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Using Constructivism in Technology-Mediated Learning: Constructing Order out of the Chaos in the Literature

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Abstract

There are a variety of epistemological positions underlying constructivism learning theory in the literature. The purpose of this paper is to identify and categorize the positions of constructivism learning theories, their relationships to each other, and the implications for instructional practice for each position. This paper clarifies these positions by differentiating the major forms of constructivism along two dimensions. The first dimension defines the constructivist position along a continuum between an understanding of reality as being objective at one end, and a view of reality that is defined subjectively at the other end. The second dimension defines each position on a continuum where knowledge is either socially constructed at the one end, or individually constructed at the other end.

Introduction

Accelerating global competition between post-secondary institutions in combination with increasing learner expectations is pressuring many higher education institutions to improve access by removing time, place, and situational barriers in ways that are cost effective. Technology-mediated learning is an option that many post-secondary institutions have begun to explore as a way to remove these barriers. Until recently there was reluctance in the higher education communities to adopt and/or integrate technologies due, primarily, to an inability of the technologies to provide the amount and quality of interpersonal interaction that is considered central to the facilitation of higher order thinking skills (such as that developed in small group discussions, Socratic dialogue, collaborative/cooperative learning, brainstorming, debriefing, case studies, problem based learning, etc.). This scenario, however, has changed. The type of interaction that is considered central to many educators can be sustained through new communication technologies such as

computer mediated conferencing. In certain applications these technologies are also proving to be cost effective and accessible to learners who are experiencing time, place, or situational barriers (Bates, 1995) while supporting the development of higher order thinking skills (Bullen, 1997; Newman, Webb & Cochrane, 1995). For these reasons many post-secondary institutions are integrating communication and instructional technologies into their teaching programs.

Though, how successful technology-mediated learning activities will be at facilitating higher order thinking skills will be dependent upon the approach taken to the design, delivery, selection, and utilization of appropriate and effective technologies with a support structure to maintain and sustain the learning transactions (Pisel, 1995; Schreiber, 1998). This often requires educators to acquire new perspectives in a number of diverse areas - one of which is philosophical orientation to teaching and learning.

One's philosophical orientation will dictate how educators will view teaching, learning, knowledge (Darkenwald & Merriam, 1982), and the use of technology. And, while one's working philosophy will not resolve problems educators encounter when integrating technologies, it can help in understanding and guiding decision making. The result, according to Darkenwald and Merriam, is intentional and informed practice where decisions regarding the application of technologies are made more reflectively and rationally. Educators who clarify and articulate their philosophical position about the use of technologies in the learning process know what they are doing as they use technologies to facilitate learning, as well as why.

Until recently, the prevalent philosophical orientation in instructional technology was instructivism (Duffy & Jonassen, 1991). Instructivists (sometimes also referred to as objectivism or the systems view) argue that using an instructional systems design model can be useful to instructional designers to systematically identify what is to be taught, determine how it will be taught, and evaluate the instruction to determine if it is effective. Specifically, educators need to pay careful attention to what it is that is going to be learned and what must already be known prior to the learning transactions. Once objectives have been identified, they are progressively sequenced from lower order to higher order learning. The instructionist position stresses the importance of using an instructional systems design model where the learning objectives are clearly identified and stated, and exist apart from the learner (Reeves & Reeves, 1997). Learning activities should be focused on the skills to be learned and presented under the best conditions for learning. The learner is assessed equitably with evaluation tools that measure the behaviors described in the stated objectives. The data from the evaluation is used to revise the instruction so that it will be even more effective with succeeding learners. Following this systems design process encourages educators to focus on the needs and abilities of the individual learner resulting in the development of effective learning activities. The process is ongoing and cyclic. Instructionists argue that using this kind of systems model is a very organized and systematic way of providing learning, where the learner is evaluated fairly with instruments that measure the behaviors described in the objectives.

The polarized view of instructivism is constructivism. The main ideas underpinning constructivism learning theories are not new. They began with the insights of Socrates who claimed that there are basic conditions for learning that are in the cognition of the individual (Kanuka & Anderson, 1998). But it was Piaget's theory of intellectual growth that had the primary influence on the development of current positions. Specifically, Piaget first emphasized the processes of conceptual change as interactions between existing cognitive structures and new experience (Piaget, 1969; Wasdworth, 1978).

Constructivism learning theories are, essentially, a branch of philosophy that tries to understand how we construct knowledge. Constructivism theorists ask the following questions (Hofer and Pintrch, 1997; Jonasson, 1996):

- What does it mean to know something?
- How do we come to know it?
- How does this knowledge influence our thinking processes?

The constructivists argue that the `systematic' process offered by instructionists is a problem. According to constructivists, there is nothing systematic about how we learn or construct knowledge. Rather, constructivists believe that knowledge is constructed socially using language (Vygotsy, 1962) and everyone has different social experiences resulting in multiple realities (Jonassen, 1996). Constructing knowledge, then, is a socio-linguistic process where there is gradual advancement of understandings built upon previous knowledge resulting in multiple dimensions of the truth (Spiro & Jehng, 1990; Sprio, Feltovich, Jacobson, & Coulson, 1991). If we accept the assumptions that there are multiple realities of what the truth must be and learning is based on prior knowledge, educators will need to acknowledge that they cannot assume that all their learners will understand new information in the same way (as the instructionists assume). Based on this assumption, constructivists argue that educators will need to understand that learners will require a variety of different experiences to advance to different kinds and levels of understanding. Thus we must bring our learners' prior knowledge to the forefront if they are to apply their current understandings to new situations in order to construct new knowledge. To achieve this, educators need to spend time understanding learner's current perspectives and, based on this information, incorporate learning activities that have real world relevance for each learner.

