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Supporting Reflection and Learning with New Technology

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Introduction

Reflection is considered to be an important part of the learning process, especially when learning from experience, developing the skills of professional practice and for the development of meta-cognitive skills which are said to enhance learning. Recently there has been increased exploration into the ways technology can be used to support reflection in these areas (Loh et al., 1997; Seale, 1998). There has also been exploration into how technology can be used to support reflection in other ways for other purposes, for example some pieces of interactive art claim to provoke reflection in a contemplative way, where the viewer is not asked to learn anything, just consider and enjoy this process (Gaver, Beaver, & Benford, 2003; Höök, Sengers, & Andersson, 2003). I am interested to investigate whether these techniques can be employed to support reflection and learning using new interactive technologies in a way that has been little explored in the literature so far. Where it has been touched on, there is little explanation or understanding of why or what the reflection being supported is, and how that in turn is supporting learning.

My main research question is then:

- Can some of the techniques employed by interactive art to provoke reflection in a contemplative way be used to design technology to support reflection and learning?

In order to address this question, I need to consider:

1. what reflection is
2. how it is related to the learning process
3. how it can be supported; especially with interactive technologies, and importantly when this is appropriate
4. how to evaluate when reflection is occurring

And I would also like to consider:

5. could these techniques be used for another purpose?

Research Questions and the Literature

1. What is reflection?

Reflection, in the sense defined by the Oxford English Dictionary as ‘to think deeply or carefully about’, is a term used frequently in everyday language. In the literature it is discussed for its role in reflective practice, experiential learning, self development, the development of meta-cognitive skills as well as in relation to art. However, exactly what is meant by the term reflection appears to vary by author throughout these literatures in order to ‘describe their own activities’ (Boud, Keogh, & Walker, 1985b). In most cases the definitions do not fit well with how the word is commonly understood.

Dewey, one of the earliest people to consider the nature of reflection considers reflective thought to be “active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends” (1933, p118). He suggests it is an active thought process which is provoked by situations of uncertainty, doubt or difficulty and involves “an act of searching, hunting,

inquiring, to find material that will resolve the doubt, settle and dispose of the perplexity” (1933, p12).

In the field of reflective practice it is suggested that when a practitioner comes across a new, unique situation he must set the problem by constructing an understanding of the situation and re-frame it in order to apply existing theory or techniques. They can then experiment and reflect on the outcomes to assess the effectiveness of techniques (Schön, 1983). Reflection is described as a type of thinking about which enables a kind of problem solving involving the construction of an understanding and reframing of the situation to allow professionals to apply and develop the knowledge and skills of their profession.

Reflection is considered to play an integral role in learning from experience, indeed it has been suggested that ‘experience devoid of reflection has no effect on the cognitive-structural level of an adult learner’ (Reinman, 1999), that you can’t learn from experience without reflection. A number of researchers have developed learning cycles where the learners have a ‘learning experience’ and then reflect on this. Kolb (1984) for example suggests that the reflection allows the learners to form abstract concepts from their experience in order to guide active experimentation and further learning experiences. Boud, Keogh et al. (1985a) break down the reflective process into three elements; returning to the experience, attending to feelings and then re-evaluating the experience. Re-evaluation of the experience includes associating new knowledge with old, integrating the new knowledge into the learner’s conceptual framework, determining the authenticity of ideas and feelings and leads to the appropriation of knowledge. In this field reflection has been defined as ‘to think for an extended time about a set of recent experiences looking for commonalities, differences, and interrelations beyond their superficial elements’ (Gustafson & Bennett). It ‘is a term for intellectual and affective activities of explaining experiences to get new understandings from’ (Boud et al., 1985a).

