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Seeing the landscape and the forest floor: changes made to improve the connectivity of concepts in a hybrid problem-based learning curriculum

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Problem-based learning (PBL) curricula utilise authentic problems that are based in the real-world of practice. This very characteristic enables students to develop an intimate knowledge about the intricacies of practice, metaphorically, seeing the details of the forest floor. However, it is equally important for students to develop an overall conceptual framework of the curriculum and understand how the different aspects of the subject domain relate to each other, i.e. seeing the landscape. This paper explores the extent to which these two aspects of curriculum design, in particular the landscape, were achieved in an 'Education Theories' module for lecturers in higher education. It utilises Hung's 3C3R problem-design model to help develop these connections. The findings alert curriculum designers to pay more focused attention to the holistic problem from Hung's model and the model's relationship with other learning resources (lectures, etc.) in supporting connectivity in PBL hybrid curricula.

Keywords: problem-based learning; connections; scaffolding; problem design

Introduction

Problem-based learning (PBL) is an instructional approach to curriculum design that uses, or simulates, real world, authentic, contextualised problems as the driver to the learning process (Gentner, Loewenstein, and Thompson 2003; Mauffette, Kandlbinder, and Soucisse 2004; Savery 2006). If well-designed, PBL curricula should also enhance students' conceptual development and reality construction. This approach not only enhances student motivation as it provides relevance to the students' current lives; but also functions to afford implicit situational, cultural, and contextual information, which is critical to their practice of the subject knowledge but which is often ignored in traditional instructional methods (Dolmans and Snellen-Balendong 1997; Mauffette, Kandlbinder, and Soucisse 2004). One of the strengths of the contextualisation and authenticity of PBL problems is that it helps students acquire situational knowledge, which is critical for them to effectively retrieve and apply appropriate domain knowledge (Hung 2006). This situational knowledge is more tangible, detail-oriented, as opposed to content knowledge, which is more abstract, principle-oriented. Situational knowledge is more grounded. Metaphorically speaking, it is like having your feet on the ground and being able to examine the level of detail on the floor of a forest. In PBL, students are guided to establish their knowledge about the details on a forest floor. However, Hung (2006)

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cautioned that students' knowledge base may be compartmental if the conceptual connections among the problems within a PBL curriculum are not carefully designed. Consequently, as many researchers agree (see, for example, Dolmans et al. 1993; Drummond-Young and Mohide 2001; Lieux 2001), conceptually disconnected PBL curricula may result in students' difficulty in integrating the subject domain. Extending the forest metaphor, students may not be able to conceptualise the landscape of the subject domain.

We believed that the conceptual connections that structure a PBL curriculum are crucial to students' success in integrating their knowledge base. The connections within a PBL curriculum are an under-discussed area in PBL literature and more research is needed to provide PBL educators with deeper insight and guidelines. Therefore, we used a reflective practice model of action research (Elliott 1991) consisting of two cycles, in an attempt to plan, act and reflect upon the question: How can lecturers design curricula in order to ensure connection of concepts so that students can see links between the contextual details (on the forest floor), yet still retain the overview of the subject domain concepts (the landscape)? In addition, to what extent can this be achieved in a single module approach (Savin-Baden 2008)?

The findings and discussion in this study, although based on a PBL curriculum, should be of benefit to those improving the connectivity of other curricula. (The term 'module', in this study, is a unit of study. In this case, as University College Dublin is in the European ECT credit scheme, this post-graduate module, which is 15 ECT credits, is approximately 330 student-effort hours.)

Literature review: the concept of connection in problem-based learning (PBL) curricula

Many researchers agree that the ability to cross-reference related concepts and information is a necessity for developing a complete understanding of a subject domain and solving ill-structured problems (see, for example, Jacobson and Spiro 1994; Kitchner 1983; Spiro et al. 1988). This cross-referencing ability is largely determined by the strength of the learner's understanding of the conceptual framework on the subject. As Clark and Linn (2003) contended, knowledge integration is essential to establishing this conceptual framework.

