TEACHING IN THE INFORMATION AGE: THE CREATIVE WAY!

M. Khalid Hamza, Ph.D.

Bassem Alhalabi, Ph.D.

Florida Atlantic University, Center for Distance Education Technologies (CDET)
CSE Dept, 777 Glades Road, Boca Raton, Florida 33431
Tel: (561) 297-3182, Fax: (561) 297-2800, E-mail: khamza@cse.fau.edu

Abstract: Are students uninterested in the study of computing? Do they complain that computing is “dry” or that the subject matter has no relevant application to the “real world?” Do they seem frustrated, bored, and inattentive? Your mission as a creative facilitator is not to assign a grade; your mission is to educate students to think, to learn, and to make new connections that they never before thought possible. A teacher's guidance, constructive feedback, and facilitated instruction should pave the way for students to meaningfully bridge prior knowledge with new knowledge. In this paper, the authors suggest how teachers might teach creatively, particularly with respect to computing curricula, while they enjoy the teaching and learning processes.

1. Teachers: Can Be Prophets Of Creativity!

A teacher’s primary mission is not to assign a grade; it is to educate students to think, to learn, and to make creative connections that they previously thought impossible (Hamza, 1996; Hamza, 1998; Torrance & Safter, 1990). According to Lowman (1984), teachers who are successful in these approaches are extraordinary; they advocate intellectual excitement, they build trust, and they foster a sense of sociability. In addition, studies by Alexander and Knight (1993) suggest that the learning environment traditionally called the "classroom” should be interactive, dynamic, interesting, and thought provoking. To accomplish these goals, a teacher must be a tolerant facilitator, a passionate educator, and an involved decision-maker. When using computers in the classroom, set aside the traditional instructional approaches that base grading systems on dull memorization, conformity, and authority (Jonassen, 1996). Do not “force-feed” information or create all possible associations. Mentioning information replaces teaching; it conjures the “illusion of learning” and the “illusion of teaching” (Durkin, 1978-79). Find alternative ways to evaluate achievement and invent instructional objectives that are based on thinking, learning, and practical performance. In safe, nonthreatening environments, students learn are more successful in identifying concepts and applying rules to real problems. When teachers acknowledge goals, interests, and cognitive skills, students will also be more likely to produce higher order thinking and problem solving.

Remember to treat students with respect as young colleagues. Try to observe other creative, innovative classrooms. Attend creativity conferences and network with others who promote creativity (Kauffman & Hamza, 1998). Show optimism, a sense of humor, and a casual attitude. Build upon non-threatening, flexible, and creative environments; encourage questions, opinions, and teamwork. The preservation of our way of life and our future security depends upon our most important national resources, our intellectual abilities and, more particularly, our creative abilities. Now is the time to learn all we can about those resources (Guilford, 1959, p. 2).

2. Learning Domains: Educating the Mind!

Learning objectives should dictate instructional strategies, whether specifically focused upon the accomplishment of lessons or the result of larger course objectives. Because scholastic marks are not absolute indicators of knowledge, “B students” may be more knowledgeable than “A students.” Therefore, probe their incoming skills to determine the overall mixture of knowledge and understanding. Ask students how they learn best and what events would make the class the best or the worst class they will ever take.

You might also ask them what computing classes they have taken. Do they have a computer at home and are they "online"? What types of software packages or programming languages have they used? As designer of this creative environment, your goal is to portray an overall picture of your students' expectations, their skills, and their learning strategies. When you learn more about them, you can flexibly design instructional objectives, strategies, and assessments to meet student needs and achieve learning outcomes (Gagne, Briggs, & Wagner, 1992; Smith & Ragan, 1999).

Work backward from expected learning outcomes to achieve instructional goals. Do not emphasize concepts over hands-on learning or vice versa. Hands-on learning may appear to be the most potent form of computer education; however, it only produces temporary gains because perpetual changes in computing software result in profusions of market upgrades. Therefore, students must also learn the logical, systematic thinking of programming and basic information systems theories in order to transfer domain-specific knowledge to newly acquired information- thus, connecting prior knowledge to new knowledge in a meaningful way. When you acknowledge the following learning domains, you not only train and lecture, but you also teach and educate the whole person: 1) cognitive strategy (capabilities that influence the learner's own learning and thinking behavior); 2) psychomotor skills (coordinated muscular movements); 3) verbal information ("knowing that," i.e., to recall verbatim, to summarize from facts, names, dates); 4) intellectual skills ("knowing how," i.e., the application of relational and procedural concepts and rules to solve problems); and 5) attitudes (similar to cognitive strategies, a mental state that predisposes a learner to selective behavior.

