ICT for (I)nspiring (C)reative (T)hinking

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The capacity for creative thinking in the workplace is a generic skill that employers value highly in their employees. Although creativity is regarded as an important employability skill, it is a quality in which tertiary graduates are often lacking. Thus, the development of creative thought should be promoted as an integral part of tertiary education; Information and Communication Technology (ICT) can assist in accomplishing this task. Research suggests that ICT has the potential to encourage and support creative thinking throughout the learning process. This paper investigates the links between the theories of encouraging creative thinking in an educational context, and the practice of incorporating ICT in the implementation of learning strategies. The paper reviews the constraints and challenges associated with the deployment of ICT as a tool for encouraging creative thinking, and concludes with suggestions for effective implementation.

Introduction

The term 'creative thinking' or 'creativity' is an amorphous term with a number of possible definitions. There is a large amount of literature that explores creativity and creative thinking, along with many different theories and approaches towards describing and measuring these concepts. However, despite the significant number of studies conducted in the area of creative thinking, there has been little research into the integration of creative thinking and ICT. Various researchers have concluded that the principles of, and encouragement in, creative thinking can be applied to any learning activity (Nelson, 2005; Reid & Petocz, 2004; Renzulli, 2002a; Runco & Chand, 1995). This paper describes how ICT can be used to encourage creative thinking in a tertiary learning environment.

What is creative thinking in a tertiary learning environment?

A widely accepted definition of creative thinking describes it as a process leading to the production of a result, or a concept, that is unique and usable (Aldous, 2005). This particular definition incorporates the common themes found within a number of pre-existing theories of creativity; 'effective novelty' and the requirement for the end-product to be 'original and useful' appear to be of most importance. The two essential processes, which occur during the act of creative thinking, include the cognitive process (what we know), and the non-cognitive one (what we feel). Hence, the thinker's emotional state is intrinsically linked to the effectiveness of creative thinking. This conclusion, reached through research conducted into Neural Networks theory, puts forward the idea that creativity is "relative to the originator of the novel production" (Aldous, 2005, p. 45). This notion forms the basis for investigating the process of creative thought in an educational context.

Creativity can be defined as a combination of thinking and innovation that is, a notion of different intelligences working together. This is accomplished by using a combination of 'seeing, thinking and innovating'. The investigation by Wheeler Waite, and Bromfield (2002), which built upon the previous work of Boden (2001), investigated the notion of surprise, and described creative thinking as an ability to discover new ideas "that are surprising yet intelligible". Hence, the process of implementation of creative thinking in the learning environment is a dichotomy between divergent and convergent thinking practices (Wheeler et al., 2002). As a result, the aim of creating unique or novel ideas can be best served by an approach involving the development of an array of solutions to a problem based on logical (cognitive) thought processes, without discounting the emerging, initially illogical or non-cognitive, ideas and concepts.

The concept of 'novelty of thought' is an alternative way to describe creativity and the differences between divergent thinking (generating multiple solutions to a problem), and convergent thinking

(generating one idea to solve a problem). An important question, raised when considering the idea of novelty of thought, is who decides what is novel? (Nelson, 2005). This is a problem for educators trying to encourage or assess creative thought, as the assessment of creativity is dependent on the cultural or experiential background of the person who is assessing it. This is emphasised in recognition of a 'creative achievement', which may include social recognition, or facilitator and/or peer review. Another aspect of creative thinking, which is not necessarily product or result-driven, is the concept of 'trait creativity'; here, underlying creative thought processes may not result in a creative outcome (Nelson, 2005). In an educational context, where creative outcomes are expected, 'creative achievement' appears to be more applicable.

There is a well-established link between creativity and people who are considered to be 'gifted'. A creative thinker is someone who is recognised for creative achievements, or someone who can generate many unique and usable ideas. Hence, the recognition comes from educational institutions and other organisations that identify gifted students (Renzulli, 2002a). This supports the concept of 'creative achievement' that can be contextually recognised by teachers or peers.

