Using educational technologies to understand how learners solve problems

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In this paper we examine how a highly interactive educational technology program *Child Growth & Development in the first 12 months of life* was used to investigate the problem solving behaviour of learners. This preliminary study was also used to evaluate the study instruments ahead of a more substantial investigation. The design of the program was informed by Problem Based Learning (PBL) philosophy with authentic problems as the stimulus for problem solving activities. We describe how an electronic record of learners' movements and activities was captured by an embedded audit trail system, as learners progressed through the steps of a problem solving procedure. This method revealed highly individual problem solving behaviours for learners. Similarities and differences were shared between learners at different stages of the process. External measures, including learner perceptions of problem solving ability, were used to supplement the audit trail data. This enabled a more detailed picture to emerge of the factors that may influence problem solving skills, including confidence, approach-avoidance style and self-control.

Keywords: problem solving, problem based learning (PBL), educational technologies, audit trails

Introduction

One of the themes the committee has encouraged authors to consider this year is *Who's Learning – how well do we know our students?* The theme itself conjures up more questions – do we know how our students use educational technologies? Do they use them in the way that designers and developers envisaged? We design educational technologies with the best intentions of providing students with enhanced learning opportunities, but do the students see it that way? Does the use of a theoretically based design necessarily guarantee its effectiveness as a learning tool? Do we concentrate on getting the theory right, but overlook personal characteristics such as confidence and motivation?

In this paper, these questions are explored within the context of problem solving, a skill highly valued by educators and future employers, but often elusive to graduates. Problem solving is arguably the most important cognitive activity for young people in everyday and professional contexts (Jonassen, 2000). In Australia, it has been listed as one of the employment related key competencies in compulsory education and training, and is included in a set of generic skills compiled by the Australian Council for Educational Research (ACER) for graduate skills assessment (Oliver & Towers, 2000). However, it is a complex process that is poorly understood.

It is acknowledged that problem solving is a highly variable process, determined by the nature of the problem, the way the problem is represented and individual differences in problem solvers (Jonassen, 1999). Jonassen (2000) points out that problems differ in complexity or the number of elements (variables, functions or issues) they contain and the relationship between elements. Some problems are embedded within a context, while others are abstract. Problems also differ in terms of their structuredness. Well-structured problems (known as text book problems) are well defined – all elements are presented to the problem solver, the goal is known and a limited number of rules and principles apply. On the other hand, ill-structured problems are not well defined – all elements are not initially known and additional elements may only become apparent after further investigation. Indeed, the revelation of extra information may change the nature of the problem. Moreover, ill-structured problems have no clear goals, they often require integration of several content domains to solve and multiple solutions may apply. Most problems encountered in everyday life are ill-structured.
Problems can also be presented to and perceived by solvers in different ways, therefore, the personal representations that solvers construct are highly individual and can be influenced by the context and fidelity of a problem (Jonassen, 2000). Many individual differences have been identified amongst

problem solvers, including familiarity with problem type, level of domain knowledge, cognitive style, metacognition, underlying beliefs about the nature of problem solving, attitudes and beliefs about one's ability to solve the problem (self-confidence), motivation and general problem solving skills (Jonassen, 2000).

Jonassen (1997) argues that the teaching of problem solving in formal education has received little attention. This may in part be due to the ongoing debate about whether generic or context-independent problem solving skills can be learnt and applied to different contexts. It may also be because the problem solving process itself is not well understood. Nevertheless, Jonassen's (1997) belief that learners need more experience at solving complex, ill-structured problems embedded in context, is noteworthy. One teaching strategy that purports to teach problem solving skills is Problem Based Learning (PBL).

