AUTHENTIC LEARNING INTERACTIONS: MYTH OR REALITY?

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Abstract

This paper examines a project which utilises a virtual dental clinic and a fictitious eight year old patient - "Matthew" to situate students within an authentic learning environment. A case is presented which requires the student to examine clinical information about Matthew in the form of patient history, clinical slides, radiographs and expert information from teachers, psychologists and an endocrinologist. The dental student creates a legitimate treatment plan for Matthew by analysing information typically obtained in a real patient encounter. A situated-learning design was adopted as it provided a means of engaging the dental student with a legitimate case of a paediatric patient with diabetes. The student is required to make a treatment plan based on the information gleaned from the resources and then compare their reasoning with that of an expert paediatric dentist. An initial evaluation of the virtual dental clinic was undertaken in order to determine the perceptions of practicing dentists in relation to the case.

Keywords

authentic learning environments, situated cognition, case-based learning, multimedia design, paediatric dentistry, virtual patient encounters

Authentic Learning Environments

Authentic learning experiences are "those which are problem- or case-based, that immerse the learner in the situation requiring him or her to acquire skills or knowledge in order to solve the problem or manipulate the situation" (Jonassen, Mayes, & McAleese, 1992, p. 235). "Authentic tasks enable students to immerse themselves in the culture of the academic domain, much like an apprentice" (Young, 1993, p. 43). Interest in environments that immerse students in authentic learning experiences, where the meaning of knowledge and skills are realistically embedded, has been longstanding (Dewey, 1938; Piaget, 1952). More recently, attempts to enhance cognition in authentic learning-performing tasks have become widespread (e.g., Brown, Collins, & Duguid, 1989; Cognition and Technology Group at Vanderbuilt, 1991, 1992, 1993). The need for realistic experience and real-world problem-solving is also advocated. Ramsden (1987) suggests that university graduates are not obtaining deep conceptual knowledge that will allow them to think like experts in their discipline. We contend that a key role of a university education is to produce health professionals who are capable of solving complex and ill-structured problems and have the ability to reflect on their professional practice. This practitioner is capable of reflecting on the

practical demands of the real-world, continually monitoring their own professional thinking for the ultimate aim of solving related or new professional problems. However, there is a continuum of knowledge acquisition that leads to a fully-fledged expert in professional practice. Jonassen, Mayes, and McAleese (1992) suggest a continuum of introductory, advanced and expert learning phases. The introductory phase is typified by initial knowledge acquisition by the novice learner which involves learning about well-structured content domains. The advanced phase deals with ill-structured domains. "During this phase, learners acquire more advanced knowledge in order to solve more complex, domain- or context-dependent problems" (Jonassen, Mayes & McAleese, 1992, p. 231). Expertise is the third phase in the continuum. Experts appear to be able to uniquely represent problems, which facilitates the solving of problems in an efficient and effective manner. The role of providing authentic learning experiences in the university setting is an attempt to immerse the learner in the advanced phase in order to move them toward the development of expertise.

Authentic learning contexts like the virtual dental clinic may have a number of advantages over more decontextualised teaching and learning settings. The authentic nature of the technology-enhanced, student-centred learning environment may create a context within which knowledge is anchored in authentic contexts. An effective learning environment enables learners to use its resources and tools to process more deeply and extend thinking (Jonassen, 1996; Jonassen & Reeves, 1996; Kozma, 1987). Harper, Squires and McDougall (2000) suggest that "only in complex, rich environments will learners have the opportunity to construct and reconstruct concepts in idiosyncratic and personally meaningful ways" (p. 118). We have attempted to provide a virtual dental clinic in order to foster these types of interactions.