Some factors that foster creative thinking have been investigated more extensively, or are seen as more important, than others. For example, much of the research discussed in the above paragraphs examined the process of producing a novel idea, whereas in some instances it may be more pertinent to investigate the process of evaluating creative ideas (Groborz & Neçka, 2003). A person who thinks creatively and generates a large number of solutions, also tends to have the capacity to evaluate and dissect these ideas. A creative person can generate solutions, as well as judge which of those solutions merit further investigation. This is supported by studies that tested cognitive control and evaluative aspects of creative thinking. Those studies concluded that, in some instances, effective cognitive control allows for a more accurate evaluation of other people's ideas (Groborz & Neçka, 2003). This highlights the importance of encouraging not only the generation of multiple unique ideas, but also the ability to effectively evaluate ideas and determine their usability.

Creativity incorporates two different types of knowledge: declarative and procedural. Declarative knowledge can facilitate creative thinking by providing factual information, and procedural knowledge can assist with developing strategies to explore and evaluate ideas (Brophy, 1998; Sternberg, 2003). Several psychological studies into creativity suggest that creative thinking is linked to knowledge, motivation, problem finding, ideation, and evaluation (Collins & Amabile, 1999; Nelson, 2005; Runco & Chand, 1995); hence, a person's ability to define a problem is affected by the person's existing knowledge. Figure 1 illustrates the relationships between those factors in a two-tier model of creative thinking. The first tier represents a skill set: problem solving represents the ability to define a problem; ideation symbolises the ability to generate multiple unique ideas quickly; and, evaluation represents the ability to critically analyse the ideas. The second tier represents the knowledge base: procedural (the knowledge of how to do things), and declarative (the retained factual information). In addition, the model includes two types of motivation: intrinsic (personal goals), and extrinsic (external pressures such as incentives or contingencies). The links between the various factors describe the inter-relationships in terms of a multi-directional flow for example, the ability to find a problem can lead to the generation of ideas (ideation) and, in turn, these new ideas can prompt a search for further problems (Runco & Chand, 1995).

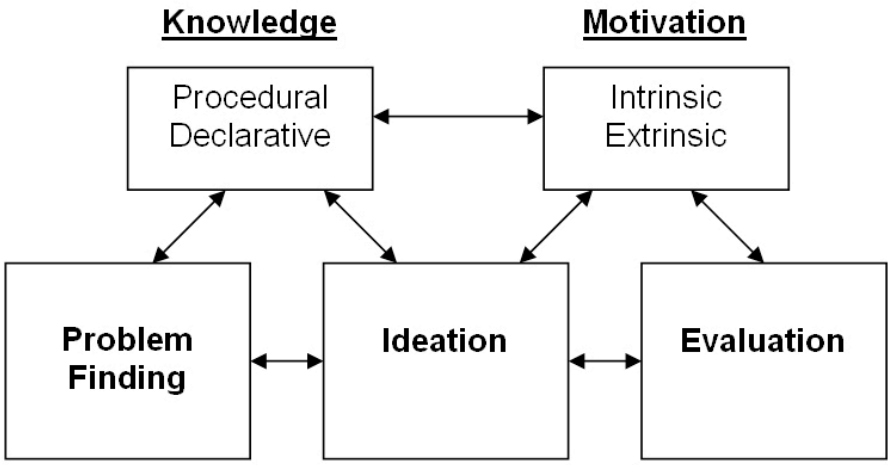

Figure 1: Two tier model of creative thinking
(Runco & Chand, 1995, p. 245)