Educational technology programs that use a PBL design, with real-life problems as the stimulus for problem solving activities, provide a valuable tool to investigate the problem solving behaviour of learners. The authors have previously used a PBL designed program, *Child Growth & Development in the first 12 months of life* embedded with an audit trail system, to identify two different behaviours of learners searching for resources to assist them with their problem solving activities (Elliott, *et al*., 2005). "Specific" learners used a quick, targeted approach, while "general" learners used a systematic approach, taking up to 50% longer to complete their research. By supplementing the audit trail data with external measures, a correlation was identified between the type of behaviour students displayed and their understanding of the problem. Specific learners exhibited a greater understanding of the problem than general learners.

The earlier study focussed on the search behaviour of learners. In this paper we describe how similar methods were used in this preliminary study designed to investigate the behaviour of learners throughout the entire problem solving process, from the initial problem analysis through to implementing a solution. The study also allowed us to evaluate the use of the Problem Solving Inventory (Heppner, 1988) to enable a more detailed picture to emerge of the different behaviours learners exhibit while solving problems.

Theoretical insights into PBL and problem solving

Problem Based Learning (PBL) is a widely used curricular reform. It was first developed at McMaster University in medical education in the 1960s, but is now pervasive in architecture, biochemistry, business administration, dentistry, economics, engineering, geology, law, nursing, optometry, social work and veterinary education. In its ideal form authentic problems are used as a context for small groups of students to acquire factual knowledge, to learn generic processes such as problem solving and evidence-based enquiry skills, and to develop self-directed or life long learning strategies (Albanese & Mitchell, 1993; Norman & Schmidt, 1992). In medical education, PBL also enables basic sciences to be integrated with clinical knowledge, and promotes the development of clinical reasoning strategies (Norman & Schmidt, 1992).

Many variations of PBL are practiced at different institutions, prompting Barrows (1986) to devise a taxonomy of PBL methods. However, as a general rule the PBL procedure involves the following stages: Identification of problem elements, Formulation of hypothesis(es), Identification of learning needs, Individual study/search, Evaluation of understanding and Development of solution(s). It is important to note here that PBL should not be confused with problem solving learning where learning activities are centred on problems. Authentic PBL strictly follows the structures and procedures first classified by Barrows (1986).

PBL focuses on the process of learning. It recognises learning as an integrated process of cognition, metacognition and personal development (De Grave *et al*., 1996). Cognitive science research provides explanations for the learning mechanism of PBL (Norman & Schmidt, 1992; Schmidt, 1993a). The problem analysis stage of the PBL procedure (e.g. identification of problem elements, hypothesis formulation and identification of learning needs) is thought to serve four main purposes: activation of learner's prior knowledge, elaboration of knowledge, placing knowledge in context and, engaging learners and stimulating their curiosity (Schmidt, 1993b). During problem analysis existing knowledge is questioned and evaluated. A mismatch between an individual's existing state of knowledge and the details of the problem they are working on creates cognitive conflict, which in turn leads to a conceptual change in the learner's knowledge.

Although cognitive science theories predict that students in PBL curricula should be better at problem solving than those in traditional courses, reported outcomes show mixed results (Albanese & Mitchell, 1993). Evensen and Hmelo (2000) suggest this is because in the past, traditional academic measures based largely on declarative knowledge, were used to assess outcomes. More recently, studies have shown that PBL students are able to transfer their problem strategies to new problems and to create more coherent solutions than traditional students (Evensen & Hmelo, 2000).

Although the development of PBL has been informed by cognitive science theories, reflections by Barrows (2000) on starting up the PBL medical course at McMaster University, tend to indicate that the curriculum change was driven by pragmatic reasons rather than developments in cognitive science at that time:

> They [the committee] decided that from the beginning, learning would occur around a series of biomedical problems presented in small groups with the faculty, functioning as "tutors or guides to learning". No background in educational psychology or cognitive science guided them, just the expressed hope that students would be simulated by the experience, would see the relevance of what they were learning to their future responsibilities, would maintain a high level of motivation for learning, and would begin to understand the importance of responsible professional attitudes (Barrows, 2000, p. vii)

However, references to aspects of PBL can be found in the writings of educational theorists of the era, such as Gagne (1966). Additionally, Schmidt (1965) described the problem solving ability of a PBL group, compared with a group who had been taught to memorise how to solve one problem and to another group given only the principles on which the initial set of problems were based. The groups were given increasingly difficult problems to solve. The first group were able to solve problems based on progressively more complex principles whereas the others were not able to go beyond the initial context.