Learning Design

Teaching dental students to treat patients safely and efficiently presents many challenges. The declining availability of suitable patients attending the teaching clinics of the Royal Dental Hospital of Melbourne in association with the University of Melbourne prevents students from developing a range of experiences in total patient management. A disadvantage of traditional preclinical laboratory teaching is that students are not able to integrate theoretical and practical skills. The use of a situated learning approach may help to overcome a recognised drawback of school and university education which may "provide too little engagement with genuine situations and too much emphasis on theoretical perspectives" (Resnick, 1987 quoted in Herrington & Standen, 2000, p. 198). Consequently there are concerns that dental students are not competent in combining preventive and restorative management philosophies while integrating diagnosis and treatment planning (Suivinen, Messer, Franco, 1998). Multimedia case simulations were considered to be a viable alternative as they replicate the dental clinic without requiring 'live' patients. The diabetes module provides an opportunity to develop and consolidate the concept of integrated patient care. In particular, the learning outcomes for the module focus on: (1) competence in history, examination, diagnosis and treatment planning skills, (2) integration of theoretical and practical aspects of total patient management, (3) understanding of the relevance of the medical condition to dental health and dental treatment with attention to precautions when delivering treatment, and (4) recognition of the significance of medical conditions in treatment planning for their dental condition.

In order to create a realistic learning experience for the student paediatric dentist it was essential that we immersed the student in an authentic case. We utilised principles of situated learning which suggests that there should be "an active relationship between an agent and the environment, and learning must take place during the time the student is actively engaged in with a complex, realistic instructional context" (Young, 1993, p. 45). We utilised the following principles of authenticity to guide our creation of the diabetes scenario. Young (1993) suggests six principles. Herrington and Oliver (1995) suggest nine critical characteristics of situated learning which focus on the interactive multimedia program, implementation and the learner. Choi and Hannafin (1995) suggest a conceptual framework that focuses on the role of context, the role of content, the role of facilitation and the role of assessment.

Young (1993)	**Herrington & Oliver (1995)**	**Choi and Hannafin (1995)**
• real-life problem-solving	**Interactive Multimedia Program** • provide an authentic context that reflects the way knowledge will be used in real-life	**Role of Context** • general atmosphere • physical setting • background events

	• provide authentic activities • provide access to expert performance and modelling of the processes • provide multiple roles and perspectives	• authenticity • situational intent • transfer • anchoring knowledge
• ill-structured complex goals • opportunity to engage in collaborative interpersonal activities.	**Implementation** • provide coaching and scaffolding • provide for integrated assessment of learning within tasks	**Role of Content** • context and content are inextricably connected • content determines authenticity and veracity • knowledge as tool • content diversity and transfer • examples and non-examples • cognitive apprenticeships • anchored instruction
• opportunity for the detection of relevant versus irrelevant information • involvement of student's beliefs and values	**Learner** • support collaboration and construction of knowledge • promote reflection to enable abstractions to be formed • promote articulation to enable tacit knowledge to be made explicit	**Role of Facilitation** • modelling • scaffolding • coaching, guiding, advising • collaborating • fading • using cognitive tools and resources
• active/generative engagement in finding and defining problems		**Role of Assessment** • self-referencing • flexible, transferable knowledge and skill • diversity and flexibility of learner-centred measures • generating and constructing • continuous ongoing process • ecological validity

The virtual dental clinic provides an authentic learning environment in which the trainee paediatric dentist can examine information about a paediatric patient with diabetes. This approach attempts to immerse the learner within a typical clinical scenario and then asks them to create a relevant treatment plan.

The first step in our design process was to select a situation suitable for authentic learning. Previously we had created two other modules on Congenital Heart Disease and Down syndrome in which scenarios were used to engage the student with the relevant content. A module on diabetes created unique challenges for the design team. A virtual paediatric diabetic patient was created in order to address the difficulty of obtaining relevant patient photographs. In our interactions we wanted to increase the level of student engagement with the content and embarked on contextualising the scenario content within a virtual dental clinic. We were also careful not to overwhelm the dental student with an overly complex case. "While complexity may be necessary to provide authentic learning environments, too much complexity can make learners feel insecure and lose track of learning objectives" (Harper, Squires and McDougall, 2000, p. 127). This setting would allow the embedding of authentic activities such as the examination of radiographs and patient information within a realistic clinical situation. We began by photographing the dental clinic and then creating the virtual dental clinic and waiting room. Figures 1 & 2 illustrate the virtual dental clinic and office with Matthew the virtual patient. The drop-down menu also displays the information that can be accessed in the clinic: patient records, clinical slides, radiographs, specialist information and navigation into the office setting.

