ORCHESTRATING PROBLEM BASED LEARNING: A CASE STUDY OF CONCEPTUAL SHIP DESIGN FOR NON SPECALISTS

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SUMMARY

Problem based learning (PBL) which simulate authentic scenarios are often the pedagogy of choice for teaching complex curriculum areas like Ship Design. Design projects typically present competing possible actions, and while individuals and teams may work on different parts of the problem these need to come together as a whole. Critically there is a need to draw on a wide range of resources covering theory, technical tools and data, reference materials as well as experience. The design process is iterative and how and when specific resources are used is part of the learning. The context for the research reported in this paper is a module called 'Ship Design' which is an elective component of an MSc Course in Maritime Operations and Management at City University London. We conducted an ethnographic study into student activity on this module and found amongst other things that under time constraints students experience information overload and loss of direction. We found that this is remedied by interventions from the teacher and the use of appropriate resources for reasoning. These insights were used to design an on line tool which associates design phases with heterogeneous resources and represents iteration points. This is an example of orchestrating resources. It is also an example application of semantic technologies for modelling design and learning with wider applications.

1. INTRODUCTION

In professional environments experts are characterized by their capacity to tackle complex problems and deliver practical solutions. Complex problems often present competing possible actions. In these situations making decisions calls on wide ranging knowledge of theory and practice and it may not be possible to specify the problem formally or solve analytically without many iterations. In addition complex projects invariably need expertise across disciplines (e.g. engineering, business, finance, economics, and law). At the same time while individuals and teams may work on different parts of the problem these never the less needs to come together as a whole. An example of a complex project is ship design [1]. The context for the research reported in this paper is a module called 'Ship Design' which is an elective component of an MSc Course in Maritime Operations and Management at City University London.

The purpose of the module is to expose students to a conceptual ship design problem and thereby teach them that the design process is not a procedure that passes from one step to the next in a linear fashion. Rather, it is an iterative procedure that endeavours to satisfy constraints, not only at the technical level but also in terms of economics, legal, environmental, commercial and safety issues. Since the students on this MSc course are heading towards careers in marine management and operations, the subject is treated in terms of basic or conceptual ship design rather than progressing towards detailed design issues which are more the province of design engineers.

Problem-based learning (PBL) is often the pedagogy of choice for teaching curriculum areas where engineering, design, innovation and management issues are entangled. It is clear from decades of research and practice that PBL needs careful design and management and this is explored in classical and more recent publications [2, 3, 4]. For this paper PBL is understood as an exercise in which students have to solve a complex real world problem within time constraints to a specified standard. In the Ship Design Module PBL is embedded in a case which is authentic in simulating a likely design scenario. Students have to navigate resources and tasks, work in teams and individually and are assessed on their performance.

In the more practical 'how to do it' literature PBL is sometimes merged with other approaches which are regarded as student centred [5]. There are ongoing controversies about differences between PBL and related approaches [6]; and which pedagogies are best suited for students to develop competencies and theoretical understanding that can be transferred to more specialist academic work and work outside the university. Guided instruction is regarded as preferable to more unstructured methods by some writers [7] while others argue that PBL can be designed to be carefully guide learning while at the same time engaging and motivating [8]. It can be argued that definitions are academic as in practice pedagogies are rarely pure. What is missing from more general/academic discussions is specificity around how different students (as part of a group) cope with problem solving exercises and evidence of interventions which are effective.

The research reported in this paper is concerned with the question: What are students doing when they are engaged with this form of learning? Following this questioning we are also interested in the design of education technology to support students learning in areas where learning outcomes are complex.

The rest of the paper is organised as follows. The background section (2) describes the Conceptual Ship Design Module. This module was one of the settings for a ESRC/EPSRC funded technology enhanced learning research project called Ensemble, and Ensemble work with cases in complex domains and semantic technologies is described. Section 3 is concerned with the research approach including Ensemble influences, fieldwork, and design to support learning. Section 4 presents finding and implications from the field work in the classroom. Section 5 describes how the implications are interpreted to design a semantic web application to support the students and how the technology is a type of orchestrated intervention. The paper ends with some preliminary conclusions (section 6).

