Technology Integration for Meaningful Learning - the Constructivist View

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Abstract

The purpose of the article is to explore the relationship between constructivism, technology, and meaningful learning it seeks to explore constructivist teaching strategies that could benefit student learning in ways that are different from those practiced in traditional, non-technological classrooms. The combination of technology and the constructivist approach is changing pedagogy.. We are moving towards a future in which computing is becoming more ubiquitous and there is evidence that technology is changing the way teachers conduct their teaching. Even so, few teachers are integrating technology into their teaching in ways that can support meaningful learning. Those who are usually successful in teaching with technology are those who constantly strive to facilitate student-centered learning environments that support and improve the depth and scope of student learning. Further, they are likely to have experienced shifts in their learning paradigms and embraced constructivist teaching styles. The authors describe four models for technology integration based on the theory of constructivism: (1) technology integration goals based on constructivism, (2) ways to use technology in real classrooms, (3) technology teaching and (4) teaching with technology. The authors also designed a checklist that can be helpful in integrating technologies in the real classroom for meaningful learning.

Key words: Technology integration, Meaningful learning, Mindtools, Constructivism.

I. Introduction

Technology includes two components: a product-a tool that embodies the technology, and a process-the information base of technology. The technology integration is a process in which computers and other technologies are used as tools to support the tasks of teaching and learning. Technology integration is the use of technology tools in general content areas in education in order to allow students to apply computer and technology skills to learning and problem-solving. Generally speaking, the curriculum drives the use of technology and not

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vice versa (Jolene Dockstader, 2008; Edutopia, 2011). According to the International Society for Technology in Education (ISTE): "Curriculum integration with the use of technology involves the infusion of technology as a tool to enhance the learning in a content area or multidisciplinary setting... Effective integration of technology is achieved when students are able to select technology tools to help them obtain information in a timely manner, analyze and synthesize the information, and present it professionally. The technology should become an integral part of how the classroom functions - as accessible as all other classroom tools. The focus in each lesson or unit is the curriculum outcome, not the technology." (Cited in U.S. Department of Education, 2008)

Jean Piaget (1977) asserts that learning occurs by an active construction of meaning, rather than by passive percipience. He explains that when we, as learners, encounter an experience or a situation that conflicts with our current way of thinking, a state of disequilibrium or imbalance is created. We must then alter our thinking to restore equilibrium or balance. To do this, we make sense of the new information by associating it with what we already know, that is, by attempting to assimilate it into our existing knowledge. When we are unable to do this, we accommodate the new information to our old way of thinking by restructuring our present knowledge to a higher level of thinking. According to Jean Piaget (Ginn, 2010) constructivist learning is based on four stages (active engagement, participation in groups, frequent interaction, and feedback) of cognitive development. In these stages, children must take an active role in their own learning and produce meaningful works in order to develop a clear understanding. These works are a reflection of the knowledge that has been achieved through active self-guided learning. Students are active leaders in their learning and the learning is student-led rather than teacher–directed (Wood, Smith, and Grossniklaus, 2011).

Vygotsky's work highlights the importance of "others" in the learning process. His position is that "learning awakens a variety of internal processes that operate only when the child is interacting with others in his environment and in cooperation with his peers" (as cited in Peterson, 1992, p. 3). Vygotsky introduced the social aspect of learning into constructivism. He defined the "zone of proximal development (JPD) learning," according to which students solve problems beyond their actual developmental level (but within their level of potential development) under adult guidance or in collaboration with more capable peers.

The Constructivism is an educational theory that emphasizes hand-on, activity-based teaching and learning during which learners develop their own frames of thought. Constructivism draws on the developmental work of Jean Piaget (1977) and Kelly (1991). Twomey Fosnot (1989) defines constructivism by reference to four principles: learning, in an important way, depends on what we already know; new ideas occur as we adapt and change our old ideas; learning involves inventing ideas rather than mechanically accumulating facts; meaningful learning occurs through rethinking old ideas and coming to new conclusions about new ideas which conflict with our old ideas.

As teacher and student roles shift with the integration of technology, a closer relationship seems to develop between students and teachers. Any change involves taking risks and many teachers may wonder if all the time and effort will be truly worth it. Jonassen & Wilson (1999) noted the excitement and enthusiasm generated by students while they construct their own understanding using technology-based tools are more than sufficient reward for taking those risks (p. 221).

