Creativity and Innovation in Education

Selections from Educational Technology Magazine

Samuel Jackson, Jiahui Zhang, Richard E. West, & Hyram Brown

Table of Contents

Samuel Jackson

Brigham Young University

Jiahui Zhang

Brigham Young University

Richard E. West

Brigham Young University

Dr. Richard E. West is an associate professor of Instructional Psychology and Technology at Brigham Young University. He teaches courses in instructional design, academic writing, qualitative research methods, program/product evaluation, psychology, creativity and innovation, technology integration skills for preservice teachers, and the foundations of the field of learning and instructional design technology.

Dr. West's research focuses on developing educational institutions that support 21st century learning. This includes teaching interdisciplinary and collaborative creativity and design thinking skills, personalizing learning through open badges, increasing access through open education, and developing social learning communities in online and blended environments. He has published over 90 articles, co-authoring with over 80 different graduate and undergraduate students, and received scholarship awards from the American Educational Research Association, Association for Educational Communications and Technology, and Brigham Young University.

He tweets @richardewest, and his research can be found on http://richardewest.com/

Hyram Brown

Brigham Young University

Series Introduction

Richard E. West

This book is part of a series of books, each republishing selected articles from *Educational Technology Magazine*. This publication began in 1961 as an independent magazine discussing a wide variety of issues related to technology in education and training. In doing so, the magazine frequently discussed idea technologies, as well as digital ones. In this way, it became one of the leading venues for theoretical and practical discussions about instructional design, educational psychology and the learning sciences, online and distance learning, and technology integration. Its editor, Lawrence Lipsitz, passed away in 2016, but previously had granted me permission to republish articles from the magazine in an open access book, by noting they were used by permission from the magazine. This permission was then renewed with Howard Lipsitz who controlled the copyright of the magazine after Larry's passing. Their hope is that the quality work from this magazine receive new life and value for the field.

To create each book, we first developed search strategies to identify potential articles within the corpus of the magazine that fit the topic at hand. We then reviewed these potential articles to determine fit to the book's topic and objective. These books may be useful as supplementary or primary readings for a graduate-level special topics course, or as personal enrichment. While they may be dated, as the magazine is no longer publishing and the field marches on, they will serve as launching pads for serious inquiry into these topics.

If you have questions about contributing an edited book to this book series, or have other questions about the books in this series, please contact me at rickwest – at – byu – dot – edu.

Book Introduction

ARTICLE SELECTION

The subjects of Creativity and Innovation are wide-reaching and complex, and have been studied at great length by a number of scholars. The process of selecting only a few articles for inclusion in our book was difficult but valuable. We began by searching within the ERIC (Education Information Resource Center) database for all articles published in Educational Technology, searching by its ISSN. We then searched within this corpus for any article with the words creativity and innovation in the body. This produced a list of 175 articles. We reduced this list to 40 articles by skimming titles and abstracts to find the articles based with the greatest relevance to current practices in the field, clarity of writing and message, and uniqueness in approach. We eliminated articles that discussed outdated technologies or specific case studies that were not applicable to the field of instructional design in general. Then, using Google Scholar, we checked the number of citations for each article and narrowed our list down even further to include the most cited articles of those remaining.

Many articles from the decades of Educational Technology could certainly have been included in this book, and would have made valuable contributions. We feel, however, that these 15 articles represented particularly strong contributions to the discussion on creativity and innovation. As we were selecting the articles, we noticed that they fell into three major areas of inquiry that formed the organization for this book.

SECTION 1: WHAT ARE CREATIVITY AND INNOVATION? DEFINITIONS AND HISTORY

Creativity as an instructional issue has at various times swung in and out of designers' and researchers' focus. The selections in this first section explore some of that history, as well as introducing various definitions and ways of thinking about creativity and innovation.

Several of the selections in this section represent moments in the history of educational technologists' thoughts about creativity. For example, Epstein (1993) overviewed a now-out-of-favor behavioristic explanation for creativity, and argued that all supposed creativity is completely understandable and predictable with appropriate research. Dick (1995) and Rowland (1995) discussed the value of creativity as an instructional goal and the impact that instructional design methods may have on the creativeness of instructional designs. Caropreso and Couch (1996) expanded on some of the questions raised by that dialogue with an excellent curation of several researchers' thoughts about creativity, particularly including definitions and suggestions for inspiring creativity.

Innovation, similarly to creativity, is also frequently defined as a creative event, the introduction of a new product, idea, or process into the sphere of education that changes the capabilities, needs, or reach of teachers and students. This definition is exemplified in the work of Collis (1996) and Boocock (2012), who each described the impact of computers and the internet as innovations in the educational industry, and offered suggestions for how to best use the innovations of the future.

SECTION 2: FOSTERING INDIVIDUAL AND GROUP CREATIVITY AND INNOVATION

Next, we have selected a number of articles that provide guidelines for how to facilitate creativity and innovation for individuals and groups. The fact that creativity and innovation are inherent skills of human beings is no longer a controversial topic as before. However, the questions that have emerged are when and how to provoke one's creativity and innovation in education. Scientists have realized that the more developed the technology to which people have access, the less creative and innovative they become. Therefore, the articles we selected in this section try to address this issue.

Why is fostering creativity and innovation difficult? Shank et al. (1994) wrote because they are "associated with developing and practicing the necessary techniques" (para. 1) . Oftentimes in K-12 settings, for example, teachers are found to focus too much on simply delivering course content to increase test scores. However, they have not realized that fostering creativity and innovation in class can increase learners' intrinsic motivation to learn the content. In addition, while we focus on the role of teachers to teach, we forget that the skills of being creative and innovative are difficult to teach through traditional methods. Therefore, it is essential for teachers, or perhaps they should be referred to as facilitators, to be able to adapt teaching models to cultivate creativity and innovation. Although most of the examples discussed in this section come from classroom settings, we argue that the models can be generalized to other situations.

SECTION 3: IMPLEMENTING CREATIVITY AND INNOVATION

What good are creativity and innovation if they are not implemented? The third topic we discuss in this book seeks to answer that question. Implementing creativity and innovation can take many different forms, from role-based design (Hokanson & Miller, 2009) to creating an interdisciplinary design studio (West, 2016). However, the end goal of each of these forms is the same: to enhance learning experiences and inspire all parties involved. We echo the words of Hong, Clinton, & Rieber (2014) when they wrote:

When was the last time you were inspired to learn? . . . When this happens, you probably don't even think about the fact that you are learning something, but instead allow yourself to be carried away by the feeling of adventure and satisfaction. The person or group who designed whatever is was that inspired you did something very special. (para. 2)

Not only does creativity inspire and open the minds of instructional designers to a broader spectrum of design possibilities, but it also helps engage students in the learning process. When students feel the freedom to be creative and innovative in their education, they gain intrinsic motivation to learn, and they can take greater ownership of the knowledge they gain. Designers create instruction that provides this freedom for students through their own creativity and innovation. Thus, we see that creativity and innovation can start with instructional designers and then be passed to the students, much like how the flame of a match can ignite the wick of a candle. According to Osguthorpe, Osguthorpe, Jacob, and Davies (2003), "releasing the imagination of learners is the primary aim of good education. We assert that for instructional designers to release the imagination of others, they must be working in ways that improve their own imagination" (p. 22).

Therefore, it is crucial that designers first learn what creativity and innovation are and how they can obtain these traits in their own lives (the first two topics of this book) so that they can better implement them and encourage learners to think creatively and innovatively for themselves. Without this knowledge, creativity and innovation cannot be implemented, and the aforementioned inspiration will be difficult, if not impossible, to achieve.

REFERENCES

Boocock, S. S., (2012). Educational technology classics: Technology and educational structure. Educational Technology, 52(1), 55-56.