The constructivists see instructivism as offering a quick and easy fix to very well defined problems in education, where the problem is defined as a gap between `what is' and `what should be'. Constructivists argue that educators are faced with an incessant onslaught of problems in a field that is constantly changing. As many educators feel a victim of this kind of instability, they look to the literature for guarantees for the right way and to justify what they are doing - for themselves, their learners, and their organizations. Educators often feel a need for exemplary teaching models (or learning envrionments) that promise soundness with an enduring academic approval - such as what the instructionists offer in their instructional system design models. Unfortunately, according to constructivists, the promises inherent in systems models, along with the educator's eagerness

to know what `successfully works' corresponds with a disinclination for educators to think critically. That is, it is much easier for educators to follow an instructional systems design model and feel that it is right and good because the literature on it says so, than to grapple with the complexities of our 'ill-structured' world in which we must function (Jonassen, 1997; Koschmann, Myers, Feltovich & Barrows, 1994). A major problem with instructivism, then, is that it discounts the reality of the ambiguous, complex, and continually changing world in which we live. Consequently, learning activities must be presented in an ill-structured way that will reflect the complexity of functioning in a changing world after the course has ended. This, according to constructivists, cannot be achieved through a predefined systems view.

Significance of the Study

Only recently has it become feasible to consider constructivism principles within the context of technology-mediated higher education (Gunawardena, Lowe & Anderson, 1997; Blanchette & Kanuka, 1999). This is due primarily to advances in communication technologies resulting in an effective means to implement constructivism principles, which would be difficult to accomplish with other media (Driscoll, 1994). Specifically, communication technologies have the capacity to provide an interactive environment that can support instructional methods required to facilitate constructivist principles. For these reasons, constructivism has become a popular epistemological position for many educators who are using technology-mediated learning. Unfortunately, educators who take on the challenge of trying to make sense of the literature on constructivism often find it to be an overwhelming adventure. There are a variety of epistemological positions that coexist in the literature on how we construct knowledge - many using the same constructivist label. Conversely, there are many different labels used to describe the same central ideas inherent in many constructivist positions. Adding to the labeling confusion is another problem: some of the education literature describes constructivism as a set of instructional strategies, some describe constructivism as a learning theory, and others describe constructivism philosophically - or as a way we come to understand ourselves and our environment.

The following literature review identifies the writings on constructivism that are noteworthy. Writings were identified as noteworthy when they made important theoretical points about the use of constructivism for technology-mediated learning.

Method

Reviews of the literature generally summarize results of past studies, suggest possible explanations for discrepancies in past research findings, and direct future investigations (Cooper & Dorr, 1996). This paper includes a description of the literature from disparate sources in the area of educational technology and constructivism. The review of the literature in this study does more than just describe and report the literature; it synthesizes diverse sources, explains findings, and integrates them into a series

of recommendations for the design of instructional activities based on constructivism.

Findings From the Narrative Literature Review

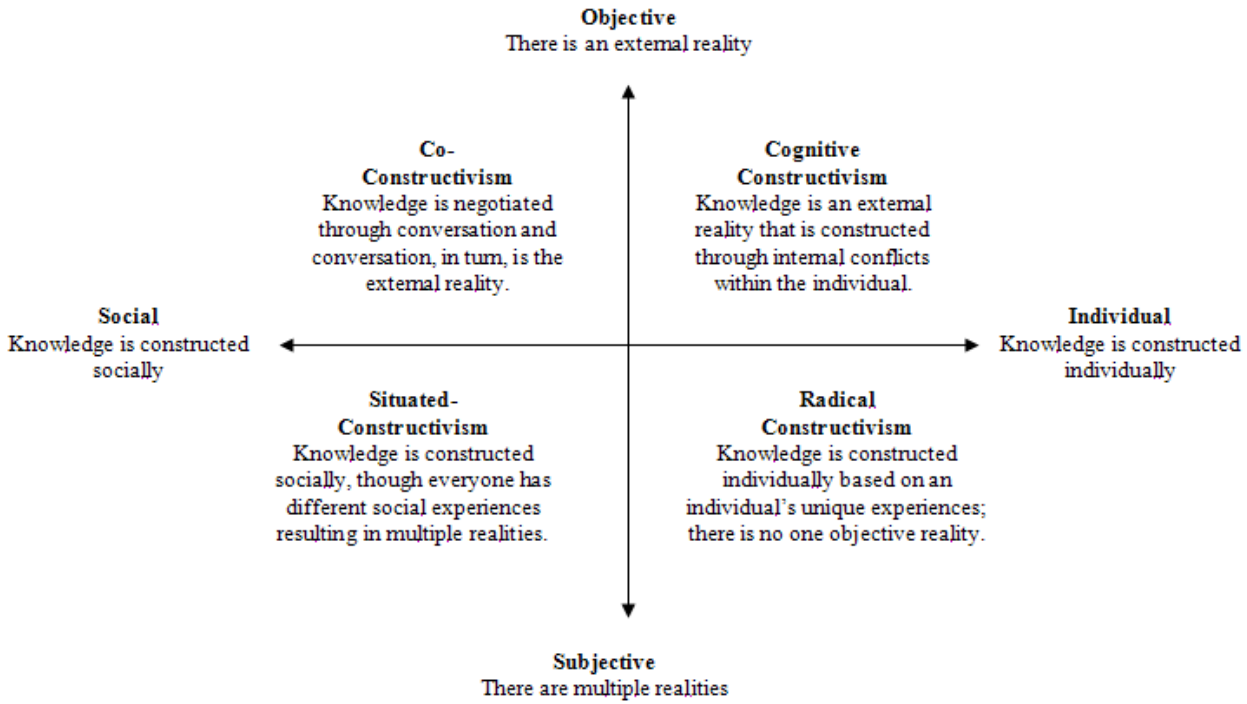
The major forms of constructivism fall along two dimensions. The first dimension defines the constructivist position along a continuum between an understanding of reality as being objective at one end, and a view that reality is defined subjectively at the other end. Where educators fall in this first dimension will influence not only how knowledge is constructed (i.e., what are we trying to understand?) but also the way educators will facilitate learners to construct these understandings in the learning process. For example, should the focus be on increasing a learner's capacity to understand an objective reality or on the capacity to understand more deeply the perceptions and sense of this reality?

