Does the theory of social constructivism have any role to play in computer-based learning? – A Literature Review

The principle behind a literature review of any topic is to determine the following three factors: What is known about the topic? What is one's critical response and reflections having reviewed that knowledge? Can one apply that knowledge to one's practice? These three factors provide the broad framework within which I hope to carry out a basic literature review of the topic of social constructivism and computer-based learning. The rationale behind choosing this particular topic lies in the fact that social constructivism has become an increasingly popular theory in describing both the learning and teaching process and as a result it is influencing new trends in the design and delivery of many areas of the curriculum. Without doubt, the information and communication technology (ICT) revolution has similarly influenced classroom methodologies and is an increasingly significant aspect of our students' lives beyond the school walls. How then can teachers marry this revolution with changing pedagogical ideologies; in order to improve their own teaching strategies as well as their student's learning processes? This review is an attempt to examine that particular question by relating the principles of social constructivism to the methodologies involved in computer-based teaching strategies. Before that review can take place it is essential that the concepts under investigation be clearly defined and a brief overview of their historical development outlined.

In the late 1970's and early 1980's, psychologists and educational theorists were becoming increasingly dissatisfied with existing theories of learning and cognitive development, calling for less emphasis on individual attributes and developmental stages and more on cultural and communicative factors. Perhaps, the most seminal piece of writing to influence this change in emphasis was Children's Minds by Margaret Donaldson (1978). This is essentially a re-interpretation of the Piagetian theory of a children's' intellectual development. It basically argues that such theories have underestimated the reasoning powers of children and concludes with the implications of this for learning in schools. Throughout, she re-examines Piagetian theories of egocentrism, the age at which reasoning abilities are reached and the role of language in cognitive development. As a result contemporary thinking on how children think and learn is no longer overly dominated by the maturational Piagetian and behaviourist theories of cognitive development. Considering the time gap since initial publication, it would be very easy to dismiss this book on the grounds that it belongs to a particular historical and cultural milieu and as such has little relevance for today. Yet, to do so would be to ignore just how influential the publication was at the time and even today its most enduring influence has been in putting Piaget in perspective. Regardless of this influence, Donaldson (1978) herself did not develop any new theories as such; rather she assimilated and applied those of Vygotsky. His work provided a valuable source of ideas for all those interested in an alternative, social perspective to that of behaviourism and the concept of social constructivism was in its ascendancy. The outcome being not only a different model of cognitive development but also a different model of classroom education.

As suggested, the ideas of Vygotsky are the basic premise on which the theory of social constructivism is developed. At its simplest, social constructivism declares human learning and cognitive development to be a social and communicative processes, whereby knowledge is shared and understandings are constructed in culturally formed settings. Mercer (1994) in his article entitled Neo-Vygotskian Theory and Classroom Education succinctly outlines the basic principles of constructivism and how they can be applied in the classroom. He states that Vygotsky viewed the child as a profoundly social being who only becomes aware of itself through social interaction with others. The cognitive development of a child is not just driven by internal processes rather it is by active adaptation to its social world. Processes that occur between the child and others become the basis for processes that take place within the child. Dialogue, interaction and argument become internalised to form the basis for reflection, logical reasoning and the formation of new concepts. As a result, Vygotsky saw a central and constructive role for adults in fostering childhood development, this he felt could be best achieved through extending the child's zone of proximal development (ZPD). Mercer (1994: 101) quotes Vygotsky himself as stating that the ZPD is "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more able peers." In other words, a student's learning or problem solving ability can be extended and enhanced by providing the appropriate kind of cognitive support and assistance.