2. BACKGROUND

2.1 CONCEPTUAL SHIP DESIGN MODULE

The setting for the research reported in this paper is a Masters course in Maritime Operations and Management (MOAM) at City University London. On this course the students are a mixture of new graduates and mid-career professionals from various maritime sectors including commercial, naval, recreational and offshore. The MOAM course is broad based with core modules in maritime – technology, operations, economics and accounting, management, law and insurance. The course also offers elective modules on maritime - environment, risk management, security, marketing, offshore, ports and harbour management and design. The last elective module is on ship design. Consequently, the student undertaking the this module will have taken at least two of the other elective modules beforehand.

The Ship Design module comprises 4 days of scheduled teaching time so clearly there is no intention to train ship designer as such, instead the rationale is to develop the technical and business literacy that future managers and leaders will need to work effectively with marine contractors. In broad terms the aim of the Ship Design module is to enable students to experience a ship design project wrapped up in a case study which is a realistic scenario. The background information to the design problem is described in Figure 1.

In terms of learning the module goals are to:

- to teach students about the basics of designing a ship, starting with client requirements and a business plan;
- to enable students to appreciate the multi-disciplinarily skills and knowledge involved in this complex project; and
- to give students practical experience of making decisions drawing on authentic data in an open-ended problem that has no single solution.

The Design Problem

The directors of the small shipping company are considering replacing their existing and only passenger/cargo ferry which was built in 1975. The ship is currently in good condition but they foresee a time when the cost of keeping the ship up to the standards required by the Maritime Safety Agency and Lloyd's Register, with whom the ship is classed, will become high in terms of the company's cash flow and balance sheet. Additionally, the costs of maintaining the ship to the standards expected by the passengers and of reliably maintaining the ship's schedule through unscheduled breakdowns will inevitably increase as time passes.

As a consequence, the board of directors has invited conceptual design options to be presented to them on a possible replacement for the ship within the next few years. Within the proposed design options the following should be included:

i. The basic ship type, form and layout.
ii. The machinery and propulsion type, auxiliaries and layout.
iii. The outline of the electrical system and communications.
iv. The personnel safety arrangements.
v. An environmental plan for the ship's operation.
vi. A supporting economic case, including operational costs, marketing and analysis of the competing transport options.

Figure1: The Ship Design Project

As the Ship Design module is offered towards the end of the course, once student have completed core modules and been assessed, it is possible to assume that students already have some of the basic knowledge about engineering, naval architecture, economics, operations, health and safety, marketing, finance, and so on.

The module begins with a day of lectures on naval architecture, marine engineering and the design process which extends their knowledge gained from the compulsory modules based on marine technology and operations. The students then have two and a half days to work in groups to come up with a conceptual ship design to perform specific duties; Figure 1. At the end of this time each group makes a presentation to a board of selected personnel on their proposed design and the student's individual contribution to the design. This is assessed as is the report that each student is required to write as part of the assessment for the Ship Design

Module. The assessed report has to be completed within six weeks from the end of the module.

Some of the rules and features of the design exercise are worth noting:

- Students are allocated to groups to distribute as far as possible the experience and capabilities of individuals.
- Since shipbuilding and operation are international undertakings, the students in each design group are, as far as possible, chosen for their different cultural backgrounds because when working under pressure these differences can be highlighted.
- The group is asked to elect a *chief designer* and other members of the group take on responsibility for various aspects of the design while recognising that the whole ship concept needs to be addressed.
- The physical space for the design exercise is organised with suitable equipment, breakout spaces, and access to computers.
- Significant volume of resources are available in hardcopy and online including access to libraries and databases.
- The lecturer is available to provide help and guidance.
- The details of the assessment process and marking criteria are explained.