In the following section the intricate link between constructivism and meaningful learning is discussed, including the characteristics of the constructivist classroom and the changing roles of teachers and students in promoting meaningful learning. This is followed in the next section by an exploration of technology integration from a constructivist perspective. Four models of integration are presented, including technology teaching and technology for teaching; the barriers to technology integration are discussed and a practical checklist for moving towards integration of technology into learning is presented.

II. Constructivism and meaningful learning

2.1. Constructivism

Constructivism is an educational theory that emphasizes hands-on, activity-based teaching and learning during which learners develop their own frames of thought. It is based on the belief that students learn best when they gain knowledge through exploration and active learning (McBrien & Brandt, 1997). According to Gredler (2001), constructivist perspective views knowledge as a human construction, the learner's knowledge as adaptive, and the teacher's role as that of challenging the learner's way of thinking.

Different views are held on constructivism which emphasizes cognitive or socio-cultural aspects of constructivism; but essentially, constructivists perceive learning as an active process of constructing rather than acquiring knowledge (Duffy & Cunningham, 1996). The instructional process is viewed as supporting that construction rather than exchanging the knowledge. The tenets of constructivism, therefore, support active learning that is reflective, authentic, contextual, and collaborative. (Novak, 1998).

Constructivism contrasts with the view of knowledge in which there is passive transmission of information from one individual to another (Hoover, 1996). Instead, it embraces an understanding that learning requires active engagement on the part of the learner (Jenkins, 2000) and that learners construct what they learn and understand based on their experiences in different situations (Schunk, 2000). When the students continuously reflect on their experiences, students find their ideas gaining in complexity and power, and they develop increasingly strong abilities to integrate new information. One of the teacher's main roles then becomes to encourage this learning and reflection process.

Merrill (1991) identifies various assumptions underlying the frame of thought underpinning active learning which include: (a) knowledge is constructed from experience; (b) learning is

a personal interpretation of the world; (c) learning is an active process of meaning-making based on experience; (d) learning should occur (or be situated) in realistic settings; and (e) testing should be integrated with the task, not a separate activity (cited in Mergel, 1998, p.9).

Contrary to criticisms by some (conservative/traditional) educators, constructivism does not dismiss the active role of the teacher or the value of expert knowledge. Constructivism modifies that role, so that teachers help students to construct knowledge rather than to reproduce a series of facts. The constructivist teacher provides tools such as problem-solving and inquiry-based learning activities with which students formulate and test their ideas, draw conclusions and inferences, and pool and convey their knowledge in a collaborative learning environment. Constructivism transforms the student from a passive recipient of information to an active participant in the learning process. Always guided by the teacher, students construct their knowledge actively rather than just mechanically ingesting knowledge from the teacher or the textbook.

2.2 Constructivist Classroom

When we encounter something new, we have to reconcile it with our previous ideas and experience, sometimes changing what we believe, or perhaps discarding the new information as irrelevant. In any case, we are active creators of our own knowledge. To do this, we must ask questions, explore, and assess what we know. Constructivist teachers encourage students to constantly assess how the activity is helping them gain understanding. By questioning themselves and their strategies, students in the constructivist classroom ideally become "expert learners." This gives them new tools to keep learning. With a well-planned classroom environment, the students learn HOW TO LEARN.

The constructivist classroom relies heavily on collaboration among students. There are many ways classroom collaboration contributes to learning. The students learn about learning not only from themselves, but also from their peers. When students review and reflect on their learning processes together, they pick up strategies and methods from one another. The main activity in a constructivist classroom is solving problems. Students use inquiry methods to ask questions, investigate a topic, and use a variety of resources to find solutions and answers. As students explore the topic, they draw conclusions, and as exploration continues, they revisit those conclusions. Exploration of questions leads to more questions. Calkins (1986) laments that in most classrooms, we neither teach students to ask questions nor allow them to ask questions, but simply require them to answer our questions, although asking questions is a challenging and important part of thinking and learning. By letting students ask questions, they are encouraged to ask more probing, more appropriate, and more effective questions. By asking their own questions, students acquire more consciousness of and control over their thinking. Students having "control over their thinking" is an important matter in a constructivist classroom.

Students have ideas that they may later see were invalid, incorrect, or insufficient to explain new experiences. These ideas are temporary steps in the integration of knowledge. For instance, a child may believe that all trees lose their leaves in the fall, until s/he visits an evergreen forest. Constructivist teaching takes into account students' current conceptions and builds from there.