The second dimension defines each position on a continuum where knowledge is either socially constructed at the one end, or individually constructed at the other end. This dimension examines the degree to which social, contextual, and cultural factors determine our constructed knowledge. As with the first dimension, where educators fall in this second dimension will influence their teaching and learning practices. Specifically, assumptions of how we construct knowledge on this continuum will influence the emphasis that will be placed on social interaction, group process, and the learning and practicing of socio-linguistic skills.

Despite the differences of each position along these two dimensions, each constructivist position has underlying similarities. Common to each position is a belief that we construct knowledge based on what we already know (there is no *tabula rasa*) and that learning is an active rather than a passive process.

Figure 1 is an illustration of where each constructivist position may be placed in relation to the other positions and the label that is frequently applied to each in the literature.

Figure 1: Epistemological constructivism positions



Following is a description of each position.

Cognitive Constructivism

This view approaches learning and knowing as an actively constructed individual thought process (King and Kitchener, 1994; Glaser, 1990). The assumption here is that we construct knowledge through a reasoned integration of internal contradictions - though our internal contradictions occur as a result of interaction with the environment. These contradictions, according to Lyddon (1995), encourage us to construct knowledge by understanding phenomena that have direct teleological development resulting in improved knowledge. Similar to Lyddon's view, Bruner (1986) claims we construct new knowledge based upon our current knowledge; the process is ongoing (Perry, 1970), where we continually build upon what we have already learned. In this process we continually acquire a better understanding of our external world; it is a dynamic and successive process.

Sometimes referred to as *critical constructivism*, this position is consistent

with Piagetian schemes. Basically, Piaget (1970) theorized that knowledge grows and evolves and we are always in a process of constant evolution (Piaget in Brainerd, 1978). He describes learning as the process of continually re-inventing our understanding or knowledge to take our past experiences into account (Carver and Scheier, 1988; Piaget and Inhelder, 1973). As we interact with our environments, we will undoubtedly encounter phenomena that are inconsistent with our constructed knowledge of the world. As we process new information into a coherent system, it is done in one of two ways: when it is consistent with our pre-existing schema it will be assimilated; when it is inconsistent with our pre-existing schema it will be accommodated. Assimilation is the adoption of new information that fits into a pre-existing view. Accommodations are changes in response to environmental pressures resulting in the adoption of a new view. The central idea underlying Piaget's theory of accommodation is similar to Festinger's (1957) theory of *cognitive dissonance* or Schmidt's theory of *cognitive restructuring* (in Belkin, 1982) and also Mezirow's (1990) theory of *perspective transformation*. These theories of learning are concerned with changes that happen as a result of new information that is inconsistent with current beliefs.

Cognitive constructivism also maintains that there is a true (or objective) world that we aspire to understand - though it postulates that we can never reach absolute understanding (Young, 1997). When we construct knowledge we are developing more adequate understandings of what the truth must be. Thus, constructing knowledge is an evolutionary process whereby reality can be understood. Cognitive constructivists, then, are of the opinion that there is an external reality that we continuously strive to understand (Kelly, 1955).

Although this view focuses on the individual, it does not deny the importance of social interaction. Rather, it acknowledges that we interact with our environments, be they physical or social environments. Moreover, it is through social settings that cognitive disturbance typically occurs. For example, through discourse or exchange of ideas with others we come to understand the inconsistencies or inadequacy of our understandings. In cognitive constructivism, however, the focus remains on the individual development of understanding, even when learning takes place in social settings.