Caropreso, E. J., & Couch, R. A. (1996). Creativity and innovation in instructional design and development: The individual in the workplace. Educational Technology, 36(6), 31-39.

Collis. B. (1996). The Internet as an educational innovation: Lessons from experience with computer implementation. Educational Technology, 36(6), 21-30.

Dick, W. (1995). Instructional design and creativity: A response to the critics. Educational Technology, 35(4), 5-11.

Epstein, R. (1993). Generativity theory and education. Educational Technology, 33(10), 40-45.

Hokanson, B., & Miller, C. (2009). Role-based design: "A contemporary framework for innovation and creativity in instructional design". Educational Technology, 49(2), 21-28.

Hong, Y., Clinton, G., & Rieber, L. P. (2014). Designing creative user interactions for learning. Educational Technology, 54(2), 20-25.

Osguthorpe, R. T., Osguthorpe, R. D., Jacob, W. J., & Davies, R. (2003). The moral dimensions of instructional design. Educational Technology, 43(2), 19-23.

Rowland, G. (1995). Instructional design and creativity: A response to the criticized. Educational Technology, 35(5), 17-22.

Shank, G., Ross, J.M., Covalt, W., Terry, S., & Weiss, E. (1994). Improving creative thinking using instructional technology: Computer-aided abductive reasoning. Educational Technology, 34(9), 33-42.

West, R. E. (2016). Breaking down walls to creativity through interdisciplinary design. Educational Technology, 56(6), 47-52.

I

What are Creativity and Innovation? Definitions and History

1

The Internet as an Educational Innovation

Editor's Note: Collis. B. (1996). The Internet as an educational innovation: Lessons from experience with computer implementation. *Educational Technology*, *36*(6), 21-30.

Introduction: Will the Cycle Repeat Itself?

For over a decade, countries and regions around the world have pursued various initiatives to stimulate and support the use of computers in their educational systems. These initiatives have taken many different forms in different countries, some focusing on strategic support for hardware- and software-related programs, some on strategies more directly focused on curricular and instructional aspects of computers, some (fewer) on strategies for the school manager, and others (many) on different approaches to teacher education and support. Regardless of the focus or scope of the initiative, it appears that one type of result consistently occurs: a result that acknowledges the teacher as the key figure in the eventual success or lack of success of any computers-in-education initiative.

The wave of social and technological developments that stimulated interest in computers in schools in the late 1970s and early 1980s appears to now be paralleled by a similar surge of interest in educational aspects of the Internet. Throughout the world, the use of wide-area network capabilities for communication and access to new forms of information engagement is stimulating a wave of initiatives with respect to telecommunications in schools, particularly telecommunications via the Internet and applications such as e-mail and the World Wide Web (WWW). I will argue that this wave can be seen as an iteration of the "computers in education" wave of 10 to 15 years earlier.

What did we learn from the first wave? To what extent can we expect the patterns and results of the first wave to reappear in a second wave, this time focused on the computer network rather than just the computer? What might we do more efficiently and effectively the second time around in terms of responding to a computer-related innovation at the strategic and policy-related levels?

These are the questions addressed in this reflection. The conclusions that will be drawn are:

- In critical ways, the "Internet in education" is a second iteration of the "computers in education" phenomenon of the 1980s.
- In many critical ways, we can expect the same sorts of implementation results; however, the unique characteristics of the World Wide Web, coupled with differences in society compared to a decade earlier, suggest that certain breakthroughs in implementation success will occur in this second wave.
- The experiences of the field and of decision-makers with respect to computers in education in the 1980s present an interesting legacy with respect to the Internet in education, in some aspects positive and in others a burden. We will do well to learn from experience.

Sketching the Iteration: From Computers in Education to Computer Network Applications in Education

In the 1960s, research initiatives began relating to the use of computers for educational purposes, and the study of computer science (called by different names in different countries) became established as academic and professional domains. By the 1970s there was already considerable experience with the development of computer-based learning systems; for example, the PLATO environment was used in The Netherlands to create a complex mainframe-based system to support the learning of statistics at the university level that is still in use today (in an evolved version, of course).

With regard to teachers and schools, however, the breakthrough came via the impetus of a social and technological phenomenon: the personal computer. In 1979 and 1980 in particular, an explosive synergy occurred: The personal computer afforded personal control, allowing the individual to work independently of mainframe computers. Society saw this as a revolutionary, romantic, and powerful new opportunity; education was pushed by the same energies. Computers could revolutionize education, could even revolutionize the process of cognitive development of the child, and in more practical terms, could bring new competitive possibilities to schools.

Table 1. Comparing "Computers in Education" with "The Internet in Education."

Push Factors	Computers in Education 1979/1980	The Internet and Education, 1996/1997
Technological Breakthrough	–the microcomputer	–public access to the Internet and the WWW
Social Response	–we must have a computer, in our homes, in our schools…	–we must be able to get on the Internet, in our homes, in our schools…
Social Vision	–personal computers will revolutionize society and will create powerful new opportunities for those who can handle them	–the information highway will revolutionize society and will create powerful new opportunities for those who can handle it
Commercial Push	–a vast new market for goods and services	–a vast new market for goods and services
Social Expectation	–schools must not be left behind; all students must be computer-literate	–schools must not be left behind; all students must have "driving licenses for the information highway"
Vagueness	–metaphors and predictions are strong; results are anecdotal	–metaphors and predictions are strong; results are anecdotal
Push Factors	**Computers in Education 1979/1980**	**The Internet and Education, 1996/1997**
Pioneers show the promise	–both in theory and practice, there are impressive ideas and examples of how the computer can enrich and re-engineer education	–both in theory and practice, there are impressive ideas and examples of how the WWW and other network environments can enrich and re-engineer education
Educational decision-makers must and do respond	–every school must get computers; funding must be found; new initiatives are needed; policy and strategy are needed…	–every school must get **on the internet**; funding must be found; new initiatives are needed; policy and strategy are needed…

The overall movement is unstoppable	–computers are pervasive throughout society	–interconnectivity via computer networks is pervasive throughout society
The rich will get richer…	–an incentive, and a fear	–an incentive, and a fear

Concurrently, there were fears as well: computers would replace the teacher and would distort the social development of children at the same time as they would disenfranchise large groups (such as girls) from status and success.

It is interesting to compare the start of the computers-in-education wave of the early 1980s with the "information highway" wave of the mid-1990s. My argument is that we are now experiencing a second iteration of what we experienced before. Table 1 suggests some major points of similarity.

The computers-in-education wave did not occur in a vacuum, either technologically or in terms of educational experience. As noted earlier, computers had been studied and used in education in many ways prior to the "personal computer" breakthrough of the late 1970s. But the personal computer provided the "trigger event" to unleash the first wave of broadscale educational activity. Similarly, networks, including the Internet, had been in use in educational settings for many years before the trigger event of the World Wide Web (WWW) unleashed the second wave of broadscale social expectation. The trigger event idea is critical; a trigger event is rather like a break in a darn. Much water must be accumulated behind the dam wall before the pressure to erupt becomes inexorable, and then when the breakthrough occurs, the flood cannot be stopped.

What Has Happened in the First Wave?