While this might seem to be a simple and basic realism, it is not always so clear-cut and sometimes teachers merely play lip service to its application and implications. Some of the misconceptions involve viewing the ZPD as an attribute of the child rather than the activity at hand. Thus the role of the teacher in developing, setting and administrating the task is of vital importance. Similarly, the teacher is involved in more than mere facilitation. Simply developing a well-designed activity or selecting a problem solving task and then leaving the child to get on with it is not enough and actually goes against the very nature of the concept. It is the stimulus of the teacher in assisting or scaffolding the child that is of importance and any task the child can accomplish without assistance is not going to extend their ZPD. As Vygotsky stated, "Instruction is only good when it proceeds ahead of development. Then it awakens and rouses to life an entire set of functions which are in the stage of maturation, which lie in the zone of proximal development," (Mercer, 1994: 103). Another misconception is that the ZPD concept is the same as that of scaffolding but there are subtle differences. Once again the danger lies in viewing scaffolding as merely 'helping' the child and begs the question, can any type of teacher intervention that ensure the child learns something be labelled scaffolding? Mercer (1994: 97) goes someway towards answering that question and cites four criteria for determining if scaffolding takes place. Firstly, help that allows the child do something they could not do unassisted is scaffolding, but only if it will enable them eventually to complete the task on their own. There must also be evidence that the student successfully completed the task with the teacher's help, and that as a result they can proceed to a greater level of independent competence. Here we can see that the learners' success is dependent on both the quality of the intervention and the initial planning and design of the task at hand. But how does any of this relate to computer-based learning and how can the theory be applied to the practice?

Many could argue that much of the quality educational software provides some elements of scaffolding and this is somewhat true. Problem-solving programs provide structure and guidance as well as feedback but the feedback is limited and cannot cover all problems or questions and thus cannot be seen as providing scaffolding. It is the function of the teacher to provide that extra feedback and ensure that scaffolding does indeed take place. Equally, the teacher can ensure scaffolding takes place through their organisation of the class, through their cognitive support in selecting the software, deciding who should work together, how the task is to be introduced and explained, the follow-up activities envisaged and how it is all tied in to previous learning experiences and ultimately the curriculum. While detractors could highlight the point made earlier, that the ZPD is not the attribute of the individual child and thus no class could have a shared ZPD, it is my belief that this is why computer-based learning can so readily foster the principles of constructivism. By allowing the students work individually, the teacher can more easily ensure scaffolding on a personal basis and in turn promote the advancement of each student through the ZPD of that particular program. Similarly, working in pairs or small groups can cultivate scaffolding through collaborative learning.

These ideas are discussed in some detail by Light and Blaye (1994) in their article, Computer-based learning; the social dimension. They begin their article by outlining how programming can lead to the development of problem-solving skills and state that "the writing, testing and 'debugging' of programs offers a uniquely powerful resource for the development of abstract thought and high-level problem-solving abilities," (Light and Blaye, 1994: 206) and go on to emphasise the individual constructive activity of the child in acquiring such a skill. While this is almost certainly true, the reality is that most computer use in our schools operates at a less advanced level, with computers being viewed as merely writing tools, spreadsheets and basic mathematical problem solvers. The constructive aspect of computer use is thus not commonly found as the student rarely engages creatively with the computer program. Furthermore, this scenario ignores the social dimensions of the learning process. What is probably more relevant to this review is the fact that most computer-use in schools is shared by paired students or small groups due to hardware shortages and thus the social element of learning is encouraged almost unintentionally and collaborative learning can occur. The implications of this for a constructivist approach to teaching is dramatic in view of the notion that the student is a social being, who has different experiences and, who has much to learn through co-operation and collaboration in discovery techniques in particular and dialogue in general. Light and Blaye (1994: 207) promote this view and state that "a number of early studies point to the conclusion that work with computers promotes both a high level of task-related interaction and a high probability of students calling on one another for help". How then can the computer teacher move on from the behaviourist-based problem-solving activities and channel this social occurrence into a constructivist-based learning opportunity? According to Light and Blaye (1994: 215), students typically use their peers as sources of help when faced with computer tasks, even when help facilities are available on the program itself. The authors fail to demonstrate how teachers can best utilise such social opportunities and it must be stressed that it is not the particular equipment or software used in the classroom, but how that material is used that is of significance to a constructivist approach. The suggestion by Light and Blaye (1994: 215) that advances in technology could lead to the possibility of the computer playing the role of working companion and teacher to the child, interacting in such a way as to maximise the learning, seem remote and

ignores the fact that little research has been undertaken to determine the actual processes involved in collaborative learning.

