist approach to learning and international/intercultural collaborative learning.

# Knowledge and beliefs are formed within the learner

Constructivist theory asserts that learning occurs when links are made between new information and individuals' existing knowledge. Two very important notions arise from this idea. The first is that students construct new understandings using what they already know and that prior knowledge influences what new or modified knowledge they will construct from new learning experiences. The second notion is that learning is active or interactive rather than passive. When confronted with new information, the student will judge the degree to which the new information matches the existing knowledge and based on that judgement modify existing knowledge.

The fact that learners construct meaning through linkages is particularly important when thinking about two computerbased applications – concept mapping and hypertext. Concept mapping predates hypertext and consists of a two-dimensional diagram representing 'the conceptual structure of a subject matter' (11). Concept mapping allows a learner to combine elements into a meaningful statement or proposition. Increasingly sophisticated software has been developed to allow learners to explore new areas of information through an interactive concept map. Gaines and Shaw have developed concept maps that their students can explore and interact with by editing and linking them to their own concept maps. They show how computer-based concept mapping tools can be used to aid collaborative learning by sharing maps on personal computers, working together on linked maps on different work-stations and sharing maps across the World Wide Web (WWW) (16). Various programs are commercially available such as INSPIRATION which supports complex, highly graphical three-dimensional mapping (http://www.inspiration.com) and Co-MOTION which is a shared whiteboard program which allows students to brainstorm and create concept maps (http://www.mayaviz.com/web/solutions/ comotion.mtml).

Using a constructivist design for a web-based course, Conceicao-Runlee and Daley had students create concept maps electronically with the INSPIRATION software program. The concept maps were then used as the format for on-line discussion of their understanding of texts they were required to read. They found that using these concept maps, students could share, discuss, alter or revise their maps as their learning and understanding of the concepts under study grew and changed (17).

Dental hygienists around the world practice in settings which vary in terms of legislation, material resources, health systems and cultural norms and values. Construction, display and comparison of concept maps by students in each of the participating countries should allow them to identify similarities and differences in the solutions offered to the clinical case. This comparison will stimulate discussion surrounding the cultural and social systems in each country and an appreciation of how these aspects influence the clinical practice of dental hygiene. It could also allow students to understand more clearly why they do the things that they do themselves.

There is an interesting similarity between the cognitive linking that underlies comprehension and the network-like structure of hypertext/hyper media. The hallmark of hypermedia and hypertext is its non-linear structure. This structure may more closely resemble the cognitive structures that learners construct as a result of learning than do traditional print media which requires the reader to follow the information from start to end. Hypermedia allows the user to determine the direction of use and the exploration of information. 'Since the essence of hypertext lies in its making connections, it provides an efficient means of accustoming students to make connections among materials they encounter' (9).

Supporters of the educational value of hypertext/hypermedia suggest that the effects of exposure to it will cause learners to incorporate these characteristics into their own thinking and presentations (18). Activities involving the personal construction of mental models using visual format that hypermedia affords may overcome some of the problems created by asynchronous online communication such as the difficulties of using BBS outlined previously. Others suggest that there might be a downside to Hypermedia (9, 19). The freedom to flit from screen to another could result in the shallow network of connections lacking any intellectual merit.

Concept mapping and the sharing and modifying of concepts via computer-mediated communication is an active constructive process through which strong links are made between new and existing concepts. Hypertext/media is also an active process allowing links to be made but caution must be exercised to avoid developing superficial networks.

## Learning activities should cause learners to gain access to their experiences, knowledge and beliefs

Constructivist learning theory asserts that there are many ways to interpret the world and that there are many perspectives or meanings for any one concept. These individual perspectives arise from experience, existing knowledge, beliefs, thoughts, feelings and actions (20). Learning activities should attempt to integrate all these aspects and should allow the learner to make explicit each of these aspects.

Email, teleconferencing and chat rooms have been used to link individuals and class groups from different cultures. There has been a report on the use of these mediums in a French language course for college students. One of the main reasons given by the authors for selecting this technology was to allow learners to reach what they call 'inter-cultural stance' – a place somewhere between the two cultures. From this inter-cultural position, students were able to look critically at their own culture as well as at the target culture. This allows a non-threatening critical analysis of the learner's personal and professional beliefs and values systems (21).

# Learning is a social activity enhanced by shared inquiry

Construction of meaning by individuals does not occur in a vacuum. Vygotsky believed that cognitive development was

based on social relations and subsequent constructivist theorists all acknowledge this. Meaning is, therefore, negotiated from multiple perspectives and the role of education (including dental hygiene education) should be to promote collaboration with others to bring multiple perspectives to bear on a problem (22, 23).

A case in point is the study by Järvinen which sought to examine the extent to which students spontaneously generate problem-solving situations and thereby create possibilities for the transfer of knowledge and skills within a group. The goal of the study was to familiarize pupils with some areas of computer technology, specifically control and programming skills. Students worked in groups using the Lego/Logo Control Lab learning system. A pupil-centred, open-ended problem-solving approach based upon the personal needs of the pupils and their past experiences was used. The author concluded that social interaction is extremely useful in promoting technological problem solving and learning. There appeared to be equal amounts of knowledge transfer among the pupils in which expert know-how was transferred to the novice and situations in which the pupils acted more like peers and learned from one another (10).

