Pre-Service Teachers and the Web: Does Access to the Web Enhance Creative Thinking about Teaching?

Abstract: This study examined teacher creativity and its relationship with emerging technologies. Eight pre-service mathematics teachers of high and low creative skill were asked to generate creative ways of introducing specific topics to students. Each participant performed two tasks, one with a Web search tool, and one with related books. Sessions were observed, and post-task interviews conducted. In addition, browser log files were analyzed, and experts rated the ideas generated. Evaluation of this data provided that participants believed that the Web was an integral tool in the creative process, but did not demonstrate search techniques that reflected this, did not typically generate their ideas from the information resources provided, and did not achieve higher creativity scores when using the Web.

Introduction

Although creativity is considered by many to be an important characteristic of quality teaching, there is little research addressing the impact of emerging technologies on creativity in teachers. Currently, the most prominent technology in education is the Web, which may be evolving as a de facto component in the creative process. This study examined the relationship between Web search tools and individual creativity in pre-service teachers.

Background

Literature examining this specific relationship is sparse. Given this scarcity, three more broadly defined areas of scholarship guided the inquiry:

Teacher Creativity

Teacher quality is consistently linked to student achievement (Darling-Hammond, 1999). While various components comprise a quality teacher, Darling-Hammond listed teacher creativity as one trait that regularly demonstrates a positive relationship to student learning. Similarly, Esquivel (1995) noted, "teachers who have developed their own creative competencies, and implement specific creative methods and techniques in their classroom, are more effective in enhancing students' creative abilities than teachers who follow more traditional instruction approaches" (p. 185).

As such, the desire to promote classrooms that support creativity is well documented and often supported at the national level (Gunseli, 2006; Loveless, Burton, & Turvey, 2005; Park, Lee, Oliver, & Cramond, 2006; Williams, 2002). In the United States, the *New Commission on the Skills of the American Workforce* (National, 2006) provided several suggestions for educational reform. Among them are references to the need to foster creativity in students. The report noted, however, that it is not possible for students to graduate with theses desired skills "unless their teachers have the knowledge and skills we want our children to have" (p. 12); for example, creativity.

The notion of creativity in teachers manifests itself in two ways. First, teachers who are more flexible during classroom teaching are considered creative; Sawyer (2004) called this type of teaching "improvisational performance." Second, teachers can also be creative in the ways in which they prepare for classroom activities. Clements (1995) asserted that this requires that teachers "play with ideas" about how to teach.

Creativity

Scholarly definitions of creativity vary widely from one research study to another (Plucker, Beghetto, and Dow (2004). One particular difference is that between eminent (e.g. see Csikszentmihalyi, 1997), and everyday (e.g. see Ward et al., 1999) creativity. During this study, the latter was of interest, with the following definition:

> Creativity is the interaction among *aptitude, process, and environment* by which an individual or group produces a *perceptible product* that is both *novel and useful* as defined within a *social context* (Plucker et al., p. 90)

Theoretical frameworks that outline the creative process are many (e.g. see Amabile & Tighe, 1993; Bruner, 1962; Csikszentmihalyi, 1997; Osborn, 1953; Sternberg & Lubart, 1999; Wallas, 1926; Ward, Smith, & Finke, 1999). Most of the proposed stages and sub-processes can be encapsulated by the concepts of generation and exploration, and are iterative in nature. This study was particularly interested in how ideas are generated and explored, an activity that is often a precursor to the development or implementation of an actual product (Griffiths-Hemans & Grover, 2006). Finally, Goor and Sommerfeld (1975) provided that high-creativity and low-creativity individuals might actually use different creative processes.

Technology, Cognition, and Creativity

Pea (1985) defined *cognitive technologies* as "any medium that helps transcend the limitations of the mind" (p. 168). He supported the notion that technology use, specifically the computer, actually causes a reorganization of mental functioning and "becomes an indispensable instrument of mentality" (p. 175). Similarly, Solomon and Perkins (2005) proposed that technology and cognition could combine in three ways, resulting in the cognitive *effects with, of, and through* technology. Most relevant to this study was the *effects with* technology, where an intellectual partnership between technology and user, at the same time that one is using the technology, emerges.