We all know the story of the past 15-20 years with respect to computers in education and how these early hopes and fears have worked their way out in practice; however, each of us may see the results through a different optic and with different interpretations. The old adage of seeing a cup as half-filled or half-empty relates to our interpretation efforts. There are many different reports and analyses of what the results of the first wave of computers-in-education may be, and there have been a number of attempts to synthesize these results at the international level. In a recent book, Children and Computers in School (Collis, Knezek, Lai, Miyashita, Pelgrum, Plomp, & Sakamoto, 1996), three of the largest and most carefully controlled of these international comparative investigations are further synthesized. Conclusions such as the following 12 points seem to be justified when one looks at the international picture. To a certain extent, I offer the following as my own interpretation, although much research can be cited to support the interpretations, and of course my view of the cup may seem half-full or half-empty to others:

1. **Into the system:** Computers are present in educational institutions throughout the world, with computer rooms as standard as a school library or cafeteria. Every educational jurisdiction spends money in a regular way on some aspect of its computer provision. Computer-literacy courses or modules of some sort have become standard practice. Teacher education includes some acknowledgment of the need to prepare teachers for the use of computers. Many educational professionals have their identities and job definitions related to computers.
2. **First-level problems affect everyone:** So-called "first-level problems" confront every step of computer use in schools, by teachers, and by students. These problems are the same throughout the world. Individuals fight with them, at great cost of time and energy, until gradually an institutional response removes some of the personal burden. Computers do not work; software crashes, software is too difficult to install or understand, software is too expensive; there is no way a teacher can have a computer on his or her desk in the classroom (there may not even be an electrical outlet anywhere near the desk even if he or she had a computer and had a place to set it); there is no projection device so that students can see what the teacher might want to demonstrate; computers are fixed in the computer room and are not accessible when and where the teacher can manage their use by students; there are not enough computers, the computers are too old, too slow, too limited in memory; the teacher does not have time or a place to work personally with a computer, the teacher has no time…and on and on.
3. **Second-level problems are also persistent:** Gradually, first-level problems are reduced (never eliminated) through a combination of personal efforts on the part of committed teachers and institutional and system-wide responses. But a more challenging level of problems remains. These second-level problems are also familiar throughout the world: teachers do not see how to integrate computers into their instruction; teachers and decision-makers are not convinced of the payoff of computer use on the "real" markers of school achievement—student examination results; no matter what approach to teacher inservice training is attempted, it is not enough; no matter how hard we try, software is never good enough or appropriate enough.
4. **Good things are happening:** Throughout the world there are countless examples of good experiences with computers in individual lessons and with individual teachers and students. The results of these good experiences are elusive to measure with tests or to demonstrate in terms of any changes on broadscale educational output, but those involved know that quality instructional moments are occurring.
5. **Diffusion is difficult:** The good things that are happening are related to special people or situations and do not diffuse much into mainstream practice. Good teachers are associated with good examples of computer use. There is no evidence that the computer use made these teachers into good teachers. A good teacher sees possibilities in a powerful technology, sees a way to realize them in his or her own situation, and has the energy and persistence to implement them, usually at personal cost. In contrast to the more idiosyncratic success stories, substantial, long-term, expensive initiatives are needed to sustain computer use among the mainstream of teachers. Diffusion into practice has not yet much occurred.
6. **Different policy and strategies come to similar ends:** The above patterns seem to occur regardless of what policy or strategy has been employed. There are many different models for regional or national support of computers in education, ranging from indifference to highly integrated. Yet the results summarized here seem to repeatedly emerge. There are differences related to policy, to be sure, but at a broad level, the results seem to be similar. There are computers in schools; it is difficult to use them; it is even more difficult to see how to use them in instructional practice; some teachers do find a way and are associated with interesting and probably important learning experiences; diffusion into mainstream and meaningful practice is difficult and does not occur much. That so many different national policies and strategies at so many different levels of cost and activity generally lead to the same result, is in itself an important observation.
7. **Cost-effectiveness is not demonstrated:** There is no broadscale evidence, yet, to equate the amount of money (indirect and direct) which has been spent on computers in education with a corresponding payoff in terms of educational outputs. We do not seem to be able to say that a country's expenditures and efforts with computers in education have resulted in noticeable, sustainable, system-wide differences in student achievement.
8. **Not to fear:** We can be comforted that many of the fears expressed at the start of the first computer wave have not materialized. Computers have not replaced teachers; computers have not made the school obsolete; computers in schools have not turned children into anti-social problem cases; students generally have little "computer anxiety" and assimilate some level of computer-use skills, enough to function in their societies, through social osmosis,

regardless of our concerns with curriculum or instructional units for computer literacy. "Keyboarding" does not have to be taught. The life of the school goes on….

9. **Not to gain:** With the exception of a handful of large companies (I have heard that perhaps eight U.S. companies have nearly 50% of the world market in educational software), little or no money is being made from educational software. The software that is pervasive in schools is that which is pervasive in society as a whole, or is provided by the particular local initiative. Despite the success of the eight large companies, a market for educational software does not really exist unless propped up by external funding. Creating educational software that is portable among countries so that the market for its use is increased has rarely occurred. Once national or regional initiatives supporting the dissemination of locally-made software packages are finished, the locally made packages do not further disperse (although they may continue to be used in pockets of local settings).
10. **From subsidized exploration to…its withdrawal:** The computers-in-education wave was fueled by enthusiasm, by predictions and visions, and by the simple need to be involved in it. But throughout the world, the broadscale initiatives that were established as special national programs or special collaborations can no longer expect to receive the funding support that was available a decade earlier. There is a pendulum effect of a sort: in many countries, ministries and other educational decision makers are saying: "OK, good. We had a big project, the project succeeded in putting x computers in x schools, providing x hours of training for x teachers, supporting the production of x pieces of educational software with accompanying instructional materials, and funding x research and evaluation projects from our university partners. We learned much from this project, good, But now the special project must be over. Funding is scarce; other special projects demand our attention. if you want more money, show us the facts, the data, the results. We cannot afford to finance more exploratory and preparatory studies…." And teachers are saying: "OK, I tried it, but it didn't really work for me, so don't expect me to respond again to the next workshop or project. I really must get back to my real work…" And school administrators are saying: "Fine, we have a computer room, it is always filled, Teacher x does a good job in there, so let us now turn our attention to other things. We certainly don't need days off for teacher workshops about computers in education; we did that…."
11. **The teacher is the critical variable in computer use in the school setting, but not the critical variable in the student's computer use outside the school:** Whatever is done or not done by policy-makers, researchers, teacher-educators, and vendors, the teacher is the critical variable in the use and impact of computers with his students in his classroom. Conversely, what students do with computers outside of the classroom context, in their homes and in society more broadly, does not seem much related to what they do in school or to what their teachers do or not do.
12. **The computer has been a solution in search of a problem:** In general, countrywide or regionwide computer-implementation plans have not developed as a response to specific problems that teachers are experiencing, as expressed by teachers, but instead have been motivated by some combination of the "push factors" listed in Table 1. This may be why diffusion has been difficult; why cost-effectiveness on a broad and sustainable scale has been difficult to document; why second-level problems have been so hard to overcome (outside the stimulus of a special project or pioneer). Many voices have told teachers about the potential of the computer in their classrooms, about what they must know, about how they should proceed. But how often has the starting point been teachers' own voices about their problems and needs (not with respect to computers, but with respect to the teaching and learning situation in their own classrooms)? How often has an analysis taken place based on these needs, with perhaps the result that money could have been better spent on some other intervention?

Must or Should We Re-invent the Wheel? Lessons from Past Experience and Their Application to the Internet in Education

Given these 12 conclusions about the first wave of computers in education, what are my predictions about the second wave, relating to the Internet in education? In Table 2, I repeat the 12 conclusions and follow each with a comment and a suggestion. These are my own views, presented for debate.

But is There Something New? Will the Second Wave Be Different?

