Custom Module Deliverables

1. Report on educational psychology approaches relevant to mixed-initiative styles of interaction (2,500 words +/-20%, 60%) [Sections 1, 2 and 3]
2. Dissertation approach (2,000 words +/-20%, 30%) [Sections 4, 5 and 6]
3. Addendum characterising the type of dissertation and proposals for appropriate methods of assessment (length as appropriate, 10%) [Appendix A]
4. Relevant technical explorations [Non-assessed – Appendix B]

Custom Module Workplan

1. Underlying educational psychology
   - Preparatory reading.
   - Discussions on draft themes with tutor using e-mail.
   - Prepare Interim Report.
   - Feedback from Tutor.
   - Distillation of relevant parts to incorporate into dissertation proposal.

2. Dissertation proposal preparation
   - Initial explorations of contributory elements that would possibly form a part of the digital artifact (proof-of-concept system) that might be created as part of the dissertation:
     - NPC technology
     - Chatbot technology
     - Moodle link up
   - Proposal discussions, contributions and refinements.

3. How would we examine this?
ABSTRACT

My proposed MSc dissertation area is “mixed-initiative” approaches to education and how they might be supported by intelligent systems. Mixed-initiative means that the various agents can take the lead or initiative in an interaction at appropriate times, in contrast to tutor guided learning or student discovery-based learning. I am interested in how scenario-based training and learning works, and what is the most effective way to support learners in such a context.

This is a very broad field with a vast existing literature on both the cognitive psychology and artificial intelligence sides. The readings and work undertaken for the “custom module” allowed appropriate reading, especially of the educational psychology side, consideration of project methodology, preparatory technical explorations, and discussion of how a practical “computer science” style approach to the artifacts created could be assessed.

The custom module work was designed to address elements that should set up a suitably defined MSc in e-Learning dissertation project which can be undertaken in the time available, and which will provide useful inputs to my continuing AI and collaboration focused research on “Virtual Spaces for Intelligent Interaction” with an emphasis on mixed-initiative support to scenario-based training.

This report for the custom module begins with a brief overview of work from artificial intelligence on intelligent teaching systems, then seeks to summarise relevant threads of work from educational cognitive psychology which are felt to be relevant, especially as they relate to multi-agent activity. There follows an outline of the approach to the dissertation and contributions towards the MSc dissertation itself. The dissertation style will be a technical scoping and proof of concept study and not involve human participants in experimentation. Appendix A summarises a study of relevant assessment methods and its conclusions. An extra non-assessed Appendix B gives additional details of technical infrastructure relevant to the eventual dissertation studies.

SECTION 1 – AI IN LEARNING SYSTEMS

Intelligent Tutoring Systems and AI in Education

Computer Aided Instruction (CAI) has been employed to support the presentation of materials to learners for almost as long as computers have been available. Artificial Intelligence researchers have been interested in applications to teaching and learning for almost as long (O’Shea and Self, 1983). The book by Sleeman and Brown (1982) on Intelligent Tutoring Systems (ITS) is a classic text and brings together separate papers which describe work on the key systems and by the key researchers of the day. These include SCHOLAR, SOPHIE, GUIDON, DEBUGGY and WEST. This early work sought to incorporate student models and feedback such that the materials presented to the students could be adapted to their level of understanding of previous materials and not to cause them to become too frustrated by either too simple or too complex a level of material.
Additional insights and a history of the use of AI techniques in learning and teaching is provided by O’Shea and Self (1983). A later introduction for the non-specialist to the themes in intelligent teaching systems and AI applications to education was provided by Nwana (1990) who also includes a comprehensive list of intelligent tutoring systems and environments.

Wenger (1987) for his PhD studies provided a more uniform overview of the early work on intelligent systems for tutoring, reviewing the key systems such as SCHOLAR, GUIDON, the various SOPHIE systems and the simulation-based STEAMER by comparing their features in a common terminological framework. He also observed (Wenger, 1987, p. 21) that there were varying degrees of control over the learning in the ITS systems which he classified as strict monitoring, mixed-initiative and coaching. Even the very earliest ITS systems such as SCHOLAR and the original SOPHIE sought to provide inputs only to guide learning in a mixed-initiative way by tracking student performance on a “semantic network” of concepts to be learned.

**Computer Supported Collaborative Learning**

The first two decades of work on intelligent tutoring systems was mostly focussed on one-to-one teaching to support a single student working alone. But most recent work has been involved with peer-to-peer teaching and the social framework in which most learning takes place. This is often called Computer Supported Collaborative Learning (CSCL). For example,

> “Educational researchers and practitioners have long believed that learning is heavily influenced by the motivational consequences of social interactions inside and outside the classroom.” [from LRDC web site at http://www.lrdc.pitt.edu/]

The ITS research agenda is predicated on the Piagetian (constructivist) model of learning (Piaget, 1954), with the CSCL work calling upon the social constructivist notions coming from Vygotsky (1934).