A constructivist teacher and a constructivist classroom exhibit a number of discernable qualities markedly different from a traditional or direct instruction classroom. A constructivist teacher is able to incorporate flexibly and creatively ongoing experiences in the classroom into the negotiation and construction of lessons with small groups and individuals.

Constructivist classrooms are structured so that learners are immersed in experiences within which they may engage in meaning-making inquiry, action, imagination, invention, interaction, hypothesizing and personal reflection. Teachers need to recognize how people use their own experiences, prior knowledge and perceptions, as well as their physical and interpersonal environments to construct knowledge and meaning. The goal is to produce a democratic classroom environment that provides meaningful learning experiences for autonomous learners. Lester and Onore (1990) suggest that the attitudes, values, and beliefs of a teacher, specifically those related to the belief of student as constructor of knowledge, make it possible to create a democratic environment. A democratic classroom is self-regulating.

In a constructivist classroom, the teacher and the student share responsibility and decision making and demonstrate mutual respect. Using constructivist strategies, teachers are more effective. They are able to promote communication and create flexibility so that the needs of all students can be met. The learning relationship in a constructivist classroom is mutually beneficial to both students and teachers.

A constructivist classroom is a student-centered classroom. The student-centeredness of a constructivist classroom is clearly apparent in a reader response approach to literature. Recognizing the significance of the unique experiences that each reader brings to the reading of a selection of literature, the teacher in a response-centered approach seeks to explore the transaction between the student and the text to promote or extract a meaningful response (Rosenblatt, 1978).

Another quality of a constructivist class is its interactive nature. Authentic student-student and student-teacher dialogue is very important in a constructivist classroom. Belenky, Clinchy, Goldberger, and Tarule (1986) inform that constructivists distinguish didactic talk, when participants report experiences, but no new understanding occurs, from real talk where careful listening creates an environment within which emerging ideas can grow.

Belenky et al (1986) explain that in "real talk", domination is absent, while reciprocity, cooperation, and collaborative involvement are prominent. Consequently, constructivist

activities in the classroom that focus on speaking and listening promote not only constructivist thought but also important connections between teacher and students. In the constructivist classroom the teachers focus on students' learning rather than on teacher performance (Lester and Onore, 1990; McNeil, 1986; Dewey, 1916; Bentley and Dewey, 1949).

Finally, in the constructivist classroom, the focus tends to shift from the teacher to the students. The classroom is no longer a place where the teacher "expert" pours knowledge into passive students, who wait like empty vessels to be filled. In the constructivist model, the students are urged to be actively involved in their own process of learning. The teacher functions more as a facilitator who coaches, mediates, prompts, and helps students develop and assess their understanding, and thereby their learning. One of the teacher's biggest jobs becomes asking good questions.

2.3 Changing Roles of Teachers and Students

Calkins (1986) notes that there is a thin line between research and teaching. At the same time when teachers teach children, they also teach teachers because children show how they learn; teachers just have to watch children carefully and listen to them. This kind of watching and listening may contribute to a teacher's ability to use what the classroom experience provides to help him or her create contextualized and meaningful lessons for small groups and individuals. The ability to observe and listen to one's students and their experiences in the classroom contributes to his or her ability to use a constructivist approach. Paradoxically, a constructivist approach itself contributes to one's ability to observe and listen in the classroom. Thus, the process is circular.

In constructivist learning environments, the traditional role of instructors as dispensers of information is challenged, and the new role of instructors is that of a guide, who challenges students' thinking and encourages reflection in the learning process (Brooks & Brooks, 1999). As a guide, the instructor is no longer an authority who transmit knowledge by telling students what they must learn (Cuban, 2001) but one who shares knowledge with the learner (Novak, 1998).

Modern technology-rich classrooms such as multimedia and hypermedia provide teachers and students with an opportunity to change roles – students can use the technology to make presentations and teach one another while teachers can learn from the technology's offerings about students' interest and abilities (Sharp, 2002). As noted above, learning is viewed as an active, group-oriented process in which students construct an understanding of knowledge utilized in problem-solving situations.

2.4 Meaningful Learning

According to Ausubel (1960), meaningful learning occurs when there is a personal recognition of the links between concepts; the most important element of meaningful learning is not so much in how information is presented, but how new information is integrated into an existing knowledge base. Based on Ausubel's cognitive learning theory,

three tenets of meaningful learning are learner's relevant prior knowledge, meaningful material, and learner choice to use meaningful learning (Novak, 1998).

