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Student Teachers' Perception of Information Technology and Creativity

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Information technology (IT) and creativity are acknowledged as important components of teacher education. Discussions have been focused on how IT should be integrated into teaching and learning (see e.g., Teo, 1997), and how creativity should be enhanced (see e.g., Goh, 1997). Less attention is given to how IT can help promote creativity. In this paper we investigate student teachers' perception of the use of IT for cultivating creativity. First, we examine the concept of IT and creativity in education. Then we present student teachers' views on the use of IT to promote creativity. Lastly, we derive implications of student teachers' conceptions of IT and creativity for improving teacher educational curriculum.

Information technology has become a buzzword in almost every sector of life. While a consensual and precise definition of IT is lacking, we denote it to be computer-based technology deployed for communicating, storing, and processing information, idea, and concept. IT differs from "multimedia" in the sense that the latter is relatively more encompassing as it includes, in addition to computer-mediated communication (CMC) tools, the conventional media like printed books, television, cassette recorder, etc (Reimann-Rothmeier & Mandl, 1997). IT comprises a broad range of computer hardware and software applications, like word processors, databases, spreadsheets, semantic networking programs, expert systems, hypermedia authoring tools, microworlds, teleconferencing, etc. Presumably, learning with IT can engage its users in a variety of critical, creative, and complex thinking skills, which are essential for evaluating, analyzing, connecting, and synthesizing information, for analogizing, visualizing, and extending ideas, and for designing, planning, problem-solving, and decision making (Jonassen, 1996). In short, IT can serve as a communication facilitator, a rich informational resource, a presentation gadget, a designing and manufacturing tool, an organizing and managing device, and a problem-solving prop. Given these versatile functions, the application domains of IT are wide-ranging, from mundane everyday activities (e.g., playing computer games; reserving air-ticket with the personal computer at home) to consequential scientific research and development (e.g., artificial intelligence technologies in the service of student modeling; human-computer-interaction research on augmenting the capacities of IT per se). Of particular importance are the implications of IT to educational reform which is deemed inevitable, considering the societal transformations instigated by the rapid advent of computer technologies. Such a reform entails changes in instructional, curricular, administrative, and research aspects (Fetterman, 1998; Lesgold, 1993). Definitions of creativity vary from individual competence to favourable socio-cultural environments. Because creativity is studied extensively across disciplines and cultures, it is incomprehensive to describe it using several sentences. Despite the difficulty in arriving at a consensual definition of creativity, recent studies admit the importance of understanding the concept of creativity by taking individual, societal and cultural factors into account. Individuals' creative potentials can hardly flourish when they do not receive ample socio-cultural support. The modern conception of creativity acknowledges creativity as potentials that all individuals' possess. Every individual, common person or expert, can be creative in one or more disciplines (Gardner, 1983, 1993). Differences between individuals' creativity lie in their styles of creativity and the complexity of their creative performances. Every individual possesses his/her conception of creativity (Sternberg 1985). To be creative, an individual has to acquire knowledge and skills, and be persistent and motivated to complete a task (Amabile 1983a, b). Creative performances of an individual do not happen in a vacuum. They are products of the individual's efforts, commitment and talents in his/her areas of

specialization supported by people and resources around him/her. Social acceptance determines whether a creative idea, act or performance can be passed on to the next generations. In order to convince others of their creativeness, creative individuals should acquire communicative skills and leadership qualities (Simonton 1988).

Cultivating creativity goes beyond structural changes in the curriculum, assessment, and pedagogical infrastructures. It involves a series of cultural and psychological transformations in conceptualization as well as practical implementations of theories and techniques of creativity. The transformations challenge a fundamental issue, that is, about how creativity education can assimilate strengths and merits of the contemporary educational system. Acknowledging the process of learning such as acquiring expertise, skills, and knowledge of the fields, creativity education starts with cultivating students' interests and desires to share their independent ideas that can be new and original to them. Students should be given the opportunity to develop their skills in improving, searching connections, and discovering combinations among pieces of information. Their confidence and motivation in attempting new tasks using unconventional strategies should be enhanced. Creativity education encourages not only exploratory behaviours and attitudes, but also acknowledges small and incremental improvements on existing products/ideas, combinations and connections between concepts, as well as new discoveries. In summary, the major challenge of creativity education is on how to prepare favourable conditions that can uncover and foster creative potentials. In line with this viewpoint, educators and researchers should search for suitable frameworks and strategies that can optimise creative processes in teaching and learning.