The conceptual Ship Design module is a response to the challenges of teaching and learning for professional development. It requires students to: "deal with complex issues both systematically and creatively, make sound judgements in the absence of complete data, and communicate their conclusions clearly to specialist and non-specialist audiences" [9].

This is, in other words, about preparing students for the world of 'working in industry'. Margetson [10] contrasts profession-based with subject-based conception of expertise. Subject-based expertise tends to emphasise content knowledge i.e. *knowing that* such and such is a case. This is very different from *knowing how* expertise where the emphasis shifts to finding and using information, tools and other resources appropriately. Clearly understanding of content is still important but Margetson critique is to "deny that content is best acquired in the abstract, in vast quantities, and memorized in a purely propositional form, to be bought out and 'applied' (much) later to problems" [page 38].

The Ship Design module was one of the research settings for a project which investigated the design of teaching around complex learning outcomes and the design of education technologies to support this process. The work of the project in the Ship Design setting is described next.

2.2 THE ENSEMBLE PROJECT

The Ship Design module and the MOAM Programme were research settings for a Technology Enhanced Learning (TEL) research project called Ensemble (Ensemble: Semantic Technologies for Enhancement of Case Based Learning). Ensemble is one of eight major projects funded under the joint ESRC and EPSRC Technology Enhanced Learning Programme, which is part of the broader Teaching and Learning Research Programme in the UK.

The Ensemble project (2008-2011) bought together an interdisciplinary team spanning eight higher education institutions, with research settings at Liverpool John Moores University (e.g. Dance and Education Studies), the University of Cambridge (e.g. Archaeology and Plant Sciences), and City University, London (e.g. Maritime Operations and Management). Across these setting the project investigated the role of cases around which learning is focused, and the part that emerging semantic technologies and techniques can play in supporting this learning.

There are a number of reasons why the Ship Design module is a particularly interesting setting for the Ensemble project. First the students are presented with a realistic case for the conceptual design exercise including authentic resources (e.g. charts, tide tables, engine lists, passenger numbers, and information on competition in the region). The students are also set a problem which required them to draw on wide ranging resources from many different sources, in different media formats and from different locations. In addition there are time pressures and group dynamics. It is possible to analyse the design of the pedagogy and also see how this works out in practice thorough detailed observations in the classroom. This is taken up in the research approach section.

The Semantic Web (which includes technologies and techniques) has been described as an extension of the current web [11, 12]. The W3C Semantic Web Activity Statement tell us that the Semantic Web is a vision "That allows a person, or a machine, to start off in one database, and then move through an unending set of databases which are connected not by wires but by being about the same thing" [13]. The semantic web vision is about defining and linking data in ways that can be used by machines and people for reuse, interrogation and visualisation of data across various applications [11, 12, 13]. This describes some of the possibilities evident in research and commercial applications, but the vision in its totality does not yet exist certainly not in education where learning outcomes are complex [14]. The possibilities are an open research question and the next section of this paper takes this up.

3. RESEARCH APPROCH

This section explains the Ensemble project and three suffice for this. These points set the scene for the research is the MOAM setting and the field work process is described.

The first point is concerned with adopting a limited but useful notion of semantics. It is enough to understand semantic technologies as tools and techniques for aggregating information from heterogeneous digital sources in ways that support specific teaching and learning tasks. The term heterogeneous is used because the technology works to assemble the information from many different places, for example the web, databases, online library, and e-books. In addition the data/information can be in many formats, e.g. video, audio, text, and spreadsheet – but critically the person using this technology does not need to be concerned with this automated backend.

The second point is concerned with usability of tools for experimentation. Many of the technologies that could lead to wider adoption of semantic technologies in education already exist but these are difficult to understand outside the specialist community and demand excessive time and effort to learn and use in a useful way. They are therefore not accessible to technicians supporting the lecturers or the lectures themselves. It is because the threshold for access and experimentation with these technologies is too high that the affordances of semantic technologies remain a mystery to lecturers. To tackle this problem the Ensemble technical team has extended the toolkits developed by the SIMILE project at the Massachusetts Institute of Technology (MIT) [14, 15]. The application described later in this paper is developed using these open source tools.

