Using a Telescope in the Cave:

Presence and Absence in Educational VR

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1 Introduction

Recently developed information technology, such as interactive multimedia and virtual reality, has a profound impact the way people deal with information. Often, they engender a strong feeling of presence, of being an active part of the reality that is portrayed. It is this feeling of presence that differentiates the new learning technologies from the old; and it is this same feeling of presence which is both their greatest strength and their most severe weakness. Here, we discuss the respective roles of presence and also of absence in relation to virtual worlds designed for learning.

We characterise absence as a psychological focus on conceptual processing, and presence as a psychological focus on direct perceptual processing (of things which are present in the current environment). We suggest that virtual worlds tend to elicit a sense of presence because they present information as directly perceptible objects and spaces, rather than as linguistic specifications requiring conceptual processing if they are to be understood.

We describe our models of the role of presence and absence in learning. We conclude by suggesting that effective conceptual learning (and also useful perceptual learning) in virtual worlds depends on designs that support both perceptual and conceptual processing, both presence and absence. The resulting changes in how students deal with relevant knowledge promise to make classroom learning less exclusively conceptual, but also less fragile, and more like learning in the world outside.

2 Presence and Absence in Education

"Unpredictability is often said to be the essence of creativity. But unpredictability is not enough. At the heart of creativity lie constraints: the very opposite of unpredictability. Constraints and unpredictability, familiarity and surprise, are somehow combined in original thinking."

Margaret Boden (1995)

Today's education stresses abstract and logical thinking (which in our terms is to be absent) and preferably using a high (i.e. large) attention span. One problem this produces is that people are not good at applying high attention to relevant concepts over a long period, since this is very tiring and the mind tends to wander onto other things. Most of today's VR applications, on the other hand, stress experiencing and exploring information, emphasising presence, which makes the users feel that they are there within the created reality. This also tends to involve a high attention span, though focused on the information presentation itself rather than on concepts behind the representation. The weakness of this approach is that although it is initially very engaging, the user does not gain much new knowledge, even when viewing the display for a long period. And after a while, boredom sets in, and once again the mind starts to wander. All of this points out the necessity of every now and then breaking the absence in traditional education and of breaking the presence in VR-based learning. The opportunity to change the world that is modelled in a VR provides a focus for breaking presence - since meaningful change requires conceptual work for its planning and execution (see Waterworth and Waterworth, 1999).

These breaks occur differently depending on where the learner is in terms of skill acquisition stages (Dreyfus and Dreyfus, 1986). A novice has to direct all of his/her attention to the skill being learnt both when it comes to conceptual and to perceptual learning. Furthermore a novice uses knowledge-based behaviour requiring conscious attention (Rasmussen, 1986). This points to the necessity of moving between being present and being absent and in this way reduce the heavy workload involved in learning a new task. Another advantage of shifting between presence and absence in the learning situation is that it makes the user both more engaged and involved in the learning situation, and therefore less likely to get bored.

An expert on the other hand does not need to use most of the attention span when adding new items to existing knowledge because he/she has already both declarative and procedural knowledge about the topic. Also, the expert is able to mostly rely on skill-based behaviours which are largely unconscious or to use rule-based behaviour. Neither of these kinds of behaviour require the learner's whole span of attention. This suggests that the existing model of an expert is only expanding, but in order to keep the expert engaged and feeling motivated to learn more without being bored, it is important to keep transferring between a mental state of presence and that of absence.

We suggest a learning model that stresses the importance of breaking the sense of presence to carry the learner forward in the learning process. This model also considers where the learner is in terms of stage of knowledge acquisition. Another important factor is to try not to have long continuous periods where the learner has to use a high attention span. We believe that the model could be used to understand the acquisition of conceptual knowledge as well as perceptual skills, although the learning situation differs between the two. The main components of the model are

the difference between absence and presence, the quantity of attention demanded at the moment, and the five skill acquisition stages (figure 1).