Implications for Practice

The underlying assumption in cognitive constructivism is that internal contradictions instigate the construction of knowledge, conflict or puzzlement are necessary stimuli for learning (Tobias, 1991). The cognitive disturbance resulting from the conflict and puzzlement will determine the organization and nature of what is learned. Similar to Piaget's theory, instructional methods in this view "aim to confront the learner with situations that make the inherent inconsistencies in the learners' naive model plain and challenge the learners either to construct better models or at least to ponder the merits of alternative models presented by the teacher" (Perkins, 1991, p. 19). Based on this assumption, educators need to provide learning environments that capitalize on inconsistencies between the learners' current understandings and the new experiences they

encounter. Activities requiring learners to compare and contrast two opposing positions would be appropriate instructional methods. Learning environments, then, should be designed to challenge understandings and the role of the educator should be one of catalyst. Based on these premises, there are two necessary instructional conditions: (1) educators know the learners naive model; and (2) opportunities for real or simulated dialogue in which inconsistencies are revealed.

While learners should be encouraged to compare conflicting ideas (Perkins, 1991), they should also discuss conflicting views through argumentation (Kuhn, 1991). The argumentation should be based on their existing knowledge as they try to accommodate new knowledge that is internally inconsistent. When the focus is on the learner's accommodation of conflicting ideas, it is necessary that the instructor act as a catalyst providing learning opportunities that enhance this process. Provision for opportunity to reflect on both the learning content and process is important. Instructional methods such as case studies, debates, individual and group summarizing, and team teaching using heterogeneous grouping are appropriate instructional activities that will instigate internal conflicts, facilitating the learner's individual development of understanding. It is recognized that interaction with peers who have different ability levels and backgrounds are a main source of conflict that can stimulate this process.

Radical Constructivism

The fundamental assumption in this position is that reality is only a speculation, or a supposition, or - at most - a hypothetical position that is, really, just an individual's opinion. Knowledge is, essentially, a function of the workings of our cognitive structure and thus a very personal experience (Maturana, 1991). There is no shared reality (Suchman, 1987).

In this view we construct knowledge based on our environment and experiences (Clancy, 1986; Winograd & Flores, 1986). As each one of us will never have exactly the same environment or experiences, we will never form exactly the same understanding of reality (Jonassen, 1991). Therefore, we can never know what exists in reality, as we can never compare our assumptions of realities with others. That is, based on the assumption that no two people will ever have exactly the same experiences, other realities will always be different. According to Honebein, Duffy and Fishman (1993), knowledge is not permanent or fixed; rather, it is constructed individually through our experiences in a particular context. Thus, our understandings are embedded in our experiences. Knowledge, according to Jonassen (1990), "is based upon individual constructions that are not tied to any external reality, but rather to the knower's interactions with the external world. Reality is to a degree whatever the knower conceives it to be . . . if knowledge is constructed individually, then there is no objective reality, and our experiences determine our reality" (pp. 32, 34). Thus, there are many ways to structure our world and there are multiple realities, or many meanings, for any event or concept. There is no one correct meaning that we can strive for (Jonassen in Reigeluth, 1991) and there is no objective reality that is independent of our thoughts (von Glasersfeld, 1984). According to Cooper (1993), "external phenomena are meaningless except as the

mind perceives them . . . Constructivists view reality as personally constructed, and state that personal experiences determine reality, not the other way around" (p. 16).

Although this view is sometimes labeled *extreme constructivism* in the literature, many individuals who fall in this category claim that they are not extreme in their position. The implied negative connotation that comes with the labels `radical' and `extreme' motivates many writers who fall into this category to deny they are radical constructivists or extremists. It is unfortunate that these labels have been applied to this position as it is not any more - or less - extreme or radical than any of the other views. As Figure 1 (above) illustrates, this view is merely one of four `positions' describing knowledge construction.

Implications For Practice

Writers criticizing radical constsructivism state that it is impossible to predict learning outcomes - as there is no objective reality from which we can construct them. As Winn (1993) explains, if there is no objective reality, there is nothing that instructors can do that will influence the understandings of learners. While it is true that this position of constructivism maintains there should be few specific guidelines for instruction, it would be absurd to say there is nothing educators can do that will influence and facilitate the process of knowledge construction.

Similar to the cognitive constructivism position, educators need to recognize that learning is an individual process. However, where the cognitive constructivism position sees the role of the educator as a catalyst, the radical constructivist sees the role of the educator as a guide or coach to learners in selecting or developing their own learning strategies. Different from cognitive constructivism, educators should not impose on the learners a particular way to learn. Rather, the function of the educator is to support what the learner decides to do and accept that there will be diversity of understandings within each learner. In the radical constructivist position, the learner is given the responsibility for deciding what and how to learn.

Learning activities need to be authentic with unplanned instructional responses (Bendar, et al., 1992). The cognitive apprenticeship model (comparable to mentoring relationships) and collaborative problem solving (or group problem based learning) are instructional methods that would be appropriate for this view (Duffy and Bednar, 1991). As Honebein, Duffy, and Fishman (1993) note, these methods provide authentic learning activities where the activities of the learner are relative to the environment in which the learning will be used. In addition, if learners are to function effectively in their own worlds, learning activities must be designed in a way to develop their metacognitive skills. Metacognition, according to Flavell (1976), refers to one's knowledge concerning one's own cognitive processes or, stated simply, thinking about thinking. The Metacognition process requires that learners take ownership of their learning and performance (Honebein, et al.; Jones, et al., 1997).