Creative thinking is hard to define, because it is difficult to determine what is creative. Is it a person, a characteristic, an idea, or a product? This question can be addressed by looking at the factors that affect educators (Reid & Petocz, 2004). Investigation of the 'domains of learning and creativity' can highlight the perceptions of creativity across different disciplines. What is seen as creative in one discipline, might not be viewed likewise in another. Creativity is a 'social construct': people define it based on their own surroundings, and they share it with people of similar cultures and experiences. Reid and Petocz (2004) concluded that creative thinking in relation to education is seen as a "component of the environment". They linked theories of creative thinking to established educational hypotheses such as the Structure of the Observed Learning Outcome, also known as the SOLO taxonomy (Biggs, 1999), as an example. This taxonomy describes the importance of students incorporating several different elements to generate a unique concept, and assists in measuring the depth of thought that has been used to solve a problem. Linking the creative thinking theories with established educational 'learner' theories presents a strong argument for addressing a holistic approach to encouraging creativity in the classroom. Reid and Petocz (2004) further stressed the importance of developing a classroom environment that is conducive to encouraging creative thought.

ICT and creative thinking

There has been a substantial amount of research into encouraging creative thinking in the learning environment; connections were made also between creative thinking and educational, or 'learner', theories. These can assist teachers in developing ICT-inclusive strategies to encourage their learners to think creatively. This section provides an overview of some developments in this field.

Blogs

A weblog (blog) is a website that allows the user to post time-stamped diary entries. These entries (posts) can be sorted into categories, and made available to other users to view and make comments. Blogs offer a great promise in addressing one of the major hurdles in developing creative thought processes: the constraints of the 'norms' of traditional educational systems. According to Vint (2005), it is possible to address those constraints by 'unlearning' the existing organisational rigidities and generalised prescribed curriculum. Hence, teachers need to create an environment that supports and fosters creative thought. Well-designed activities and assignments, thought provoking content, and continual positive feedback can assist in generating an environment conducive to creative thought. One such possibility is the implementation of an experience diary in the form of a blog for students. Such a diary allows students to collect all of their experiences and draw upon them to generate new ways of looking at new situations; and, breaking old patterns can help students analyse new situations. Thus, blogs support the development of creative thinking through engagement in collaborative work, and development of communication skills. In addition, blogs are easy to use and portable; they facilitate collaboration between different learner communities; and, they enable the upload of images and video (Duffy & Bruns, 2006).

Students need to be aware of 'where they are headed' and have the freedom to explore their ideas within the learning environment (Reid & Petocz, 2004). Especially in the case of design-based subjects, students' appreciation of the design process as a 'personal engagement' assists with making them aware of their own learning processes. A blog can help students in critiquing their learning by looking at a historical record of what they have learnt and how they learnt it (Duffy & Bruns, 2006). A blog can be a valuable tool for research students and their supervisors as it combines geographical flexibility with the immediacy of feedback. It can serve as an online digital portfolio of student work that can be accessed anywhere and anytime by the involved parties. An example of such practice is illustrated in Figure 2. The research student in question is undertaking a Masters degree in education and is being supervised by two supervisors from different locales. The blog allows communication between the student and the supervisors when meetings in person are difficult to arrange. In addition, the blog offers the benefit of date stamping communications, which can be easily reviewed by the student and contribute to the reflective learning process.

The learning environment fostered by the teacher plays an important role in encouraging students to think creatively. Elements that assist in this process include: presentation of interesting and contemporary information, assessment of student's commitment to the task at hand, and feedback on specific learning task (Renzulli, 2005). Renzulli (2002b) outlines some programs designed for 'gifted' education that are currently being researched and adapted for general practice. These include a focus on the ideas developed, as opposed to the skill development; concentrating on themes, as opposed to specialised subjects; developing student talent portfolios; using performance assessment, as opposed to product assessment; grouping students with mixed abilities; and, focusing on the application of knowledge, instead of the