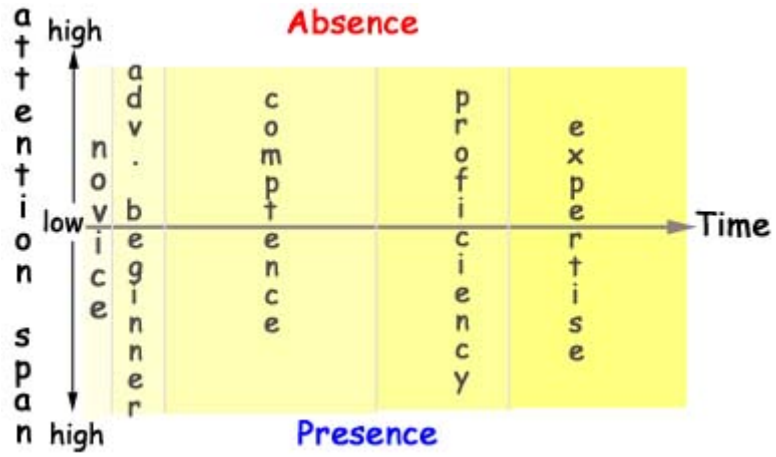

Figure 1 - A framework for understanding learning in VR

The framework is an aid to understanding, analysis and the design of learning environments when applied to specific cases (see below).

An example of conceptual learning is, for example, when you want to learn a new language (see figure 2a). At first you have to learn a few single words and some simple rules to put the words together in order to create simple sentences. This takes all of the learner's attention and makes him/her absent - using abstract thinking. This is typical knowledge in the two first steps at the skill acquisition stages, novices and advanced beginner. These stages are very abstract and conscious. Then suddenly the learner starts to experiment (to change the world; Waterworth and Waterworth, 1999) with their new learned skill and tries to speak the new language more spontaneously, which indicates that he/she has become competent and that he/she is more present, but still most of the attention span has to be used in order to practice the newly learned skill.

As the learner becomes more and more experienced it is possible to use less and less attention in the interaction, but he/she still has to learn more words and rules which means every now and then to break the presence and return to absence. An expert does not need much attention to learn more because by that stage it is possible to learn at the same time as using the skill. This implies that the jumps between presence and absence are more or less unconscious, but that in a situation of need the expert has the possibility to switch to a high attention span of absence or a high attention span of presence depending on the situation.