An excellent example of the CSCL approach is described in Soller (2001) which has influenced my own proposed research agenda. She has studied the use of Personal Learning Assistants (PaLs) which can employ a limited and structured grammar of inter-agent speech acts and performatives relevant to learning in a social community involving peer-to-peer and student-to-tutor activities.

**Learning by Exploring and Construction**

One influence of AI researchers has been in using “constructionist” principles in educational technology, themselves a refinement of Piaget’s approach. The LOGO system (Papert, 1993) provides an exploratory learning environment and is a foundational example of this approach. Situating building activity in a world in which a “turtle” can move and draw lines described by a constructor allowed the LOGO environment to give immediate feedback and encourage experimentation and refinement of the learner’s design. LOGO had an influence on many subsequent “learn by building” environments, whether in software simulations or even in a range of LEGO “Mindstorms” robotic construction kits.
Learning by Debugging

A number of approaches to the use of AI in tutoring involve “debugging” the process or model a student has of some subject matter under the guidance of a tutor. Several of these systems are based on a representation of plans or scripts (Schank and Abselson, 1977) which may not be correctly applied by the learner. For example, the DEBUGGY system (Burton, 1982) seeks to diagnose and correct specific procedural errors in a learner performing arithmetic operations.

Close to my own interests, NOAH (Sacerdoti, 1977) is an AI planning system which could generate repair plans for mechanical equipment and interact with a student repairing the equipment. The student could be guided to unravel faulty steps, and understand the fault in their understanding, prior to trying again to get back on track with a valid repair approach.

Computer Supported Pedagogical Agents

The work of Amy Soller (2001) has already been mentioned, as she employed Personal Learning Assistants (PaLs) in her approach. But a number of people have studied pedagogical agents in classroom settings especially where mixed-initiative approaches to learning are being taken (Lester et al., 1999) and where animated and lifelike learning support agents are employed (Johnson et al, 2000).

A number of papers presented at the Researching Learning in Virtual Environments International Conference (ReLIVE, 2008) on 20-21 November 2008 at The Open University explore pedagogical agents in virtual worlds, a topic very relevant to the topic of my study. So not surprisingly there are many relevant papers and indications of further work in this collection of papers.

SECTION 2 – RELEVANT EDUCATIONAL PSYCHOLOGY

Learning by Doing

Piaget (1954) observed that children learn about the world by exploring it and playing with it. He claimed that an environment that is set up to encourage appropriate discovery can accelerate learning. Papert (1993) worked with Piaget prior to co-founding the MIT AI Laboratory and took the ideas further by encouraging learners to construct entities to reinforce their understanding.

Vygotsky (1934) emphasised the importance of experience through interaction with the environment. Vygotsky described the Zone of Proximal Development (ZPD) in which he believed really valuable learning takes place. This is a situation where a learner is just beyond their comfort zone of existing competence and where, with suitable training and perhaps a constrained context and set of choices, they can acquire new knowledge or refine their existing knowledge through their grounded experiences.
Situated Learning

Gee (2008) contrasts the work on symbolic reasoning in the head advocated by some in the AI community, for example, by Vera and Simon (1993) and the Learning Sciences notion of cognition as “interaction in the social and material world” advocated, for example, by Greeno and Moore (1993). Gee notes:

“Earlier learning theory argued that the mind works like a calculating device, something like a digital computer. On this view, humans think and learn by manipulating abstract symbols via logiclike rules. Newer work, however, argues that people primarily think and learn through experiences they have had.”

Gee in a talk in 2012 (Gee, 2012) notes that in much school learning “we have handed learners the manuals without the game”, i.e., there are processes and definitions, but they are not grounded in the situation and world they apply to. Scenario-based training gives the situation in which the processes to be learned are meant to be applied.

There are a number of studies (e.g., Barsalou, 1999a; Barsalou, 1999b) which indicate that people run a simulation in their heads of actions to be carried out in the situation they are addressing and that the imagery involved is essentially pictorial in nature.

“... comprehension is grounded in perceptual simulations that prepare agents for situated action” (Barsalou, 1999a)

Scenario-based training gives the situation in which the processes to be learned are meant to be applied and allows for learner experience of them in a controlled and perhaps less dangerous setting than real life. It allows the experiences to be assimilated and a perceptual picture built of the consequence of performing activities in that world. This later allows more effective replay of those experiences and adjustment of them in new situations.

Social Learning

Lave and Wenger (1998) continue the approach of Vygotsky and describe learning as a situated process in the context of social engagement with “communities of practice” – a group who share knowledge and methods for some area of expertise. The earlier Social Learning Theory of Bandura (1977) is based on the premise that people learn through observing others performing activity. Wegner (1998) notes the benefit of viewing learning as taking place “in the context of our lived experience of participation in the world”, and believes that learning is fundamentally social in nature. Rheingold (1993) also shows examples of learning being encouraged through exploring simulated worlds and exercises in them.