In accord with the epistemological assumptions of the constructivist learning theory, which has informed a body of educational research and inspired a diversity of innovative instructional designs in the recent decade (see e.g., Steffe & Gale, 1995), learning is inherently active, reflective, self-regulated, social, collaborative, situated, and problem-oriented in nature (Weinert, 1996). Computer technologies are demonstrated to be effective in enhancing this form of learning (see e.g., Vosniadou et al., 1996). Among others, the model of computer-supported collaborative learning/work (CSCL/W) is viewed as particularly promising (see e.g., Dillenbourg, *in press*; McGrath & Hollingshead, 1994). Email, Internet Relay Chat (IRC), and videoconferencing are but some of the common means employed for sharing ideas and solving problems collaboratively, and the Internet furnishes an extensive database from which users can extract useful information. Moreover, the CMC technology that can transcend geographical and temporal barriers expands the scope of partnership with which one can work and renders learning activities flexible and self-regulating. Taken together, computers as cognitive tools can support, guide, and extend the thinking processes of their users. These tools provide structural, logical, causal, systemic, or visuo-spatial formalisms that scaffold different kinds of thinking and knowledge representation (Jonassen & Carr, 1998). Furthermore, learning with IT is intrinsically motivating because of its capabilities of furnishing an authentic or realistic learning environment, of presenting dynamic images, of empowering learners with sense of ownership and control, and of generating immediate feedback. Consequently, learning with IT presumably boosts learners' interest in the subject matter concerned, self-confidence, self-awareness, and higher-level thinking skills.

It is envisaged that classroom computerization will be in full swing in the coming decade. The application of the newly invented computer technologies such as networking in education, however, is still at its nascent stage. The compelling concern is whether teachers who have been brought up under a traditional educational system are well-prepared for the imminent revolutionary changes. Given that their attitudes towards and expertise in IT will have significant impact on children, it is intriguing to know how student teachers perceive IT: Is IT a tool for enhancing their teaching efficiency, a device for promoting their pupils' higher-order cognition like creative thinking, and/or a challenge to their customary role as a knowledge dispenser? Can IT be employed as a source of creativity or an integrated medium

for creative performances? We will answer these questions by interpreting student teachers' ideas on how IT can promote creative thinking in Singapore classrooms. We formulated five research questions:

- 1) Do student teachers explicitly acknowledge that IT can enhance creativity?
- 2) How novel are student teachers' ideas in relation to the use of IT for enhancing creativity?
- 3) Which domains do student teachers' ideas concerning the use of IT for enhancing creativity?
- 4) Which functions of IT for promoting creativity do student teachers perceive?
- 5) Which type of knowledge of IT and creativity do student teachers have?

Method

Subjects

140 student teachers of the first year Bachelor degree program participated in a brainstorming session. Their average age was 20.12 years. They were students of two introductory educational modules related to educational and developmental psychology and instructional technology.

Procedures

The student teachers were requested to generate ideas related to the question: How can IT help promote creative thinking in Singapore classrooms? The brainstorming took place in a hall. The student teachers were divided into groups consisting of 4 to 6 persons. In the first 10 minutes they wrote down ideas individually on yellow cards (first brainstorming). Then they shared the ideas with group members (for about 10 minutes). They were told not to criticise or evaluate the ideas. To encourage participation and avoid embarrassment, all cards were placed on the desk and were mixed randomly in such a way that group members could not identify and associate the ideas with the writers. After the sharing session, participants were given another five minutes to write down additional ideas individually using green cards (second brainstorming).

Analysis of data

Some ideas were classified as inappropriate, for example, some are only related to the conditions for using and promoting IT, and some are general claims or non-specific to IT. The qualitative data were coded as follows:

Research question 1: Does the respondent explicitly acknowledge that IT can enhance creativity? There were three possible responses, namely yes (Y), no (N), and not applicable (n.a.), referring to the statements given by the respondents which were vague, irrelevant or incomprehensible.