Novak (1998) argues that meaningful learning occurs when a learning task can be related in a non-arbitrary manner to what the learner already knows. Meaningful learning underlies two things necessary for understanding new knowledge: potentially meaningful concepts and the ability of the learner to relate the new knowledge in a meaningful way to his or her prior knowledge (Reigeluth, 1999).

Meaningful learning is constructed with rote learning, which does not allow the establishment of important links and relationships. Novak believes that while rote learning may incorporate new information into prior knowledge structure, it lacks interactions, and thus, fails to support understanding of the relationships between objects. Once a learner acquires knowledge, he or she must bring to mind and establish proper relationships between the new knowledge and the prior knowledge for meaningful learning to occur. In addition, better understanding of concepts will result from proper negotiations of meanings across links that are created with relevant prior knowledge.

To demonstrate the difference between rote learning and meaningful learning, let us consider a situation whereby students are learning five vowels in English ("A," "E," "I," "O," and "U") associated with construction of words, phrases, and/or sentences. In rote learning, a student learns the five vowels, but fails to see or understand the relationships between these vowels – the vowels exist in the student's memory as distinct, unrelated knowledge. When recalling the vowels in sentence construction, each vowel is recalled individually.

On the contrary, in meaningful learning, a student sees connections between the vowels; the vowels exist in the student's mind as related knowledge that the students can use to solve given language problems. In meaningful learning, the student understands relationships between the vowels and is aware of the differences and similarities that exist between the vowels. When recalling the vowels in sentence construction, one vowel recalled activates the memory of other vowels in what could be described as an organized and integrated knowledge recall.

III. Technology Integration through a Constructivist Approach

3.1 Technology

Technology has been introduced into classrooms because educators believe it has a great potential to improve education and student learning by providing a more active learning, and more varied sensory and conceptual modes; less mental drudgery; learning better tailored to individuals, and as better aid to abstraction (Dede, 1998). However, the potential for educational technology to enhance student achievement can be realized only if it is used appropriately (Dede, 1998).

Model 1: Technology integration goals based on constructivism

Determination of the goals of technology integration is a task for the instruction designer. The classroom setting should be changed or rearranged based on the goals of technology integration in instruction. The following picture is showing the goals of technology integration based on the theory of constructivism.

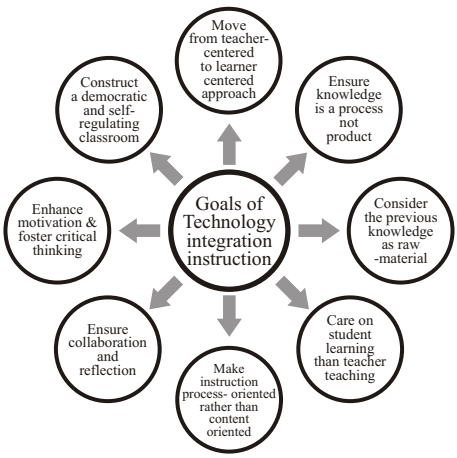

Figure 1: Goals of technology integration in instruction

Tools are extensions of our human capability (Forcier & Descy, 2002). A tool alone does not function until it is used properly. Computer technologies, as tools can empower students with thinking skills and learning skills, and improve student's affective and cognitive outcomes (Waxman & Huang, 1996). In addition, computers can help students to solve problems and think independently and collaboratively (Knapp & Glenn, 1996). Further, the use of computer technology to address realistic situations is likely to promote the integration of disciplines, foster a team approach to problem solving, and enhance individual responsibility (Singh & Means, 1997).

Educational technology can be used in the classroom as an instructional tool, as a learning tool, and as a storage device (Perkins, 1992). However, in the classroom, computers are best used as instructional tools to support student learning rather than as programming devices. Using technology, instructors are able to facilitate and scaffold learning through the components of technology integration, leading their students into areas of inquiry that invite collaboration, cooperation, and construction of knowledge as well as giving some of the control to the students in the different uses of technology (Bruning, Schraw, & Ronning, 1999).

A critical issue related to technology use is that computer technology should not drive instruction (Jonassen, 2000). Rather, instruction should drive the technological tools being used. The most effective way to benefit from technology is to integrate it into the curriculum as opposed to integrating curriculum into technology (Goodman, 1996). Additionally, instructors should strive to provide intellectually powerful and technology rich environment for students without undermining sound pedagogical practices (Anderson & Becker, 2001).

Technology is not a substitute for good instruction; effective instructors strive to integrate computers in their lessons to engage multiple learning styles of their learners. Zisow (2000) highlights the effect of instructors' teaching styles in the use of technology in the classroom. A focus on mere technology may not help to enhance learning, but good pedagogical practices that focus on teaching first and technology second may possibly lead to effective classroom computer technology use that can support student learning.