The third point is concerned with research data and analysis. The Ensemble project was conceptualised as an interdisciplinary learning environment within which participatory research and design, collaborative analysis and interdisciplinary exchanges was ongoing.

The research carried out in the MOAM setting is influenced by Ensemble and the range of activity is listed in Figure 2. This paper is concerned with the field work in the classroom which looks at what the students are doing in the classroom; and the design of the intervention which is an application using semantic web technology.

The fieldwork observations adopt the working practices of ethnography where the researcher takes detailed notes and stays close to the practice (what the students are doing). The researcher also carefully selects appropriate points to ask questions during informal periods like breaks and lunch. Still photographs are taken to supplement the notes with due care to avoid being intrusive.

During the field work the researcher observed how the group performed the tasks as specified in the Module briefing. Particular attention was paid to recording observations when there was visible progress and periods where the students were unable to go further. The researcher also looked for periods of collaboration and lack of collaboration and took notes on individual, subgroups and whole group interactions.

(1) Field work in the classroom
(2) Work with lecturer and course team: knowledge elicitation and modelling
(3) Work with lecturer, course team and resources provider s: resources specification and modelling
(4) Representation of ship design exercise
(5) Work with SIMILE/Ensemble tool kit: develop application

Output: An application using semantic web resources

Figure 2: Stages of research. In this paper the focus is on stage 1 and the output

4. FIELD WORK FINDINGS

This section interprets the fieldwork observations on how and when materials and resources were used by students and the patterns of individual, subgroups and whole group activity and interactions. The analysis then identified events and factors which helped students to make progress and factors which hindered progress.

4.1 FINDINGS

It seems that there are two distinct dynamics that set apart periods of progress and periods of frustration and apathy and this was evident at the level of the group and the individual. This distinction is an abstraction which moves beyond casual observations and is not intended as a caricature. There are certainly random contingencies entangled in group dynamics and differences in capability of individuals - casual observation will show only these.

It should also be pointed out that activities where no progress is visible can be significant in terms of the students' gaining an overview of the available resources, for exploration or orientation. This was confirmed in follow up conversations with the students. Also close observation data showed that silent work periods could be productive and this was clear from what came before and after.

Productive periods show signs of engagement and energy in the following ways:

- The group talks about how the set problem and the stages of it there by gradually transforming an ill

structured problem into a set of - provisional - structured tasks.
- There is justification-directed discussion for example in analysis of the client requirement and the competition.
- There is meaningful directed search and browsing through resources, for example in deciding between alternative engine types.
- The argumentation is decision focused for example: "we need to design for 600 passengers, and a trimaran would get very big" → looking at the detailed chart of the harbours, (researcher's notes).
- There is example-based reasoning for example: "if we go for one ship it means fitting in pleasant accommodation for err passengers…and ahh crew, and carry cargo…and what about stability? We need to improve on the passenger sea sickness and general experience……" → looking at pictures of hull types (researcher's notes).
- Key artifacts like diagrams, photographs, maps, examples and students notes play an important role to get started with something, as a focal point of group discussion and to ground reasoning. Concrete resources like spreadsheets, formulae, technical specifications and charts also serve to help make sense of the theory.

These periods are clearly necessary and desirable. But there does appear to be periods where students are unable to go further and are overwhelmed by the complexity of the problem and the amount of information. For some groups the researcher observed that:

"morning of the first day is characterized by little collaboration, and quite long (up to 20 minutes) periods where students appear to browse through resources randomly, or discuss issues without structure or clear sense of direction. Such discussions focus on concepts or issues that are somehow relevant to a previous one, the discussion hence having the character of an associative chain, rather than a cyclic movement returning to the question or concept that initiated the discussion, and where data become meaningful within a certain question. Absent in these discussions are also argumentation structures or justification-driven reasoning." (researcher's notes).