Art work is often said to ‘provoke’ or ‘invite’ reflection. By looking at or interacting with the art work, artists claim that you are drawn to consider what they are presenting, saying, suggesting or asking. In interactive art especially the work can even surprise or confuse (Gaver et al., 2003; Hindmarsh, Heath, Lehn, & Cleverly, 2002; Sengers et al., 2002). This use of the term reflection seems similar to Dewey’s use (1933); thought provoked by uncertainty and perplexity to resolve doubt: Though perhaps in the case of art, more an attempt to order thought or even enjoy the discord. Reflection is used loosely to describe ‘thought about’ or ‘contemplation’ of an issue raised.

We also have common sense notions about the meaning of the word reflection. We usually think it will involve looking back over ideas or experiences, and consider ourselves ‘reflecting’ rather than just ‘thinking’ in situations where the material is complicated and we don’t really know what the outcome will be. Considering this and the rest of the reflection literature, Moon (1999) presents the idea that in fact reflection is ‘a form of mental processing with a purpose and/or an anticipated outcome that is applied to relatively complicated or unstructured ideas for which there is not an obvious solution’. She argues that the varying definitions in the literature are due to confusion between the purpose of reflection and what it involves: Researchers tend to define reflection in terms of what they are trying to use it for. She presents an input – process – output theory of reflection, where the input is background knowledge, theories or feelings, and the outputs or purposes for reflection discussed in the literature are (p99):

- Learning and the material for further reflection
- Action or other representation of learning
- Reflection on the process of learning
- Critical review
- The building of theory

- Self-development
- Decisions or resolutions of uncertainty
- Empowerment or emancipation
- Other outcomes that are unexpected – images or ideas that might be solutions
- Emotion

Her argument then is that there is only one reflective process, which can be defined really no more accurately than above. Although this is in fact a plausible and well argued point of view, it does not seem particularly helpful. In order to support reflection it is necessary to understand the purpose for which reflection is needed, and to then support that process.

2. How is reflection related to the learning process?

In the literature above it is clear that reflection is considered important for many different types of learning. Exactly what the cognitive processes are that could be considered reflection and how they in turn aid learning is quite hard to establish from the literature. Constructivism, the most popular theory underpinning western educational practices at present (Luckin & Ainsworth) is often referred to.

Piaget (1964) suggests that there are some things that cannot be learned from direct experience alone but require some amount of internal processing; equilibration or self-regulation. He believes that in the act of knowing, the subject is active and will react in order to compensate for any external disturbances, in other words experiences which do not fit in with what is already known. This reaction or restructuring takes place in a number of ways. Firstly is *assimilation* where new information or experiences are fitted to existing patterns of knowledge or experience. Then there is *accommodation* where there is a certain amount of bending of the initial structure in order to take account of, or accommodate, the new information. These processes of assimilation and accommodation allow the learner to maintain a state of equilibrium. Disequilibrium occurs when a complex example is encountered and this requires a change to the deep mental structure of knowledge.

Vygotsky also believes that concepts are formed by intellectual construction rather than associations or repeated experiences (Vygotsky cited in Reinman, 1999). The evolution of a sign system has allowed people to think in an abstract way, something he believes is unique to humans, and the internalisation of this sign system which can occur only in a social context is vital for an individual's development. He discusses the importance of generalisation: The development of scientific concepts which happens at school is essential for providing a structure for the development of everyday concepts.

Moon (1999) developed a speculative 'map of learning' based on the constructivist view of learning and the notion of a cognitive structure where she tries to show the role of reflection in learning. There are three main areas for reflection that she sees; straightforward or initial learning which involves the restructuring of the cognitive structure to accommodate new learning, learning resulting from the representation of learning for example when writing an essay, and in the upgrading of learning where previous material that has been learnt only at a surface level and as isolated pieces of knowledge is reflected on and integrated into the cognitive structure as a whole. Also many insights into how reflection is considered to support learning can be gained from looking at the techniques which are used to support reflective thinking in learning.