Steinkuehler (2004) commenting on this same debate states:

“Through participation in a community of practice, an individual comes to understand the world (and themselves) from the perspective of that community. Here, semantic interpretation is taken as part of what people do in
the lived-in world; it arises through interaction with social and material resources in the context of a community with its own participant structures, values, and goals (Greeno and Moore, 1993). For example, an individual becomes attuned to a particular object’s constraints and affordances through the regular pattern of interaction that individual has with it, but this regular pattern of interaction is shaped by the individual’s membership in a particular community for whom the object has meaning, usefulness, and relevance for a given task with a given (individual or collective) goal.”

Gee (2005) explores interactions between members of a community in an “Affinity Space” or “Affinity Group” (Gee, 2007, Learning Principle 35) where they are bonded by shared objectives, processes and experiences rather than just membership of a community.

Brown and Campione (1994) describe learning in a “Community of Learners” within a “Zone” of joint activities – named after the work by Vygotsky (1934) on the Zone of Proximal Development. Collaboration between people and interaction with artifacts in the environment, combined with good scaffold processes (Wood, Bruner and Ross, 1976) allow a learner to achieve a new level of accomplishment.

Communities, Action and Change

Kurt Lewin (1946) was an early investigator of problem solving activity in a community of practice. He describes “Action Research” as:

“… research on the conditions and effects of various forms of social action and research leading to social action that uses a spiral of steps, each of which is composed of a circle of planning, action, and fact-finding about the result of the action”.

He was particularly interested in the way in which participants had to be edged to “unfreeze” their current processes and models of the environment in order to be open to new approaches or “change” before they then were able to “freeze” the new methods adopted and be able to apply them effectively and routinely in the changed circumstances. The unfreezing step usually requires some form of intervention such as a restructuring, or the creation of some form of real or perceived crisis. Lewin’s “unfreeze – change – freeze” model is still the underlying basis of many strategies for managing change in organisations.

Intrinsic Motivation and Learning Principles in Games

Tom Malone’s studies of the intrinsic motivation which can apply in the use of games for educational uses (Malone, 1981) give us some indication of how to design engaging experiences in simulation orientated environments.

I have sought to be mindful of the 36 learning principles identified by Gee (2007) as being factors that could be utilised from effective game experiences to be used more broadly in scenario-based training. I grew to appreciate more the value of Gee’s principles as I applied them in reviewing a number of different styles of game experience, and a strong “take-away” for me in the IDGBL course was this set of
principles and how they might apply to my professional interests in scenario-based training.

Gee (2008) continues to develop the idea of effective learning principles that can be adopted from engaging games and states that:

"... good video games recruit good learning and that a game’s design is inherently connected to designing good learning for players..."

Gee identifies the learning opportunities afforded by achievable challenges that are selectable or adjustable by the game, environment, tutor or learner to stretch their skill and retain interest, but not to be impossible to perform.

5E Instructional Model

NASA's educational programmes explicitly adopt a constructivist learning approach called the “5E instructional model” (NASA, 2012) to help students build their own understanding from experiences and new ideas. The 5Es represent five stages of a sequence for teaching and learning: Engage, Explore, Explain, Extend (or Elaborate), and Evaluate. The 5Es model was originally developed for the US Biological Science Curriculum Study in the 1980s and has been refined since (Bybee, 2009). It credits Piaget (1954) and Vygotsky (1934) as its prime influences.

I believe that the NASA 5Es approach could be a useful guiding framework for the stages of support given by an automated agent in a learning situation. The overarching activities involved could provide a guide to the activities engaged in by students, the tutor and the AI-driven classroom assistant, and hence the structured grammar (as used by Soller, 2001) which might be used to take initiative in a mixed-initiative training situation.

SECTION 3 – NOTIONS OF ACTIVITY

Relationship between Custom Module and Dissertation Area of Study

I have not yet developed a coherent approach to linking the very many concepts and works in my area of study which I am seeing from educational psychology and advanced educational technology work. But it is clear that there is an interesting and perhaps unexplored overlap between work in these areas and the work I have been engaged with in artificial intelligence on rich plan representations, agent technology and task-support systems, especially for collaborative work.

The work will draw on the conceptual and technological I-X Framework (Tate, 2000), the <I-N-C-A> conceptual model of activity (Tate, 2003) and work on intelligent I-Rooms (Tate et al., 2010) Tate, 2011). The main contribution of this will be to provide a simple, abstract and extendable model of collaborative activity into which the cognitive psychological insights can be fitted. If this is done, some level of automated plan and agent activity analysis, planning and activity execution support can be provided.
I see the custom module as setting up a rich resource base, and having allowed time for the necessary background reading for work on the dissertation to get off to a good start. The work has clarified the areas to be explored, and established a number of conceptual themes I hope to draw on. In this sense, the custom module work has, to me, achieved its primary objective.

**Contextualised Activity**

I am broadly exploring an emerging notion of “Contextualised Activity” in this report, as that seems to be a theme I can develop as a key contribution to the dissertation research and it allows me to cluster here notes and references which I feel will contribute to an eventual analysis for the dissertation.