Figure 1: Virtual dental clinic

Figure 2: Virtual dental office

Secondly, we provided multiple entry points into the clinical information. This allowed the user to explore the clinic and obtain the necessary clinical information about Matthew. We wanted the student to "criss-cross the landscape of knowledge" in order to obtain information that would enable them to complete the relevant treatment plan (Young, 1993, p. 46). The user can navigate around the clinic and find information in two ways. By travelling around the clinic they will find hotspots which provide clinical information. A site map also provides clinical information enabling the student to access patient records (patient information, medical history, height and weight, dental history and social history), seven clinical slides, three radiographs, and expert information from a teacher, psychologist and endocrinologist. By providing the necessary scaffolding for the novice learner we attempted to move the learner toward expert case management.

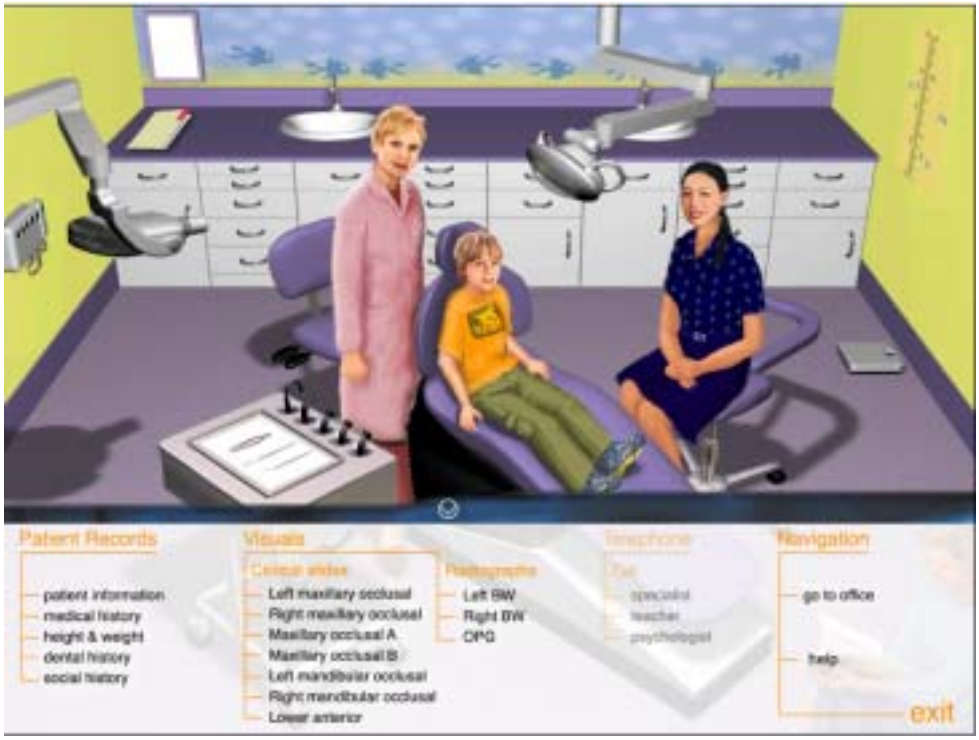

Figure 3: Drop-down menu which allows access to clinical information about Matthew