Computer-related technology can also help to motivate learners to learn as well as support a variety of instructional approaches such as cooperative learning and critical thinking (Grabinger, 1996). Further, technology can enable students to become: (a) capable information technology users; (b) information seekers, analyzers, and evaluators; (c) problem solvers and decision makers; (d) creative and effective users of productivity tools; (e) communicators, collaborators, publishers, and contributing citizens (International Society for Technology in Education, 2000).

3.2 Technology Use and Student Learning

Model 2: Ways to use technology in Classrooms

There have been different ways to use technologies in classroom. The selection of the appropriate technology in class is essential for ensuring effective learning. Examples of appropriate technology use in the classroom include the use of instructional software for subject matter learning, implementing internet activities, applying multimedia skills in the classroom, and learning to work with graphics and audio devices. When used as learning tools, technology provides tremendous opportunities to enhance classroom instruction. Figure 2 shows some of the ways to use technology in class.

Recently technologies have transformed the way we live, work, and teach (Hill & Hannafin, 2001). These changes have been rapid and consequently have placed numerous demands on instructors who are already burdened with other teaching responsibilities. According to Jonassen et al. (1999), teachers need to seek ways of using technology as a learning tool for their students even if they do not master the technology and cannot act as an expert. They should feel comfortable in allowing students to move into domains of knowledge where they themselves lack expertise. They must recognize that in the learning process they may encounter phenomena they do not understand or questions they cannot answer. (p. 22)

Although technology is usually viewed as a delivery and instructional tool, many instructors struggle to support their students to learn form, and about technology, but ignore the most important aspect -- learning with technology. Students learn meaningfully when they learn with computers, and not just about or from computers (Jonassen, 2000).

When students learn with computers, technology is viewed as a resource to help them develop, among other things, higher order thinking, creativity, and research skills (Reeves, 1998). Further, when students learn from computers, the computer is viewed as an intelligent, artificial tutor whose goal is to increase students' basic skills and knowledge. However, both dimensions of technology use are important and, if used judiciously, could enhance students' understanding of the content presented in class.

Instructors should be supported to benefit student learning in various ways. Institutions should, therefore, first assess the technological needs of their instructors in order to provide relevant workshops that could benefit teachers to successfully integrate technology into their

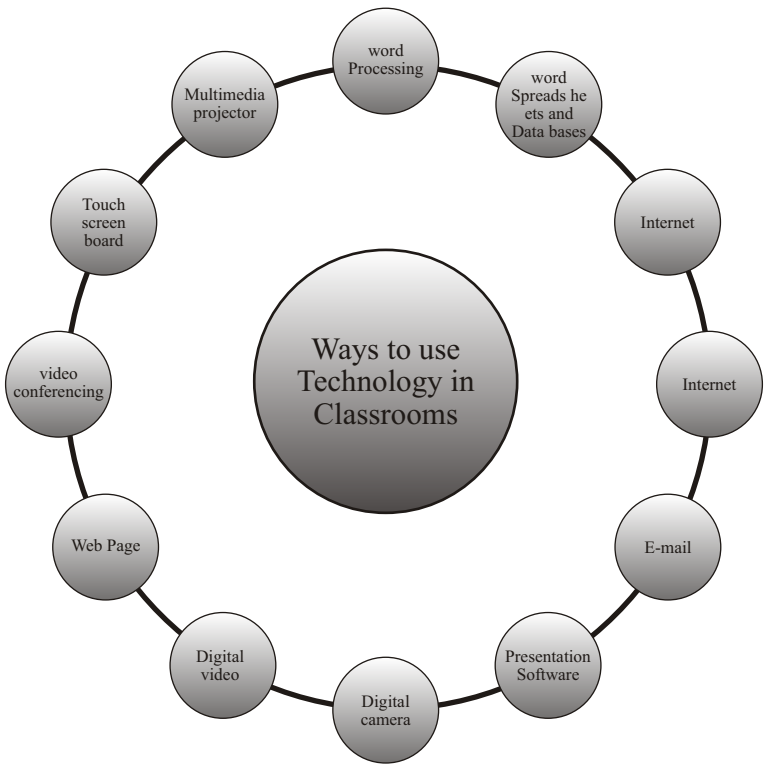

Figure 2: Technology in Classrooms

classroom instruction. Instructors are willing to spend a reasonable amount of time, for instance, learning effective strategies to integrate computer technology into their courses, when they realize the value of computing to support improved learning for their students (Kent & McNergney, 1999).