The PBL or project-based curriculum organises content knowledge around simulated or real-life problems (Dolmans and Schmidt 1994). As a result, PBL students are likely to organise their knowledge base around problems (Gallagher 1997). A PBL curriculum also places a great emphasis on the depth of the subject area as well as on detailed contextual factors. This problem-based knowledge organisation and emphasis on contextualisation helps students retrieve relevant domain knowledge efficiently and effectively (Gentner, Loewenstein, and Thompson 2003), as well as developing their situational knowledge in relation to the domain knowledge. However, it has been observed that students have a tendency not to be intrinsically apt to integrate what they have learned (Dolmans et al. 1993; Drummond-Young and Mohide 2001; Lieux 2001). If the PBL curriculum provides no means for facilitating students to engage in a knowledge integration process and see the interconnections among the constituents (concepts, principles, procedures and factual information) within a subject domain, students' 'problem-packaged' knowledge could become 'compartmental' knowledge (Hung 2006). Thus, students may be able to see the forest floor but not the landscape. That is, without establishing

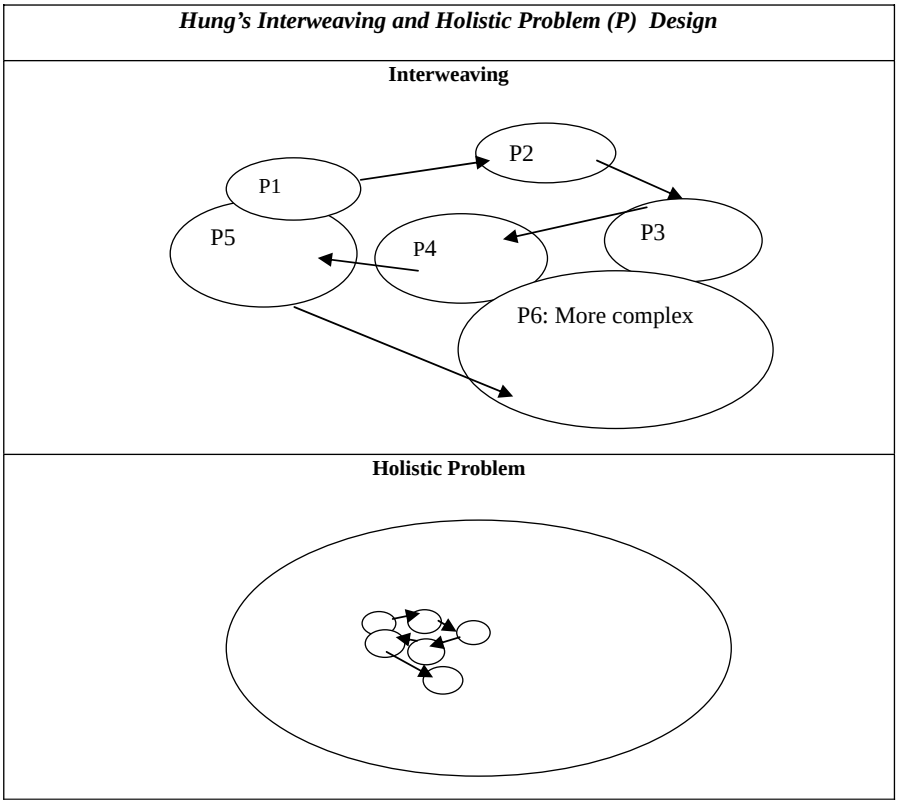

Figure 1. Making connections.

an integrated conceptual framework, students may possess highly contextualised and in-depth, yet disconnected individual pieces of, domain knowledge.

In Hung's (2006) 3C3R PBL problem-design model, 'Connection' is one of the 3C components, which addresses the importance of facilitating students to interconnect-related concepts and information within the domain knowledge through appropriate PBL curriculum design. In this paper, this Connection component is further described by Hung (one of the authors), as including two categories: these are (1) interweaving and (2) holistic. The interweaving connection designs problems that helps the learners develop the interconnections among the individual concepts, principles, procedures and information; while the holistic connection helps the learners establish a holistic view of the domain knowledge (see Figure 1).