3. How can reflection be supported, especially with new technology?

Going through the literature there are a myriad of techniques and theories about how reflection should be supported. Although some techniques are particularly advocated for supporting reflection for a given purpose, there are a number of general themes which

emerge. Below is a summary of techniques that are already used, with some examples of how technology is used.

General themes:

Restructuring and integration of knowledge

This idea is important in the experience literature and reflective practice literatures. Thinking of reflection in these terms relates quite clearly to constructivist learning theories.

Raising awareness of:

- of incomplete knowledge
- of inconsistencies in knowledge
- of assumptions
- of knowledge

These features seem to be fundamental to reflection and almost all techniques can be seen as a way of achieving this. Raising awareness of knowledge in these ways makes it possible restructure and integrate knowledge to form a complete whole, but restructuring or reframing knowledge can also be a way to raise awareness of the issues listed above.

The importance of seeing from multiple perspectives

The 'looking backness' of reflection is one way in which an experience or material is seen from another perspective. Many researchers talk about the importance of seeing experiences from another perspective (Ackerman, 1996; Boud et al., 1985a; Schön, 1983) and many of the techniques for supporting reflection advocated by others listed below are to enable different perspectives to be considered. Again, viewing from different perspectives can help raise awareness in the ways discussed above.

Techniques

These are techniques suggested to support reflection. Some examples of how technology has been used are included.

guidance

- reflective questioning
 - journaling
 - portfolios
 - face-to-face
- challenges
- support of restructuring/reframing
- support to link goals to feedback

discussion

- face-to-face peer
- web/email discussion forums (Seale, 1998)

recording

- speech capture
- journaling
- portfolio: Portfolios are a collection of materials which can be looked back at to consider an event or learning process. A number of researchers have explored supporting this with technology (Barrett, ; Loh et al., 1997)
http://ali.apple.com/ali_sites/ali/exhibits/1000156/Reflections.html
- email/web discussion forums
- video

representation/re-representation of knowledge/thinking

- Writing
- Talking

- Non-verbal techs: Mind-mapping techniques and other similar graphic techniques could be considered to fall under this category; a number of technologies exist to support them e.g. Media Fusion (Bellamy, Grant, Cooper, Borovoy, & Adams).

self-explanation:

- a number of software programs have been developed to support this particular approach to reflective learning (Conati & Carenini, 2001; Hausman & Chi, 2002).

looking back over: remembering techniques

causing surprise/confusion

- ill-structured material
- Interactive art work (Gaver et al., 2003; Hindmarsh et al., 2002; Sengers et al., 2002)
- Ambient wood II horn
- Novel physical-digital coupling (Price & Rogers, ; Rogers & Muller, in submission)

This final section is the area I am most interested in, in terms of my thesis. Gaver et al. (2003) present a framework for using ambiguity in interaction design. They suggest that ambiguous situations require people to take part in making meaning, that this is inherently pleasurable and leads to a deep appropriation of the article. Three types of ambiguity are suggested along with techniques for creating and using them in design; ambiguity of information, ambiguity of context and ambiguity of relationship. Sengers et al. (2002) work on *Influencing Machine* is an example of a piece of interactive art where people were asked to post cards which altered the system dynamics to try and get them to reflect on the effect they were having on the system. They experimented with providing different amounts of feedback to the users to try and find the balance between an intriguing ambiguity and a frustrating experience. I would like use these ideas to try and get the technology to raise the questions that spur reflection in a less explicit or verbal way than many of the techniques listed above.

4. How can reflection be evaluated?

What techniques do people use at the moment to evaluate the effectiveness of these reflective techniques and are there any other techniques that could be used? I have not really looked into these issues yet.