Several characteristics of the Web make it a promising environment to enhance creativity. Its non-linear organizational scheme can support the serendipitous nature of creativity (Cropley, 2006). Its wealth of information provides a fertile ground to support various creativity sub-processes such as the retrieval of existing related ideas, searching for novel or desirable attributes in an idea, or associating or combining ideas (Ward et al., 1999). It can represent information in a variety of forms, facilitating the transformation of ideas from one form to another. And, given the benefits of collaboration in creative tasks (Csikszentmihali & Sawyer, 1995), several sources on the Web may represent a proxy for collaborative interaction.

Research on the role technology plays in creativity is modest. Most is business oriented, examining software that organizes the creative process (e.g., Klein, 2000) or the difference between computer-mediated and face-to-face collaborative brainstorming (e.g., Kerr & Murthy, 2004). In education, it is even less prevalent, mostly focused on student creativity (Jamieson-Proctor & Burnett, 2002; Howe, 1992; Michael, 2001; Shneiderman, 2002; and, Majid, Tan & Soh, 2003).

The dearth of scholarship that focuses on teacher creativity creates a need for studies such as this, given the importance of both creativity and technology in our society and schools (Florida, 2002; Friedman, 2005). At the same time, research needs to better reflect the current learning environment, where a great deal of inquiry is performed alone, using the Web. Finally, since Google is currently the dominant Web search tool (Sullivan, 2006), it is the centerpiece of this study.

Research Questions

1. Does access to Google during a creative task increase the creativity of ideas generated by pre-service teachers when compared to traditional sources of information?
    a. To what extent is Google used as an "indispensable instrument of mentality" during the creative task (Pea, 1985)?
    b. To what extent do pre-service teachers use search keywords during the task that facilitate the generation and exploration of ideas (Ward, Smith, & Finke. 1999)?
2. What process differences do high-creativity and low-creativity pre-service teachers demonstrate when using Google during a creative task related to teaching (Goor and Sommerfeld, 1975)?

Methods

This study utilized a mixed-methods design with pre-service mathematics teachers. The subjects were selected given their general interest in higher quality math teaching and an expected facility with the Web. The participants were recruited from a mathematics-teaching course. All members of the class were administered an alternative uses task (adapted from Guilford, 1967) where they were asked to list as many possible uses for a common house hold item. Divergent thinking tasks such as this have an established history of reliability (Plucker & Renzulli, 1999) and are often used to estimate the potential for creativity (Runco, Dow, & Smith, 2006). Four of the top scoring students, and four towards the lower end, were invited for the lab-based portion of the study.

Each participant generated two separate ideas for introducing topics (the Pythagorean Theorem and probability) to classes in their field. One task was undertaken with the support of Google, and the other with related books. Participants were observed during their tasks, and short interviews followed each task. Content analysis was performed on the log files generated by searches. Finally, the ideas generated by the participants were evaluated for

creativity using a subset of the *Creative Product Semantic Scale* (CPSS) (Besemer & O'Quin, 1989), by two experts in the field.

Data

Log Files

The log files generated during Google sessions provided the following evidence:

1. Eight participants utilized only 26 unique keywords resulting in 20 conceptually unique search phrases in more than 4.5 combined hours of searching.
2. Participants rarely included keywords outside of those commonly associated with the given topics.
3. Only one search was performed in an area outside of Google's basic Web search (e.g. in images, video, or news).

Interviews

Interviews provided the following evidence:

1. Participants used the resources provided for the exploration of ideas, but most often the primary ideas were generated from their own thinking or experiences (12/16 sessions).
2. Participants indicated that the Web was more helpful in their tasks than the books.
3. Seven of eight participants indicated that they would use the Web on a similar task in the future.
4. Mindset was the most prevalent difference in the more highly creative participants.

Creative Products

Creativity scores for participant products provided the following evidence:

1. Average creativity scores for Google and book conditions did not differ statistically (Wilcoxon Signed-Ranks Test: n=7, W=16, not significant at the .05 level, two-tailed test).