A much more satisfying article is that of Strommen (1992) entitled, Constructivism, Technology, and the Future of Classroom Learning, who outlines more than clever ways to use computers in the traditional curriculum. Not only does Strommen (1992) strongly believe that constructivism and computer-based learning have much to offer each other, he also believes that this relationship must form the basis for a radical overhaul of the educational system in light of dynamic advances in ICT. Strommen (1992: 1) claims "in the course of 20 years, a dramatic rift has opened between the process of teaching, and learning, in the schools and the ways of obtaining knowledge in society at large." Accordingly he calls for education "to embrace the future and empower our children to learn with the cultural tools they have been given," by which he means those of the technological revolution. Furthermore he offers suggestions as to how this can be achieved and firmly states that the framework for this educational reform is constructivism. This transformation can take place if we develop "curricula that match (but also challenge) children's understanding, fostering further growth and development of mind, " (Strommen, 1992: 2). Such curricula must encourage the students to carry out applicable experimentation and manipulation and testing of ideas in a realistic context, rather than the endless, repeated rote learning currently encouraged. He also stresses the importance of collaborative learning advocating those ideas previously outlined in this review. Strommen (1992) is particularly useful in that he not only posits a new approach to teaching, one based on the ideals of constructivism, but he also provides concrete examples of how this might be applied in the classroom. He outlines the role of the teacher and students as well as the aims, objectives and basic methodology involved in a project that utilises the MacIntosh Hypercard programming system, (Strommen, 1992: 3), and goes on to highlight several specific outcomes that are relevant to this review. Firstly, he demonstrates how students select the project content in an intelligent and complex manner, one that ties in with the aims of the curriculum. Secondly, although each student had access to an individual computer, they chose to work collaboratively, "it was common to observe one child tutoring another in a new procedure," according to Strommen (1992: 4). Thirdly, the role of the teacher was more complex than normal, providing both technical assistance and creative consultation. Furthermore, he states that the students spent more time performing significant activity that is not directly computer related, such as creative writing and library research skills. Each of the outcomes listed above are significant educational activities clearly relevant to constructivist theories.

While his arguments are convincing, and one can readily concur with his view that "the key to success lies in finding the appropriate points for integrating technology into a new pedagogical practice, so that it supports the deeper, more reflective self-directed activity children must use if they are to be competent adults in the future," there are some aspects that require deeper consideration. The reality is that most teachers lack the technological expertise and vision to fully appreciate the possibilities afforded by such a radical overhaul, not to mention the simple fact that they are further restrained by limited budgets. The lack of fundamental educational research and resources, coupled with inadequate in-service training, are immediate obstacles to any transformation of the curriculum as advocated by Strommen (1992). At present and at best,

computers are often viewed as little more than ‘electronic workbooks’, useful tools but little more. Yet, his ideas should not be dismissed as unworkable or unrealistic simply because teachers are unwilling to embrace change and seize control of technological advances. His final suggestion that new forms of assessment are required is an excellent example of how his ideas can be applied by all teachers who agree with the principles of constructivism. Adherents should similarly agree with assessing their students’ learning processes as they are occurring, rather through the final outcome. By doing so, the teacher can easily identify those areas where individual students require extra scaffolding or attention. Thus we are considering a more qualitative rather than quantitative approach to assessment, one more readily identifiable as being based on the tenets of constructivism. In summary, the article by Strommen (1992) succinctly encapsulates the doctrine of constructivism as well as providing concrete examples of how these can be applied in the classroom and indeed why it is important that this must happen. In the meantime, teachers can take on board the tread of his argument and apply small yet significant changes to their own practice based on his suggestions.