All learning in this view must provide the ability to not only accommodate but

to also encourage learners to understand multiple perspectives. In other words, instructional activities must be authentic *and* provide for the opportunity for learners to generate and evaluate alternative perspectives. It is not enough that learners know their own world, they must also be able to see and solve problems or perform tasks from alternative perspectives. This view would agree with Schon's (1987) advice that instruction needs to include helping the learners to not only `solve' problems, but also `identify and choose' and define the problems to be solved. The learning process, then, has "at least as much to do with finding the problem as with solving the problem found" (Schon, p. 18). The need for learners to not only `problem solve', but to also `problem set' is based on the assumption that in the real world there are many realities that make it impossible to construct and use knowledge derived from a systematic and determined body of knowledge. According to Jones, et al. (1997), learners need to learn how to think critically and strategically to solve problems in a world where there are many and diverse contexts.

Instructional strategies should also include content sequences that progress from simple to complex with a variety of contexts. The progression from simple to complex learning should continue until there are realistic levels of complexity in the learning environment and the learner is functioning in the `authentic' environment (Honebein, Duffy and Fishman, 1993; Strommen, 1995).

Situated Constructivism

In the situated constructivism learning theory, there is an assumption that we can know what is real - but not with certainty (Young, 1997). Although this may seem paradoxical, it is not. Duffy and Jonassen (1992) explain this paradox with the reasoning that we impose our own realities on the world, rather than an external reality that is imposed on us. "There are many ways to structure the world, and there are many meanings or perspectives for any event or concept. Thus there is not a correct meaning that we are striving for" (Duffy and Jonassen, p. 3). Similar to the radical constructivism view, this position sees our world as comprised of complex and ill-structured environments where there is no reality in any absolute way. According to Spiro, et al. (1991), one reality is false; multiple realities are true.

How we construct knowledge has nothing to do with truth validation; rather, meanings emanate from the patterns of our individual and unique social experiences that occur over time in a contextual, situated, and continually changing synthesis. Different from radical constructivism, then, this position asserts that knowledge is constructed as a social process rather than an individual process. Using social patterns that we observe over time, we conceptually interpret events, objects, and perspectives in our environments and construct knowledge (Jonassen, 1991). Restated, we each have unique social interactions that we interpret. As we interpret our social interactions over time, patterns emerge (Wittegenstein, in Spiro, et al., 1991). Our individual interpretations of these emerging patterns are how we construct knowledge. What this means is that we live in a world where there are multiple realities or a *multi-universe* (Dell, 1985). Brown, Collins and Duguid (1989) draw parallels to Wittegenstein's pattern making and refer to `indexing' our experiences. Our knowledge of our experiences becomes a

part of the meaning of the knowledge we create. According to Belenky, et al. (1986), "all knowledge is constructed and the knower is an intimate part of the known" (p. 137). Thus, knowledge is grounded in the experience and the experience is critical to the understanding of and ability to use that knowledge. The process of constructing knowledge, therefore, involves examining and understanding the experience where the process occurred.

As Figure 1 (above) illustrates, the situated constructivism view of multiple realities is in agreement with the radical constructivism position but not the critical constructivism view, which asserts that there is an objective reality that we strive to understand. Alternatively, the situated constructivist position asserts that knowledge is constructed socially, in disagreement with the radical constructivist position, which claims knowledge construction is an individual process (but in agreement with the cognitive constructivist position).

Implications For Practice

Based on the assumption that there are multiple realities, Spiro, et al. (1991) argue that there is a need for "multiple dimensions of knowledge representation, for multiple interconnections across knowledge components" (p. 67). The emphasis on learning in this view capitalizes on the students' need to create interpretations and actively struggle with a variety of opposing understandings (Cunningham, 1991; Perkins, 1991). Although this may at first glance seem similar to the central concept in the cognitive constructivism view, it is not. Specifically, although both views would agree that opposing views should be presented as a social process, the cognitive constructivism view maintains that conflict should be encouraged and actively explored, whereas situated constructivism believes that conflict should be deferred. Situated constructivism invites learners "to `bracket' their intuitive models for a while and just learn a new way of thinking and talking about the phenomena. When the new way has become somewhat familiar and consolidated, then the instruction turns back to the naive model and explores relationships between the two" (Perkins, 1991, pp. 19-20).

Instructional activities from this view are largely concerned with collaborative problem-solving skills resulting in "advanced knowledge acquisition in ill-structured domains" (Molenda, 1991). In an ill-structured world where there are multiple truths, learners must be able to use their knowledge flexibly, "to be able to find the most useful of the valid representations to fit the needs of a particular case, one must have available a diverse repertoire of ways of *constructing* situation-sensitive understandings" (Spiro, et al., p. 22). In agreement with the radical constructivist position, instructional strategies might include exploration of multiple and differing perspectives, general and content specific problem-solving processes, and - in particular - using a random access instruction strategy discussed by Spiro et al. (1990). Random access instructional strategies focus on explorations of multiple views (preferably, though not necessarily, contradictory views). An example that McManus (1996) provides of random access instruction is the use of the World Wide Web and cross-links that "take the learner through the same information several times and from several directions. This enables the learner to explore multiple routes through the same content

thereby reinforcing cognitive construction." Small discussion groups following the presentation of each view on the topic would enable the learner to explore and understand multiple perspectives of the content. In the end, the goal of instruction is to help the learner understand multiple interpretations of reality, rather than to assure that the learner know `the' reality (Cunningham, 1992).