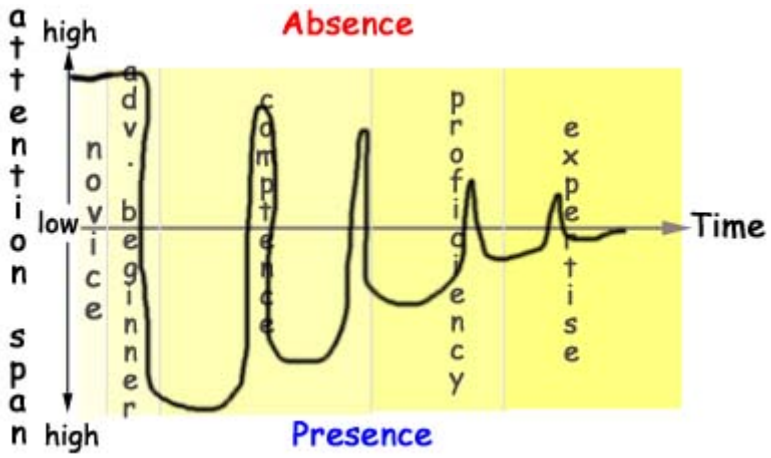

Figure 2 a) an example of conceptual learning

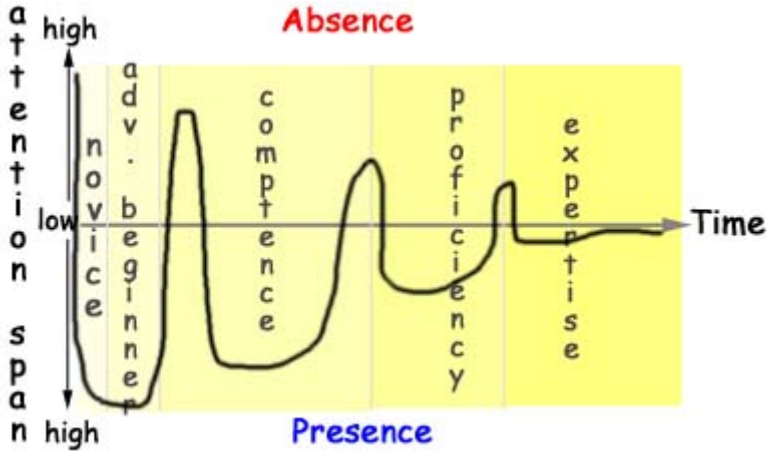

Figure 2 b) an example of perceptual learning

When learning a perceptual skill on the other hand, as for example to ride a bike, the learner starts with learning the importance of keeping the balance of the bike and trying to practice that skill on the bike. This takes almost all of the learner's attention span and is performed mainly by the body in a state of high presence (Figure 2b). After reaching the stage of preserving balance it is time to learn to steer, brake and control the bike, which leads the learner in to the next stages of acquisition skill, advanced beginner and competent learner. As the learner improves the skill he/she is able to use less attention riding the bike, and that attention could be used for other things. As in conceptual learning an expert does not need much attention to learn more because in that stage it is possible to learn at the same time as using the skill, so this implies that by the time the learner becomes proficient or expert the curves have become the same.

3 The Wheel of Creative Learning

Presence is a strength in educational settings because the attentional focus produced by a strong experience of being present can be expected to activate and motivate the learner. But it is a weakness if attending to the present display inhibits the formation of more general, abstract

concepts about the kinds of entities portrayed in the display. In other words, it may be that presence stimulates initial conscious experience in a desirable way, and thus supports relevant perceptual learning, but that it tends to inhibit the kind of conceptual learning that underlies generalisable, abstract knowledge. Such knowledge depends on absence, as well as presence. To achieve timely opportunities for the absence of mind underlying conceptual learning, it is necessary to break the sense of presence at appropriate points in the process, as we have suggested above.

Fencott (1999), in similar vein, points to the importance of both perceptual cues and surprises for conceptual learning in educational VR. Cues perceptually reinforce the unconscious expectations one has when acting within a virtual world; in other words, they engender and support a sense of presence. Surprises, on the other hand, break those expectations (and the sense of presence) and stimulate reflection. Whitelock and Jelfs (1999) report compatible experiences with a range of virtual learning environments.

What is true for learning is, we suggest, also true for creative thought. Waterworth (1997b) pointed to the way in which new technologies, by allowing information to experienced in a variety of vivid media and forms, expand the possibilities for creative inspiration. In other words, experiencing the same underlying information in different representations, and through a variety of sensory channels increases the range of concrete perceptions through which information is experienced. These richer perceptions may then lead to more original concepts. For this to happen, as with conceptual learning, we suggest that there should ideally be both the feeling of presence afforded by rich perceptions, and the absence of mind required to examine any resultant insights conceptually. This gives a new way of looking at education, and at learning in general.

People learn throughout life, the new born has to learn a great many sensori-motor skills, children learn to talk, cycle and a lot of knowledge in school, we learn a profession, to be a wife or husband, to look after children. Even old people have to learn to stop working and adjust to the new lifestyle of being old with everything that involves. All of this shows that learning has a very central position for human beings - to be human is to learn. Education can be said to be a controlled way of learning, as for example in today's school system from early age to different kinds of higher education and separate courses for adults. One problem with today's education, as mentioned earlier, is that it stresses abstract and logical thinking (conception), which we call absence, at the expense of concrete representation and reasoning (perception), which we call presence (see Waterworth and Waterworth, 2000, for more details).