I began this reflection by asking if we could learn from our computers-in-education experience with respect to our expectations for teachers' use of the Internet, particularly the WWW accessed via the Internet, and I have argued that there are many insights that can be applied. I do think, however, that the Second Wave does involve some things that will make a difference in terms of increasing the likelihood of implementation. Focusing particularly on teachers, I think that:

- The common and easy-to-use user interface of WWW browsers will be as helpful and attractive to teachers as it is in general in society, thus lowering some of the traditional barriers to teacher use of computer software.
- The ease with which the WWW with its search engines now allows us to access ideas and examples and images and materials through a single user interface is something which has never happened before. Such uniform front-end ease and international access to materials did not accompany the computers-in-education movement. We could read about an interesting software package, but had no way to see it or use it. We have finally made a breakthrough in the traditional dissemination bottleneck, and the breakthrough is at many levels. It is at a personal level: Teachers can look for and decide for themselves what they find interesting, not needing to wait for the filtering process through committees and resource offices. It is at an idea and energy level: There are many, many good and creative sets of materials being made available via the WWW by teachers and students that can now flow into the international community in a way that was never possible before. The cost of this freedom is loss of quality control, but teachers as professionals must be able themselves to judge if a resource is useful or not. This in turn implies a new priority for teacher education: wisdom, in making choices and in doing self-evaluation of possibilities. We have typically assumed the curriculum experts, the inservice professionals, and the textbook authors would be well-informed and trustworthy; now we must teach teachers (and students) to take the editor's task onto themselves.
- Another thing which is interesting is that the WWW supports teachers' access to discrete resources, to units of learning materials which can be integrated into one's own lesson and situation. We did not succeed with educational software, I think, because the teaching act is too personal to be handled by an instructional software package to a teacher's satisfaction. But finding and making use of good resources and units of information is something different. Teachers will, I think, be much more likely to see the use of good quality images and example materials that they can embed in their own lessons than they have been likely to see the use of a software package that tries to teach.
- The WWW is a flexible and universal medium; it is platform independent and capable of being used in many ways and with many different media forms. The surge of creative development of WWW technology is a breakthrough in society as a whole. For a while at least, ordinary people can do powerful things with the functionalities of the WWW, taking us back to the creative feeling that fueled the "computers in education" breakthrough of the late 1970s.

Predicting Diffusion: The "3P" Model

I and my colleagues have earlier argued that the likelihood that a teacher accepts a computer-related innovation into his or her practice is a function of three variables: expected payoff, level of problems that have to be overcome, and intrinsic pleasure in being involved with the innovation. We call this the "3P Model" (see, for example, Collis & De Vries, 1 993; Collis, 1996), and have seen it to have explanatory value in many different settings. The 3P Model says that the vector sum of Payoff, Problems, and Pleasure must be sufficiently positive in order for usage to occur. In general, "Problems" is a negatively-valued vector; pioneers and enthusiasts bring high value to the "Pleasure" vector (and also predict much higher values for the "Payoff" vector than do non-enthusiasts).

Table 2. Lessons from the First Wave applied to the Second Wave.

Results from the First Wave	Implications for the Second Wave
1. Into the system	We can expect access to the Internet (or whatever it evolves to) to be as common in schools as having a telephone number or a computer room. We can predict that students and teachers will be as familiar with the WWW (and its evolution) and with e-mail as they now are with faxes and word processing and automatic bank machines and pincodes. ***Lessons from the first wave?*** Economies of scale can help this process of system-wide presence, but the technology will change so quickly as will the social persuasiveness of the technology, that only the most strategic decisions relating to infrastructure access and cost reduction need be the focus of policy and strategy. We do not need to teach “Internet literacy” (although wisdom is a different matter).
2. First-level problems affect everyone	Schools will find it very difficult to offer useful amounts of Internet access to students or teachers. Classrooms will have no network connection, school networks will not easily adapt to Internet connectivity, server connections will crash, and having a teacher in the school technically able to solve Internet-related problems will be very difficult. Costs and security issues will increase compared to stand-alone computer use. ***Lessons from the first wave?*** Anyone advocating any form of Internet use should walk through each step of access problems with a classroom teacher in the actual classroom setting. A three-partner discussion, between the teacher, the school decision-maker, and a representative of the regional or national strategic team must occur so that “little problems” such as no printer access in the classroom and no projection device are given respect and attention.
3. Second-level problems are also persistent	Identifying educationally relevant uses of the WWW that teachers can see as applicable to their own needs and feasible in their own situations needs careful attention. A major possibility for such identification is the fact that the WWW provides access to resources not available in the school through a single user interface and a single sort of search tool. But the fact that “everything is available” will not necessarily mean the teacher sees or accepts the usefulness of “everything” in his or her practice, especially as “everything”implies junk as well as quality. ***Lessons from the first wave?*** Look for one convincing application of the Internet that is solidly useful in the particular school or teacher culture. Build on this, show it in practice, get evidence to convince teachers that this particular application is “worth it,” and then do all possible

	to make it easy for them to make use of the application itself.
4. Good things are happening	Very good things are happening, particularly with respect to teachers applying in varied ways the functionalities of the WWW in learning settings. The fact that WWW functionalities can be used in an "intranet" context (that is, within the schools's own local area network) means that their value does not have to involve access to the Internet with the cost and quality control issues that this access entails. ***Lessons from the first wave?*** Look for examples of "good things" and support the teachers involved. Give them time and opportunity, and recognition. They are the pioneers; they may also be the only ones to really exploit the medium in the short-term, so use limited funds to support them rather than to try and engage everyone.
5. Diffusion is difficult	Some teachers will make good and powerful use of network opportunities, but we can expect that most will not, at least in the near future. ***Lessons from the first wave?*** Similar to Point 4 above, it does not seem to pay off to attempt to provide across-the-board inservice training in terms of results in practice. The "rigger event" strategy (Point #3), coupled with reduction of first-level access frustrations (Point #2), and support of one's creative pioneers (Point #4) will probably be more effective than national plans for "Internet skills for teachers" or expectations of system-wide implementation or expectations of vaguely understood goals such as "being a citizen of the global community."
6. Different policy and strategies come to similar ends	When a flood has begun, it will continue. Thus, social pushes for access to and use of the Internet, the WWW, and their follow-ups are occurring, regardless of what policy or strategy is chosen for the schools. ***Lessons from the first wave?*** Decision-makers need not invest substantial effort looking for a "best approach" or policy; a powerful idea will find its way. Be aggressive in supplying teachers and schools will affordable and convenient Internet access, look for the local-relevant "rigger event", reduce the most frustrating access problems, support your goo and creative teachers, this can be don in many ways. There is no "best" way.
7. Cost-effectiveness is not demonstrated	Just as it has been difficult with computers in education to show cost-effectiveness evidence, we can expect it will be even more difficult with networks in education. But we do need to try. ***Lessons from the first wave?*** We need to collectively take the issue of cost-effectiveness measurement very

	seriously. We must move beyond theoretical predictions of great benefit to some sort of objective evidence that increased access to wide-area networks is paying off. Thus, we must start now, gathering some types of useful baseline indicator data, so that perhaps in five years we can say, “Yes, but before we used all aspects of the WWW services extensively, students only reached the x level of some kind of attainment but now we can demonstrate that students are reaching a better level.” Will we be able to say this in five years? Perhaps we should start by asking teachers: What are your problems and what are some indicators of those problems?
8. Not to fear	Newspapers around the world featured articles in 1995 and 1996 about the dangers to children of the pornography on the Internet. Governments have even taken initiatives to “protect” children from this danger, through technologies such as “chip cards” and special agents, and through “urgent” legislation. ***Lessons from the first wave?*** Given the increasing access to the “big world” and its evils that bombard children in every part of their lives, it does not seem to be a cause for concern that school use of the WWW is going to corrupt the morals of our students. Nor does it seem that we need to anticipate sociological or psychological damage from network use, any more than it occurred from personal computer use. More seriously, we do not need to fear that schools will soon disappear and teachers will be replaced by some virtual equivalents.
9. Not to gain	While the Internet will open up new channels to the international dissemination of electronic learning materials, there is not likely to be a corresponding rush of purchase orders via the many types of forms from within WWW pages. Teachers and schools will want **free** materials or services subsidized by their local jurisdictions; a commercial market for educational network services is not likely to develop. ***Lessons from the first wave?*** It is unlikely that commercial groups will make large profits from school access to the Internet. In contrast, more use will be made of teacher-made and student-made materials, because these will be available for free. This means that decision-makers cannot expect commercial interests to support schools’ Internet access. Funding will have to come from the educational jurisdictions, and increasingly from the individual parents and teachers in a school. Of course, this will lead to inequities in educational opportunity reflecting the inequities in society; networking will not reduce them