3. Enthusiasm and Interest: Can you spark it?

When students are inattentive in class, they are most likely dreaming of doing something that interests them. Therefore, your enthusiasm and attitude set the tone of your classroom. Make learning fun, stimulating and productive. Knowledge is animated, constructed information that is meant to be shared but not possessed (Perkins, 1986). Consider the following examples. Ask students greet one another each class period and encourage them to share personal experiences, including success and that which they perceive as failure. Liven social skills and self-management in the form of card games from reading assignments. Assign projects that spark interest in the systematic analysis of web sites based on selected criteria, i.e., user friendliness, content quality, cognitive applicability, management, and effectiveness. Ask students to share analyses and incorporate findings. Motivation is greater when they can associate new material with tangible events. Foster problem solving skills and innovative thinking; ask students to divide into small groups based on opinion surveys that result from an interesting topic. Stir interactive, controversial debate. Present questions, ideas, and disputable issues, and encourage new intellectual horizons to build communities of learners that offer positive attitudes aimed at higher achievement and quality production (Karre, 1994). Scenario creates interest in subject matter and defines applicability to subject content associated with real world problems, computer issues, and concerns. Students are more likely to enjoy creating a personal expense account spreadsheet or a profit and loss statement of a virtual business plan while they use the "what if analysis" than if they complete a meaningless assignment that only awaits a grade.

4. The Fun of Perceiving the Power of 2!

Long rumored to be an unenlightening, straightforward task, explaining the power of 2 can spark sheer imagination. For example ask students, without using a calculator, to guess the thickness of a .1 mm paper if folded in half 25 times. Indeed, were it not for the impossible mechanics of folding it, the paper would be 3.35 kilometers thick. A few more folds and it would measure in hundreds of kilometers!

The binary system represents number quantities similar to the decimal system, in that the decimal system uses ten digits, 0 through 9, and the binary system uses only 0 and 1. The value of a decimal number is calculated as a sum of weighted powers of base 10. For example, $3079 = 3\ (10)^3 + 0\ (10)^2 + 7\ (10)^1 + 9\ (10)^0$ or 379 = 3x1000 + 0x100 + 7x10 + 9x1. In the same fashion, binary numbers are evaluated as follows: $1101 = 1\ (2)^3 + 1\ (2)^2 + 0\ (2)^1 + 1\ (2)^0$ or 1101 = 1x8 + 1x4 + 0x2 + 1x1 = (13 in decimal).

To represent the power of 2, one binary digit assumes two possible forms (i.e., 0 and 1). To represent twice as many, you use a second binary digit (i.e., 00, 01, 10, 11). Therefore, decimal number 13 can be represented in binary as 1101, a more storable numbering protocol of 0's and 1's in the computer. The display on the printer or monitor screen is converted back to the original decimal digits, which require 10 different electronic states. To further represent twice as many, you use a third binary digit (i.e., 000, 001, 010, 011, 100, 101, 110, 111), and so on. Thus, every time you need to double the possibilities (multiply by 2), you add one more digit. In contrast, whenever, you need to reduce the possibilities by half (divide by 2), you eliminate one digit. To spark curiosity, ask students to think of a concealed number that you will guess with the help of the binary system. You might first ask students to think of a number from a range of numbers between (1 and 8). Suppose the concealed number that the students chose is number (6). Your first guess is going to be the median of the range, number [4].

Then ask if the concealed number is less or equal (<=) than number [4], or greater than (>) number [4]. The answer is: greater (>) than number [4]. Next, eliminate half of the numbers of the original range (eliminate 1-4). Now, state your second guess [6], which is the median of the remaining range (5-8). Then ask if the concealed number is <= or > your second guess. Their reply will be <= number 6. State your third guess [5], the median of the new range (5-6) after eliminating the other half of the remaining range (eliminated 7-8). If the concealed number is <= or > than your third guess, then 6 is the concealed number.