In fact, comparisons between PBL problem solving procedures and models of problem solving processes reveal many similarities. Gick's (1986) information processing model of the problem solving process describes the construction of a problem representation, the search for (or generation of) possible solutions, and the implementation and monitoring of solutions. To develop a problem representation, the learner identifies attributes of the problem and maps the problem onto prior knowledge, thereby building a personal interpretation of the problem. It is through this process of schema activation (linking the problem to existing knowledge) that learners attempt to find a schema for solving that type of problem (Gick, 1986). Resnick and Glaser (1976) relate these processes to memory, indicating that the problem representation is developed in working memory and then the learner searches through long term memory for a "stored" solution. If a solution can't be retrieved then the learner may restructure or redefine the problem.

Gick's (1986) model incorporated several previously published models of problem solving (Newell & Simon, 1972; Bransford & Stein, 1984), but is often regarded as a simplified version of events. Nevertheless, the objectives of the problem representation according to Gick's (1986) model directly relate to the problem analysis stage of the PBL procedure when the problem is clarified, prior knowledge is activated and individual learning needs are identified. In both cases this is followed by a search phase and then implementation of a solution. These similarities indicate the validity of using educational technology programs with a PBL design to investigate the problem solving behaviour of learners.

The *Child Growth & Development* program

The *Child Growth & Development in the first 12 months of life* program is a highly interactive educational technology program developed to facilitate the learning and teaching of child growth and development to medical students studying paediatrics. The design of the program and the reasons behind the development has been previously described (Elliott, *et al*, 2003). In brief, the program is structured around problems that a family encounter as their newborn son grows and develops over the first year of life. Students work through each problem to arrive at a solution, which they present to the family in the form of advice. The problem used for the current study arises when the infant is two weeks old and relates to the mother's anxiety about breast-feeding and the baby's unsettled behaviour.

The design of the program was informed by PBL philosophy and a critical evaluation of the program showed that it aligned well with the original structures and procedures of Barrows (1986) (Elliott, *et al*, 2003). A common PBL problem solving procedure was used, which consisted of: Identification of problem elements, Formulation of hypothesis(es), Identification of learning needs, Individual study and search for information, Evaluation of understanding and Development of solution(s). Details of each phase and the instructions given to learners are shown in Table 1. To guide students through the entire problem solving process, it was broken down into a series of seven sub tasks. Tasks 1, 2, 3 & 4, for example, comprised the problem analysis phase of the problem solving process. Task 5 was part of the study/search phase, as were tasks 2 and 7 because students were encouraged to search the resources for additional information before submitting their responses. Model expert answers were given as immediate feedback after students submitted their responses to each task.

Table 1: Problem solving procedure used in the *Child Growth & Development* program

Task	Instructions
1 Identify problem elements (from vignette)	• Play the video and listen to Louise's [the mother's] comments. • Enter any parental concerns you identify into the notebook and submit.
Feedback 1	Expert feedback
2 Formulate hypothesis(es) Study/search	• What possible hypotheses might explain the situation between Jack [the baby] and Louise (e.g. what factors could be causing, contributing to, or influencing the parental concerns)? • Enter your hypothesis/es into the notebook and then submit. • You may wish to consider additional information to help you formulate your hypothesis/es. If so, investigate the Resources…
Feedback 2	Expert feedback
3 Identify learning needs	• What additional questions would you like to ask Louise? • Enter these in point form into the notebook and then submit.
Feedback 3	Expert feedback
4 Identify learning needs	• What information do you require from a physical examination? • Enter these in point form into the notebook and then submit.
Feedback 4	Expert feedback
5 Study/search	Plot Jack's growth on his centile chart.
Feedback 5	Expert feedback
6 Evaluate understanding	• Use the additional information you have gathered to formulate your understanding of the problem. • Enter your formulation into the notebook and then submit.
Feedback 6	Expert feedback
7 Develop solution(s) Study/search	• What advice would you give Louise regarding her concerns about two week old Jack? • Outline your advice in the notebook and then submit. • You may want to revisit the Resources…
Feedback 7	Expert feedback