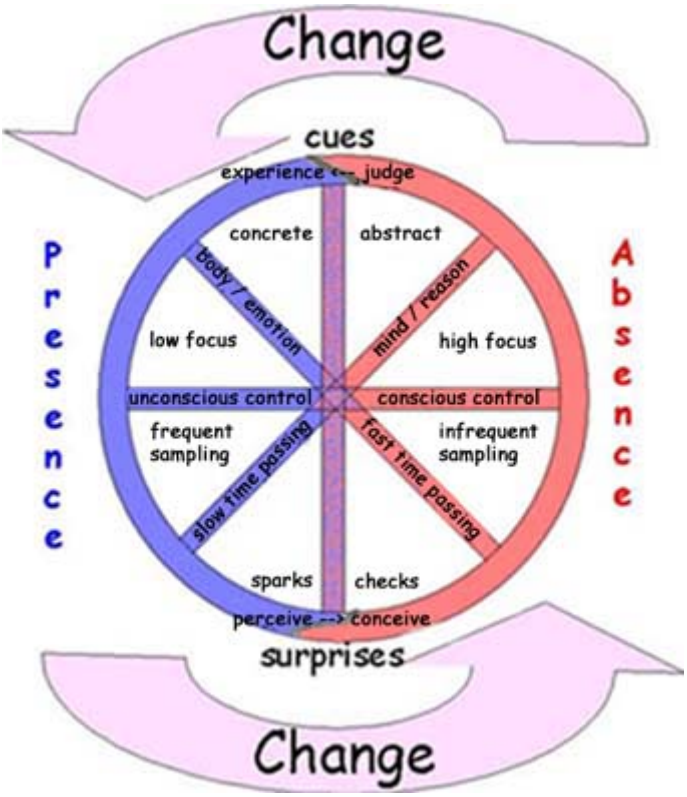

Figure 3 - The wheel of creative learning

We believe that when people learn new things and are engaged and motivated to learn they have to oscillate between presence and absence in a similar way as when they are creative. Our view is that all learning includes a creative aspect in the development of useful and understandable knowledge. This implies that learning and creativity have a lot in common, including the movement between presence and absence, as well as knowledge transfers between consciousness and the unconscious. Our model of learning, the education wheel (Figure 3), is very similar to our model of creativity (see Lindh, 1997). The wheel combines the best of traditional education and VR-applications which elicit presence. Furthermore it combines the strengths from both traditional learning and learning by doing.

4 Two Examples of the Learning Wheel in Motion

The wheel of learning (Figure 3) should be viewed as a wheel rolling forward to new experiences. It does not describe the whole learning process, as for example of learning to cycle or learning a new language. It portrays the ongoing process in learning; the wheel rolls around all the time. This takes place both for novices and all the range of learners up to and including experts. Furthermore it does not matter much whether the learning is conceptual or perceptual. There is no start or ending of the wheel's journey to new knowledge, but if we think of a specific learning task that will determine where we enter the wheel.

4.1 Perceptual Learning in Life

As an example of perceptual (sensori-motor) learning, consider a person who is quite good at cycling, but who has never cycled in winter when it is frozen and slippery on the roads (here in Sweden, at least). We start with the position where our friend is out cycling and suddenly he experiences the bike starting to slip and he is about to fall. This is a concrete experience where his body and emotion perceive this input. Most of his actions are under the control of the unconscious but our bike rider has to frequently sample the environment consciously. He feels that time passes very slowly (one effect of frequent stimulus sampling; Waterworth, 1983) and suddenly he gets a spark, an idea, how to handle this new situation. This means he moves from presence to absence to check the new idea.

While absent time seems to pass faster since in order to conceptually examine and create a plan of his new idea he has to stop sampling the environment as frequently as he did before. His consciousness takes control of designing and executing the plan, which means that he uses high focus thoughts, where he concretises the abstract mentally. After the new plan to solve the problem is formed, he has to judge and execute the plan, which leads to experiencing a changed situation, and the wheel continues.

It is easy, in principle, to transpose this learning experience into a VR environment, where all the relevant features of the experience are synthesised and learning proceeds in the same way as in real life, but without the potential for physical damage to the individual concerned. However, it is unlikely that the benefits would justify the costs involved in this case. Similarly true-to-life sensori-motor simulations are exemplified by flight simulators and some rehabilitation systems for disabled individuals.