Interweaving category

The interweaving category concerns the interconnecting process of different parts of the domain knowledge that has been organised by the PBL problems in the curriculum. Prerequisite, overlapping, and multi-facets are three approaches that can be used under this category in problem design, depending upon the nature of the subject domain. The prerequisite approach establishes the PBL problem's connection

component in a conceptually logical order from simple/basic to complex/advanced (see Figure 1). The overlapping approach interlinks different concepts by overlapping them in several problems (also represented in Figure 1) to interweave these sub-networks (individual problems) into a larger and more complete network (curriculum). The multi-facets approach incorporates the same concept in multiple problems with different contexts to help learners understand the multi-faceted effect of variables. This attention to detail on the problems and their connectivity has similarities with Conway and Little's (2000) description of real-life problems as the micro-level implementation of PBL. This on-the-ground approach to learning allows the student to explore the forest floor in detail, and to discuss how things look close-up, in reality on the forest floor. Which aspects of the forest floor to be explored, may depend on the directiveness of the problem. The literature, in general, supports, Hung's prerequisite approach, that curricula should start with more directive problems and move to more complex, so that it is the later more complex problems that then reveal the interconnections (see Figure 1). Good problems in PBL should, therefore, slowly become less directive; they should, where possible, become more 'ill-defined', 'ill-structured' and 'messy' (Koschmann et al. 1994; Stinson and Milter 1996; Weiss 2003). Hung elaborated that the 'ill-structuredness of problems helps to deepen the learner's understanding of the topic' (2006, 59). 'The more complex problems should be those that contained a series of concepts but emphasised their interconnections, as tested against the reality of various situations' (Mauffette, Kandlbinder, and Soucisse 2004, 19). The interweaving category in problem design, therefore, focuses on how problems relate to each other and the extent that they interconnect at a more micro-level of curriculum design.

The holistic category

In contract to the interweaving category, in the holistic category, the connection component is usually utilised in one problem that requires the learners to view the subject domain holistically. Top-down and bottom-up are two approaches that can be used in the timing of a holistic problem. The problem that utilises the top-down approach functions as an advance organiser (Ausubel, Novak, and Hanesian 1978). The problem will be given to the students at the beginning of the curriculum to equip the learners with an overall conceptual map (landscaping) to prepare them for the following problems throughout the curriculum. Conversely, the problem that utilises the bottom-up approach functions as an overall review for the learners to draw the conceptual map (landscaping) at the end of the curriculum based on what they have learned from all the PBL problems in the curriculum, including the individual concepts as well as the interconnections.

By using a combination of the holistic or the interweaving approach in a full programme of PBL the landscape can be slowly revealed over time; a *macro*-level design organises the curriculum around key concepts that 'emerge from the conceptual framework of the discipline' (Conway and Little 2000, 2). It can be challenging, therefore, to design short curricula in order to achieve both the real-life problems and the interconnection of concepts in the subject domain, if indeed it should be done at all. Hung's model gives us two useful approaches on how to improve connectivity by attention to problem design; however, there may be other

aspects of the curriculum design process that also assists in developing connectivity. This will be explored in this study.

Theoretical research framework

The aim of this study was to explore, change and reflect on the issues of connections of concepts in a PBL module in a very specific higher education context; therefore, the stages of a simple model of reflective practitioner action research model were used to structure the research process, i.e. cycle of planning, acting and observing, and reflecting (Elliott 1991). These continuous stages at times merge in each of the cycles described below. The study was conducted in two distinctive cycles: Cycle 1 involving the first and second student cohorts and Cycle 2, the third cohort of students on this module. Ethical approval was sought and granted to carry out the research study.