According to Rodriquez and Knuth (2000) , components of professional development for effective technological use should include: (a) connection to student learning, (b) hands-on technology use, (c) variety of learning experiences, (d) curriculum specific applications, (e) new role for teachers, (f) collegial learning, (g) active participation of teachers, (h) on-going process, (i) sufficient time, (j) technical assistance and support, (k) administrative support, (m) adequate resources, (n) continuous funding, and (o) built-in evaluations.

In summary, educational reform efforts should not only focus on more machines for classrooms but also developing teaching strategies that complement technology use within curriculum (Pierson, 2001). Unfortunately, many instructors lack a model that they can use to guide them through the necessary changes they will need to make to be successful in integrating new technology into their classroom (Johnson & Liu, 2000). It is important for education leaders to provide leadership with a model of technology integration that can produce feasible result. Instructional leaders must support teachers who are innovative in the use of technology so that they could help others to do so. Although infrastructure is important, leadership is critical in establishing technology as part of the school culture.

3.3 Constructivism, Technology, and Meaningful Learning

Model 3: Technology Teacher

The term 'Technology Teacher' in the following picture means the teacher surrounded by educational technologies. It does imply an emphasis on technology itself and the teachers' role as a technology enthusiast; but the goal of integration of technology into learning (use of technology for learning) can succeed to the extent the balance shifts from promoting and teaching the technology to effective use of technology for achieving the curricular and learning goals. The 'technology teachers' have to attain sound competencies and skills on different types of advance technologies to integrate those in class to enhance learning. The use of hypermedia, social blog, kiwis, podcast, etc. is changing pedagogies day by day.

Under the theory of constructivism, as emphasized earlier, teachers focus on making connections between facts and fostering new understanding in students. Consequently, constructive teaching is based on the belief that students learn best when they gain knowledge through exploration and active learning. Hands-on materials are used instead of textbooks, and students are encouraged to think and explain their reasoning instead of memorizing and reciting facts. Education is centered on themes and concepts and the connections between them, rather than isolated information.

Computer technologies should be used as tools to engage and facilitate thinking and knowledge construction of learners (Jonassen et al., 1999). In constructivist environments such as the one called mindtools (computer-based tools and learning environments, which serve as extensions of mind), learners are actively engaged in interpreting the external world and in reflective thinking, which supports constructivist knowledge construction tools (Jonassen, 2000). In constructivist environments such as mindtools, learners are actively engaged in interpreting the external world and in reflective thinking, which supports constructivist knowledge construction tools (Jonassen, 2000). Having computer technology in the classrooms does not necessarily produce better learners (Tolmie, 2001). Moreover, acquiring computer-related skills and knowledge that have no relevance to the learner or having computer literacy without meaningful activities does not support meaningful learning goals (Jonassen, 2000). Therefore, to enhance meaningful learning, instructors should guide students to construct their thoughts through activities such as problem solving, decision making, goal setting, and managing and preventing conflict and achievements.