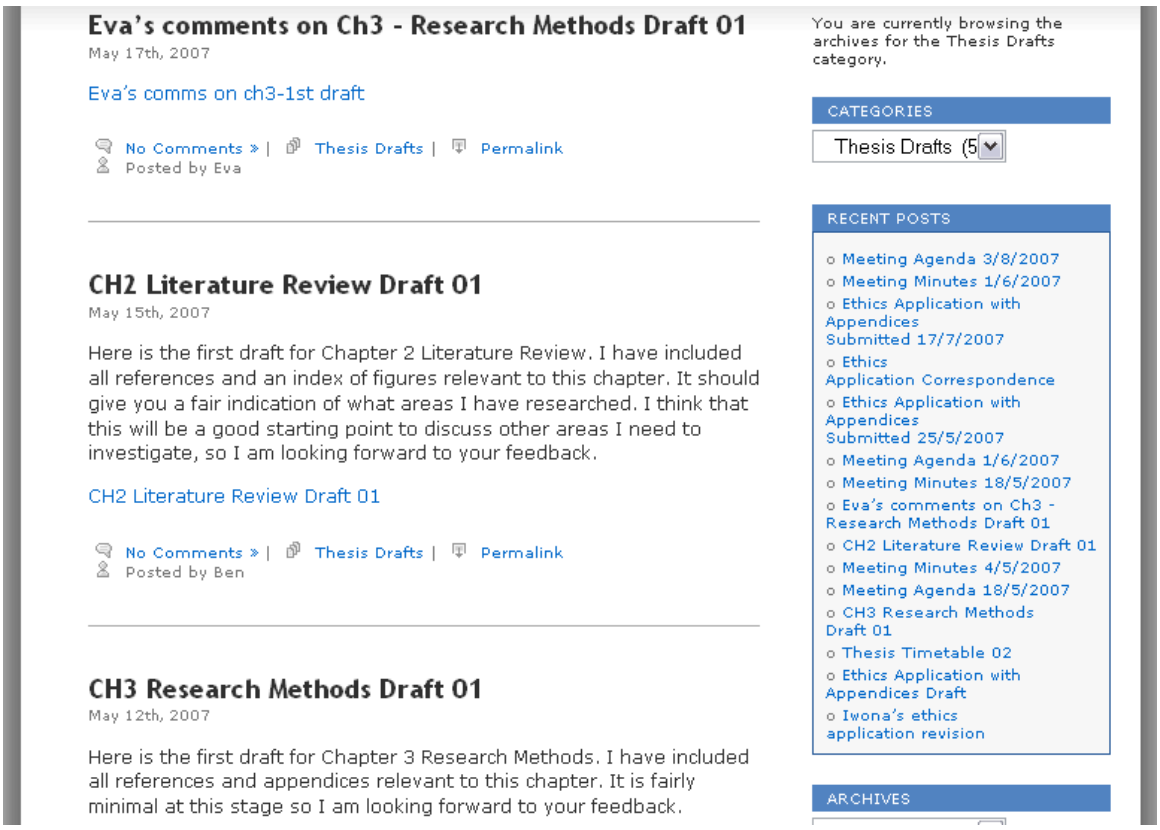

Figure 2: Example of a blog

traditional completion of exercises and knowledge transfer. These strategies aim at giving students a wide range of opportunities to explore and enrich ideas, and prompting them to follow up these ideas with other students. Blogs allow for the delivery of theme-based discussion, and provide an excellent way for teachers and learners to analyse the journey of obtaining knowledge. Moreover, incorporating multiple interconnected blogs can generate communities of learners and enable collaborative exploration and development of creative ideas (O'Connell, 2006).

Wikis

A wiki is a collection of web pages that, unlike traditional blogs, are collaborative in nature. Wikis allow the users to add and edit content submitted by other participants. The name 'wiki', derived from the Hawaiian language, means 'fast'. True to their name, wikis grow fast, can expand infinitely, and enable many users to contribute, edit and moderate content (Duffy & Bruns, 2006). Moreover, they allow students to generate ideas collaboratively through a facility to evaluate and edit entries; this is a classic example of the two-tier tree of creativity at work (Runco, 1995).

One of the key issues concerning creativity is the ability to explore multiple ideas quickly. A wiki allows a learner to quickly post an idea and let other people comment on it. Unlike blogs, that are usually maintained by a single author and thus generate longer and more detailed entries, wikis promote the generation of succinct ideas by multiple users. They allow for a flexible form of discussion and complement collaborative evaluation (Read, 2005). In addition, wikis offer the opportunity to broaden the geography of participants in brainstorming situations. For example, two universities on the opposite sides of the Earth can contribute ideas on a topic with the benefit of an ongoing and up-to-date documentation of the process.