Cycle 1

The PBL module under investigation was entitled 'Education Theories' and was a component of a 'Graduate Diploma in University Teaching and Learning' for University lecturers (Faculty) run by University College Dublin, Ireland. It was one of four modules; the only one to use PBL and it ran over a 12-week semester. It was, therefore, a hybrid PBL programme, or a single module approach as described by Savin-Baden (2008). It was designed and implemented initially in Cohort 1, a class of 21 students (lecturers) divided into three PBL groups of seven students (coded S1–S21). In the following year, it was repeated (without change) with a second cohort of eight students who comprised of one PBL group of four University lecturers and four educational developers (coded S22–S29). The well-established Maastricht seven-step model was used for implementing the PBL process (Davis and Harden 1999). The assessment of the module included continuous formative self-assessment of student participation in the PBL process and an end of module individual 4000 word essay, relating the educational theories to a problem that the students had encountered in their teaching.

Six problems were designed for the module; the majority was based on 'real-life' or simulated teaching scenarios. In order to ensure some connectivity in the module, we attempted to incorporate the approaches from Hung's problem-design model, developed in the American context, to this Irish higher education module:

(1) Interweaving:

In the initial design of the module, a matrix of learning outcomes and problems (Barrett 2005) was used in order to develop Hung's idea of overlapping of problems; problems were also designed from directive to more complex (Hung's prerequisite approach).

(2) A holistic problem:

This was designed to give an overview of the connections between some of the more established theories (see Appendix 1, Cycle 1).

In addition to focusing on the problem design, we also, on completion of the problems, invited an expert guest speaker to give an overview lecture on the subject domain of educational theories.

The module was evaluated by students using the triangulation of four different research methods: (1) the students self-assessed their performance in PBL at the end of each problem and included a reflection on their learning experience on a *Student Self-Assessment/Reflection Form*; (2) after a set of three problems, students filled in an evaluation of their experience of these problems on a *Problem-Review Form*; (3) *A Structured Group Feedback Meeting* was performed at the end of the module and the views of what should be 'continued, stopped and started' were discussed and recorded; and (4) four in-depth semi-structured *Interviews* were carried out with the educational developers (S26–S29) who had attended as students on the module, as it was felt they were key curriculum design informants. In addition to gathering the students' views, the three tutors carried out *Participant Observation* during the tutorials and then met with each other after each problem to record, validate and reflect on their observations.

In the data analysis process, using the software package MaxQDA, the data were brought from the five different sources mentioned above into more manageable units. The researchers moved backwards and forwards through the data in order to generate meaning using a constant comparative approach. Many themes emerged from the data in relation to the module design in general and the complete overview of all these themes is reported elsewhere (O'Neill 2007). Consequently, this paper will focus on the two strongest themes (i.e. 'problems based in the real world' and 'landscaping').

The first theme to emerge was the value to the students of the problems being based in the real world of their teaching, i.e. emphasis on the forest floor. This was commented not only on the findings in relation to the design of the problems, but also on how this had supported the students in applying the theories to their 'real' world of teaching. For example:

> They (the problems) were placed in the real world which was good, you could actually imagine some of these happening. (S26, Interview)

> I think the practical application for me was great...I can go to the theories and I can take them and can apply them...as a lecturer in my class. (S28, Interview)

However, despite the positive responses for the problems being based in practice, there appeared to emerge a tension between focus on the real-world of practice and the need for an overview of the connection of the educational theories (the other main theme emerging). One very experienced educational developer who was also an expert on the Education Theories, described the overview of the interconnections of the educational theories as the 'landscape', and it was from this comment that we decided to use the metaphor of landscape in this paper:

> I had the language, I had a lot of the concepts and I wonder, I think that's still a big question mark about PBL, about how do you do this when you don't know the landscapes, I knew **the landscape** ... it shortened my workload immensely in that I knew where to go. (S29, Interview)