Co-Constructivism

The most prevalent form of constructivism epistemology is co-constructivism - sometimes labeled *symbolic social interaction* or *social constructivism*. This view emphasizes the influence of cultural and social contexts in learning (Vygotsky, 1962). Co-constructivism assumes that we actively construct meanings socially through language, similar to the assumptions of situated constructivism. However, unlike situated constructivism, cultural and environmental factors - or groups of people functioning together by virtue of their shared cultural practices (Bereiter, 1992) - are essential to constructing knowledge in this view (Duffy, et al., 1993). Thus knowledge is constructed in the context of the environment in which it is encountered (Baxter Magolda, 1992) through a social and collaborative process using language (Vygotsky, 1962).

Based on the premise that knowledge construction is a socio-linguistic process dependent upon the content and culture where it occurs, this view argues that we use conversational language to negotiate meanings that results in shared knowledge and understandings. Similar to the situated constructivist position, this view maintains that knowledge construction is a dialectical process where we test our ideas on others and persuade others of the virtue of our thinking - or, conversely, are persuaded by others of the virtue of their thinking (The Cognition and Technology Group at Vanderbilt, 1991). According to The Cognition and Technology Group at Vanderbilt (1993) "by continually negotiating the meaning of observations, data, hypotheses and so forth, groups of individuals construct systems that are largely consistent with one another" (p. 3). The process of negotiating meanings, using conversational language, is how we construct knowledge. But - although we construct our knowledge socially and collaboratively through dialogue - no two people will have exactly the same conversations with exactly the same people. This view acknowledges that multiple realities exist, in agreement with the radical constructivism view - though unlike radical constructivism this position believes that it is possible for us to have shared meanings and understandings that are, as mentioned, negotiated through conversation. Thus knowledge of reality is constructed through shared meanings and shared meanings are arrived at through social negotiation using language (Kuhn, 1962; Vygotsky, 1978). The process of negotiation is how we construct knowledge and if the process of negotiation results in agreement, the agreement is reality. Restated, knowledge is constructed through conversation and conversation, in turn, is the reality.

Implications for Practice

Similar to the radical constructivism view, this position of constructivism provides few specific guidelines for instruction (Scardamailia and Bereiter in

Duffy, et al., 1993). Understanding occurs through interaction with the environment. What is learned cannot be separated from how it is learned, suggesting that knowledge is not just within the individual, but part of the entire context. Based on these assumptions, the emphasis in instruction is on the importance of helping learners engage in `generative' rather than `passive' learning activities (The Cognition and Technology Group at Vanderbilt, 1993; Jones, et al., 1997). In agreement with the other positions, learning activities such as rote memorization are insufficient instructional methods. Co-constructivism claims that that "students need to engage in argumentation [similar to the cognitive constructivist position] and reflection as they try to use and then refine their existing knowledge as they attempt to make sense of alternate points of view" (The Cognition and Technology Group at Vanderbilt, p. 6). As knowledge is constructed through social negotiation, discussions with other individuals are a primary instructional methodology. Small discussion groups in a risk free environment, brainstorming and categorizing, Socratic dialogue, and debriefing are examples of instructional methods that can allow learners to examine their understandings through other individuals. Learners should also be encouraged to test their ideas against alternative views and alternative contexts. Consistent with cognitive construction, other people are considered to be the greatest source of conflict that stimulates new learning. In addition to providing generative learning activities, instruction should also include `anchored instruction' where the instruction includes meaningful problem solving contexts (The Cognition and Technology Group at Vanderbilt, 1993). Anchored instruction provides an opportunity to create shared environments that support learners with sustained exploration.

Finally, cooperative learning is also an instructional method that can provide opportunities for generative learning. Cooperative learning is a "learner-centered instructional process in which small, intentionally selected groups of 3-5 students work interdependently on a well-defined learning task; individual students are held accountable for their own performance and the instructor serves as a facilitator in the group learning process" (Cuseo, 1997). Cooperative learning creates an opportunity to form communities of inquiry that provide learning environments that encourage critical dialogue and, hence, understanding (Vygotsky, 1978; Cuseo, 1997).

Discussion

The intent of this article was to bring order out of the chaos - and often conflicting information - in the literature on constructivism learning theories. There are a variety of positions of constructivism learning theory that vary in belief with respect to the extent that knowledge construction is subjective versus objective and the extent that knowledge construction is a social versus an individual process. Table 1 provides a comparison of each constructivism learning theory with respect to the aim of education, the role of the learner, the role of the educator, the role of content, how we construct knowledge, how we learn, and what instructional methods can effectively facilitate the learning process.

Yet although there are differences between each position, there are also central beliefs common to each position. Specifically, all concur that:

- new knowledge is built upon the foundation of previous learning,
- learning is an active rather than passive process,
- language is an important element in the learning process, and
- the learning environment should be learner-centred.

All positions of constructivism would agree that teaching cannot be viewed as the transmission of knowledge to the unenlightened from the enlightened. Nor can the learning process be teacher-centred where the student is a receptacle of information (like a `beaker' that can be filled with information). And the learning process cannot be content-centred where reality is arrived at through an observable cause and effect relationship. Rather, the educator is a guide, helper, and partner where the content is secondary to the learning process; the source of knowledge lies primarily in experiences. The educators' role is not to simply provide information; they must create the conditions within which learning can take place. The focus of education is not on the content; it is on the process.