Marvin Minsky in his book “The Society of Mind” states a principle of knowledge-based problem solving “Using Knowledge” and notes that:

> “the most efficient way to solve a problem is to already know how to solve it. Then one can avoid search entirely” (Minsky, 1985, p. 74).

Context specific activity and planning is a core concept I have used in a lot of my work. I call this knowledge-based planning and activity management. See http://www.aiai.ed.ac.uk/project/plan/. The context defines a strong set of constraints on what actions from a potentially vast set are possible and hence need to be considered. My planning systems aim to present the possibly very limited actions possible in a context or on an object and show if they can be executed now (the environmental context already admits them) or if they still need some constraints to be met to make them applicable. This can radically reduce search. I have even (in the context of banter in a conference panel discussion) been accused of “cheating” by those who use more generic blind search methods which do not use domain knowledge.

Studies of human problem solving in stressful and dangerous environments also show that people often use many constraints from the environment or their training to leap to solutions and sometimes the practitioners say “But I don’t plan, I just know what to do” (Klein, 1977). In an exchange with Gary Klein, I have compared our own approach to knowledge-based planning and constrained activity management with Klein’s studies (Tate, 2000, Appendix) and found many similarities.

**Plans, Activities, Constraints and Agents**

The terminology of plans, activities, constraints and agents is used throughout cognitive psychology and learning observation texts (e.g., Norman, 2002) and plans are used for communication (Agre and Chapman, 1989) as well as action. Suchman (2007, p. 13) suggests plans should be seen not as precursors to action but as “cultural resources” to describe projections of future activity. My own research in plan representation uses similar ontological entities for shared understanding and communication between agents, as well as a specification for performing activities. It employs a mixed-initiative multi-agent model of “mutually constraining the space of behaviour” which could be compatible.
There is a clear overlap for descriptions of contextualised and constrained (by the world) activity to the use of the term “affordance” – how the objects in the world constrain and naturally limit the choices open, often to a single natural choice. The primary reference to affordances in perception is Gibson (1979), but Gibson (1977) also covers the topic. Don Norman’s description of “Knowledge in the World” as constraining activity in a natural way is a key correspondence. Norman notes:

“Affordances suggest the range of possibilities, constraints limit the number of alternatives. The thoughtful use of affordances and constraints together in design lets a user determine readily the proper course of action, even in a novel situation.” (Norman, 2002, p. 82).

“Affordances” provide knowledge in the form of easily understood constraints on behaviours. I think that can be tied to what we want to see from a tutor in mixed-initiative scenario-based training and learning situations. We wish to take people to the edge of their understanding and then keep modifying the environment and objects in it to maintain them in a high value targeted learning situation. We should seek to contrast a mixed-initiative approach where both the learner and the tutor can respond to the environment and initiate activity, compared with a purely top down teacher guided learning and bottom up student driven discovery approach.

**SECTION 4 – DISSERTATION METHODOLOGY**

I am not a “social researcher” as targeted by the Robson (2001) Research Methods textbook, but I do consider myself an “applied scientist” and can see that much of what I attempt to do in my projects can be classified as “real world research” in the sense described by Robson (2011, p.11). I do not have a background in philosophy and educational psychology but have benefitted from guidance in these areas from my MSc tutors. This is something which Robson (2001, p.9 reference to involving a project “consultant”) suggests as a means to support a project by seeking guidance for key readings and thematic relationships.

The third edition of Robson had some useful additional or enhanced chapters relating to “Writing a Research Proposal”, “Ethics”, and “Reporting and Dissemination”. These are directly relevant to pretty much any research study and were useful reminders of the fundamentals.

The approach I propose to take in my own studies is that I will make a “plausible claim” (i.e., a research hypothesis) at the outset based on a priori knowledge and experience, and then seek to refine that statement as a result of my readings, exploration and trials. I will seek “to explore, to describe, and to explain” (Robson, 2011, p.39, who suggests the best approach is to focus on the “explain” element).

My aim will be to seek to tell a coherent “story” about the potential value of mixed-initiative scenario-based training by drawing on my own experience in planning, plan representation and agent characterisation, and that integrates work across artificial
intelligence applications to teaching and educational psychology approaches that relate to situated learning and social factors.

While Chapter 16 of Robson (2011) was mainly for those collecting quantitative data for their studies, and some distance from my interests, I was pleasantly surprised that Chapter 17 resonated in a number of areas with my proposed approach, so I was glad that I had read it in detail rather than skimming for those parts. Chapter 17 is specifically concerned with qualitative data analysis and interpretation. The “thematic coding approach” aligns with something I strive for in my own literature surveys for projects, and encourage in my own research students… that is to seek categories, classifications and threads which they can describe or cluster work as it relates to an area of interest, and then to present contributions in terms of these codes or categories along with the positive and deficient aspects as they relate to the new contribution being made in the research. The examples of themes and codes was informative and suggestive (Robson, 2011, pp. 479-480, Box 17.6). The fact that the types of things that can be coded in qualitative research studies largely describe an ontology related to agents, behaviours, activities, states and constraints (all things in my own work on the representation of plans for inter-agent communication) has not gone unnoticed.