This comment highlighted that despite some attempts to address the issue of connectivity we were still not completely successful at the landscaping aspect in the module design. There appeared some useful but surprising suggestions by the students on how a module should be designed where they can clearly see both

the landscape and the forest floor. In the module in Cycle 1, one holistic problem was used in an attempt to give this landscape (see Appendix 1) but the students instead of describing it as a useful overview, in contrast, found it *'a little directive'* (S9, Problem Review Form). This view was supported by the consistency of learning goals for this problem across the three separate groups in Cohort 1 (Participant Observation). An attempt by us to landscape the module, by using an overview-lecture at the end of the module, had mixed views from the students and the tutors on where this lecture should be placed, which ranged from the beginning–middle–end of the module:

> I don't actually think it would be more useful at the beginning ... because I think we would have relied on it ... we followed our own route and we created, it's very much discovery learning. It was reassuring to have it at the end. It was good just to sit there and go 'oh yeah'. (S26, Interview)

A view emerged from some students that there was some need to landscape the domain of 'Education Theories' at the beginning, but these students did not advocate a lecture at the beginning, they described instead that it would be useful to have something that would give them just the language to start. In the Structured Group Feedback Meeting the students triangulated this result by suggesting they read a 'common paper to begin'. The importance of some basic language to start emerged as key. In relation to the metaphor of the landscape, it might imply being able to name the individual mountains. One educational developer (S29, Interview) described that without some basic language of the educational theories:

> its like going into France and not being able to say bonjour; au revoir; merci; s'il-vous plaît...

This theme of the landscape was also linked in the data with the concept of the level of 'loose-directive-ness' of the problems and indeed there was also conflicting findings in this area. One student suggested 'start off quite directive and become less directive'.

To summarise the key findings in this cycle of the study, the students highlighted the great value of using 'real-life' problems, seeing the details in practice on the ground. These findings suggest that while the students of PBL found the problems of great relevance to their every day teaching, some students found that it did not provide them with a comprehensive overview of the educational theories. To continue the landscape metaphor, it is as if the problems provided detailed and focused views of the 'forest floor' while the 'landscape' remained blurred in the background. This seemed to imply our work using Hung's interweaving category was more successful in Cycle 1 than with his holistic category. In addition it seemed we needed to move beyond that of our efforts on problem design to explore other resources to improve in particular the landscaping aspect.

Cycle 2

In reflecting on these findings from the first cycle, we decided to make changes to improve the revised module. One change was to finish the module, in the next cycle, with a 'landscaping problem' that was also more situated in practice and designed to link more closely with the end-of-module assessment. This new problem is set out in Appendix 1. In this problem, the students had to review the connections between the

theories in order to be able to choose the one's more appropriate for new academic staff. They, as a group, had to create their own landscapes and were exposed to two other groups' views of the landscape, thereby demonstrating that there may be more than one view. This type of problem is more 'real-life', more relevant, than the original landscape problem that was presented (Appendix 1), as the students all knew the staff member and were also familiar with the equivalent of a short University Induction Course.

The previous students had described a need, at the start of the module, for some language (possibly definitions) of some of the theories. One suggestion was to start with an overview paper, which contained a brief overview of a range of the theories, as prescribed pre-reading. This was implemented in Cycle 2 and three overview papers were handed out at the start (i.e. Carlile and Jordan's Education Theories overview article 2005). Therefore, the changes made for Cycle 2 of the study based on Hung's Interweaving and Holistic problem-design categories, in order to further improve the landscaping aspect of the module, are summarised in Table 1.

In Cycle 2 of the study, 24 students (coded S30–S53) attended the revised module on 'Education Theories'. Two of the evaluation methods used in Cycle 1 were employed again: (1) *Problem Review Form* which was filled in by the students at the end of the module and (2) *A Structured Group Feedback* meeting. However, on this occasion students were specifically questioned on the extent to which the landscaping had been achieved in the module.

The findings in Cycle 2 highlighted that a greater degree of landscaping appeared to have been achieved in Cycle 1. This was evidenced by the comments on the Problem Review Form in relation to the new holistic problem confirming that it had indeed, as one student described it, 'consolidated' (S40) her knowledge. One student

Table 1. Summary of changes made following Cycle 1.