10. From subsidized exploration to—its withdrawal	Here we will suffer from being the second wave. Society, and teachers, are rather tired of computer-based innovations, and will be less tolerant of spending energy and money on them. ***Lessons from the first wave?*** Make sure the Internet enthusiasts have good awareness of the computers-in-education history of a school or district or country. This history will flavor all new computer-related initiatives in a way that the newcomer, filled with passion for the WWW, is likely to underestimate. And, also, there will be less tolerance for experimentation among teachers who already have experiences with computers. A justifiable skepticism about "fads" in education must be anticipated and respected.
11. The teacher is the critical variable	In the classroom, the teacher is the gatekeeper and the filter; the teacher, not the visionary, not the vendor, not the service providers, not the national decision-maker. A good teacher may do very good things with networking opportunities; a weak teacher will not, no matter how we try with strategies and inservice training. ***Lessons from the first wave?*** We have learned that teachers are very much influenced by and helped by each other. Stimulating and supporting teacher networking with respect to ideas about classroom applications of the Internet seems to be a good strategy decision.
12. A solution in search of a problem	Because the Internet lets teachers talk to the world and access an unlimited amount of information, we must not assume that this is going to be seen by many teachers as a response to their most real classroom problems, or even as something they want. ***Lessons from the first wave?*** Start with a careful discussion with teachers of what they perceive as their major instructional and professional problems. Do not mention the Internet in this discussion unless ou can do so as a convincing and realistic response to some of those problems.

We have found in our research, however, that for teachers who do not feel pleasure in a computer-related innovation (and in particular, in the use of telecommunications in education), not only is the Problem vector perceived as considerably more negative, but the Payoff vector is also not perceived as very strong. In other words, the 3P-Profile of the enthusiast is different from that of the non-enthusiast.

The breakthrough in network usage that is now occurring via WWW developments appears to be contributing to a reduction in the negative value of "Problems," an increase in the number of persons experiencing a "Pleasure" feeling with network use, and thus in both real and perceived ways is suggesting a positive "Payoff" vector. The personal computer breakthrough in the late 1 970s changed the "3P" relationship about computer use for the teacher and stimulated much hope in Payoff. It may be that the breakthrough of WWW functionalities and the World Wide Web itself will support a positive enough "3P" vector sum so that the teacher will implement the innovation into practice to a greater extent than has been the case with computers in the mainstream.

Conclusion

Based on this reflection, I feel more optimistic about the Internet in education, because of the WWW, than I have for many years about non-networked computer aided instruction and educational software in the classroom. However, I have learned enough from experience to know that push factors do not automatically translate into instructional integration. I would summarize the following as my major lessons learned from experience with more than 15 years of computers in education:

- Begin with teachers' own classroom problems and concerns; do not begin with the technology or its promise. Because you begin with a clear problem, you can also begin by collecting baseline data, and hopefully you will be able to show improvement against these data if the Internet application that responds to them is sensibly chosen.
- Anticipate the need to demonstrate some sort of meaningful effectiveness, fairly quickly. Thus, choose a problem that is particularly important to teachers, and if a WWW application is a realistic help to that problem, build carefully and slowly on this. Treat this as a "trigger event" and collect examples of this effectiveness in local practice. Stimulate teacher networking as a way for exchange of personal experiences about the trigger event.
- Make it as easy as possible for teachers to use the Internet in the trigger-event context; walk through each step of the process with a teacher for him or her to make use of the WWW in the classroom. An intranet approach, with a connection to the Internet, for example, may remove many practical problems for the teacher, in that he or she can download WWW materials, prepare and adapt them in advance, and use them with better control and without time sensitivity in the classroom.
- Consider not putting the school computers only in a computer room, but instead look to the ideas of a "portable" computer room: a trolley of laptops that can be rolled into the classroom; a laptop with built-in modem that the teacher (and students) can take home for preparation; a convenient way (such as infrared) to connect to a network, or at least an Internet connection handy to the teacher's desk; and, most importantly, a transviewer device on top of the classroom overhead projector and as common as the overhead projector so that the teacher can use the computer with network connection for demonstration purposes as he or she teaches as well as for student access during project and individual work. This model (Moonen, 1996) would move us much ahead of the first-level problems that have confronted teachers' attempts to integrate computers in their lessons during the last decade. It may be that the computer-room model, with its heavy and bolted-down computers, will frustrate creative and targeted Internet use even more than it has frustrated computer integration.
- Support the enthusiasts; it is their energy which will stimulate creative applications and overlook frustrations. For the rest, the majority of the teachers, work soberly on the convincing trigger event application.

References

Collis, B. (1996). *Tele-learning in a digital world: The future of distance learning.* London: International Thomson Computer Press.

Collis, B., Knezek, G., Lai, W., Miyashita, K. T., Pelgrum, H., Ti., & Sakamoto, T. (1996). *Children and computers in school. Mahwah*, NJ: Lawrence Erlbaum Associates.

Collis, B., & De Vries, P. (1993). The emerging trans-European network for education and training: Guidelines for decision makers. Report prepared under assignment from the Task Force Human Resources, Education, Training and Youth (now DG XXII), Commision of the European Community, Brussels.

Moonen, J. (1996, July). *Many questions, and a few answers.* Closing presentation to the UNESCO Second International Congress on Education and Informatics: Educational Policies and New Technologies, Moscow.

Betty Collis is with the Faculty of Educational Science and Technology at the University of Twente, The Netherlands.

2

Instructional Design and Creativity I

Editor's Note: Dick, W. (1995). Instructional Design and Creativity: A Response to the Critics. *Educational Technology, 35*(4), 5-11.

Prologue

> *If everyday design were ruled by aesthetics, life might be more pleasing to the eye but less comfortable; if ruled by useability, it might be more comfortable but uglier. If cost or ease of manufacture dominated, products might not be attractive, functional, or durable'. Clearly, each consideration has its place. Trouble occurs when one dominates all the others. (Norman, 1988, p.151)*

The phone in the office rang and it was Larry Lipsitz, editor of *Educational Technology*. "Walt, I got another one!" "Another what?" I asked, wondering why I should know what Larry had." Another one of those articles that says that ISD results in boring instruction. I get these all the time. Why don't you write something on creativity and instructional design? There has to be some response, doesn't there? Don't you feel an obligation to respond?" The last sentence was clearly an emotional trigger to get me to commit to writing an article on this topic. Since I'm a consulting editor, and thereby get a free subscription to this pricey publication, it seemed like a reasonable challenge. I responded, with firmness in my voice, "Let me think about it."

Time went by and I did think about it. The issue of creativity is being raised by the Situated Cognition/Constructivist/Anchored Instruction crowd (collectively referred to in this article as "the critics"), who are into really interesting, and sometimes exciting, stuff. I use the word "stuff" because I am not convinced that everything they create is instruction, and, in fact, neither are they.

Part of the critics' continuing justification for the validity of their ideas about the desirability of creating learning environments is that traditional instructional designers, who follow the holy grail of ISD, create boring instruction. "They" claim that these designers, who in real life are perfectly fine, intelligent people, find themselves following a linear process that results in effective and efficient instruction, but instruction that isn't very interesting or engaging. "They" say that the ISO process is the culprit.