The problem solving tasks were supported by a rich variety of resources, which students could access at any stage via drop down menus. Five items contained in the resources related specifically to the problem used for the current study. They were: Feeding, Behavioural states, Measuring Growth, Motor Development and Communication (in descending order of importance). There were also nine resources that provided more general material about newborn infants.

Method

Approval to carry out this study was obtained from the Human Research Ethics Committee, The University of Melbourne. Participants were informed of the study methods and gave their consent to participate.

Sample

A convenience sample was used in this investigation as it was regarded as a preliminary study to a more expanded investigation with health science students. The sample consisted of four participants (casual staff employed by the Faculty IT unit or the Medical Education Unit, e.g. part-time research assistants). Participants were chosen because of their similar backgrounds; for example, they were all young adults with a tertiary qualification, were not parents, did not have a medical background and had no specific training in PBL. Previous evaluation of the *Child Growth & Development* program suggested that prior knowledge of the PBL process may influence the way learners interact with the program (Elliott, *et al*, 2003), so for this study it was important that participants had uniform knowledge of PBL (in this case no experience). While *Child Growth & Development* was originally developed for medical students studying paediatrics, the content is of universal interest, and because none of the participants had children of their own, it was assumed that they had similar levels of prior knowledge about the content area. Therefore, within the context of the study, participants were viewed as actual learners, albeit novice ones. Before beginning the program, participants completed the Problem Solving Inventory (Heppner, 1988) (see *Measures*). They were then briefly introduced to the program and allowed to work through the program unsupervised and at their own pace. An audit trail of each participant's activities was saved when they exited the program. After completing the program, participants were asked to respond to two open-ended questions.

Measures

Problem Solving Inventory (PSI)
The PSI (Heppner, 1988) is an instrument used to rate an individual's perception of their problem solving behaviours and attitudes. It assesses three factors: Problem Solving Confidence (a belief in one's own ability to solve problems), Problem Approach-Avoidance Style (a predisposition to engage, or not, in problem solving activities) and Personal Control (a measure of the extent an individual believes they are in control of their emotions and behaviours). All three factors are summed to give a Total Index. Low scores for each factor or the total index represent a positive perception of problem solving abilities. The PSI has been used extensively by McMaster University to evaluate Problem Based Learning programmes (Woods, 1994).

Audit trail
A customised version of *Child Growth & Development* was used for this study, consisting of one problem. While the general functionality of the customised and standard version were very similar, navigational controls in the former were modified so as to restrict access by users to those sections of the program directly relevant to the study. An audit trail system was embedded in the program and configured to create comprehensive records of which components of the program were accessed, in what order, and for how long, as well as users' textual responses to key tasks (Judd & Kennedy 2001). Captured records were stored in a convenient and readable xml format for later analysis.

The four sets of audit trail data were analysed by comparing each set to a model problem solving process (see Table 1). The model related the tasks carried out by learners in the program, to specific phases of the process (e.g. Identification of problem elements, Hypothesis formulation, Identification of learning needs, Study/search, Evaluation of findings and Solution). Therefore, time spent, resources visited, feedback accessed, order in which resources and feedback were visited and the frequency of visits to resources and feedback were determined for each phase of the problem solving process. Comparisons of these overall patterns of use were made to identify any differences or similarities in the process. It was assumed that the time recorded by the audit trail system was spent by the learner on task and not on other activities.