5. Could the techniques I develop be used to support reflection for other purposes?

In addition to supporting learning either in a classroom or perhaps in the more informal environment of a museum for example, could it be possible to use similar technologies and techniques in the real world to provide an enjoyable way for people to take time to consider what they're doing, and in the process perhaps improve how they are doing it. This idea is related to the idea of *Slow Technology* (Hallnäs & Redström, 2001) which promotes the idea that technology should be used to 'actively promote moments of reflection and mental rest'. It is described as slow because instead of technology being used to speed up whatever we are doing, this would be to actively slow people down, provide spaces for thought in everyday life. Laurel (1986) also talks about the importance of supporting 'playfulness' in an interface to allow the user to explore or play with the features it provides with no serious consequences in order to develop an understanding of how it works.

Research to Date

I am presently just starting my 2nd of 3 years of study. Most of the research I have carried out in this area so far has been in the form of reading and discussing ideas. After finding my feet in the field by taking a number of masters courses (HCI, software design and evaluation, interactive learning environments) I became interested in the idea of pleasurable design, the

importance of considering user experience or enjoyment goals in the design process and the possibilities for physical and real world user interfaces to support these goals in ways not previously possible. I see the potential for these technologies to provide a different learning experience; to motivate, engage and encourage learners to reflect.

I also participated in the Ambient Wood II project, an Equator project exploring playful learning. The project involved installing a wireless network in a wood in order to augment and enhance a school nature trip. Images and details of children's findings were sent to their handheld computers as they explored the wood. They were able to take light and moisture readings with a special probe which gave them their results immediately. They could also listen to some sounds of the wood through a Sound Horn tool. They were asked reflective questions about things they found in the wood and prompted to look for evidence of plants, animals and processes. I helped develop some of the ideas and materials for the wood experience, and also took pairs of children around the wood as a local facilitator. It was interesting to see how technology and other techniques were used to support the children's reflective learning; the sound horn in particular embodies some of the ideas I have been thinking about.

The horn played ambiguous sounds related to the children's location in the wood that were designed to represent provoke thought about hidden processes in the wood, for example photosynthesis or a butterfly sipping nectar. These sounds cannot really be heard normally and on a previous trial, where similar sounds were played from hidden speakers in the wood, it was discovered that the children often did not notice the sounds or thought they had no relevance to what they were doing. The horn drew their attention to the sounds, which they discussed and were encouraged to reflect upon in terms of processes. The idea was to support them linking their previous knowledge (e.g. classroom learning of photosynthesis) to the present experience and the real world. For some children it was inspiring; they formed hypotheses about the kind of sounds they might 'capture' in different parts of the wood. For others the sounds were confusing, but often got them to stop and think about processes in the wood.

Ways to Proceed

At present I am looking at a piece of educational software 'Belvedere' which is designed to support critical inquiry by providing a framework for building evidence and concept maps of ideas based on information collected from various sources. I am considering how I could translate the system into a physical rather than screen based system and hope to experiment with the possibilities for supporting reflection this will open up. This will also give me a basis for comparison. In relation to my research questions above, I still need to establish the kind of thinking I consider to be reflective thinking to support learning and consider how I intend to evaluate reflection.

Areas for Input

There are a few issues that have arisen in relation to my PhD so far for which I would welcome some suggestions (or even just a bit of empathy?). Firstly, my intention and interest was in supporting reflective thought in an innovative way using new, probably physical, technologies and using these techniques to support learning since I felt that the attempts made so far were really only a start. However as I began to get into the reflection and reflective learning literatures I realised how messy they were and in fact I could probably get a whole thesis out of making a start to sort it out! Where should my contribution be? I wondered in fact if I should place the emphasis on supporting reflective thought and then talk about reflective learning as a possible application area, after all I do not really want to get into whether the reflection actually supports learning or not all in one PhD.

Putting these issues aside, at the moment I have plenty of concepts or ideas but have been having trouble operationalising them. By adapting a software that I consider does support reflective thinking already, I hope to get a foothold on how to turn these concepts into real, testable ideas. I would welcome any suggestions for how else to go about making this leap.

I would also like to know if anyone else has ideas for how I might evaluate something as tricky and personal as reflection. I think this is essential, and something that as far as I have seen so far in the literature is done very badly.

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