SECTION 5 – DISSERTATION TOPICS AND AREAS OF STUDY

Topics to Explore

- Focus on mixed-initiative, situated, community based education and training
- Task-orientated focus and (community) issue handling
- Activity execution and communication, structured grammar for collaboration and key speech acts
- Contextualised activity and constraints
- Affordances and knowledge in the environment to act as “natural” constraints
- Delivery into a shared collaboration space, I-Room, NPCs, etc.
- Asset set for exploration and potential future project work with students
- Demonstration of key concepts and tools
- Some evidence of potential value and usefulness

The basic idea is to explore a virtual space in which scenario-based training and education can be carried out and in which an artificial agent available within the space “knows” enough of the application domain subject matter to be able to support the learning of those using the space.

I am going to assume that the space is used for specific training objectives and in appropriate scenarios, so the community knowledge and processes employed within by those involved will be available.

For the purposes of the dissertation, open natural language understanding is excluded as a technology that will be used (though that becoming available in future will orthogonally supplement the methods I will explore).
One key aim of the proposed dissertation study will be to link the classroom space with intelligent systems to create “a virtual space for intelligent educational interaction”. This will, for this work specifically, be termed an “I-Zone” – a “zone for intelligent interaction” – to hint at a theme of moving participants into the Zone of Proximal Development (Vigotsky, 1934) for their learning experience and draw on terminology of the “Zone” of joint activity of Brown and Campione (1994). This requires a lot of knowledge of the subject, tasks to hand, educational approaches and some understanding of the participants. An abstract model of mixed-initiative interaction on higher level generic collaboration tasks in the I-Zone will be an approach investigated (as in Soller, 2001), to act as a framework for further work by students and research project that might be spawned by this seed effort.

**<I-N-C-A> Relationship**

My work on rich plan representations has been refined in many exchanges with scientists and practitioners working in a wide range of fields where plans are used. This has also brought me into contact with those concerned with the exchange of plan and activity related information, including in the standards community.

A core plan ontology (Tate, 1996a, Tate, 1996b) has been developed into an abstract conceptualisation termed <I-N-C-A> (Tate, 2003), expressed as a “set of constraint on behaviour” – a set of Issues, Nodes/Activities, Constraints and Annotations. This abstraction has been used as a key input to work on a range of widely applied practical uses of shared plan representations including the DARPA Shared Planning and Activity Representation (Tate, 1999), the MIT Process Handbook and its Process Interchange Format (PIF) (Lee et al., 2005) which itself became the core of the NIST Process Specification Language (PSL) (Knutilla et al., 1998). PSL has now been published as ISO Standard 18629.

What I have not done previously is to relate this work on plan ontologies to the psychology of activity, and its use in education and personal development. It should not have surprised me that the terminology of plans, activity, agents and their interactions was also used in the social sciences and educational psychology literature, since one field of AI is termed “Cognitive Sciences”. But what did surprise me was the very close match of the terminology used by educational psychologists with that we have adopted in our own work which comes from quite a different perspective and has been developed in work with a very different technical community. It involves:

- Issues to be addressed by cognitive processes
- Activities to perform after deliberation
- Constraints to respect – just because they are there – using knowledge from the world and experience

I am particularly intrigued by a statement from Norman (2002, p 84) that there are:

“…four different classes of constraints – physical, semantic, cultural, and logical. These classes are apparently universal, appearing in a wide variety of situations, and sufficient.”
I am always seeking additional well justified sub-categories of <I-N-C-A> elements, and have absorbed several from other disciplines during my professional research. This insight could be a valuable addition to my own approach to constrained activity modelling, allow for elements that typically do occur in the sort of training I engage in (where policy and cultural constraints are commonplace) and lead to insights that will be directly applicable in my work.

Further notes and literature references to follow up, many of them, are available in my study note book. This will need a systematic trawl during the dissertation stage of the MSc.

**Issue Handling**

A feature of the I-X approach is that issues are explicitly represented and used to drive problem solving. Issues are expressed as a set of questions to be addressed for the artifact (plan, process or product) represented by an <I-N-C-A> specification. Issues effectively are “pending” constraints on the artifact but ones which cannot yet be made explicit without further decision making. Issues are stated as one of seven types of generic questions that arise in collaborative problem solving and issue-based design (Conklin, 2005). The questions can lead to the generation of options, which in turn can drive collaborative discussions on the relative pros and cons of using one or more options, and evaluation criteria are sought and applied to these. This approach to problem solving is sometimes referred to as the “Questions – Options – Criteria” (QOC) method. Such reasoning is captured in I-X and in the annotations elements of <I-N-C-A> so that problem solving and design rationale is maintained for later use during adaptive execution of plans or refinement of designs during manufacture or in product usage (Polyak and Tate, 1998). The interaction between student and tutor in a mixed-initiative fashion may be supported by the exchange of issues or questions, option generation and discussion (answers), and selection of a course of action through critical evaluation using appropriate criteria.