This seems to suggest that the students are experiencing two kinds of information processing problems. First, information overload where they feel they can't process all the information that seems relevant indeed can't distinguish between what is relevant and what is not. Second, there is a sense of being lost in the information and the problem. This is where the students can't find or relocate information relevant to a particular stage of the problem or a specific task. At its most extreme this sense of being lost is when students don't know where they are, where they have been and where they are going.

When students manage to find appropriate resources at the appropriate stage of the design this propels productive activity in two ways. First it is a focal centre around which the group can work, thus engendering argumentation and justification-driven reasoning; second, examples provide students with something to start with and a way to give relevance to resources. So, for example, books, which are often theoretical and generic, are consulted with the aim of understanding the general principles behind a specific design; that understanding provides them with the basis to develop the design in line with the task.

2.2 IMPLICATIONS

The field work suggests that students experience periods which are:

A: productive, directed, and structured
B: less productive, confused, and random

Two questions arise from this: first what are the event(s) or factors which turns point B to A, and second, what can be done to reduce B periods?

There are a number of events/factors that give students renewed sense of direction:

- Teacher's interventions (e.g. questions and suggestions).
- Early group discussion about the set problem and the stages.
- Understanding design iteration as normal.
- Anchors for example simple photographs or layouts of other ships, with primary importance given to the two currently operating ships and associated data (e.g. operating schedule).
- Overviews of the process e.g. shared notes so that there is a sense of tracking progress along a time line.

The rather complex dynamics of PBL reveal some simple requirements - every group would benefit from the strategic guidance of a teacher in navigating the information and the design process. Clearly telling the students about the process and information (as they were told in lectures) is not enough and clearly the teacher can't be perpetually present at the service of every group just at the right time. The next section describes how insights from the field work has informed the design of a semantic web application which makes the teachers expertise available to the group while retaining the complexity of the problem and the possibility of alternative creative solutions.

5. ORCHESTRATING INTERVENTION

Metaphorically the PBL pedagogy observed during field work can be characterised as a kind of orchestration.

- The lecturer designs the Conceptual Ship Design exercise orchestrating what is possible in the time allocated.
- Careful consideration is given to resources needed to tackle different parts of the exercise so resources and tasks are orchestrated.
- The lecturer orchestrates interventions and provides expert guidance in situ to enable productive student activity without making decisions for the students.
- Conceptual design is a type orchestration that anticipates iteration points, time limits, and conflicting technical and other constraints.

This section now moves on to show how the orchestration metaphor is useful for analysing semantic technology deployed in the service of learning. The section ends with a description of the application that was developed.

5.1 ORCHESTRATION TAKEN FURTHER

The findings from the field study suggested that any application to support students with Ship Design (PBL pedagogy) - needed to include:

- Questions that the lecturer would ask if offering guidance face-to-face, that is questions prompts that are pedagogically informed.
- A time-line which represented the design process and possible iteration points, so alerting students to the need for revisiting decisions.
- The linking of heterogeneous resources to the tasks in a way that is adaptive to the phase of design process.

There are a number of other considerations for example the application had to be easy to maintain as the location of online resources changed; possible to be developed quickly without employing software engineers, and easy to change and discard in order to experiment with alternative designs. These technical considerations were addressed by using the SIMILE / Ensemble tool kit and the technical account of this will be published in another paper.

Also left out of this paper are the knowledge engineering techniques that were used to model the lecturer's expertise both in terms of ship design and in supporting the students to tackle the set design problem. Figure 2 show the stages of research in this setting. Following the fieldwork there was translation though (2, 3, 4 and 5). In practice the elicitation process generated substantial additional information. This is illustrated in Figure 3

Figure 3: Representations of experts' knowledge and pedagogy associated with conceptual ship design

which shows - for example paper representation of the design process, audio of lecturer's questions (refined through dialogue), glossary of potential meta tags entered into a spread sheet and researcher manual notes. This assembling process was followed by work on digitising, verifying and validating heterogeneous resources identified during the elicitation process.