Research question 2: What is the degree of innovativeness of the ideas proposed by the respondents? There were three degrees, namely low (lo), medium (me) and high (hi).

Research question 3: To which domain can the ideas proposed by the respondents apply? There were eight categories:

- (a) Technological advancement (Tec, e.g. IT is used for improving the IT technology itself)
- (b) Artificial intelligence (AI, e.g. IT is used for modeling human intelligence)
- (c) Education-teaching (Ed-T, e.g. IT is used as a teaching tool)
- (d) Education-learning (Ed-L, e.g. IT is used as a learning medium)
- (e) Everyday utilities (Ev-Uti, e.g. IT is used for resolving social problem)

- (e) Work-related activities (Wk, e.g. IT is used for increasing productivity of a company)
- (f) Leisure activities (LeS, e.g. IT is used as a kind of entertainment such as computer games)
- (g) General (Gen, i.e. The context of application is not specified and the proposal can be applied in various domains, e.g. designing a webpage is applicable in educational and/or working setting or it can also be a kind of leisure activity).

Research question 4: Which function does IT serve in promoting creative thinking? There were eight categories:

- (a) Communication medium (Comm), including social interaction, information exchange, and tutor-tutee discussion
- (b) Database (Dbase) e.g. construction of a common data-pool
- (c) Resource (Res), from which information is extracted
- (d) Demonstration tool (Demo) for presentation, simulation, and modeling
- (e) Design tool (Dsg)
- (f) Problem-solving and learning tool (Ps-L)
- (g) Evaluation tool (Eval)
- (h) Motivation agent (Mot)

Research question 5: Which kind of knowledge does the respondent have regarding the application of IT? There were two categories, namely declarative knowledge (Dec, knowing what) and Procedural knowledge (Proc, knowing how).

Results

Student teachers generated a total of 539 ideas of which 312 (57.9%) were from the first brainstorming session and 227 (42.1%) from the second brainstorming session. Nearly sixty per cent of their ideas (311, 57.7%) acknowledged the capacity of IT as a means to enhance creativity (research question 1). Less than one per cent (4, 0.7%) of the ideas denied IT capacity in enhancing creativity. Forty percent (224, 41.6%) of the items were not relevant to the research question. We analysed the 311 ideas that positively acknowledged the use of IT for enhancing creativity. All the ideas proposed by the respondents were of low innovative-ness (research question 2). Nearly all ideas presented by the respondents were declarative knowledge (310, 99.7%) and only one idea (0.3%) procedural knowledge (research question 5).

Most of the ideas were applied to educational sectors, accounting for almost 78% (Ed-T, 144, 46.3%; Ed-L, 97, 31.2%) of the total number. Other domains constituted 20% of the respondents' ideas: General application of IT (Gen, 50, 16.1%), leisure activities (LeS, 6, 1.9%), everyday utility (Ev-Uti, 6, 1.9%), artificial intelligence (AI, 4, 1.3%), work related activities (Wk, 2, 0.6%), and technical advancement (Tec, 2, 0.6%) (research question 3). We intended to find out whether there were similar distributions of ideas generated before and after group sharing. We denote before group sharing as the first (173 ideas) and after group sharing as the second (138 ideas) brainstorming sessions. In the second brainstorming session, there was an increase in the percentage of ideas for education-learning domain (Ed-L, +7.9%) (see Figure 1). The increase of percentage in the education-learning domain confirmed the group consensus on the importance of IT in learning.