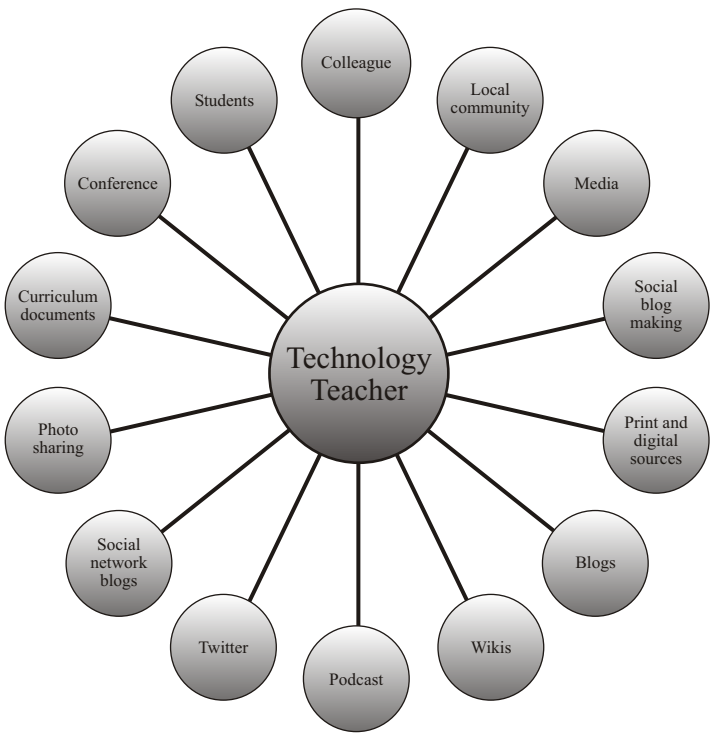

Figure 3: Technology teacher

If used appropriately, technology offers immense opportunities to help students learn meaningfully. Grabe (2004) suggest the active use of text, graphics, sound, or animation in the classroom to help students acquire and synthesize information- an activity that facilitates meaningful learning. Technology such as interactive multimedia provides rich resources that students can explore as they try to decide how to solve a problem.

Reil and Becker (2000) argue that classrooms that authentically use technology should experience change in teacher's role, learner's roles, conceptualization of knowledge and the process of teaching-learning, and assessment. Reil et al. state: Teachers who assume a professional orientation to teaching are far more likely to have made high investments in their own education, to have constructivist-compatible philosophical beliefs about education to develop the instructional practices that are related to their beliefs and to integrate computers into their classrooms in ways that support meaningful thinking and the sharing of ideas with their peers. (p. 34).

Computers can be used to support meaningful learning when technologies engage learners in: (a) knowledge construction, not reproduction, (b) conversations, not reception, (c) articulation, not repetition, (d) collaboration, not competition, and (e) reflection, not prescription (Jonassen et al., 2003). Students need to learn how to learn by engaging in meaning-making activities that provide meanings to situations, experiences, events, or actions that relate to their everyday experiences. Integration of appropriate technology into classroom practice can positively impact important dimensions of learning such as active learning, critical thinking, cooperative learning, communication skills, instructional effectiveness, multisensory delivery, motivation, and multicultural education (Barron & Orwig, 1997).

3.4 Technology Integration: Barriers

Instructors who are committed to integrating computer technology in the classroom may find the process challenging due to the barriers that exist. The barriers can either be external (first order) or internal (second order). External barriers include lack of equipment, unreliability of equipment, lack of technical support and other resource-related issues. Internal barriers include both school-level factors such as organizational culture and teacher-level factors such as beliefs about teaching and technology and openness to change (Snoeyink & Ertmer, 2001).

Resistance to change, negative attitudes toward computers, constraints on training and support, cost, and lack of access to the right types of technology in appropriate locations are other key barriers to integration of technology in the classroom (Fabry & Higgs, 1997). Other barriers include the attitude of administrators and instructors, pedagogical issues, and personal familiarity with computers (Roszell, 1995).

In line with constructivist perspective, three key issues raised by instructors in the use of technology are briefly discussed in this section. First, there is a tendency for many instructors to view instruction and integration as two separate entities that are difficult to merge, and that make demand on their time, attention, and responsibilities equally. In many instances, although instructors may be required to integrate technology into their courses, there is usually a lack of follow-up sessions to validate these requirements.

In addition, instructors may be skeptical about lack of uniformity in evaluation and assessment pertaining to technology standards to support effective instruction. Gooden (1996) emphasizes that technology is not a substitute for good instruction; effective instructors integrate computers into their lessons to engage multiple learning styles of diverse learners in the classroom.

Before technology can be used effectively for engaged learning, institutions need to ensure that technology supports the educational goals for their students. In other words, the learning goals should drive the technology use; technology is not an end in itself. Further, the goal of technology is to improve teaching and learning, not to replace teachers. As instructors get more comfortable in the use of technology, it is hoped that their instructional practices will improve and integration of technology will become an integral part of all their curricula.

Bruce (1997) argues that teachers should not only be seen as objects of change, but also as change agents who can transform the integration of their practices through the use of technology. Teachers tend to teach the way they were taught (Mehlinger & Powers, 2002) and infusing technological tools into instruction poses unique challenges to teachers who are thoroughly grounded on traditional teaching practices and are not ready and willing to change. Further, it is important to realize, however, that some elements of creativity are required of educators as well as students if the use of technology is to have a positive impact on student learning.