Work in some Intelligent Tutoring Systems has used the idea of an agenda of issues or tasks to drive student interaction with a tutor and to maintain flexibility in the dialogues involved. E.g., WEST (Burton and Brown, 1982) employs an issue tracing mechanism to identify which features the learner has mastered and to guide when it is worth the tutor taking the initiative to assist the student.

**Processes and Products/Tasks and Artifacts**

In my own work I have sought to use the <I-N-C-A> ontology to describe both “processes” (plans), and the “products” of those processes as, fundamentally, a set of parts (nodes) with constraints on and between them. The same ontology is also used to describe the capabilities of the agents who perform the processes and create or refine the products.

As an example, a process represented in <I-N-C-A> might describe a car manufacturing operation, with its nodes being a set of manufacturing and assembly activities with temporal and resource constraints on the operations and tools being
used. Whereas a product described in <I-N-C-A> would have its nodes as the set of car parts being brought together in spatial relationships to one another.

A number of psychologists have described models showing the interconnectedness of performing activity and producing artifacts. This is sometimes called the “task-artifact cycle” (Carroll et al., 1991; Carroll and Rosson, 1992) and this relationship should be explored further during the MSc dissertation work.

**OODA Loop and the Action Cycle**

For some time I have sought to use the processes of Observe, Orientate, Decide, Act (OODA Loop) postulated by Boyd (Osinga, 1995) as a conceptual framework for supporting task-oriented communication and collaboration activities in our virtual worlds meeting spaces. The “Action Cycle” and “7 Stages of Action” described by Norman (2002, p 47) provides an insight into the same flow of activities using psychology terminology and approaches.

I mentioned earlier the “5E” learning cycle used by NASA and other science educators – Engage, Explore, Explain, Extend, Evaluate – and this can usefully be related to the OODA Loop activities [http://en.wikipedia.org/wiki/Learning_cycle]

Perhaps also related is the “Experiential Learning” cycle advocated by Kolb (1984) and based on the theories of Lewin (1946). This involves a continuous cycle of concrete experience usually resulting from action in the world, followed by reflective observation, abstract conceptualisation or generalisation, and then active experimentation with the new model. Kolb and Fry (1975, pp. 35-6) explore different learning styles for individuals which address these aspects and which require different skills and aptitudes in the participants. Some are stronger performers for the different elements and act in one or more of the roles of Converger, Diverger, Assimilator and Accomodator. [http://www.infed.org/biblio/b-explrn.htm]

The overlap of these theories and my own approach to collaborative activity support in an I-Zone and the support we can give to those being trained in it should be explored during my further studies.

**SECTION 6 – DISSERTATION PROPOSAL**

**Title:** An Educational Assistant to Support Mixed-Initiative Scenario-Based Training in Virtual Collaboration Environments

- or -

Putting Plans to Use in a Mixed-Initiative Educational Environment

**Aims and objectives, research questions and hypotheses:**

To study the cognitive psychological foundations for situated social learning.

To identify effective learning methods relevant to mixed-initiative interaction between agents.
To describe the relationship between cognitive psychological activity models and the AI research informed <I-N-C-A> conceptual model of activity.

To explain how the concepts identified could be utilised in a situated training orientated “I-Zone” – a virtual space for intelligent interaction

To create, document and demonstrate a resource base for experimentation and potential re-use on projects in this area.

**Background and purpose:**

I hope to establish a number of “elements” or “influences” involved in supporting mixed-initiative scenario-based training, relate these to learning principles and experience, and then seek to identify which are found to be the most effective or influential.

I will seek to relate these to my conceptual model of activity <I-N-C-A> – Issues, Nodes (Activities), Constraints and Annotations – to provide a mechanism whereby some level of automation can be offered to support learning activities in a simulated operations centre style of decision making environment.

I will assemble a set of key readings and a technological resource base which can be used to demonstrate the concepts, and which will be designed to allow for future use on student and collaborative research projects.

**Plan of work:**

A major element the MSc dissertation study and the new area of work for me is to absorb and understand the relevance of a large body of literature on cognitive educational psychology potentially relevant to the area of study. I have deliberately gone into this in depth already during this custom module work in order to accelerate this element and to come close to having read and commented upon much of the necessary readings. I expect to continue to refine and add material to this part of the dissertation, but the literature survey is largely complete.

I expect to develop a technology demonstrator based on a Non-Player Character (NPC) avatar in an “I-Zone” virtual world simulated operations centre and which could access domain knowledge and learning related objects and process knowledge to assist a learner in a mixed-initiative fashion. The aim will be to go far enough to show the various elements and software in a form that will be sufficient for someone else to replicate and reuse.

I will focus on seeking and demonstrating features of the mixed-initiative tutor which are supported by good teaching and learning practice as found in the literature.
Resource aspects:

The resources for the project are already available via the Virtual University of Edinburgh (Vue) regions in Second Life, the Open Virtual University of Edinburgh (Openvue) regions in the OpenSim servers which I run within the School of Informatics, the experimental Moodle 2.x Virtual Learning Environment I also run within Informatics, and the Open Virtual Collaboration Environment web site and wiki at OpenVCE.net which I run and manage at Edinburgh on behalf of the international OpenVCE community.