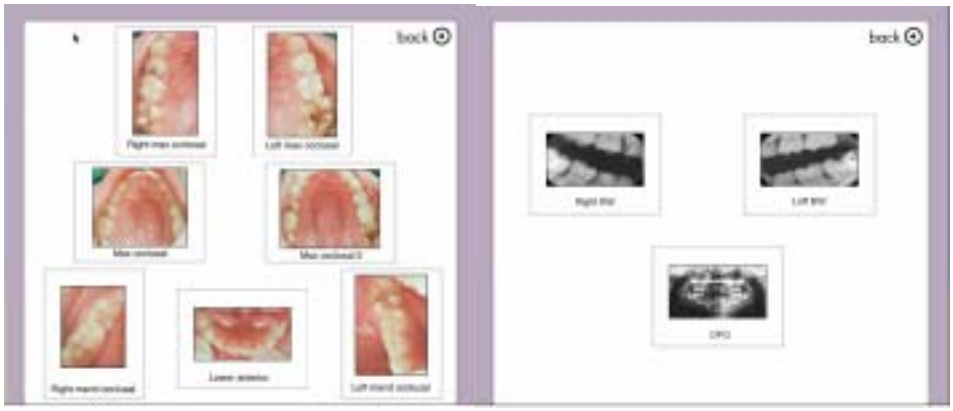

Figure 4: Clinical visuals and radiographs which can be enlarged for further detail

Our third strategy was to provide a learning context that allowed the student to learn within an expert-supported learning environment. Our role as educators was to assist the dental academics in their support role in the tutorial situation. "Instructional designs for situated learning must not only provide scaffolding for students: they must also provide scaffolding for teachers" (Young, 1993, p. 51). Lab sessions were scheduled in which students interacted with the module and were supported by paediatric dentists. "From the perspective of situated cognition, the teacher's role should be to 'tune the attention' of students to the important aspects of the situation or problem-solving activity, specifically those attributes that are invariant across a range of similar problems and therefore will transfer to many novel situations" (Young, 1993, p. 47). The advantage of utilising expert support is that some information about the case could be clarified and explained by the expert tutors. Their role in the learning process is as a coach, collaborator and mentor for student learning. Coaching focuses on "directing learner attention, reminding of overlooked steps, providing hints and feedback, challenging and structuring ways to do things, and providing additional tasks, problems, or problematic situations." (Choi & Hannafin, 1995, p. 62). Barab and Duffy (2000) suggest that the learning task should be ill-structured when utilising authentic learning tasks. Neat and tidy cases may not optimise the use of authentic tasks because they do not reflect real-

world practice. It is important not to simplify the dilemma. Instead of simplifying the case, 'support' should be provided for interacting within the authentic learning situation. However although the task should not be overly simplified, "scaffolding supports and simplifies a task as much as necessary to enable learners to manage their learning, allowing them to accomplish otherwise impossible tasks" (Choi & Hannafin, 1995, p. 61). It is also suggested that "facilitation provides learners with opportunities for internalizing information, thereby promoting the higher-order, metacognitive skill development (self-monitoring and correction skills) as well as self-regulation and self-assessing abilities" (Choi & Hannafin, 1995 p. 61).