4.2 Conceptual learning in VR

Now imagine that a class of intermediate level students is studying the battle of Waterloo in their history lesson. To learn about Napoleon in general and Waterloo in particular they are using a desktop VR application that is build like a role playing game. Every student has his or her own part to play, for example one plays Napoleon, one plays Lord Wellington (who is in command of the English troops), and one plays Blücher (who was head of the Prussian army). We start our example where the students have arrived at Waterloo with their troops and are occupying initial positions. This kind of action demands presence from the student. He frequently samples the environment in order to keep a watch on the current situation and discover any significant moves by the other players in the battle. He is highly vigilant and experiences the environment richly (and time passing slowly), acting through unconscious control with the body and emotions largely in charge. Suddenly the game stops and every student gets a written question on their screen, specific to their own concerns in the battle. For example, the students may have to specify their plan of immediate action.

This surprising event breaks the sense of presence and forces explicit conception of the situation. The student no longer samples the environment as frequently as before and moves to high focus thoughts. Time then seems to pass quickly and he starts to create a plan to solve the questions so that he can continue the game. When delivering the answers he checks to see if they are likely to

be right, which indicates that he judges the situation. If he answers the questions reasonably he is allowed to continue the game, which switches him back into a state of presence. Suitable cues must be provided by the VR to engender such periods of presence, which motivate and engage the student. Surprising breaks in the virtual action force periods of explicit conceptual learning, rewarded with presence during another episode of more direct experience.

Cycling through presence and absence is more powerful than either in isolation. Pure presence would be engaging, at least in the relatively short term, but would not lead to much explicit conceptual learning, although some implicit perceptual knowledge might adhere to the student. Pure absence - the same facts conveyed through a lengthy, "dry" lecture perhaps - would not be sufficiently engaging to hold the attention. In the latter situation little long-term perceptual or conceptual learning would take place, although the student might be able to cram in enough facts to pass a written test in class.

5 Conclusions: a Telescope in the Cave?

"The more abstract the truth one wishes to teach, the more must the senses first be seduced towards it."

Nietzsche (1882)

In VR, as in life, learning and creativity are inextricably bound together. To learn through VR, we engender presence (a sense of being there, emphasising concrete perceptual processing), but we must also provoke absence (being lost in thought, with an emphasis on abstract conceptual processing). These two sides of how people deal with information are needed to respond creatively to what we find around us, whether real or virtual, and whether taught or discovered.

Paradoxically, when we experience presence in VR, we are absent from the real world. Immersion in VR is like being trapped in Plato's cave. As prisoners in the cave we experience only reflections of reality. We can contrast Plato's view (see Plato, 1961) with Galileo's revolutionary (at the time) ideas of how knowledge is acquired - through careful observation of the real world aided by appropriate technology such as the telescope. Galileo's telescope was an example of what Ihde (1990) terms an embodiment relation between a person and technology. The technology is, as it were, taken into the experience and the world is perceived through the technology. The technology is between the observer and the object, and changes how reality is experienced - but it does not present a model of reality. Other examples of such embodied technology are microscopes, sunglasses, hearing aids and a blind person's stick. Augmented reality also falls into this category.

VR, on the other hand, exemplifies a different kind of relation between a person and a technology. Here, the observer experiences a model of reality as the only source of knowledge. This can be seen as an example of what Ihde (1990) terms an hermeneutic relation - the technology provides a representation of some aspects of reality. Other examples of the hermeneutic relation between people and technology include petrol and other gauges on a car dashboard, most of the instruments in an aeroplane cockpit, and the familiar (in north Sweden) wall thermometer indicating the outside temperature.

Classroom education had traditionally erred on the side of absence, by emphasising the conceptual at the expense of the perceptual. VR, on the other hand and by its nature, tends towards the opposite imbalance, emphasising the perceptual at the expense of the conceptual. Perceptual seduction arouses the desire to learn, and students find VR highly motivating. This, and its flexible but also concrete character, give VR enormous potential in educational settings. In some ways this is also a subversive potential, since it diminishes the distinction between real-life learning and creativity, and what goes on in the classroom. It fosters a style of learning that is less explicit, but potentially more robust and long-lasting, than conventional classroom teaching.

To realise this potential, we need to spend time in the cave, but we also need to look out through our telescope.

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