In the final article under review, Multimedia simulation: a treat to or enhancement of practical work in science education by Baggot (1998), the author discusses the advantages of using simulation in preference to traditional live practical work in the science classroom. Unlike Strommen (1992), she fails to really examine the impact of this as an improved pedagogical strategy but her findings warrant consideration never the less. In summary she claims that simulation is preferable because "it frees the pupils to exercise higher-level skills such as hypothesising, analysis, deduction, inference and concluding," (Baggot, 1998: 255). She goes on to list the advantages as promoting active learning, reducing costs and physical risks, being less time-consuming and unpredictable and difficult to control. She also suggests that evidence from the US military confirms that simulators produce more effective transfers of skills with comparable time and effort involved by the student. Any science teacher can agree that such ‘a virtual laboratory’ would have many convenient and functional advantages over live practicals and experiments, but for most it is the hands on approach, coupled with the unpredictability of the results, which really tests the applicability to reality and provides the learning opportunity. Similarly, at present there is a limited availability of good simulations that directly feed into the criteria of the curriculum, particularly in an Irish context. Yet, that is not to say the potential offered by simulation in the science laboratory is limited, on the contrary, simulation coupled with practical experiments can only enhance the learning environment.

Baggot (1998) proceeds to strengthen her argument by outlining a concrete example of how this can be applied in the classroom. She discusses research carried out by her on the use of the Interactive Microscope Laboratory (IML), an interactive CD-ROM that simulates high quality observation in biology. Her findings suggests that the students covered the skills expected of them in the syllabus through the use of the CD-ROM just as effectively as if they had carried out the equivalent live experiment. In general, she reports that student feedback and evaluation was positive, particularly for those who actually used the software as distinct from those who merely watched a demonstration of its usage. Yet, it could be argued that this has as much to say about the advantages of hands-on experience over demonstrations as it has to say about the advantages of simulations over live practicals. In her conclusion, Baggot (1998: 268) claims "there is clear evidence that pupils spend longer on, and get more quickly to, the higher-order science skills such as questioning and interpreting if they are emancipated from the drudgery of lower-order,

mechanised tasks by a computer." Again she fails to reference this ‘clear evidence’ and while most science teachers would agree with this suggestion, without reliable research, such views fail to prove thoroughly convincing, which brings us to the general conclusions drawn from this particular literature review.

What is perhaps most striking from this review is the lack of sound educational research to back up the suggestion that computer-based learning has a role to play in constructivist-based learning strategies. Existing research does not allow for firm conclusions to be drawn. Without a doubt computer-based learning does involve skills-based learning, similarly it is accessible, motivating, engaging and familiar but the extent to which this affective role also leads to cognitive growth is more open to speculation. Yet, the professional intuition of teachers and researchers familiar with both the ideology and the technology would indeed suggest that the new technologies have a major role to play in constructivist learning processes. Unfortunately, professional intuition is not enough to instigate policy change, endorse in-service training or boost the budget; only valid, reliable and relevant research can have such a profound impact. Thus in the absence of a pedagogy (firmly grounded in research) that effortlessly identifies computer-based learning as a medium through which the ideals of constructivism can be applied, interested teachers must take on board present research findings, call for more and perhaps most importantly instigate and perform relevant research themselves. It would appear from the literature reviewed that at present there is a firm consensus that computer-based learning stimulates collaborative learning. As a result, teachers must devise new techniques and tasks for stimulating and organising learning through small-group dialogue. It is my belief that computer-based learning activities are the ideal mechanism through which this can be achieved. Finally, since Donaldson published Children’s Minds in 1978, progressive concepts such as child-centeredness, active learning, ‘learning by discovery’, the teacher as facilitator as well as collaborative learning, have gradually become embedded in educational dialogue. As a consequence, it is incumbent on teachers to employ the cultural and progressive tools of ICT to apply these strategies in the classroom, by doing so they can only enhance their students’ learning opportunities.