At each task (1–7), students were asked to enter their responses as free text. These text responses were captured by the audit trail system and were compared to ideal expert answers to determine the percentage of expert content they contained. This provided a clearer picture of learners' understanding as they progressed through the problem. Learners' solutions were more difficult to score because there was no single, correct solution, therefore, they were given a rating of poor, average or good, depending on their content. Learners' behaviour during the Study/Search stage was classified as "specific" if they targeted problem-specific resources first or "general" if they used a systematic approach to searching.

Reflective questions
To verify any behavioural patterns emerging from the audit trial data against external measures, participants were asked to respond to the following open-ended questions directly after completing the program:

1 What was the problem that you had to solve in the *Child Growth & Development* program?
2 Describe how you went about solving the problem (try and recreate the steps you took to solve it).

Responses to Question 1 were given a score out of 10 according to whether the problem was stated specifically (5.0 marks) or in general terms (2.5), and whether the following criteria were stated; problem indicators (1.0), other causes (1.0 each), implications (1.0 each), outcomes (0.5) and associated factors (0.5).

Responses to Question 2 were compared to an eight-step ideal problem solving sequence, where Step 1 = Clarification, Step 2 = Hypothesis formulation, Step 3 = Identification of learning needs, Step 4 = Enquiry driven search of resources, Step 5 = Hypothesis testing, Step 6 = Review, Step 7 = Hypothesis revision and Step 8 = Solution. Learner and ideal steps are represented on the X and Y axes, respectively, of Figure 1.

Results

Problem solving profiles for each learner were constructed from three measures (PSI, audit trail and the first reflective question) and are presented in Table 2.

Learner responses to the second reflective question "Describe how you went about solving the problem (try and recreate the steps you took to solve it)?" are graphically represented in Figure 1. The self-reported problem solving sequence of each learner and the degree of deviation from an ideal sequence are shown.

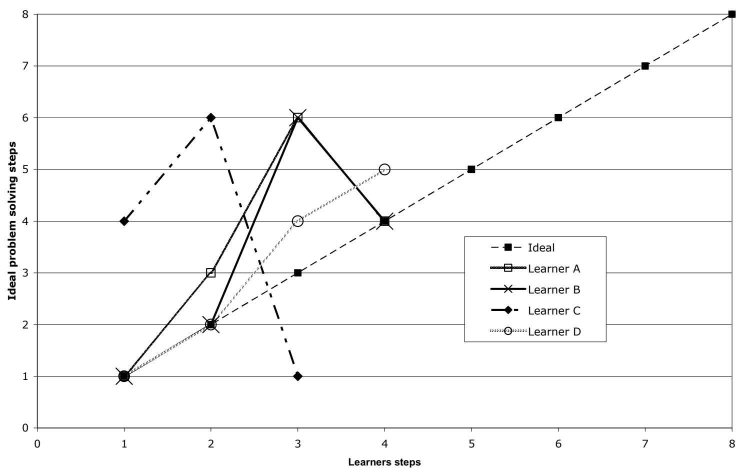

Figure 1: Learner's self reported problem solving steps compared to an ideal sequence

Table 2: Problem solving profiles of learners constructed from different measures (PSI, audit trail and the first reflective question)