5. Divergent Imagery: Mindmapping Tools & Brainstorming Techniques

Divergent imagery is the external mirror to radiant thinking that powerfully unlocks ultimate thinking; it enhances thinking potentials, it generates multiple ideas, and it organizes associations between new and prior knowledge. Mindmapping, a feature of divergent imagery, has four essential elements (Buzan & Buzan, 1993; Jonassen, 1996): 1) the subject of focus crystallized in a central image; 2) major themes of the subject radiating from the central image; 3) topics of importance represented as branches attached to more and lesser important branches; and 4) all branches form a connected nodal infrastructure. Mindmapping attempts to meaningfully connect two or more things that seem to be logically and rationally impossible to link (Dacey, 1989; DeBono, 1992), and is designed to produce individual high-quality convergent solutions from divergent productions. Making the strange familiar and the familiar strange, ambiguity is a central component that provides impetus for divergent, creative thinking.

Exercises that combine the use of mindmapping and divergent imagery provide the theoretical basis of content, including practical experience from the use of alternative radiant thinking and cognitive strategies that elevate intellectual skills. Consider the following examples to use with your students: (1) Encourage them to find, through small group interaction, twenty ways that commonly used computing technologies might be applied to negative situations or to new relations and associations among objects, people, data, facts, technologies, concepts, and theories. (2) Have them explain input, processing, output (IPOS) using unrelated objects, data, and technologies: vegetables, EZ pad, and PC card TelePath data/fax modem. (3) Ask them to create a visual commercial that promotes an alternative way to use PC electronic communication followed by a drawing of their solution(s) based on divergent imaging techniques. (4) Ask them to form small groups and create a mindmap that solves a given problem. A chosen leader in each group must ring a bell when criticism occurs. Welcome all ideas, no matter how silly, funny, or wild. Suggestions are tape-recorded or written to enhance each contribution. After they exhaust all possibilities, they evaluate suggestions by explaining the process that led to the solution, which includes a metaphoric concept map. (5) Ask them to quickly and silently, create 15 different associations from the word "education" as the center image of a mind map. Later, they will be amazed at their varying responses. (6) Ask them to create new associations between already existing associations (the word "Internet") to solve a problem, initiate a project, or see a new point of view (Jonassen, 1996; Hamza, 1998). Divergent imagery programs are now available to assist in producing such mental graphics [1].

---

[1] Visible Systems Corporation, http://www.visible.com;
ParaMind Software, Inc., paramind@aol.com;
Inspiration Software, Inc., http://www.inspiration.com;
SemNet Research Group, 1060 Johnson Ave., San Diego, CA 92103;

6. Computers as Cognitive Tools: Learning Critically and Creatively

"Computers are useless; they can only give you answers"[2]. Computers should be the mental and computational guides that promote all aspects of human thinking (Jonassen, 1996; Simons, 1993). Hence, students are able to synthesize, categorize, and process meaningful information. Thereafter, they can reflect on what they know, they can create new connections, and they can subscribe to new learning goals.

To make the class more challenging, creative, and germane to daily living, ask for the fastest way to add 16 numbers. A quick reply might be to use the fastest adder (computer) in the world, which would take 16 linear steps to add the 16 numbers. However, there are many other faster mechanisms. Encourage students to think divergently and in parallel form. Students might use 8 adders in which each adder sums two numbers to add the 16 numbers. Eight pairs of numbers will produce 8 partial sums, followed by 4 adders to add the 8 partial sums to produce 4 partial sums.

Third, use two adders to add the 4 partial sums to produce two partial sums. In the fourth step, use one final adder to add the last two partial sums to produce the final sum. Students will be amazed by the speed of adding 16 numbers in just four steps using parallel adders. You can challenge them further by asking, "How many adders do we really need?" Many students will reply, 8+4+2+1=15; however, only 8 adders are needed because we never used more than 8 adders at the same time. Now, you ask about the relationship between the numbers being added (N), the number of adders being used (A), and the number of steps it took to compute the final sum (n). The answer is $N=(2)^n$ or $16=(2)^4$ and A=N/2 or 8=16/2. This discussion will most likely enhance rational thinking, reasoning abilities, and overall creativity (see Fig. 1, Binary Tree).