Social networks

Social network websites are websites that allow people from all over the world to communicate and collaborate in a virtual environment. Social network sites such as *MySpace* and *Facebook* allow people to share ideas and information within a larger online community. The user can search using filters to find other people who have a presence within the community. These online social networks are an excellent environment for developing and sharing ideas and promoting creativity. In an educational context, these

systems can encourage creative thinking by challenging students' assumptions, building on the ideas of others (not limited to local learners) through online brainstorming, and participating in other group activities (O'Connell, 2006).

Social networks allow learners to be exposed to people who come from different cultural and educational backgrounds; this encourages the generation of new ideas. In an educational setting, students often work in teams of 'friends' and people who share similar ideas, which limit the number and 'freshness' of ideas that can be generated. This problem can be alleviated by assigning students to teams of varying analytical and creative styles to discourage the familiar path to a solution. Social networks can assist with creating new learning communities to broaden the pool of creativity and inspire creative thinking. Whitton (2004) identified four main factors that influence the environment conducive to creative thinking:

1. The "educational background" of the person, which may have included existing programs that were designed to encourage creative thought. People who have had experiences in learning to develop creative thought processes are more likely to be open to further interpretations and systems to develop creative thought.
2. The "historical place" where the creative result is developed will affect the process of creativity. When a creative process is conducted at a certain point in time, factors such as politics, educational systems and societal trends can encourage or impede the creative process.
3. The "societal framework" in which the creator belongs, can influence the creative process by learned boundaries and practices restricting or encouraging creative thought within that society.
4. The "cultural background" can affect the perception of whether someone is 'creative' or not.

These elements affect individual students differently, and many permutations can exist within a single cohort of students; this poses a problem for teachers trying to integrate creative thinking activities or assessment in their teaching practice. Hence, teachers should endeavour to learn as much as they can about their students' previous experiences and practices within the discipline. Social networks and blogs can be employed to give students the opportunity to express their creativity. This can assist teachers in helping students to develop an understanding of their own creative processes. Consequently, teachers should be encouraged to look at three main elements that can lead to a creative outcome including: "implementing", or creating something that is unique; "complementing", or taking two existing results; and, combining them and "supplementing" that is, using a combination of products to create a third product or concept (Whitton, 2004). These three elements can be transferred to a community of learners within an online social network allowing for diverse input into the development of creative ideas. In addition, students should be encouraged to evaluate each decision they make, look at each idea they develop, and decide to either discard it, reuse it, or exhibit (use) it. Figure 3 below helps to illustrate this process.