Interweaving problem design (Hung 2006)	Holistic problem design (Hung 2006)
More complex/advanced last problem (prerequisite approach)	A more 'real-life' holistic problem was designed that required students to present their own individual and group view of the landscape. This new problem was placed as the last problem (bottom-up approach)
Other changes to improve connectivity (not based on problem design)	
(1) Landscaping papers to pre-read Three overview papers were handed out at the start that gave some of the common language of the educational theories.	
(2) A landscaping lecture A lecture was delivered where *one* picture of the landscape was given, demonstrating *one* expert's overview. As there was mixed feedback on the optimum timing, this was placed midway in the module.	
(3) Designing an assessment to align with the aim of improving connectivity The final holistic landscaping problem, in addition to being tutor-assessed, was peer-assessed to ensure that the students themselves were assessors of the different overviews (landscapes) of the other student groups (Appendix 1).	

also noted that this problem was very good as 'synthesis (was) required of the previous topics' (S32). Another student noted that it 'tied everything together very well, it helped give myself an overview of what I had learned' (S30). It was also described as a 'good tool for summary' (S44). The Structured Group Feedback Meeting data also confirmed the success of the final problem in landscaping. For example, one student noted that 'The final problem did give the landscape, to me personally, I thought it was useful, it consolidated everything' and this was supported by a second student who described that 'I thought today (final problem presentation) was vital both for the preparation and what I learned from other groups ... I feel to get the landscape you need both today (the final problem presentation) and the lecture...(the mid-way landscaping lecture)'. Students in this cycle also described that the three texts given as pre-reading were very helpful. One student, who found the educational literature vague and abundant, described these texts as her 'bible' that she referred to throughout (Structured Group Feedback Meeting).

Discussion and conclusions

In the PBL module used in this research, the majority of the problems were drawn from real-life or simulated teaching scenarios that the students (lecturers) could relate to in their teaching practice. However, our students maintained that although this is well received there is a danger, as warned by Hung, for students to compartmentalise knowledge and lose sight of the overview (Hung 2006). The critics of our application of PBL to one module only would argue that the connection of concepts emerges slowly over time in a full PBL curriculum (Conway and Little 2000). Savin-Baden (2008) explores seven different PBL approaches and it appears that the more comprehensive integrated approach (mode 7) would allow for more opportunities for developing connections of concepts. Therefore, helping students develop conceptual connections poses a challenge in shorter PBL curricula and many would argue hybrid PBL programmes should not be attempted. The students in our study may not have mentioned the issue of landscaping if the full programme had been through PBL. Given this limitation in our own use of PBL, the reality in practice is that there are many international applications of PBL that could be described as hybrid (Savin-Baden 2008). How, therefore, can this connection be enhanced in these cases?

There appeared to be three key strategies that emerged from this study that supported the students in developing this connectivity: the problem-design process; use of other learning resources; and an integrated assessment.

The first strategy was the attention to the manner in which the problems were designed. Hung's (2006) 3C3R problem-design model was implemented in order to help with the design process, using both an interweaving and a holistic approach to the problem design. We were less successful initially with achieving connections and it appeared that we needed to give more attention in particular to the holistic problem. Our adjustments, in the second cycle, to both the timing and also the design of this holistic problem achieved greater success. It was designed to be less directive, more real-life and more student-driven. The students were very positive about this revised problem and strongly supported its role in helping them to see the landscape. It appears that there is quite a challenge in the design of this key problem, which may

require more attention than is realised in the design process. Although there is much literature about PBL problem design, there appears to be very little in the literature about the importance of the holistic problem at the beginning or end of PBL curricula (in our case a single module). Another area, not well-developed in the literature, is the relationship between models of problem design (i.e. Hung's 2006) and other learning resources. This appeared to be crucial as a second strategy in developing connectivity. In a single module design, there appeared to be a need to rely on other learning resources (lectures, readings) in order to improve the landscape. The use of articles/chapters which focused on an overview of the subject domain was given as pre-reading and allowed students to have some of the language needed to engage with the subject domain. The timely use of an overview landscaping lecture by an expert appeared to enhance the integration of the students' knowledge. The students strongly argued that they should have worked on some problems *before* they received this lecture. Margetson (2000) argues that one role for the lecture format in PBL is that students' misunderstandings can be corrected and that a lecture is an efficient use of time over reading the same material.