While I knew what I thought about the issues raised by the critics, I decided to find out what four of our Masters students thought about them. As part of their comprehensive examination at the end of the Masters program in Instructional Systems at Florida State University, I asked Stacey Kaufman, Karen Rice, Iris Seet, and Monte Watkins how they would define creative instruction and to indicate if they thought the ISD process resulted in boring instruction. If it does, how could the process be changed? As you might suspect, none of the students thought there was a problem with the process; the problem, if there is one, lies elsewhere. They wrote in formative answers to my questions, and I acknowledge their contributions to the thoughts that follow.

Historical Roots

The historical roots of much of what today is referred to as instructional design was Skinnerian psychology, especially as it was manifested in programmed instruction (PI) (Dick, 1987). Skinner's reinforcement theory was used to create carefully constructed self-instructional materials which provided students with a series of small frames of information, and questions and answers related to that in formation. A process similar to what we now refer to as formative evaluation was used by programmers to alter the instruction to minimize the errors made by students as they went through it.

Because students learned at their own pace, there was no group interaction built into the instruction. The purpose was to provide students with materials from which they could master a topic or skill.

The PI approach was used in a few materials for public schools and universities, and more extensively by the military. While there is no official death certificate, most unbiased observers would probably agree that programmed instruction died from the boredom expressed by students. Many students rebelled at the small steps and the forced writing of obvious answers to questions. They didn' t find the feedback very reinforcing.

While the PI form at did not survive the 60s, the general approach that was used to create it did. Skinnerian ideas were supplemented with those of the three Roberts: Robert Mager on objectives, Robert Glaser on criterion-referenced testing, and, perhaps structure for the field has been endorsed by the orders paid in advance. Most importantly, Robert M. Gagne's events of instruction and conditions of learning (Dick & Carey, 1990). While the model used by designers has expanded and changed since the early days of programmed instruction, the critics claim that we still have a problem with boredom; that we are not very creative.

Do we have an official measuring stick for boredom? Or, for that matter, for creativity? No, we don't. Research psychologists have measured creativity by asking people to name as many uses for, say, a brick as they could think of, or to form as many analogies as possible in a given period of time. The more answers, the more creative the person. But what do we mean by creative *design*? I don't really think that that question can be answered to each reader's satisfaction. Therefore, I will assume that each has a general idea of what these characteristics are, and could recognize them in his or her own domain. Actually, later in this article we will have specific suggestions about how we should define and measure creativity in the design context.

It should be acknowledged that this is not an empirical paper in which data will be presented that prove that designers who use a systematic instructional design process produce creative instruction. I am not aware of any data that indicate the degree of creativity exhibited by designers. Therefore, this article will only add to the conceptual debate on these issues.

Additional Analysis of the Scope of the Problem

It seems important to try to determine if the problem of boring instruction is limited only to those who use the systematic instructional design approach. Probably every reader has experienced, at one time or another, boring teacher-led or professor-led instruction, as well as boring TV instruction and boring self-instructional materials. Since very little instruction is systematically designed, we can assume that boring instruction can result from nearly any design approach. We should also agree that boring instruction can result from the use of any delivery system—from boring computer-based training questions to talking heads. And, perhaps we should also agree that there is, in fact, a continuum from the most boring of instruction to the most creative of instruction. It is not an "all or nothing " characteristic.

Does the Use of the ISD Process Result in Boring Instruction?

If designers use a process that learners claim results in boring instruction, then we must accept that fact. But we might want to look again at the process used by the designers and determine if they really used it appropriately. We are all aware that time and financial constraints can restrict what designers actually do on any given project. Compromises are often made, and sometimes they are costly in the end.

When I asked the Masters students about the design of creative instruction, they pointed to three areas in the design process as being critical to this outcome. The first was learner analysis. They indicated that creative instruction is somewhat in the eye of the beholder, in this case, the learners in the target population. The more we learn about them before we design the instruction, the more we can match their interests and concerns in the instruction. If the learners are anonymous, then we lose this tailoring of instruction to their interests.

The second concern of the Masters students was the instructional strategy component of the model. This is the area in which the designer specifies the delivery system, and how the content will be organized and presented to the learners. In the Dick and Carey model of instructional design (Dick & Carey, 1990), it is suggested that designers provide certain introductory information, along with information and practice and feedback for each of the major objectives to be taught. There is a great deal of freedom here in terms of how information will be clumped, and what kinds of practice activities will be used. There is no reason why other theoretical approaches could not be used to formulate the strategy for conveying information to the learner (or for the learners to identify the information that they require). In addition, each of the Masters students mentioned the use of Keller’s (1987) ARCS Model as a means of systematically addressing the motivation of learners. Keller has indicated that motivation has four components which can be included by the designer as part of the instructional strategy: (1) gaining the attention of the learners, (2) demonstrating the relevance of the instruction to the learners, (3) instilling learners with confidence to succeed with the instruction, and (4) deriving satisfaction when they do. The routine use of the ARCS strategy should insure that even the least creative of designers can develop instructional experiences that are engaging to learners. Keller’s ARCS model can be interpreted as a set of specific strategies for designers to use in order to be creative in their designs.

Formative evaluation was the third area of the model that was identified by the Masters students. Their point was that if “creative instruction” is an important characteristic of the instruction to be produced, then an array of questions can be asked during the formative evaluation to determine just how creative the instruction is perceived to be by learners. The learners can be asked such questions as, “Did this instruction hold your interest throughout? Were there places where you lost interest? Did you enjoy the game? What was the most interesting part of the instruction ? How could the instruction by made more interesting?” etc. The answers to these questions can be used to revise and refine the instruction so that it is viewed by learners as being interesting, i.e., not boring.

Two aspects of the design process were not stressed by the students in their answers to my questions: (1) knowledge of the subject-matter domain under consideration, and (2) knowledge of the context in which the to-be-learned information will be used by the learners. Researchers who have investigated the difference between novices and experts in any given field have determined that experts have developed extensive knowledge bases which they draw upon when they are solving problems in their areas of expertise. In a similar fashion, the greater the knowledge the designer has about both his or her own area of expertise and the area in which the instruction is being developed, the greater the likelihood that innovative approaches can and will be taken in the instruction. Since designers are often working in subject-matter domains in which they have no formal training, they must rely on subject-matter specialists to provide the content information. This can be a constraint on the creativity of any designer.

Related to subject-matter knowledge is knowledge of the context in which knowledge and skills will be used. Designers have been accused of decontextualizing instruction, i.e., presenting knowledge and skills without sufficient emphasis on examples of situations in which the skills will be used . Most Constructivists stress strategies for encouraging the transfer of skills from the learning context to the performance context. If designers are knowledgeable about the latter context, they can develop instruction that is not only more creative and interesting to the learner, but that also promotes transfer.

In summary, the Masters students said that ISD is not a process that results automatically in boring instruction. Interestingly, motivating instruction can be created by the designer through extensive use of learner analysis, various instructional strategies, and extensive formative evaluation. In addition, the designer's creativity will be enhanced by broad subject-matter knowledge or access to it, as well as knowledge of the context in which the newly-learned skills will be used.

Do Traditional ISD Evaluation Criteria Result in the Creation of Boring Instruction?

Let's extend the discussion about the ISD model to determine whether, *even when appropriately applied*, the model might result in the creation of boring instruction. The traditional criteria used to evaluate systematically designed instruction have been *effectiveness* and *efficiency*. The major factor driving an appropriately conducted formative evaluation is the posttest for effectiveness. The posttest is designed to assess the terminal objective for the lesson, and some of the subordinate objectives. The designer carefully summarizes the results of the posttest to identify the objectives that have not been achieved by learners. This information is used to reexamine what is being taught as well as the strategy for teaching it. Changes are made that increase the likelihood of correct performance by future learners. These changes may have nothing to do with how interesting the instruction is.