Working with the expert/lecturer it was possible to develop a representation of the conceptual ship design process. Figure 4 shows this process, the phases, subtasks, iteration triggers and the final phase when the team moves into more independent work (depending on allocated roles).

This representation was deployed in a software program (application) to support students without the presence of the teacher. The metaphor of orchestration is useful in describing the backend of the application. Resources are aggregated depending on the phase of the design. Each phase is linked to the questions and suggestions that a teacher would make if the group is struggling with that phase. The synchronisation of time/phase with selected resources and questions is (metaphorically) an orchestration for pedagogical purposes because it supports the team and individuals but does not automate the iteration triggers or make design decisions.

An application was developed using semantic web techniques and technologies and this is described next.

2.2 THE APPLICATION

The application is developed to look like a website with tabs which follow the sequence of instructions set out the paper version of the exercise: Figure 5.

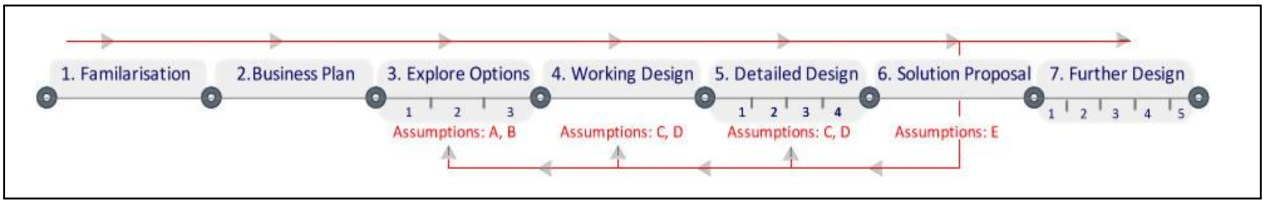

Figure 4: Ship design phases, and assumptions

An introduction page supports the introduction in the classroom so that for example students are asked to:

Figure 5: Screen shot showing tabs as stages of the exercise.

"Take the time to study the resources relating to the whole exercise. Then browse the resources by phase of design and subsection within each phase. As you go through these the questions to help you with each phase and related resources will update automatically. You may need to go back and forwards many times during the course of the exercise." (Application first page)

This is followed by a familiarisation page (Figure 6) where students are asked to prepare by reading and browsing. Before being introduced to the exercise in the class room students will have studied the instructions and a template for developing a business plan. They will also have browsed drawings, photographs and specifications of the ships used currently, charts of the sea area where the route is located and weather statistics for the area.

Figure 6: Screen shot- familiarisation guidance and resources

The main part of the application is designed to support the classroom activity. This is represented in a diagram which shows the seven phases and subdivisions (phase 3, 5 and 7) and the iteration points: Figure 4. During phase 3, 4, 5 and 6 students are shown that they need to make assumptions to move to the next phase. These assumptions may need to be revised and so the design process is iterative. The team will have to make some compromise decisions before moving to phase 7 which is 'Further Design'. The design at phase 7 will be the best fit that can be justified given the time constraints and the Business Plan.

Each of the phases are an item on a menu which when clicked on brings up linked questions and guidance that the teacher would give if physically present with the group. Importantly this guidance is links to resources that are relevant for that phase of design. This includes resources that are relevant as background reading so that the student and the group still have to exercise judgement.