Ethical considerations:

No specific ethical issues arise in the work proposed under the ethics guidelines of the School of Education and the School of Informatics. No data collection from any participant is anticipated in the research study proposed. Hence, the School of Education Student Projects Ethics Form is completed as “Level 0”. The results are intended to be openly accessible to all, and potentially to be of positive value to society through influencing training processes, especially in collaborative situations. While the same methods can be used for alternative purposes this is not considered to be a counter argument for pursuing this style of research.

SUMMARY

My studies in the custom module have focussed on readings in cognitive psychology which could inform scenario-based training employing a mixed-initiative training style rather than top down guided learning or entirely bottom up discovery-based learning. I have also learned about early work on artificial intelligence as applied to education and tutoring systems to understand the techniques which are employed. As preparation for an MSc dissertation I have begun to relate this body of work to my own previous work on knowledge rich plan representations and the underlying conceptualisation employed in my research.

As a concrete focus for the study, I have been exploring technologies which could allow the experience gained to be used to embody an AI classroom assistant in a social space in a virtual world. The aim of the assistant would be to make use of good educational techniques which have proven effective to support training tasks in the virtual space and allow it to engage in mixed-initiative support of the learners within that space.

With this background, the custom module has put in place a good resource base, and a body of relevant readings to inform the forthcoming work on the MSc in e-Learning dissertation.
ACKNOWLEDGEMENTS

Many thanks to my tutor for the Custom Module explorations, Hamish Macleod. His “feed forward” comments on a draft of this report were helpful to improve the structure and provide additional content worthy of deeper study during my future dissertation studies.

REFERENCES


http://psychology.emory.edu/cognition/barsalou/onlinepapers.html

http://psychology.emory.edu/cognition/barsalou/papers/Barsalou_BBS_1999_perceptual_symbol_systems.pdf


http://www.youtube.com/watch?v=JnEN2Sm4IIQ


http://www.open.ac.uk/relive08/catch-up.shtml (see Lo-Res and Hi-Res proceedings PDF)


Appendix A: Exploration of Assessment

Assessment Aim

This appendix seeks to characterise the type of dissertation proposed, using MSc in e-Learning course guidance and a textbook on research methods in the social sciences by Robson (2011). It has drawn on the current approaches, marking forms and inputs from senior staff in the University of Edinburgh as sources of guidance from various relevant schools: Education, Informatics and the Edinburgh College of Art.

The approach proposed is intended to relate as closely as possible to the motivation behind the work, that is to produce an asset base in the area of study which could offer a basis for future student and research projects on intelligent educational technologies applied in mixed-initiative training and teaching contexts. The asset base includes ideas and an underlying conceptual framework, a review of potentially relevant themes and readings in both cognitive psychology and artificial intelligence, and a collection of software components, libraries and prototypical or template applications.

Assessment Approach

The assessment approach proposed is to use the six standard School of Education categories for module and dissertation assessment as these are considered to be sufficiently general:

- knowledge and understanding of concepts
- knowledge and use of the literature
- critical reflection on theory and practice
- application of theory to practice
- planning and implementation of research/investigation (to be applied as appropriate)
- constructing academic discourse.

Then the aim is to instantiate and refine these with guidance drawn from the marking schemes for MSc dissertations in the Schools of Informatics and related Edinburgh College of Art joint MScs involving Design and Informatics.

Consideration of broader assessment criteria was initially thought to be required, as a specific concern was to allow for favourable assessment of the more practical and project-orientated asset creation element of the project. However, after exploration and discussion, it is anticipated that this can be addressed within the generic criteria, and specifically under “application of theory to practice” and the “planning and implementation” elements of the School of Education general marking scheme.

Additional Assessment Criteria

However, the type of MSc project results and hence the specific criteria employed in the Edinburgh College of Art’s Design Informatics course seems to have elements in common with what I am proposing. These criteria are:

[from http://sites.ace.ed.ac.uk/ddmhandbook/assessment/]
• In common with general design education practice, the main assessment of
design progress is by means of project-work (some of it group project-work),
sometimes complemented by a relatively short written report.

• Assessment will take into account:
  o the extent to which a student has contributed original ideas to the
    projects
  o the creative ability displayed
  o the depth and breadth of coursework understanding revealed
  o the extent to which the intention of the project has been revealed
  o skills in visual, written and verbal communication of the project ideas

It is proposed that an appropriate subset of these be taken as additional criteria for the
assessment of the dissertation, in the same way in which such additional criteria are
ominated by students for courses with novel types of submissions in the MSc in e-
Learning courses on Introduction to Digital Environments for Learning (IDEL) and e-
Learning and Digital Culture (EDC).