The benefits of this type of approach are twofold. First, learning outcomes are achieved. Secondly, and perhaps most importantly, it allows learners to realize that accomplishment is not the result of individual capabilities but the product of individuals and resources all making contributions and working towards a single goal. These skills are seen as valuable in most social settings including those in which dental hygienists work (24).

When considering the role of the WWW in collaborative education it is suggested that its current form is not well suited given the requirement for a high degree of real-time interaction (this is of course based on the assumption that synchronous interaction is superior to asynchronous interaction, which is controversial) (25). Currently available tools are criticized for being slow and unstable. Recent technological developments have led to a wide variety of programmes that allow for real-time audio and video as well as text communication such as Yahoo chat (http://chat. yahoo.com/?myHome) and CUSeeMe (http://www.cuseeme. com).

International projects such as OHIP, because of the time zone differences, are by their very nature mostly asynchronous with little opportunity to include face-to-face interaction in real time. It is, therefore, important that the other modes of communication are carefully considered, applied and evaluated.

# Reflection and metacognition are essential aspects of constructing knowledge and meaning

Evidence suggests that although students do not perform differently in electronic environments when compared with face-to-face environments (2, 26) the social context of such student-directed learning may develop and support important metacognitive skills. Reflection, metacognition and self-analysis can all be stimulated and developed through the construction, sharing and revision of things like concept maps (27). Even 'closed' computer-based simulations offer feedback in the form of process traces that can be used in a collaborative environment to reflect on performance and: 'Because different users will have different traces and see different events, collaborative discussion of the simulation experience offers learning opportunities as students co-ordinate *multiple points of view*' [our emphasis] (28).

Even the links created during searches of the WWW may soon be able to be used by students and instructors for reflective purposes as the use of cookies (small bits of data sent to the user's computer) is further developed. The user can check the state of the cookies at subsequent visits to a site and retrieve a memory of the previous transactions (25).

One of the advantages of asynchronous modes of computermediated communication is that there is the increased possibility for learners and teachers to reflect (28). As learners at each site are not engaged in face-to-face dialogue there is space for careful consideration before responding. Reflection before responding is considered a valued skill in learners; however, it is one which is often discouraged inadvertently by teachers rewarding rapid, correct responses from learners.

### Implications for the OHIP project

After mapping the elements of constructivist learning theory to particular technologies, the next task is to determine learning activities which utilize these technologies (28). The constructivist approach we have adopted necessarily means that the learning activities must be experiential and allow multiple opportunities for reflection. They must also be social or group enterprises but at the same time value the existing knowledge and experiences of the individual student. The case study is one approach that can meet these requirements.

In a recent qualitative study, the essential principles that facilitate higher levels of learning in Internet-based distance learning university courses were investigated. Using an openended questionnaire completed by experts and scholars with a wealth of experience in distance learning, who had published in peer-reviewed journals, the authors found that complex phenomena can be effectively taught by case studies facilitated by web-based conferencing and group work. Cases should be considered by students in small groups that generate solutions, share and critique each other's resolutions and make collaborative judgements (29).

The OHIP project will involve small learning groups (up to six students) comprised of a mix of students from the three participating universities. Students will work collaboratively using cases to assess the influence of socio-cultural contexts in different countries on the development of clinical management of common dental conditions. Learning groups will be asked to consider the scientific evidence for the treatment/management of the case and also to discuss any differences in common approaches to this management in each country. The outcome will, therefore, be a comparative analysis of the way the scientific evidence is utilized alongside the cultural, social and political conditions.

Each learning group will record their initial responses and reflections using concept mapping. These maps will then be posted on the BBS for consideration by other learning groups and further reflection and feedback. Tutors from participating universities will work with the learning groups to identify further resources that can be used to further refine their clinical management plans. Identification of variations in approaches in each country will occur during this process and will then be discussed collectively using a discussion forum within the BBS. Further clarification and discussion can occur via email between students but also between students and other experts/practitioners external to the programme. Final group reports will be published on the programme website for evaluation by tutors and fellow students.

These activities will be supported by the technologies identified above. Process and outcome evaluation will be conducted to assess the effectiveness of the selected technologies in promoting a constructivist learning environment. It will also allow us to consider the overall balance and types of learning supported and emphasized (29).

### Conclusion

'The world-wide web, e-mail, and teleconferencing are tools which afford virtually unlimited possibilities for instruction' (8). From a constructivist point of view, the most significant feature of this developing technology is the new learning environments it affords. This environment has the potential to allow learners and teachers to actively construct meaning together by sharing experience and challenging and maybe reforming beliefs and values. The outcomes of this process are varied and often unpredictable. This is one of the real strengths of such environments.

In this paper, we have articulated the important steps required in the development of an online international collaborative programme for dental hygiene students. First, we have identified our shared educational philosophy as essentially constructivist. Secondly, we have reviewed the literature in the field of computer-supported education particularly that which concerns asynchronous teaching and learning online. Finally, we have selected technologies which have been shown to support and exploit the central principles of constructivist learning to develop the OHIP. Implementation of the OHIP will take place in 2006 followed by a rigorous process and outcome evaluation. It is hoped that following this evaluation and programme modification that we will be able to extend the collaborative learning to more schools around the world.

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