The third strategy that appears to be useful for developing connectivity was the use of an assessment that focused on an integration task, i.e. to present the connections in a group project. Clark and Linn (2003) also discuss designing assessment for knowledge integration. The assessment required students to attend and to engage with the overlaps. Students were encouraged to use different media in the assessment (such as drawings, concept-maps, metaphors and drama) in these presentations in order to make these connections. Concept maps can also be used as a teaching and learning method and have been described in the literature as a useful learning resource to help make visual connections between concepts in a curriculum. Many authors have argued their success in supporting the integration of concepts in a PBL curriculum (Hsu 2004; Rendas, Fonseca, and Pinto 2006; Skinner, Winning, and Townsend 2001). In this study, concept maps were not used by the tutors, but the students themselves introduced them as a medium to represent the connection of concepts in their group presentation. Hill and Hannafin (2001) who use the term 'conceptual scaffolding' to describe a similar concept to landscaping also support students developing these maps/scaffolds themselves: conceptual scaffoldings are 'outlines provided to guide information presentation and facilitate connection making among themes. Conceptual scaffolds can also be learner generated, such as cognitive maps showing relationships among various concepts' (45).

In conclusion, similar to other studies on the implementation of PBL, some of our findings are not unique, i.e. integrated assessments. What was a little different about the results of our study was the importance of both the design/timing of the holistic problem and the relationship of other learning resources in developing connectivity. Drummond-Young and Mohide (2001), among others, appear to be correct in their argument that students are not intrinsically apt to integrate what they have learned, and curriculum designers need to allocate time to design this into a curriculum, as students may not automatically achieve this aim. This paper took an initial and small step in exploring how this may be achieved, but our findings are preliminary, and further research is needed to provide better insight in this research area.

A great strength of PBL is giving students the details of the forest floor; however, in doing this we must ensure that we support students in the climb to the mountain-top so they can also see the landscape.

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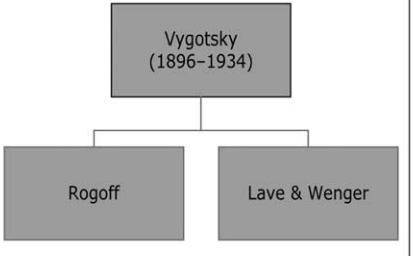
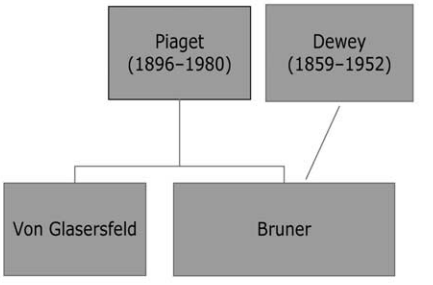
Appendix 1: The holistic (landscape) problems in Cycles 1 and 2

Cycle 1. Landscaping problem:

'Close family or distant relatives?'

Socio-cultural and constructivist theorists both highlight the crucial role that activity plays in learning. 'However socio-cultural theorists link activity to participation in culturally organised practices, whereas constructivists give priority to individual students sensory-motor and conceptual activity' (Cobb 1999, 137). Does this make them close family or distant relatives?

Family tree of the 'socio-cultural' theorists?	**Family tree of the 'constructivist' theorists?**
	

Cycle 2. Revised landscaping problem:

'David Smith requests'

David co-ordinates the four-day Centre for Teaching and Learning Induction programme for academic staff new to University College Dublin.

He has asked you to give a group presentation on 'Education principles: Connecting education theories to your teaching practice'. The group presentation is for 30 minutes and you are free to use any media. David will preview the presentation on the 4 May.