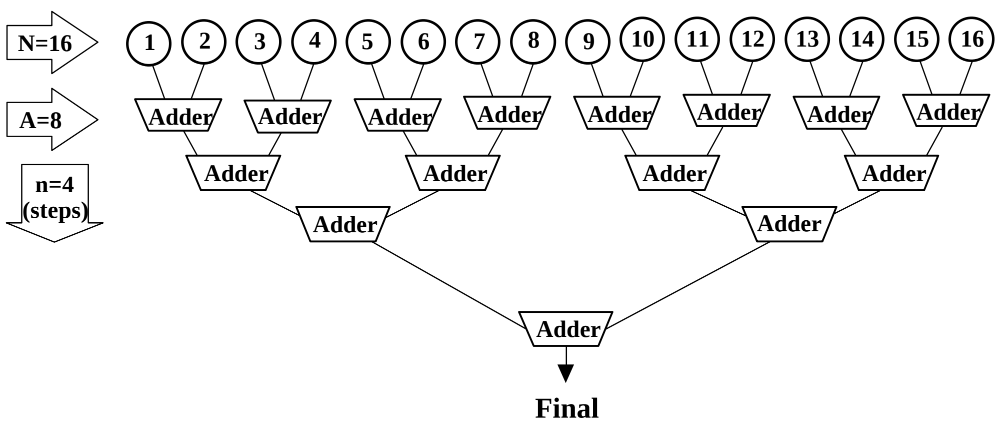

Figure 1: Binary Tree. The binary tree is a quick, graphic example that will most likely enhance rational thinking, reasoning abilities, and overall creativity. Eight pairs of numbers will produce 8 partial sums, followed by 4 adders to add the 8 partial sums to produce 4 partial sums. Use two adders to add the 4 partial sums to produce two partial sums. Use one final adder to add the last two partial sums to produce the final sum.

Continuous change pressures society's brightest individuals to quickly sort information, categorize it, connect it, and provide divergent solutions. Therefore, students must learn to manage ambiguous situations, challenging tasks, open-ended assignments, and tasks that seem impossible to complete. According to di Sessa (1988), an educated citizen in the year 2020 will be able to produce more builders of theory, synthesizers, and inventors of strategy and increasingly fewer will be employed as managers of fact. Provide tools that allow students to learn how to manage these complex tasks. Lead them to the rim of thinking and insightfully encourage them to take risks.

---

[2] Pablo Picasso.

7. Education and Technology: Students as Explorers

Technology can be the impetus that propels your students' imaginations and cognitive satisfaction in the classroom. Successive updates in Internet software and video conferencing, technology's unlimited capacity, and its growing popularity should support all aspects of instructional and educational goals. Students should investigate, share, and construct knowledge individually and together as a team. Encourage students to explore complex computer concepts through participation in small application groups that involve development and debate.

Encourage them to think critically and creatively (Hamza, 1996). Engage them in problem solving, analyzing, and synthesizing computer related theories, problems, and challenging tasks. With your guidance and positive feedback, encourage students to create project proposals and solutions to apply what they learned in class to real, pragmatic problems. Provide continuous, constructive response to excite them in the discovery process. For example, students can learn HTML (hypertext markup language) coding through classroom projects where they create a Web site about a topic that interests them. Ask them to design a proposal that should conceivably meet the demands of their employer (real or virtual) or the needs of the community. As an alternative, they can make the web design project a controversial subject, such as the fight against tobacco legislation or child pornography. As they construct their web page, challenge them to embed various emerging technologies: sound, 3D graphics, two-way audio, or two-way video. Encourage them to write a list of topics that provide interesting material for their projects. Ask them to share their thoughts not only with each other, but also with other students from the global community via the World Wide Web.

8. The Rewards of Creative Behavior and Risk Taking

Encourage students to try something new and help them realize that failure is a necessary challenge in the seamless transition to success. Do not penalize students when they make mistakes; encourage them to search for divergent solutions. Humor is a vital catalyst to this process. When students are afraid to press a computer key or to explore new programming or math concepts, you might reassure them with a funny phrase such as, "It's OK to touch the keyboard – it *won't* eat you for lunch!" Students enjoy earning bonus points toward the accomplishment of assignments and projects. Motivate them by rewarding their creativity and dedication, but be aware of your own defensiveness. Students are unlikely to think creatively if they feel threatened. Encourage them to get feedback on their solution from others who are less personally involved. Ideas must be given a chance to incubate; it is important that you give students time and flexibility in order for them to glean new ideas and associations. When students see you having fun with the subject, they will be more willing to think, to learn, to explore, and to solve problems.