Conclusions

Given the potential for the Web to facilitate creativity, the evidence provided in this study did not indicate that participants took advantage of these benefits. No significant difference was found when comparing book and Google conditions. At the same time, the keyword choices used did not reflect any substantive depth or breath of inquiry, nor did they indicate exploration outside of common mathematics and teaching resources. By not searching in news or image data, participants did not access Web resources that might have provided ideas about timely applications or visual representations for teaching. Both technological and creative deficits are indicated by this data. At the same time, participants indicated that they felt the Web was very useful during the tasks and would use it on future related tasks. Given this information, further research should concentrate on interventions that may increase the functionality of the Web in creative tasks by addressing the technological deficits (e.g. general training about how to select and modify keyword phrases and access various forms of information on the Web) and the creativity deficits (e.g. that creative ideas are often the combination of two ideas from disparate domains of knowledge) are warranted.

Most participants indicated in interviews that the central idea in their solution came from past experiences or prior knowledge (recent college classes or secondary level education experiences were commonly referenced). One possible reason for this is that feeling rushed for time, the participants chose a primary idea from memory early in the session and then just explored and developed it with the resources provided. Future research could help determine whether Web sources of information can be helpful in generating ideas by allowing the participants to write about their ideas only after a certain amount of time has passed, facilitating the use of more time on idea generation, and less on idea exploration and development.

In addition, the two highest scoring participants (both on the alternative uses task and on the teaching task) demonstrated a different mindset than their counterparts. This mindset (1) clearly recognized non-creative solutions; (2) was open to new ideas; and, (3) was iterative in its thinking. However, as one participant in this study indicated, "It is so hard when something has been beaten into your head your whole life to try to get away from it." Research that explores ways to facilitate similar mindsets in less creative teachers is also warranted.

Finally, certain characteristics of the Web may actually be minimizing its usefulness in creative tasks. It is possible that the presentation of search results actually stifles creativity, given that it is designed to provide the most

popular sites first. It is also noted in Jacobson, Maouri, Mishra, and Kolar (1996), that the level of structure defining a hypertext system may impact user ability to acquire and flexibly use complex knowledge, which is necessary for creativity. The Google results may be too unstructured and overwhelming to engage in open-ended creative tasks without proper training. Given these possibilities, studies that examine different ways of presenting search results (e.g. visual representations of search result categories) and different sequences of scaffolding are warranted.

References

Amabile, T.M., & Tighe, E. (1993). Questions of Creativity. In J. Brockman (Ed.), *Creativity* (pp. 7-27). New York: Simon & Schuster.

Besemer, S.P., & O'Quin, K. (1989). The development, reliability and validity of the revised creative product semantic scale. *Creativity Research Journal*, *2*, 268-279.

Bruner, J. S. (1962). The conditions of creativity. In H. E. Gruber, G. Terrell, & M. Wertheimer (Eds), *Contemporary approaches to creative thinking* (pp. 1-30). New York: Atherton Press.

Clements, D.H. (1995). Playing with computers, playing with ideas. *Educational Psychology Review, 7*(2), 203-207.

Cropley, A. (2006). In praise of convergent thinking. *Creativity Research Journal, 18*(3), 391-404.

Csikszentmihalyi, M. (1997). *Creativity: Flow and the Psychology of Discovery and Invention*. New York: Harper Collins.

Csikszentmihályi, M., & Sawyer, K. (1995) "Creative Insight: The Social Dimension of a Solitary Moment." In R. J. Sternberg, & J. E. Davidson (Eds.), *The Nature of Insight,* MIT Press, Cambridge, MA, pp. 329-364.

Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Education Policy Analysis Archives, 8* (1). Retrieved November 13th, 2006 from http://epaa.asu.edu/epaa/v8n1/

Esquivel, G. (1995). Teacher behaviors that foster creativity. *Educational Psychology Review, 7*(2), 185-202.

Florida, R. (2002). *The rise of the creative class*. New York: Basic Books.

Fox, L., Thompson, D., & Chan, C. (1996). Computers and curriculum integration in teacher education. *Action in Teacher Education 17*, 64-73.

Freidman, T. (2005). *The world is flat*. New York: Farrar, Straus and Giroux.