The second criterion usually applied to instruction, but at a much lower level than effectiveness, is efficiency. Does the instruction provide just what is required in order to master the objectives in the least amount of time? This criterion is usually addressed by the designer in the instructional analysis process, i.e., the process used to analyze the instructional goal in order to identify the subordinate skills that must be included in the instruction. The process is used to identify exactly those skills that are required by the learner to master the terminal objective, and, by inference, to reject skills and knowledge that are not required to achieve mastery. Designers are always admonished to eliminate the "nice to know" so that the instruction will be efficient as well as effective.

Thus, when effectiveness and efficiency are used as the major criteria for the formative evaluation, the characteristics of the instruction that are related to these criteria will get attention during revisions. It should be acknowledged that designers often use questionnaires that ask learners what they like and dislike about instruction, but the predominant use of the data is not to make the instruction more interesting *per se,* but to make it more effective.

The Creativity Criterion

Those who say that ISD instruction is boring are, in effect, invoking a new criterion to be used when evaluating instruction, namely its "Creativeness." The Masters students who wrestled with this issue identified several interesting definitions for creative instruction. One said that creative instruction is "instruction that keeps learners motivated while still meeting the objectives of the instruction. "The emphasis here seems to be on keeping learners on task so that they will achieve the objectives. There is the obvious assumption that there will continue to be objectives for the instruction, and we know that many of our critics abhor the use of objectives.

Another Masters student, who has a total quality management orientation, said that creative instruction "engages the learners and goes beyond their expectations." The focus is clearly on the perceptions of learners and their expectations, and not the expectations of reviewers of the instruction.

The critics identified an area in which ISD is vulnerable, namely, the lack of creativity in the products we design? Should we now add "creativity" to *effectiveness* and *efficiency* as the criteria by which our instruction will be evaluated and revised? Before we answer that question, let's consider what we have learned during the last ten years from the quality movement, and how that might relate to the design of creative instruction.

What's Quality Got to Do with It?

In recent years, designers have become more aware of the importance of the client's needs and perceptions regarding any product that is being delivered. Proponents of performance technology stress that instruction is usually only one component of a complex solution to an organizational problem. Performance analysis and needs assessments are becoming more routine as predecessors to the determination that instruction is the solution. Often it is not.

Likewise, from the quality movement we have learned that quality is determined not by the attributes of the product but by the satisfaction of the customer. "What the customer wants, the customer gets" is the motto of the quality movement. For designers who work in organizations with a quality orientation, there is a keen awareness of the need to satisfy their clients in terms of producing products that meet and even exceed their expectations.

What does this have to do with the design of instruction? It suggests that we can have our theoretical orientations, and argue back and forth about their validity, but in the "real world " it is the client who sets the parameters for what will be characterized as an acceptable product. Our client may place a premium on creative instruction, just as our critics insist, or they may be much more into other aspects of the instruction, such as effectiveness and efficiency. Some clients may, in fact, be more interested in where instruction is delivered, and when it is delivered, and to whom. They may be less concerned about either effectiveness or creativity.

It would seem that the most reasonable assumption to make as a designer is that a client will- want instruction that is effective, efficient, and interesting. That third criterion has always been there even if it was only implied. Our critics would have us, quite appropriately, recognize it as an important part of the design process. They would seem to focus almost exclusively on it, though, while I would simply add it to the other criteria, with the understanding that my next client will determine the relative importance of these and other criteria.

Conditions for Producing Creative Instruction

How is creative instruction designed? Let's begin with the assumption that all of us are more or less creative, and, as the research has shown, there is not a high correlation between intelligence and creativity. It would seem that, based upon what we have learned in recent years, there are at least four major factors that should be addressed. (Note that these are not presented in boxes with procedural arrows. They can be addressed in almost any sequence!)

> **Client criteria.** We must begin with the assumption that a needs assessment has indicated that instruction is part or all of the solution to a problem or opportunity within an organization. In the identification of the characteristics of the solution, the client has indicated that the designer should place a high premium on the design and development of creative instruction, that is, instruction that will be engaging to learners and exceed their expectations.
>
> By establishing this criterion, the client is implying that time and resources can and should be spent on learner analysis, learning context analysis, performance context analysis, examination of a variety of technology-based platforms, and formative evaluation.
>
> **Climate supportive of creative approach.** It is one thing to espouse creative approaches to instruction, it is another to create a work environment that supports and lets it happen. We have learned that we can't train people to demonstrate new skills on the job and then ignore the environment in which they are going to use those skills. Managers and supervisors must reinforce the development of creative instruction and reward those who do it best.
>
> **Participatory design.** The Masters students who responded to the question about the design of creative instruction mentioned the inclusion of instructors and learners on the design team. While this may not be unique to the design of creative instruction, the importance of knowing the characteristics of the target population and the instructors will be critical for creating engaging instruction.

> Perhaps one of our problems in the past was that we failed to ask ourselves this question about instruction we designed: "Would I like to study or participate in this instruction?" Even if we thought that we would, we might fall prey to the Fallacy of Self-Projection. This little known axiom states that designers should not make design decisions based upon what they, themselves, would like, or what they think their own children would like. There is almost always a gulf between the designer and the learners. That gulf includes age, education, and experience. The only way to bridge the gulf is to spend time with the learners and their instructors. Enter their world rather that making them enter your own.
>
> **Implement technology.** With a mandate from the client, support from the management, and the incorporation of learners and instructors on the design team, it is now appropriate to consider the technological opportunities that are available to provide creative, engaging, interesting, motivating instruction.
>
> Not many years ago, the media selection decision was based upon the selection of medium x or y or z. Now, often we have all the media available to us in various multimedia platforms. We still must decide how to present certain information, but it doesn't have to be at the cost of another medium. A learner can draw on a database, view a film clip, answer some questions, or send an e-mail message to another student.

Those who have designed instruction for a number of years recognize the almost exponential number of alternative ways to think about the design and delivery of instruction. It is nearly impossible to think about a situation in which the designer could fail to create engaging instruction. Certainly the opportunities are there like never before. This point leads us to the consideration of certain issues that will arise in any organization in which there is a desire to develop more creative instruction.

Is There a Down Side to Creativity?

In a recent article, Schultz (1994) discusses the problem of self-deception, a problem akin to self-projection. He describes a situation in which the executives of a company that had recently downsized were encouraging the employees to increase their risk-taking and creativity. He discussed the matter with the executives and asked them to say what first came to their minds when he said the word "creative." Schutz indicates that their responses were immediate: "beard, sandals, dirty, unreliable, late reports, never there when you want him." Their responses to "uncreative" were: "neat, on time, prompt reports, reliable." At the conclusion of the discussion, the executives decided they really didn't want more creativity.

The purpose of relating Schutz's experience is not to say that creativity has a negative connotation, but rather to indicate that it is important to be extremely clear about the characteristics of what will be considered creative and what will not, and how that relates to the current culture of the organization. If, with certain populations, this is a loaded term, perhaps we should look for more descriptive words, like motivational, engaging, appealing, or even unusual.

The second consideration is how to approach the designers who are to become more creative. Our critics would say that their lack of creativity is due to the use of the wrong model of instructional design. However, those that I have talked with speak more of time pressures, resource limitations, the organizational requirement for traditional instructional approaches, and the apparent satisfaction of both clients and learners with the instruction as it is now being delivered. Nothing succeeds like success, and once an approach is successful, it is sometimes very difficult to displace it with an unproved approach. If, on the other hand, present approaches are being severely criticized, then this is the opportunity to try something new.