	Learner			
	A	**B**	**C**	**D**
GENDER	Female	Female	Male	Female
PROBLEM SOLVING INVENTORY (PSI)				
Confidence	24.0	21.0	25.0	52.0
Approach - Avoidance Style	48.0	38.0	54.0	71.0
Personal Control	13.0	12.0	16.0	24.0
Total Index	85.0	71.0	95.0	147.0
AUDIT TRAIL				
Identify problem elements (Task 1)[1]				
Time spent on task	1.5 min	3.3 min	3.0 min	2.4 min
Elements identified[2]	75 %	75 %	50 %	50 %
No. of times vignette was played	2	6	5	3
Formulate hypotheses (Task 2)[1]				
Time spent on task	3.8 min	30.3 min	25.8 min	30.7 min
Hypotheses identified[2]	36 %	21 %	21 %	14 %
Most frequently visited resource (during this task)	Feeding	Feeding	Feeding	All resources equal
No. of visits to this resource	4	3	3	1
Identify learning needs (Tasks 3&4)[1]				
Time spent on tasks	2.5 min	3.3 min	3.9 min	3.4 min
Learning needs identified[2]	32%	36%	14%	11%
Most frequently visited resource (during tasks)	Expert feedback	None visited	Fathers	None visited
No. of visits to resource	3	-	1	-
Study/search (Tasks 2, 5, 7)				
Time spent on resources	3 min	26.2 min	26.1 min	28 min
Search pattern	Specific	Mixed (predominantly specific)	Mixed	General
Evaluate understanding (Task 6)				
Time spent on task	0.6 min	1.5 min	1.0 min	0.7 min
Problem formulation[2]	No response	No response	33%	67%
Develop solution (Task 7)				
Time spent on task	1.4 min	4.7 min	2.5 min	3.9 min
Solution rating[3]	Average	Good	Poor	Poor
REFLECTIVE QUESTION				
Problem score[4]	7.5	3.0	3.0	2.5

1 Tasks 1, 2, 3 & 4 make up the problem analysis phase of the problem solving process.
2 For these tasks, free text responses entered by learners were compared to an ideal expert answer to determine the percentage of expert content they contained.
3 Solutions entered by learners as free text responses were given a rating of poor, average or good, depending on content.
4 Learner responses to the first question "What was the problem that you had to solve in the *Child Growth & Development* program?" were given a score out of 10.

Discussion

Problem solving profiles showed that learners A and B performed the best problem analysis (e.g. Tasks 1, 2, 3 & 4) but achieved this outcome differently in terms of time spent on tasks, support material accessed and information identified. Learner A, for example, spent the least time on all tasks. Her study was highly specific, and during the hypotheses formulation phase she only accessed *Feeding*, the most important resource, switching back and forth from the task screen to the resource a total of four times before submitting her response. She did not visit any other resources, although she had viewed all four menus prior to going to the *Feeding* resource, presumably looking at their content.

On the other hand, learner B visited all fourteen available resources (both specific to the problem and more general). She spent the first five minutes of her search systematically accessing the resources in the order they appeared on the menus. However, having located *Feeding*, her study became highly specific as she targeted *Feeding* twice more. To identify learning needs, learner A appeared to rely on the expert feedback about hypotheses, accessing it three times in total. She also visited the *Feeding* resource again during this phase. Learner B, however, did not access any support materials while identifying learning needs, but her response contained more additional information required to solve the problem, that any other learner.

Whilst in the program, learners A and B developed average or better solutions to the problem. However, this result didn't necessarily translate into a good score when the question "What was the problem that you had to solve in the *Child Growth & Development* program?" was asked after completing the program: learner A obtained the highest score of 7.0 while learner B scored 3.0. When asked to describe how they went about solving the problem, learners A and B described similar steps (see Figure 1).

In contrast to the profiles of A and B, learner C performed poorly in the problem analysis phase, identifying fewer elements, fewer learning needs and formulating fewer hypotheses. His study/search pattern was unpredictable. At times he visited resources in the order they appeared on menus, at other times he visited resources randomly. Although he did not find the *Feeding* resource until late in his search, when he did find it his study became specific and he accessed the resource three times. The solution to the problem that learner C submitted whilst in the program was poor, and he also obtained a low score (3.0) when asked to define the problem after completing the program. The self-reported steps he took to solve the problem suggest that he began his individual study before clarifying what the problem was and what he needed to know to solve it.