9. Conclusion

Teaching creatively for effective learning demands a migration from inherited practices of instructing, thinking, and using computers as mere drill and practice appliances. The ultimate goal of all teachers should be to facilitate the use of computers and computing technologies as mind tools (cognitive tools) to accompany thinking, reasoning, creating, learning and inventing. You may wish to try a few of the suggestions in this article and continue to include other suggestions as you feel comfortable in making additions. Avoid using "filtering" processes that block awareness. Help students to become more involved with practice exercises that regard problems as opportunities to uncover solutions. Encourage students not to conclude their search from the first solution; encourage them to generate numbers of possible solutions and select the best solutions from the group. After all, you are the prophet of creativity!

10. References

[Alexander & Knight 1993] Alexander, P. A., & Knight, S. L. (1993). Dimensions of the interplay between learning and teaching. *The Educational Forum*, 57, 232-245.

[Buzan & Buzan 1993] Buzan, T. & Buzan, B. (1993). *The mind map book.* New York: Penguin Group.

[De Bono 1993] De Bono, E. (1992). *Serious creativity: Using the power of lateral thinking to create new ideas.* New York: HarperCollins.

[di Sessa 1988] di Sessa, A.A. (1988). What will it mean to be "educated" in 2020? In R.S. Nickerson & P.P. Zodhiates (Eds.) *Technology in education: Looking toward 2020.* (pp. 43-66). Hillsdale, NJ: Erlbaum.

[Durkin 1978-79] Durkin, D. (1978-79). What classroom observations reveal about reading comprehension instruction. *Reading Research Quarterly* 14, 481-533.

[Gagne, Briggs, & Wager 1992] Gagne, R. M., Briggs, L. J., & Wager, W. W. (1992). *Principles of instructional design* (4th ed.). Orlando, FL: Harcourt Brace.

[Guilford 1959] Guilford, J. P. (1959, April 13). *Three faces of intellect.* Paper presented at The Walter V. Bingham Memorial Lecture delivered at Stanford University, CA.

[Hamza 1996] Hamza, M. K. (1996). *Exploration in teaching strategies that foster creative thinking and problem solving in a community college.* UMI Dissertation Services.

[Hamza 1998] Hamza, M.K. (in press,1998). Touching students' minds in cyberspace: Eight creative tips. *Learning & Leading with Technology.*

[Karre 1994] Karre, I., (1994). *Cooperative Learning Tools in the College Classroom*. Greeley, CO: University of Northern Colorado.

[Kauffman & Hamza 1998] Kauffman, D., & Hamza, M. K. (1998, March 11). Educational reform: Ten ideas for change, plus or minus two. *Technology and Teacher Education Annual 1998.* Association for the Advancement of Computing in Education SITE Conference, Washington, DC.

[Lowman 1984] Lowman, J. (1984). Mastering the techniques of teaching. In G. DuBois (Ed.) Hidden characteristics of effective teachers. *Community College Journal of Research and Practice*, 17, 459-471. Washington, DC: Taylor & Francis.

[Perkins 1986] Perkins, D. N. (1986). *Knowledge as design*. Hillsdale, NJ: Erlbaum.

[Simons, 1993] Simons, P. R. J. (1993). Constructive leaning: The role of the learner. In T. Duffy, J. Lowyck, & D. Jonassen (Eds.), *Designing environments for constructive learning.* Heidelberg, Germany: Springer-Verlag.

[Smith & Ragan 1999] Smith, P. L. & Ragan T. J. (1999). *Instructional design*. Saddle River, NJ: Prentice-Hall, Inc.

[Torrance 1979] Torrance, E. P. (1979). *The search for satori & creativity*. Buffalo, NY: Creative Education Foundation, Inc.

[Torrance & Safter 1990] Torrance, E.P. & Safter, H.T. (1990). *The incubation model of teaching: Getting beyond the aha!* Buffalo, NY: Bearly Limited.