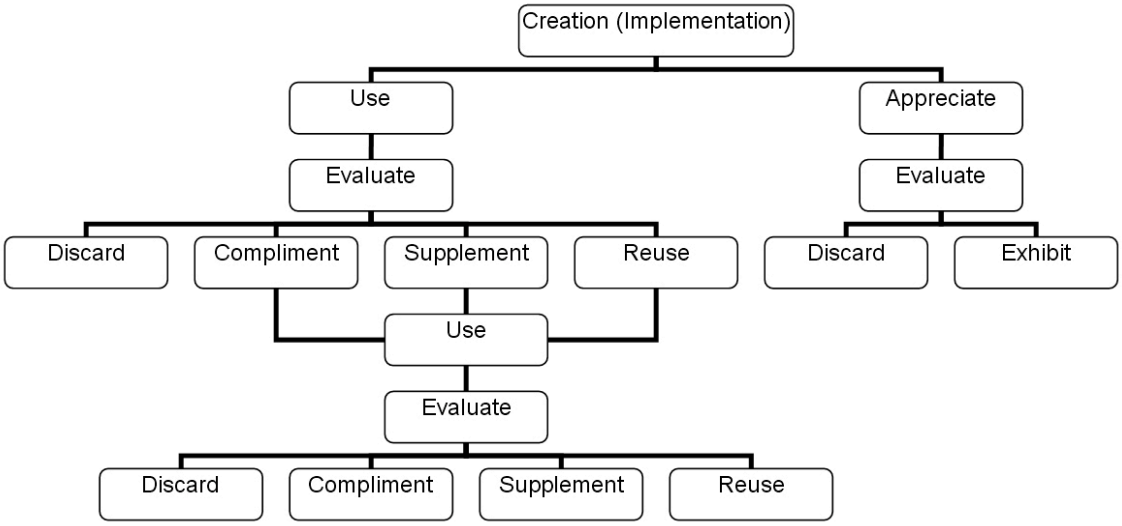

Figure 3: Tree of creativity (Whitton, 2004, p. 22)

It is recommended that teachers train their students to use the "Tree of Creativity" in order to become proficient in analysing and evaluating their unique concepts and products (Whitton, 2004). This can involve integrating activities such as group brainstorming in an online environment, and setting tasks that require students to develop a list of solutions to a given problem.

Virtual learning environments

Virtual environments do not offer the hands-on experience, or substance, of a real environment. Substance and real-life experience are crucial factors in many disciplines and, in those disciplines simulations and virtual environments should always be used in collaboration with real-world practice. However, in many areas simulated environments offer a unique opportunity for learners to develop their creative thinking skills. A virtual field trip, for instance, can assist students in learning how to solve real world problems more effectively. A virtual space is safe from the physical hazards of the real world and therefore allows students to try unique ideas without the risk of injury (Peat & Taylor, 2005). This supports the trend to generate learning environments where students can experiment with new ideas freely and in collaboration with other online participants.

One of the most publicised virtual worlds is *Second Life*. It is a three-dimensional (3D) world where people can interact through their online 3D identity (avatar), communicate with others, participate in numerous virtual activities, and create content for the virtual 3D world. *Second Life* has the potential to offer learners unique opportunities to develop their creative thinking skills. It allows students to collaborate without being restricted by time and place, and supports student-centred learning. In addition, the ability to integrate other technologies such as video, images, PowerPoint presentations, voice and sound, and 3D structures within *Second Life* allows an endless array of possibilities to share ideas and develop creativity (Prestridge, Dunn, & Lang, 2006).

Virtual environments attract small groups of people collaborating and then dispersing after a specific task or issue has been resolved. These 'on-the-go' learning communities are seen as effective from the point of view of the participants because of the immediacy with which an issue can be resolved (Anderson, Annand, & Wark, 2005). This could be problematic when trying to encourage creative thinking, as it contradicts the recognised theories that emphasise the need to thoroughly explore ideas and solutions.

Constraints and concerns

Teachers trying to incorporate ICT to encourage creative thinking in their students face many challenges; the constraints of convention and the 'prevailing norms' alone can hinder the students' ability to be 'creative'. This can manifest itself in many ways. Generally students' perception of creativity focuses on the end-result however, according to the literature, the end-result forms only part of the creative process (Cullingford, 2006). Often students tend to wait for inspiration, as if creativity was some 'external force', instead of working through the process of creative thinking (Cullingford, 2006). However, as discussed previously, a number of methods can be employed to help students understand their personal creative thinking processes, and lead to the development of better creative thinking practices. Interactions in online group activities involving peers from all over the world appear to be particularly helpful in turning around initial perceptions of participating students.

Learned habits can affect students' perceptions of creativity, and the development of habits with age is a predominant theme. Ageing is said to narrow down people's choices of food, social circles, and activities. With age, people tend to develop ingrained patterns and routines that are difficult to break. This is especially evident when a teacher tries to encourage students to think differently. Once again, helping students to understand their own thinking 'habits' can assist in breaking those habits and open up the possibility to think creatively. In traditional education systems, the reliance on 'regurgitation of facts' can seriously impede attempts to persuade students to explore new ideas (Vint, 2005). However, it might be possible to encourage students to critically analyse those regurgitated facts in collaboration with online peers, and develop strategies to look at preconceptions, or pre-learnt knowledge, in a new light.