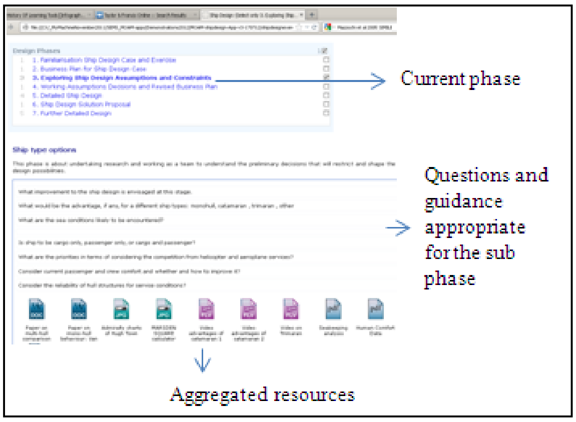

Figure 7: Screen shot showing guidance and resources associated with design phase 3

For example figure 7 shows the screen at phase 3. Phase 3 is 'Explore Options' which has three sub phases: (1) Ship type options; (2) Ship type in relation to docking options; and (3) Ship type in relation to fittings, reliability and operational costs. Figure 7 shows the screen available to the team when working on this phase. There are guidance questions which the applications displays for example:

- What improvement to the ship design is envisaged at this stage.
- What would be the advantage, if any, for a different ship types: monohull, catamaran , trimaran , other
- What are the sea conditions likely to be encountered?
- Is the ship to be passenger only or cargo and passenger and, thereby, obviate the need for the present additional cargo ship?

Linked to this is a paper on multi-hull comparisons, admiralty charts, Marden Square data, data on human comfort, and videos of catamaran, and trimaran in action both at model and full scale in different sea statuses.

The exercise involves team work and individual contributions. In phase 1 members of the team take on a specific role for example Navel Architect, Marine Engineer, Business Manager, Ship Safety Officer and so forth. After the 6th phase which is about agreeing the final concept design, business plans, rationale and assumptions; the application then steers individuals in developing a more detailed specification of design of the area for which they are responsible.

This is an example of technology enhanced learning. The *learning* is orchestrated to address some of the findings from the field work:

- Ill structured problem of design is represented as a set of - provisional - structured phases and sub phases with associated decisions and tasks.
- Question prompts guide justification-directed discussion so that team work and collaboration is more focused.
- The application encourages argumentation that is decision focused as the next task is visible on the timeline.
- There are examples (from those identified by the expert) that are part of the resources perpetually accessible to encourage example-based reasoning.
- The linked web of resources offer perpetual anchors like diagrams, photographs, and maps.

The *technology* deploys semantic techniques and technologies; and the Ensemble/SIMILE tools and the lower threshold to rapid application development. The *enhancement* is in the orchestration of task, resources and pedagogy which simulates the presence of the expert/lecturer. This is augmentation rather than replacing the teacher. Critically the application enhances by orchestration rather than automation. Students still have to make their own decisions and mistakes and they are guided in learning from these.

6. CONCLUSING REMARKS

As was indicated in the introduction to this paper there is much valuable research in the area of PBL [2, 3, 4, 5, 6,]. Much of this is concerned with challenges associated with instituting major educational change. From this previous work our research confirms the following are important: commitment of staff, type and scope of the problem is appropriate, sufficient investment in resources, ongoing renewal of resources, and appropriate assessment methods [2, 4]. Beyond these general heuristics we found that even if the design of PBL is theoretically optimised there are still issues around supporting the students and we suspect this is generally the case - given that implementation of PBL varies widely [17]. Students find it difficult to manage time during problem solving to allow for iteration, and select appropriate resources as tools for though and decision making.

In our field work we drew on the Ensemble project to use ethnographic approaches to understanding student activity and this resulted in new insights. This contrasts with more statistical methods of investigating effect which are difficult to interpret [16, 17].

Our fieldwork in the MOAM setting found a mixture of reasoning strategies adopted by students and the striking role that resources and other material have on student activity and learning outcomes. This will be taken up and theorised in new research to better understand materiality in PBL and learning generally.

This paper has described a semantic web application to support students before, and during the PBL exercise. The application demonstrated aggregation of guidance and heterogonous resources from multiple sources. To do this we piloted techniques and strategies which could generalise to other pedagogies, complex domains and subject areas. This will be taken forward by working in other setting within MOAM including operations, law and risk management. In doing so we are moving forward into investigating the utility of the Ensemble technologies and techniques to more general area of active learning [17] as well as variants of PBL.

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