The Case
Presenting Complaint: *Matthew is 8 years old. He presented with sensitive teeth, the left side being worse than the right. His mother mentioned that he will not brush his teeth because they hurt. She is concerned that he has not been eating well during the past few weeks.*
Dental History: *Matthew's last dental visit was when he was 5 years old. The School Dental Service performed a checkup and no treatment was required at that stage. Matthew brushes his own teeth once a day and does not floss his teeth. He has fair oral hygiene.*
Medical History: ***This young boy was diagnosed with insulin dependant diabetes at 14 months of age. He has 2 injections: before breakfast and dinner. The injections consist of a combination of short-acting and intermediate insulin. Matthew's parents give the injections. Matthew has a high carbohydrate diet with frequent intakes throughout the day. Matthew has regular medical checkups with his paediatric endocrinologist every three months. His diabetes is well monitored and stable. There have been no complications.***
Height and weight measurements: *Height: 130 cm (75^{th} percentile)* *Weight: 27 kg (50^{th}-75^{th} percentile)*
Social History: *Matthew was born in Melbourne and lives with his parents and two older brothers. He attends a primary school close to home. He has tennis lessons every Sunday morning, swimming lessons on Thursday afternoons and last year he started Auskick on Saturday mornings. Matthew has cello lessons on Tuesday after school. Matthew belongs to the local cub pack and they meet every Monday evening.*
Teacher *Due to his checkups at the hospital, Matthew is absent from school for a significant number of days. He is in an age-appropriate level at school and has remedial teaching to keep him at the same level as his class. The other students are aware of Matthew's medical condition and they are supportive of him, especially when he misses a day of school to go for his checkups. He has many friends in his class. Matthew does not need his insulin injections during school hours. In case of emergencies, Matthew's teachers will contact his parents for instructions.*
Endocrinologist *Matthew has been a diabetic for 7 years. He attends regular checkups every 3 months to assess his blood glucose control and to decide if there is any need for adjustments in medication. He adapted well to a modified diet and daily administration of medication by his parents. There was a period of time when Matthew experienced some frustration regarding his lifestyle. His parents were supportive through this episode. If any treatment under general anaesthesia is required, it should be performed in a major hospital so that the endocrinologist can monitor Matthew and adjust his glucose level. Matthew should be admitted the day prior to the procedure for blood glucose monitoring. He will be able to return home on the same day as the treatment if his glucose level is stable. It is important that Matthew has not had any recent episodes of hypoglycemia.*
Psychologist *A year ago Matthew went through a difficult stage. He was angry that he needed his insulin injections twice a day. During medication times, he would refuse the injections and his parents would spend significant time convincing Matthew to have his medication. At birthday parties Matthew was upset that he could not eat the whole bag of lollies like other children. I consulted with Matthew and his parents over a number of sessions and these issues were resolved.*

Table 1: Case information that can be accessed in the virtual dental clinic

Young (1993) suggests that traditional forms of assessment in situated learning may prove to be inadequate. Authentic learning tasks must be assessed using methods that best align with the task. Our fourth strategy was to align activities/assessment with the creation of the authentic learning situation. We attempted to do so by asking the students to develop a treatment plan using an electronic version of the protocols utilised in a traditional clinic. Our aim in developing this method of assessment was to foster

higher-order thinking skills. We were also conscious of providing a method of formative assessment that allowed "generation of ideas and the presentation of problem-solving processes such as planning, implementing, and revising." (Choi and Hannafin, 1995, p. 65). In order to simulate the use of the treatment chart, an electronic dental chart was created to allow users to create treatment plans. The electronic dental chart allows the trainee dentist to select a category of dental services and allocate a specific treatment for individual teeth. This chart also allows the user to complete cases and submit information to obtain expert feedback. The expert feedback provides precise information about the treatment protocol for each tooth. The student can compare their treatment plan to the expert and then re-enter the virtual clinic to rectify any inaccuracies and misconceptions. This concept of authentic assessment tasks is essential in the instructional design of authentic learning tasks. "Assessment should be a seamless, continuous part of the activity (a learning/assessment situation)" (Young, 1993, p.48). The final exam paper also mirrors the authentic learning task in the multimedia package by utilising a case-based learning approach.