All positions also agree that, if learning is based on prior knowledge, then educators need to acknowledge that they cannot assume that all their learners will understand new information in the same way. Thus educators must understand that learners need different experiences to advance to their different kinds and levels of understanding. Educators must bring the learners' current understandings to the forefront if learners are to apply their current understandings to new situations in order to construct new knowledge. To achieve this, educators should incorporate problems that have real world relevance to the learners through interaction with others where the interplay among other learners facilitates individuals to become explicit about their own understanding by comparing it to that of their peers.

As the use of language is also important to all positions, all views agree that educators need to incorporate learning activities that facilitate learners to improve in their communication skills. Specifically, educators should include activities that enhance learners' confidence and ability to express viewpoints as well as help learners to develop coherent organization and precise expression of ideas structured in a manner that matches the speaker's (or writer's) purpose and intended audience. Journaling is an example of an instructional method that facilitates the process of internalizing dialogue (Vygotsky, 1962). Specifically, journaling is considered to be an instructional activity that reinforces the skill of reflecting what was simultaneously being discussed with others (Burnham, 1992; Reinersten and Wells, 1993; Beyerbach, 1992).

Finally, if knowledge is actively constructed then educators must have the learners `do' something; "that is, create a product for delivery to the teacher, classmates, or others. Requiring students to do something ... increases the depth of learning by the student who produces the deliverable. We learn best by doing" (Klemm and Snell, 1996). In agreement with Klemm and Snell, Perkins (1992) emphasizes that the learner be more than an

`active processor of information' but also elaborate upon and interpret the information. The products that learners create must be "meaningful, challenging experiences that involve planning, development over time, presentations and debriefings about what [they] learned" (Jones, et al., 1997). After the learners have done something, time to reflect is required. Reflection "can be seen as an essential human capacity for thinking about oneself, events, or circumstances with a view to interpreting and understanding those things" (Evans, 1991, p. 12). Time facilitates learner reflection about new experiences, how those experiences compare to their current understandings, and how different understandings might provide learners with improved understandings. Brooks and Brooks (1993) suggests five guiding principles to facilitate constructivism in our classrooms: (1) posing problems of emerging relevance; (2) structuring learning around primary concepts: the quest for essence; (3) seeking and valuing students' points of view; (4) adapting curriculum to address students' suppositions; and, (5) assessing student learning in the context of teaching.

Examples of instructional methods that facilitate constructivism learning principles have been provided throughout this paper. But how well do these methods translate to the online learning environment - or `*can'* these instructional methods even be translated to technology- mediated learning? While not all instructional methods translate well to technology-mediated learning, most do - and some work even better online than in face-to-face learning environments. Following are three examples of instructional methods that facilitate constructivism learning principles and translate well to technology-mediated learning environments.

Debate

The debate is an instructional method that facilitates articulation of thoughts and argumentation through the use of language. Instructors can use debates to enhance their learners' confidence and ability to express viewpoints as well as help them to develop coherent organization and precise expression of ideas structured in a manner that matches the speaker's (or writer's) purpose and intended audience. To maximize the effectiveness of debates, instructors should establish a few ground rules before beginning. Debates can range from highly structured, formal interactions, to quite casual exchanges of viewpoints. There is, however, a tendency for technology-mediated debates to be more successful when they are structured and formal. Whether or not the debate is formal, there needs to be a moderator and judge. The moderator's role is to enforce the rules of the debate and the judge's role is to determine the winning team. To help contribute to a successful debate, instructors should adhere to a structure similar to the following:

- The class size should not consist of more than 25-30 participants and not be less than 10- 15. There should be two teams with an equal number of team members on each side. There should also be a moderator and a judge, who is usually (but not always) the instructor. When there is an odd number of class participants, one learner may be chosen to be the debate moderator.
- The topic should be an issue related to the course content and one where

there are polarized views on the issue presented. Content on the topic and the related issues should be presented to the learners, but they should not be told which team they will be assigned to in the debate until the onset of the debate. The instructor should make every effort to get to know where each class participant stands on the issues presented and have them argue on the side that they do *not* agree with.

- Members of the team have a predetermined time limit to present their position on the issues. If using synchronous technologies (such as audio or video conferencing), the time limit should be two to three minutes to present for individual team members. If the technology is asynchronous (such as a listserv or computer mediated conferencing software), the time limit might be 24 to 48 hours with an opportunity for each team member to post one message no longer than one screen of information.
- After each team has presented their most important points, the opposing teams may take turns to counter any points raised by their opposing team members.
- The debate should be concluded with an opportunity for each team to present concluding remarks.

The desired learning outcome of a debate is to force learners to confront situations that that result in contradictions that challenge the learner to acquire better understandings. To make the debate effective at facilitating constructivism principles, the instructor will need to ensure learners take a stand that is contrary to their current belief system. This will help the learners to actively challenge their understandings by searching out new information and experiences of which they have little working knowledge.

Case Method

Much of the literature on constructivism learning principles stresses the importance of experiential learning. Case studies provide one such opportunity to enhance learning through the examination of real life situations tailored to raise those issues that are important for learners to consider (Boyd, 1980; Dixon, 1991). A case study provides information about a simulated (or sometimes real) situation; learners respond to predetermined questions or develop an action plan (Marsick, 1990). If cases are developed so as to bring about a questioning of learner assumptions and if learners are also provided with the opportunity to examine those assumptions in interactions with others, critical self-reflection will be fostered (Hudspeth, 1991; Stolovich & Keeps, 1991). Writing case studies includes the following (Graf, 1991; Lacey & Merseth, 1993).