According to Dias (1999), one often overlooked yet serious challenge to effective integration of technology in the classroom is the anxiety that change generates. As Harris (2000) notes:

When teachers are asked to integrate technology they are really being asked to change in two ways. First, they are asked to adopt new teaching tools such as the computer and Internet. These are vastly different tools from the classroom tools many currently use such as the chalkboard, overhead projector, or television. Second, teachers are asked to change the way they teach their students, which may include changing the role they play in the classroom and the way their classrooms are physically arranged. (p. 12)

Model 4: Teaching with technology or technology for learning

The barriers of integrating technologies in education are not uncommon phenomena. Thus, the following model to minimize the technology integration barriers is proposed. The main

issues are not just to use technologies in the classroom; rather, how to use and utilize technologies in an effective manner is the major concern. If educators try to teach with technology, the major types of barriers in specific contexts have to be identified. The barriers may be related to various relationships and interaction among the components of the teaching-learning process. ; These relationships are, among others, between teacher and student, student and technology, technology and learning content, content and -curriculum development, curriculum and its implementation by the class teacher. How these relationships function through continuous communication and effective interaction will determine if the goals of "teaching with technology" can be achieved. (In Figure 4).

It has to be recognized that there are many practical and mundane barriers, in addition to those related to concepts and vision, to the use and integration of computer technology in the classroom. Lack of relevant software, lack of time, lack of funding, technical problems, teacher attitude toward computers, resistance to change, poor administrative support, and poor training are some of the factors that are compounded by the a lack of vision and commitment to integrate technology into the curriculum and the classroom. Even so, the behavior, investments and commitment of individual instructors and school leaders ultimately make a difference (Green, 1998).

Considering the practical realities that are faced in schools and classrooms, a checklist is suggested which may be helpful in applying the model of "teaching with technology."

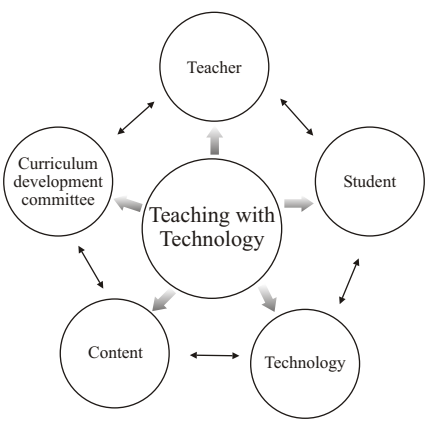

Figure 3: Teaching with technology

Table 1. A checklist to integrate technology into the real Classroom

	Criteria	Yes	No
1	Is it updated in terms of known and available learning technology?		
2	Would it make a difference in improving the cognitive level of students?		
3	Can it help in changing prevailing learning and pedagogic approach?		
4	Does it encourage students to learn on their own?		
5	To what extent is it supported by available electronic materials and methods for teaching?		
6	Is it motivating both to teachers and students?		
7	How difficult or complex is it to manage the initiative effectively?		
8	Does it help to assess student learning?		
9	Is it realistic in the context of the prevailing school environment?		
10	Is it cost-effective for the institution?		

IV. Conclusion

The use of technology for meaningful learning raises serious and significant issues as to how best we can educate our students. Promoting technology for technology's sake is a recipe for failure. Constructivist pedagogical principles coupled with appropriate technology integration shows the potential for major improvements in teaching and learning practices. The teacher's role remains primary and central to effective integration of technology in the classroom. As - Guhlin (1997) put it, "Technology integration is similar to a tidal wave, growing silently in strength, then falling with an unstoppable roar upon those who paid no attention or showed little interest".

The article highlights four implications of constructivism for teaching and learning: (1) The role of teachers has to change - teachers will act as guides or facilitators to provide students with opportunities to test their current understanding of concepts taught. (2) Teachers have to recognize that all children do not learn the same way and adapt their own behavior accordingly.. (3) Teachers should provide learning experience that incorporate problems that are important to students, not those that are primarily important to teachers and the educational system. Group and peer interaction is a key approach for this purpose. . (4) Teachers should give students ample time and opportunity to engage in reflection of the new experiences for concrete knowledge building based on past and current understandings.

As Sandholtz (1997) emphasized, technology is not a panacea for educational reform, but it can be a significant catalyst for change. To those looking for a simple innovative solution, technology is not the answer. To those looking for a powerful tool to support collaborative learning environments, technology holds tremendous potential. If technology is used effectively as a tool for learning, students can be more creative, autonomous and collaborative than in classrooms where technology is not accessible to students. There is one clear common thread throughout the literature and that is the need to accept technology as being a part of our students' lives and to respect the powerful learning tool that it can be. As David Thornberg (cited in Galas 1997-1998), the well-known futurist, affirms, "We as teachers can truly provide students the real tools of technology to cross the bridge to their future instead of our past" (p.21).

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