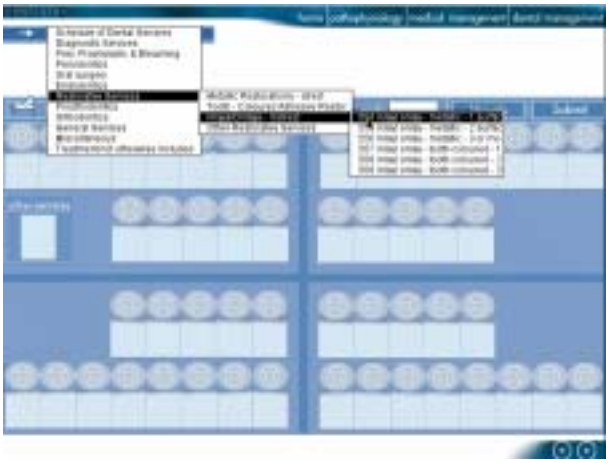

Figure 5: Electronic treatment plan utilised for the diabetes clinical case

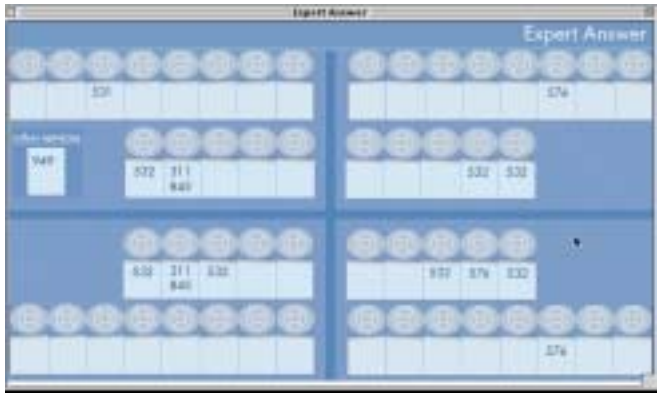

Figure 6: Expert answers for the diabetes treatment plan

Our fifth strategy was to provide detailed feedback to the student in relation to the case. At the conclusion of the case and after a number of questions the student is provided with the following comprehensive feedback in relation to Matthew's case.

Matthew has a demeanor that would allow you to complete his dental treatment in the dental surgery with local anaesthesia. However, anaesthesia of sensitive teeth with enamel hypoplasia is not reliable and it has been found that nitrous oxide aids in treatment of such teeth. Treatment at the practice would consist of numerous lengthy appointments. Matthew's mother was concerned about her son's glucose control during long appointments and also the amount of schooling he would miss to attend his dental appointments. A general anaesthetic session was indicated in order to complete treatment in one visit.

Matthew will be hospitalised in a major hospital so that the paediatric endocrinology team can monitor his diabetic condition. Under the general anaesthetic, both the paediatric anaesthetist and endocrinologist can maintain Matthew's blood glucose level. Developmental defects of enamel can occur if there have been insults, prenatally or postnatally, during the formation of the dentition. Many medical conditions have been associated with enamel defects, for example maternal illness in the last trimester, prematurity, low birth weight, recurrent ear infections, fever, chronic asthma, gastric reflux, etc. It is possible that Matthew's diabetic state could have contributed to his hypoplastic teeth.

Matthew has a Class I occlusion. The third molars have not formed. At this stage the hypoplastic first permanent molars should be restored and retained. The stainless steel crowns on the left permanent molars are interim restorations. Should Matthew require orthodontic extractions at a later stage, consideration would be given to extracting these molars with enamel defects provided that the premolars were unaffected and caries free. Alternatively, if the molars are retained, permanent restorations (ie. gold, ceramic or porcelain fused to metal crowns) should replace the stainless steel crowns in the early adulthood years. The hypoplastic molars, in particular the lower left first permanent molar, may become nonvital. If this situation arises, the position of the second molar and the presence of the third molar should be assessed. Endodontic treatment and a permanent crown, versus extraction of the nonvital tooth, are treatment options that should be considered. It is important that discussion with the parents should include the long term treatment and prognosis of these teeth.

The upper left first primary molar has a large disto-occlusal cavity. Should there be pulpal involvement, the tooth will require pulpal therapy followed by the placement of a stainless steel crown. The lower left first primary molar has mesial and distal caries. Three-surface restorations in the deciduous molars, in particular first molars, have higher failure rates. To improve the longevity of the restoration, a stainless steel crown is the treatment of choice. The upper and lower right first primary molars have large distal cavities with pulpal involvement and the lesions extend subgingivally. Restoration of these teeth would be difficult. These teeth should be extracted. Since Matthew has a Class I occlusion with no crowding, space maintenance has to be considered. At this stage upper and lower band and loop appliances are appropriate space maintainers. Impressions for the construction of the appliances could be taken before the general anaesthetic session which would allow insertion of the space maintainers at the time of the extractions.

The diabetic patient should be placed on a frequent recall maintenance program after dental treatment is completed until his or her susceptibility to recurrent oral disease has been established. Regular topical fluoride applications may be considered at home and professionally. Sealants can be placed as the permanent teeth erupt. A mouthguard for sports activities will need regular replacement with development of the dentition. Patients and parents should be aware of the importance of oral health in relation to the diabetic condition.