- Selecting *objectives*. These will depend on the subject and quite often involve such interpersonal skills as revolving conflict, leadership or management techniques.
- Providing *background* in the form of a clear description of the actual problem. Only one major problem should be presented and focused on. Information on the nature of the environment, the players in the case, the resources available, and any time frames that apply need to be included.
- The inclusion of *relevant information* of major influences on people in terms of specific events, facts, and circumstances which relate directly to the incident

or problem. These may be social contexts, previous experiences, or cultural backgrounds. These should also be made as authentic as possible.
- Formulation of *discussion questions* need to be developed to guide the activities of the learners and facilitate the exploration of the issues contained in the problem situation. The questions should lead the learners to recognize alternative solutions, consider contributing influences, and anticipate probable consequences.

Other elements to include when writing case studies are as follows.

- Select facts and incidents that will be easily recognizable.
- Identify characters and keep to four at the most; one or two is best. Describe clear pictures so readers do not get confused.
- Include brief dialogues that give a sense of the characters involved.
- Introduce key characters early and link them clearly to the problem.
- Include social/organizational content.
- The concluding sentence should point out a need for some form of action.

When using case studies in technology-mediated learning environments, the web would be an appropriate medium to present the case study and following discussion questions. If the web is not being used, the case should be presented in paper based format. To make the case study as effective as possible at facilitating constructivism principles, consideration should be given to having the class participants develop the cases, rather than the instructor. Irrespective of whether the learners or the instructor develops the case study, it should be presented to the class prior to the discussion and read individually. Once the class has read the case, the instructor should use heterogeneous discussion groups to discuss particular points of view. Groups that include a mix of gender, culture, socioeconomic status, and age will provide multiple perspectives to the problem presented in the case. If the instructor is using synchronous technologies, the learners should be provided with approximately 30-45 minutes for discussion on the questions followed by a presentation of their findings, opinions, or beliefs to the entire class. If the instructor is using asynchronous technologies, the instructor should have access to an online learning environment capable of dividing the class into small groups. The small groups should have approximately one week for discussion. The discussion should then be followed with a summary developed by each group of their findings, opinions or beliefs and presented to the entire class. Opportunities for all class participants to respond to the group summaries should also be provided in both asynchronous and synchronous environments.

Case studies can be made more effective at facilitating constructivism learning principles in asynchronous environments through the use of role play. According to Renner (1997), role playing is experiential learning at its best and can be used to "insert a slice of life into the classroom, connect theory with everyday practice, practice unfamiliar skills in a safe setting, and learn to appreciate contradictory viewpoints" (p. 64). Role play can be made even more interesting with asynchronous software that allows for users to have an `*alias*'. The alias option is where a user can be assigned an alternate user name on the conferencing software. Using the alias, the instructor can

assign roles from the case study to class participants where they are a different gender, socioeconomic status, ethnic origin, or age. In this way, the learners must not only *act* from an alternative perspective, but also *respond* to their fellow class mates who will not know the `true' identity of each class member. This kind of learning activity helps learners to understand that much of what we know to be true (our objective and external realities) is often contextually and culturally situated.

Brainstorming

Brainstorming is an instructional method that works well when used in combination with the nominal group technique (group problem solving) (Korhonen, 1990). Brainstorming is most often used to channel a group's collective thoughts through structured group input over a short period of time in ways that invite uninhibited participation (Renner, 1997). This process can result in fresh solutions to old problems.

Brainstorming works well with group sizes that are not larger than eight (Renner, 1997). When using synchronous technologies, such as video or audio conferencing, one participant should be assigned recorder of the ideas generated while the rest of the group spontaneously contribute their ideas. The time required should range from five to fifteen minutes with an equal amount of time for evaluation and discussion. When using asynchronous technologies, such as computer mediated conferencing software, group sizes should also be limited to eight. Limiting group size with computer-mediated conferencing software is important in that it will as ensure that all class participants have an opportunity to generate their ideas, yet will not result in an overwhelmingly large number of messages to read - as can often happen when group sizes are too large. One to three days is the time frame suggested for brainstorming with asynchronous technologies; longer periods of time can often result in the degeneration of fresh ideas. Rather than a final discussion on evaluation, as is suggested with synchronous technologies, the group should work together through a negotiation process and produce a summary of the most worthwhile ideas generated.

The desired outcomes of brainstorming include, according to Renner (1994), the development of new solutions to existing problems, inspire collective creativity, and effect group synergy. Brainstorming supports constructivism learning principles through the facilitation of a collaborative group process where shared understandings are negotiated through a socio-linguistic process.

Conclusion

If learning is, as constructivists argue, a process whereby we actively construct knowledge using language based on our past experiences, then context-rich, long-term learning environments with tools that enhance communication and access instructional methods that provide real-world examples are required. This kind of learning environment will provide learners with experience-based learning opportunities to practice

and reflect on the learning process and to a lesser extent the content. Moreover, according to constructivism learning principles, in this kind of learning environment the tasks will reflect the complexity of the real world in which learners must function after the planned learning activities have occurred.

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