Goldstein, L. (2003). The pedagogical power of myth in teacher education. *Journal of Educational Thought, 37*(2), 157-176.

Goor, A., & Sommerfeld, R. E. (1975). A comparison of problem-solving processes of creative students and noncreative students. *Journal of Educational Psychology, 67*(4), 495-505.

Griffiths-Hemans, J., Grover, R. (2006). Setting the stage for creative new products: Investigating the idea fruition process. *Journal of the Academy of Marketing Science, 34*(1), 27-39.

Gunseli, O. (2006). Creativity of Turkish prospective teachers. *Creativity Research Journal, 18*(1), 65-73.

Howe, R. (1992). Uncovering the creative dimensions of computer-graphic design products. *Creativity Research Journal*, 5(3), 233-243.

Kerr, D. & Murthy, U. (2004). Divergent and convergent idea generation in teams: A comparison of computer-mediated and face-to-face communication. *Group Decision and Negotiation, 13*(4), 381-399.

Loveless, A., Burton, J., & Turvey, K. (2006). Developing conceptual frameworks for creativity, ICT, and teacher education. *Thinking Skills and Creativity, 1*, 3-13.

Majid, D., Tan, A., & Soh, K. (2003). Enhancing children's creativity: An exploratory study on using the Web and SCAMPER as creative writing tools. *The Korean Journal of Thinking and Problem Solving, 13*(2), 67-81.

Michael, K. (2001). The effect of a computer simulation activity versus a hands-on activity on product creativity in technology education. *Journal of Technology Education, 13*(1). Retrieved March 4th, 2006, from http://scholar.lib.vt.edu/ejournals/JTE/v13n1/michael.html

National Center on Education and the Economy. (2006). *Tough choices or tough times: The report of the new commission on the skills of the American workforce.* Retrieved December 14th, 2006 from http://www.skillscommission.org/executive.htm

Osborn, A. (1953). *Applied Imagination*. New York: Scribner's.

Park, S., Lee, S. Y., Oliver, J. S., & Cramond, B. (2006). Changes in korean science teachers' perceptions of creativity and science teaching after participating in an overseas professional development program. *Journal of Science Teacher Education, 17*, 37-64.

Pea, R.P. (1985). Beyond amplification: Using the computer to reorganize mental functioning. *Educational Psychologist, 20*(4), 167-182.

Plucker, J. A., Beghetto, R. A. & Dow, G. T. (2004). Why isn't creativity more important to educational psychologists? Potential pitfalls and future directions in creativity research. *Educational Psychology, 39*(2), 83-96.

Plucker, J. & Renzulli, J. (1999). Psychometric Approches to the Study of Human Creativity. In R. J. Sternberg (Ed). Handbook of Creativity. Cambridge, U.K.; New York, NY: Cambridge University Press. P. 35-61.

Runco, M., Gayle, D., Smith, W.R. (2006). Information experience, and divergent thinking: An empirical test. *Creativity Research Journal, 18*(3), 269-277.

Sawyer, R.K. (2004). Creative teaching: Collaborative discussion as disciplined improvisation. *Educational Researcher, 33*(2), 12-20.

Shneiderman, B. (2000). Creating creativity: User interfaces for supporting innovation. *ACM Transactions on computer-human interactions, 7*(1), 114-138.

Sternberg, R. J., & Lubart, T. (1999). The concept of creativity: Prospects and paradigms. In R. J. Sternberg (Ed). *Handbook of Creativity* (pp. 3-15). Cambridge, U.K.; New York, NY: Cambridge University Press.

Sullivan, D. (2006). Retrieved November 29th, 2006 from http://searchenginewatch.com/showPage.html?page=2156451

Wallas, G. (1926). *The art of thought.* New York: Harcourt, Brace.

Ward, T.B., Smith, S.M., & Finke, R.A. (1999). Creative Cognition. In R. J. Sternberg (Ed). *Handbook of Creativity* (pp. 189-212). Cambridge, U.K.; New York, NY: Cambridge University Press.

Williams, G. (2002) Identifying tasks that promote creative thinking in Mathematics: a tool. Paper accepted as a research report for the Mathematical Education Research Group of Australasia Conference. Aukland New Zealand. July 2002.