Students often find it difficult to maintain balance between the design and technology aspects of the creative learning process. Technology can become an obstacle to learning, especially when a student is first exposed to a new and/or novel technology. The student may become too focused on the technology and neglect the need for developing creative ideas through exercising visual abilities, for example. Training students to understand that creativity drives technology, and not the other way around, can 'save' students from being blinded by the technological aspects of a task at the expense of good creative design principles (Mohler, 2001).

There is a general consensus that creativity can be encouraged if there is a direct link between the clarity of instruction, the student's motivation, and the outcomes (Reid & Petocz, 2004; Smith, 2003). Problems arise if the student's perception of what is expected by the teacher does not compliment the student's motivation. This can be alleviated by using 'off-task peer discussion'. Online social networks, with which

the student is already familiar, such as *MySpace,* can assist in complimenting the task at hand with the student's motivations. According to Smith (2003), students construct their own learning more efficiently when interacting with their peers. In addition, a safe exploratory environment where students can elaborate, synthesise, generate, share and combine ideas is of primary importance. This can help to break down the preconceived notions of: 'is this what the teacher wants?'

It is important for teachers to assess the validity of an ICT product that they intend to use to encourage creative thinking. Many products available may not necessarily meet the needs of the teachers and learners. People need readily accessible information to assist in the process of creative thought. Computer software can help to disseminate knowledge and knowledge integration, which can lead to the generation of new ideas. Greene (2002) investigated the use of software by the general public and outlined seven key factors that can assist educating the public in utilising the software and thinking creatively. The seven key factors are defined as support for:

1. "Pain-free exploration" by rewarding exploration to encourage the user to delve further into the software structure;
2. "Engagement with content to promote active learning and discovery" achieved by encouraging the users to explore without explicitly telling them what to do;
3. "Search, retrieval, and classification" tools that allow the users to comprehend and easily access the required information;
4. Collaboration allowing users to share ideas and develop new understandings;
5. Allowing users to save or undo their work at any stage of a task, giving users the freedom to explore the full potential of an idea and enabling them to keep a record of it;
6. Encouraging "instructive wrong answers" by allowing users to develop entirely new strategies to complete a task or generate an idea;
7. And, finally, easy access to critical functions – crucial to avoiding user frustration.

As the implementation of ICT in educational institutions increases, it is important to keep in mind that ICT needs to be used as a tool that can provide learners with the opportunity to break old learning habits as a way to manifest creative expression, and as a facilitator in constructing learning experiences.

Conclusion

Creative thinking in a learning environment encompasses critical analysis of problem solving, development of new ideas, and the implementation of those ideas; the end-result of this process should be a usable product. Consequently, learners who have learned the skills to generate creative concepts that are unique and usable have the potential to be more successful in the workforce. Hence, creativity is skill sought after by prospective employers.

Encouraging creativity in a learning process can be achieved by: creating an environment that 'sparks creativity', connecting experiences to new ideas, providing new ways of looking at the surrounding world, critically analysing pre-existing knowledge, designing multiple pathways for one goal and, facilitating a deeper understanding of an issue. Although strategies aimed at encouraging creative thought in students vary, they tend to include one dominant theme: the need to develop an environment where students can explore, rationalise, combine, and share ideas. The development of such an environment can benefit greatly from the deployment of ICT, and in particular online social networks, blogs, wikis, and virtual worlds. These technologies can enhance learning through online group work using wikis, or creating portfolios of experiences using blogs, just to name a few.

Second Life and other virtual world technologies seem to have a particular role to play in supporting creative thinking. These technologies have the potential to particularly impact on the way students develop their analytical, communication, and literacy skills (Levine, 2007). The preference for using familiar everyday technologies would suggest that students are more likely to choose to participate in a virtual environment activity than listen to a traditional lecture, or simply read a textbook.

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