Similarly, learner D also performed poorly at the problem analysis phase of the problem solving process. She identified fewer problem elements, hypotheses and learning needs than any of the other learners and her responses suggested that she did not have a good grasp of what she needed to know to solve the problem. During the hypotheses formulation phase, learner D carried out a systematic search of all fourteen resources in the order they appeared on the program menus. The search was thorough, taking approx 28 mins to complete, with an average of 2 mins being spent on each resource (ranging from 0.6 to 9.5 mins). This systematic searching of all resources suggests an inability (or unwillingness) to make judgements about which material would be more helpful to solving the problem.

Flavell (1976) postulated that the "deliberate, systematic search for whatever problem-relevant information happens to be available for retrieval" (p232) is an adaptive strategy in children unable to solve problems for which they have appropriate solution procedures. It is interesting to note that Learner D formulated a good understanding of the problem whilst in the program, but was unable to translate this into a good solution, or a high score for the reflective question. Moreover, her self-reported problem solving steps most closely resembled the ideal problem solving process than any other learner (see Figure 1). It appears that she knew the appropriate information and an effective problem solving process but was unable to bring them together to actually resolve the problem.

When the problem solving profiles of learners are viewed in light of the PSI scores, it is interesting that the low scores obtained by learners A and B for each problem solving factor (Confidence, Approach-Avoidance Style and Personal Control) and the Total Index indicated that they held positive perceptions of their problem solving abilities. Scores obtained by learner C for Confidence and Personal Control were similar to means from a sample of normal male adults (e.g. 21.8 for Confidence and 14.9 for Personal

Control (Heppner, 1988). However, the high score obtained by Learner C for Approach-Avoidance Style is indicative of a perceived tendency to avoid problem solving activities. This may explain why he began his individual study before clarifying what the problem was, preferring to delve straight into the resources rather than analyse the problem and work out what he needed to look for. The high scores obtained by learner D for all three factors and the Total Index, indicate a negative perception of problem solving ability. Could her negative perception of problem solving ability have prevented her from successfully completing and solving the problem?

Conclusion and future directions

This study has highlighted the role that educational technology programs such as *Child Growth & Development,* which use a PBL design with real-life problems as the stimulus for problem solving activities, can play in investigating the problem solving behaviour of learners. The study revealed highly individual problem solving behaviours for different learners. Similarities and differences were apparent between learners for different phases of the problem solving process.

The use of the PSI to determine learner perceptions of problem solving abilities and to relate them to behaviour has raised an interesting research question. Can a learner's negative perception of their problem solving abilities prevent them from successfully completing and solving problems? Jonassen, (2000) notes:

> If problem-solvers do not believe in their ability to solve problems, they will most likely not exert sufficient cognitive effort and therefore will not succeed (Jonassen, 2000 p.71).

However, it should also be pointed out that the study participants were considered novices in the field and therefore, would be expected to experience some difficulty with the subject matter.

Further research is needed to answer the question about the effect of perception of problem solving abilities on problem solving outcomes. We are currently in the process of repeating this study with a cohort of 26 post-graduate nurses studying paediatrics at The University of Melbourne and a cohort of 60 graduate nurses from The Royal Children's Hospital, Melbourne. These cohorts are specialising in child health and have a particular interest in the content of the *Child Growth & Development* program. We aim to determine if similar problem solving behaviours emerge to the ones identified in this study, and if they relate to learner perceptions of problem solving abilities, including confidence, approach-avoidance style and control.

In conclusion, education programs based on solid theoretical learning and teaching models are a valuable means of determining how students learn with educational technologies. In this particular case, audit trail data has given us insights into the variety of ways learners approach problem solving. In addition, the use of external measures has allowed us to identify possible intrinsic factors that may influence the behaviour of problem solvers. These methods serve as an example of how we can "get to know our students better", and in so doing, be in a better position to provide them with meaningful learning experiences.

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