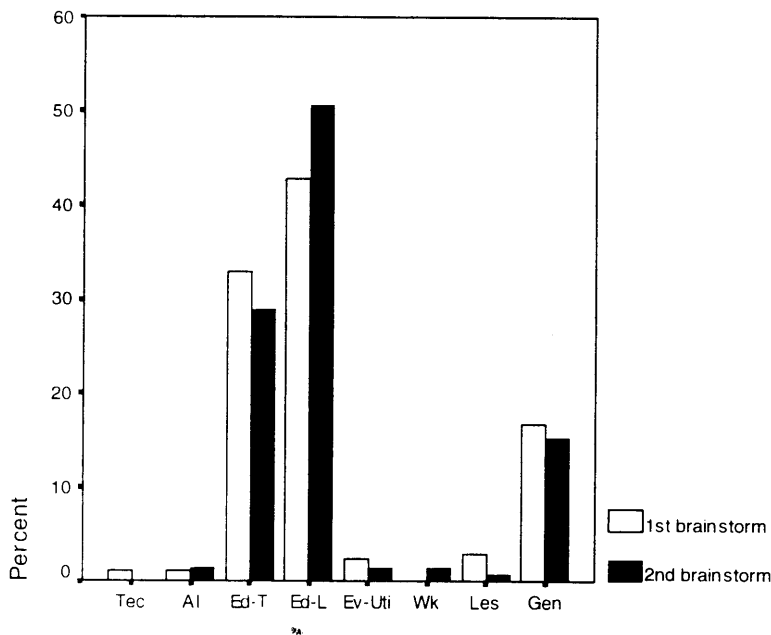


Figure 1: IT and creativity -- application domain

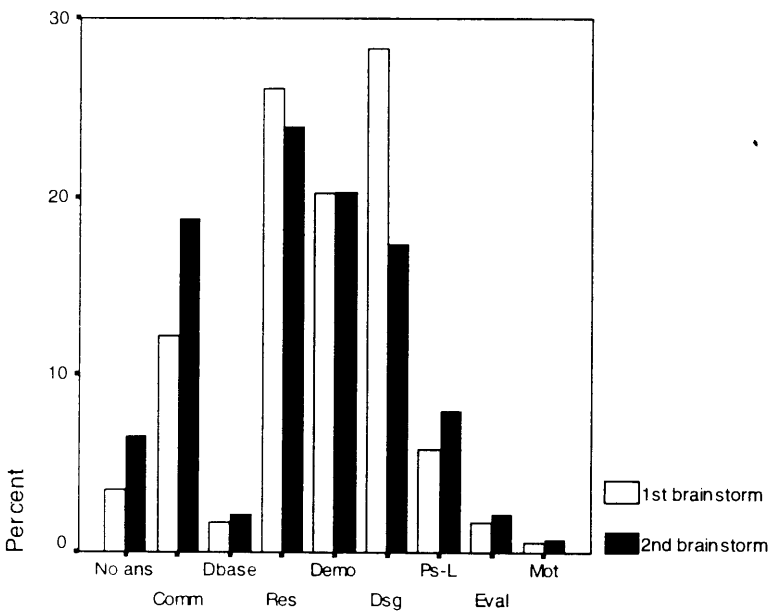


Figure 2: IT and creativity -- functional analysis

IT was perceived as resources (Res, 78, 25.1%), design tools (Dsg, 73, 23.5%), demonstration tools (Demo, 63, 20.3%), communication tools (Comm, 47, 15.1%), problem solving and learning tool (Ps-L, 21, 6.8%), evaluation tool (Eval, 6, 1.9%) and database (Dbase, 6, 1.9%) (research question 4). We compared the distributions of ideas generated in the first and

second brainstorming sessions. In the second brainstorming session, there was an increase in the percentage of ideas for IT as communicative tools (Comm, +6.7%) and problem solving and learning tools (+2.2%), respectively. There was a decrease in the percentage of ideas for IT as resources of knowledge (Res, -2.1%) and design tools (Dsg, -10.9%), respectively (see Figure 2). Interactive modes of the use of IT were highlighted after the group sharing session.

Discussion

In order to use IT to enhance creativity, teachers have to be convinced that IT can offer the capacity to induce favourable working environment and can be significant in cultivating creative performances. The belief in the significance of IT for generating creative performances is a prerequisite for infusing IT into creative learning and teaching. From the responses, we realise that half of the ideas were vague or irrelevant as if the student teachers did not endorse completely the potentials of using IT for promoting creativity. Given the vague and irrelevant information, it can be inferred that most of the student teachers only theoretically knew some technical terms of IT, but had limited practical experience of adopting IT. The student teachers recognised the use of IT in the educational domain (see Figure 1). They perceived IT mainly as resources of knowledge, design tools, communication tools, and demonstration tools for presentation, simulation and modelling. Rarely was IT accepted as tools for challenging higher order thinking such as problem solving and evaluative thinking. Less likely was IT regarded as a source of motivation (see Figure 2). We propose that the group sharing might have the effect of focusing the participants' attention on a specific domain of the application of IT that is more relevant to them.