Evaluation

An initial evaluation was undertaken to determine user perceptions in relation to the virtual dental clinic. Three practicing paediatric dentists participated in a focus group. A number of insights were gained into the design of the virtual clinic and its authenticity. We examined the match between the actual clinical setting and the virtual dental clinic. It appeared that presenting all relevant clinical information in one session may overwhelm the student. *"If we think about the diabetes case and ... the virtual clinic, what do you think about that case in terms of how realistic it was..." "It would be quite different. You would probably have more than one appointment and that was quite tricky deciding – on the first day I probably wouldn't do all these things. You could put them under general anaesthetic. Apart from that it was quite difficult if you had to write the whole lot out on the same day you would probably do something after the general anaesthetic get them back two weeks later and say okay, how's the toothbrush going."*

Navigation also appeared to be an issue in the virtual clinic. We provided two methods of navigation. These included a site map and 'hot spots' in the clinical setting. Although we provided a brief tutorial for the students all three students still failed to utilise the 'hotspot' information. *"When I moved the mouse it came up and I didn't realise what I could click. I think if you want us to get the picture on the top of the menu, you should have it flashing or something like that. So that it shows up."* Further design work is being undertaken to address this misunderstanding. An animation will be utilised instead of the existing

help screens to highlight relevant information in the virtual clinic. Our design attempted to provide an open exploration of the clinic. However this proved too advanced for the users. Although we provided flexible access to the resources to solve the clinical case, the students still utilised the sitemap in a traditional top-to-bottom and left-to- right reading pattern as opposed to clicking on information that they considered relevant at that point in the case. *"When you went into the office?" "I went back to the menu and went to help. I couldn't understand. So then I went back to the other picture and found it by accident. I clicked on the telephone or something."* The sequence of information was also important to the user. *"Did you actually read about the teacher; the specialist information?" "Don't you think this information should go before the examination? You are talking about the medical history and social history. It should go before the examination." "If it was a referral, you would get a note from a doctor before she actually comes in, which gives you the whole..., and you don't have to look for anything."*

Our goal of designing the module so that students would need to revisit some clinical information appeared to be successful in some instances. *"Did you go back to the visuals when you were completing the treatment plan? Did you need any other information at that point?." "Patient file, complaints and history. I did use it, but I did go back to the pictures quite a lot. How many times? Three, five times. I think I wrote it down which made it a bit easier. I don't know the numbers so it made it a lot harder."* However it appeared that the students had difficulty providing a treatment number from the electronic treatment plan as opposed to the usual paper-based booklet. It also appeared that obtaining expert feedback could have been optimised. *Did you all submit and get the expert answers? I didn't get the answers. I went to next. That's why I didn't find the expert…. Maybe it's a good thing to put the expert under next. Down the bottom. So you go to the next phase."* Further evaluation with a subsequent group should also inform the design and provide feedback to the development team. However it does appear that there is a fine line between authentic myth and reality.

Conclusion

Our next step in the process is to create a number of scenarios that may foster transfer to like cases and to more ill-defined cases. This is important as "one of the major concerns about situating instruction in specific contexts is that students' understanding and application of these concepts will stay welded to the context" (Cognition and Technology Group at Vanderbuilt, 1993, p. 52). In order to address this issue we intend to construct new dental scenarios that are directly analogous to the diabetes case. This is considered to be 'transfer to analogous problems'. The virtual dental clinic can be reconfigured with different information and different case parameters. Individual treatment plans can be developed in conjunction with expert paediatric dentists utilising other cases of importance to the learner. Numerous cases can be completed allowing the trainee dentist to become familiar with expert dentist strategies and treatment plans. This learning design is not "context-free" but it does attempt to provide a generic framework which can be reutilised for other case content (Hedberg, Wills, Oliver, Harper, Agostinho, 2002). The overall aim of designing authentic learning tasks is to improve dental health care. Once we have achieved transfer to real-contexts the individual paediatric dentist should continue to adapt to complex real-world cases.

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