Dissertation Preparation Process

It is proposed that the dissertation, and indeed the submission on this custom module,
use the concept of “feedforward assignments” (Hounsell, 2010) which involves a
process, or perhaps in some cases even a cycle (as in Model 3 of Tong, 2011, model
3, 2011, page 153) of “draft – comment – revise – (re)submit”. Though it is hoped
that a single pass through these stages might be all that is required in this specific
instance.

My dissertation is likely to take the “alternative” form described in the MSc in e-
Learning Dissertation Guide for 2011/12 (p.5 bottom):

“...You may, alternatively, wish to write a dissertation which is more philosophical,
working extensively with the theoretical or conceptual literatures, or drawing on
existing research findings, and offering you the chance to formulate and present in
some detail an area of thinking of your own on a certain topic.”

The project may involve the creation of a system and its documentation to
demonstrate and make concrete elements of the work. This is a style of submission for
the work that underpins a typical computer science or informatics MSc dissertation. It
is expected that the practical work will be related to the relevant literature to show an
understanding of previous appropriate work.

Additional References

University of Edinburgh Enhancing Feedback Website.
http://www.enhancingfeedback.ed.ac.uk/staff/resources/feedback.html

Feedforward in Module Design”, British Journal of Educational Technology, Vol. 42
No. 6, pp-152-155.
As part of this study and the dissertation which will follow a number of technologies are being explored to ensure that a suitable basis would be available to provide an embodiment for the classroom assistant in a virtual world like Second Life or OpenSim, but potentially using facilities that could be provided in any suitably open scripted virtual world in future.

This involves the following elements, which are being examined in sufficient outline to ensure that resources are available and identified, that preliminary investigations indicate they could work in the AI classroom assistant context, and that a simple demonstration has been performed to check the facilities out.

1. Avatar Embodiment without user Monitoring or Login – using LibOpenMetaVerse ‘Bot or Non-Player Character (NPC) technology.

2. Chatbot facility for answering questions and giving guidance – using Pandorabot (ALICE) and MyCyberTwin chat bot frameworks.

3. Link to external knowledge-based systems, activity planning and task or procedure following aids, natural language text chat generation – using the I-X Technology Helper.

4. Linkup with an authenticated Educational or Collaborating Web Portal e.g., OpenVCE or Moodle.

**Avatar Embodiment and Non-Player Character (NPC) Technology**

A means to embody the classroom assistant in an in-world object needs to be found. There are several ways this can be done:

1. Via a fully functional avatar (much like a normal user would use)
2. Via an in-world object, which could be some simple 3D object or designed to look more like an avatar
3. Via a Head-Up-Display (HUD) which individual user (student) could attach or have attached for them when they enter a classroom.
4. Via an avatar-like Non-Player Character (NPC).

All would allow for various types of script execution, and via avatar or HUD “attachments” can be used to communicate with and move the avatar and object in world as needed.

There are two principal ways to animate an avatar in Second Life and OpenSim:

a) Via an external program using an appropriate library (Lib OpenMetaverse – http://openmetaverse.org/) and via logging in as a normal user and communicating to the avatar in a similar way to how a virtual world viewer communicates user inputs to and avatar in the virtual world. If using Second
Life, an avatar controlled in this way is referred to as a “bot” and must be identified as such under the Terms of Service (TOS).

b) Via scripts running in-world and which use special Non-Player Character functions (available now in OpenSim, and planned to be available in future in Second Life). See http://opensimulator.org/wiki/NPC

There has already been done a substantial amount of work on NPC's in OpenSim - more information can be found here:

- http://opensimulator.org/wiki/OSSLNPC
- http://pastebin.com/dkm2i0rs
- http://pastebin.com/T71YyMcb
- http://www.youtube.com/watch?v=ljLlbF0mzwQ&feature
- http://opensimulator.org/wiki/PCampBot

Moodle and SLoodle

The Moodle Virtual Learning Environment (VLE), and the SLoodle module to link Moodle to Second Life and OpenSim in-world facilities is being explored. In particular a generic module is being adapted to act as a flexible framework for adding
AI classroom assistant functionality which can utilise and modify course and participant information from the Moodle VLE.

- http://www.moodle.org
- http://www.sloodle.org

A diary of experimentation to date on Moodle, SLoodle and the custom modules is available via the Moodle tag on blog posts at:

- http://holyroodpark.net/atate/weblog

**Chatbot Technology**

Pandora bots based on the ALICE framework and MyCyberTwin chat bots as used on the Vue regions in Second Life and OpenSim are being explored to act as a knowledge communication and FAQ mechanism for the AI classroom assistant.

Further information is available at:

- http://chatbots.org
- http://mycybertwin.com
- http://pikkubot.de/dokuwiki/doku.php?id=wiki
- http://www.pandorabots.com/
Appendix B.1: MyCyberTwin Chatbot

http://mycybertwin.com
Ai Austin MyCyberTwin
https://mycybertwin.com/chat/aiaustin
useridnum=32285

Appendix B.2: Pandorabot AI Chatbot

http://pandorabots.com
Ai Austin Bot – based on Annotated ALICE –
http://www.pandorabots.com/pandora/talk?botid=a796a091be3426da