Using IT for creative teaching, learning, and administration challenges a person's computer technological skills and ways to integrate these skills into content delivery. A teacher has to be professional in his/her content areas as well as in applying computer technology for educational purposes. Unfortunately, it seems that most of the student teachers' knowledge of IT is declarative in nature. According to Anderson (1985), declarative knowledge ("knowing that") is essentially factual knowledge which can be stated and made explicitly (e.g. to name different parts of a car or to explain how different sub-systems of a car work together to produce the movement of the engine). Procedural knowledge ("knowing how") is concerned with how to do something which is often implicit and not easily verbalised by the performer (e.g. driving a car; diagnosing malfunctions in a car). IT competencies have to be defined in terms of declarative knowledge and procedural knowledge of which the latter is more important for promoting creativity. Nonetheless, procedural knowledge is somehow difficult to be detected by using paper-and-pen tests, but it is likely to be demonstrated in practice.

Before the student teachers participated in the brainstorming session, the first author mentioned the objectives and programs of the Singapore IT Master Plan, but did not explicitly define IT. The student teachers may refer IT to both computer-based technology and conventional instructional technological tools such as overhead projector and transparencies. A post-hoc interview with a colleague teaching instructional science confirmed this speculation. According to the same colleague, the student teachers perceived computer positively as a means to get attention and gain learning interests from the pupils/students. They, however, did not seem to have the competence or confidence to integrate the use of IT in the content teaching, a fact derived from the evaluations of their assignments. Our findings were consistent with the results of various studies showing that student teachers use IT in their school-based practice only to a limited extent although most of them harbour high expectations regarding the contributions of IT to education (Baran & Bruillard, 1994; Robertson, 1996).

During their entire teacher educational course, this group of students attended one compulsory and/or an optional course about instructional technology of which only several hours were allocated to the use of IT (computer-based technology) in the classroom. A number of respondents mentioned that "powerpoint" could be used as a presentation tool.

However, other than "powerpoint" they seemed to know hardly any other IT software. This could be why the respondents could only vaguely describe the IT functions. The student teachers probably knew the technical terms but had insufficient knowledge about the actual applications of IT. There could also be the lack of hands-on experience in using IT in their jobs or studies. Lack of IT skills and expertise could be another reason why the student teachers presented low innovative ideas.

Indeed, it is a considerable demand on practising teachers to incorporate IT into classroom teaching. They are expected to be not only expert at the content knowledge they teach, but also skilful in manipulating computer technologies to meet different educational purposes. More important, it is far from enough to teach IT concepts in abstract (e.g., by lecturing). With the use of the conventional chalk-and-talk approach, what students can acquire is most likely to be declarative knowledge, but not procedural knowledge essential for operating IT as a pedagogical tool. While the conceptual understanding of basic principles underlying the design of software applications are important, becoming a competent user of IT is better achieved through learning-by-doing approach. Apart from mastering the prerequisite skills of operating IT applications, a proficient teacher should know how to select an appropriate application for a specific target group learning a particular subject domain in a specific context. While mastering programming technique is not a must for being an IT user, some basic knowledge of file management and data handling may be helpful.

Future research should examine the relation between the student teachers' knowledge and skills in using IT for creative teaching and learning and their practical experiences in these areas. Furthermore, teacher training in IT is crucial not only for student teachers but also their experienced counterparts, given that the latter often play a supervisory role in teacher education. Indeed, IT is evolving at a breath-taking pace and therefore it is difficult for users to keep abreast of its most updated development. Nonetheless, caution should be taken that we are not enslaved by computer technologies and should not use these cognitive tools mindlessly. As Clark (1983, 1994) consistently emphasises, educational technologies will have little impact on learning unless they are applied with appropriate instructional strategies. Admittedly, being a teacher in the contemporary information-explosion era is particularly challenging and demanding. Hence, it is necessary for educational researchers and practitioners to constantly monitor and evaluate the use of IT in teaching and learning.

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