Does the Linearity of the Design Process Limit Creativity?

We can't leave the topic of this paper without some consideration of what seem to be the fundamental concerns of our critics. While they may acknowledge the usefulness of certain components of our design model, they are concerned with what they perceive as its *linearity*, and the consequent limitations on creativity. They interpret the standard ISD model as requiring the designer to begin with the first box on the left and to proceed, lockstep, toward the right from one box to the next, never thinking about the next box until the present one is “completed.” This lockstep approach is seen as severely limiting the designer’s options in the process; it doesn’t allow for moving back and forth among the steps as new information and insights are gained.

My response to this observation is that the model that appears in the Dick and Carey (1990) text was never intended to reflect how instruction is designed in the “real world.” It was created initially as a way of representing the various innovations that were occurring in programmed instruction and curriculum development, and to place those innovations in a sequence in which they would be useful to the user. Over time the model has changed only slightly, and it has been learned initially by thousands of students as a left-to-right, one-step-at-a-time process. It always seemed to me that this is a reasonable strategy for teaching a process to novices.

Few students are very creative on their first use of the model on a project. They focus on how to perform each step in the model, and how to create a product that can be formatively evaluated. Few will ever do it exactly that way again. They will do what works for them, and what is required or permitted by their employer. And the more experience they have at designing instruction, the more effective, the more efficient, and the more creative they will become.

It should be explicitly noted that it is quite demeaning to practicing designers to be accused of creating boring instruction because they can think of and do only one step of the model at a time. This observation implies that some designers have been able to break out of this mental model and are now able to produce creative instruction via unspecified approaches. The rest are left behind, forever locked into an inappropriate linear model. That this argument is taken seriously surprises me. It is a straw man of the first magnitude. I know of no designers who either believe or practice such a rigid approach to their profession. Designers are aware of the need to consider many components of the model at the same time, and in no way can their thinking be described as linear.

How Do Designers Really Do What They Do?

Although I am highly critical of a number of studies in the literature that purport to describe “what designers really do,” I am willing to accept the evidence, such as in Wedman and Tessmer (1993), that indicates that designers do not do all the steps in the typical ISD model. Designers are aware of what steps they do and the ones that they don’t do, and they can give a variety of explanations, such as those listed above about why visitors learning anything? we asked. He still didn’t understand. Attendance at the museum was high. It systems design: Five principles toward a new mindset. designers are not more creative, for their selection of steps. Therefore, I find no evidence in either the literature or my experience that suggests that designers are not creative simply because they blindly follow a linear, ineffective, model.

Will Our Instructional Focus Be Lost?

Perhaps the greatest threat to appropriate application of Constructivism within our profession is the possibility that we will lose our *instructional* focus; that creativity will replace effectiveness, that having fun will replace learning something, and that we won’t know the difference. How many times recently has the reader encountered some new “instruction” that was engaging, fun, and almost addictive? What happens when the designer asks, what will students know or be able to do when they finish this activity that they couldn’t do before? If there isn’t a good answer, then what we have encountered is probably entertainment.

This concern is perhaps the most important for all designers who consider themselves to have an overwhelming need to be creative. If we find ourselves in situations in which the criteria for evaluating our instruction are re-prioritized so that effectiveness and efficiency are superseded by creativity, we could easily find ourselves creating mere *edutainment* or *infotainment*.

The constructions of our critics will likely find a place in our education and training programs, but I am not sure why. They often assume entry behaviors that learners don’t have. They provide practice on skills that have never been mastered or were mastered long ago. They purport to encourage problem solving but offer little evidence of such because of the Constructivist aversion to *criterion-referenced testing*, that is, the reluctance to establish standards of performance that all learners will achieve. The “assessments” that are utilized are usually in the form of presentations of portfolios of completed activities. No value judgments are made. But, is it educationally worthwhile if the learner is simply engaged, and has fun?

Those designers who adhere to a systematic design approach may be the only employees in an organization who focus on changes in human performance. Many industry savants suggest that, in the future, most companies will have access to the same technology and that it will be very difficult for any given company to gain a significant technological advantage over other companies. What will make a difference for an organization is the competencies of the staff, and particularly their abilities to anticipate and solve problems. Here we are, back in the camp of the Constructivists and their focus on relevance, context, and problem solving.

Are Instructional Design and Constructivism Compatible?

Constructivists have argued that you are either with them or against them. You can’t accept only some of their ideas and reject the rest (Bednar, Cunningham, Duffy, & Perry, 1992). I disagree with this position. We have benefited greatly from the concerns raised by the Constructivists, and the next edition of the Dick and Carey (1996) instructional design text will reflect some of these influences. However, the text still features a fundamental systematic design process.

I would argue that designers who augment ISD fundamentals with judicious use of selected Constructivist principles will make design decisions that result in instruction that is both engaging to learners and produces learning outcomes that are required by the client. What is required is a balanced perspective, and a balanced set of criteria by which we evaluate our efforts. (See Lebow, 1993, for a set of Constructivist values that he suggests might be adopted by instructional designers.)

Design and technology are important for businesses and scientists alike. In a recent statement by the American Association for the Advancement of Science (1990, p. 28) about what all Americans should know about science and technology, there appeared the following statement: “But there is no perfect design. Accommodating one constraint well can often lead to conflict with others. For example, the lightest material may not be the strongest, or the most efficient shape may not be the safest or the most aesthetically pleasing. Therefore, every design problem lends itself to many alternative solutions, depending on what values people place on the various constraints. For example, is strength more desirable than lightness, and is appearance more important than safety? The task is to arrive at a design that reasonably balances the many trade-offs, with the understanding that no single design is ever simultaneously the safest, the most reliable, the most efficient, the most inexpensive, and so on.”

As a closing comment, let me recount an incident described by Norman (1988, p. 153), who is a psychologist interested in the design of things we encounter every day. He describes his visits to a local science museum at which he observed that visitors try hard, seem to enjoy themselves, but usually miss the point of the displays. “The signs are highly decorative; but they are often poorly lit, difficult to read, and have lots of gushing language with little explanation….! took one of my graduate classes there to observe and comment; we all agreed about the inadequacy of the signs, and, moreover, we had useful suggestions. We met with a museum official and tried to explain what was happening. He didn’t understand. His problems were the cost and durability of the exhibits. ‘Are the visitors learning anything?’ we asked. He still didn’t understand. Attendance at the museum was high. It looked attractive. It had probably won a prize. Why were we wasting his time?” Are designers also wasting the time of the critics?

References

American Association for the Advancement of Science. (1990). *Science for all Americans*. New York: Oxford University Press.

Bednar, A. K., Cunningham D., Duffy, T. M., & Perry, D. J. (1992). Theory into practice: How do we link? In T. M.

Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction: A conversation*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Dick, W. (1987). A history of instructional design and its impact on educational psychology. In J. A. Glover & R. R. Ronning (Eds.), *Historical foundations of educational psychology*. New York: Plenum.

Dick, W., & Carey, L. M. (1990). *The systematic design of instruction* (3rd ed.). New York: HarperCollins.

Dick, W., & Carey, L. M. (1996). *The systematic design of instruction* (4th ed.) New York: HarperCollins.

Keller , J. M. (1987). Strategies for stimulating the motivation to learn. *Performance & Instruction*, 26(8), 1- 7.

Lebow, D. (1993). Constructivist values for instructional systems design: Five principles toward a new mindset. *Educational Technology Research & Development , 41*(3), 4-16. Reprinted in B. Seels (Ed.) (1995). *Instructional design fundamentals: A reconsideration* (pp. 175-187). Englewood Cliffs, NJ: Edwucational Technology Publications.

Norman, D. A. (1988). *The design of everyday things.* New York: Doubleday Currency.

Rowland, G. (Ed.) (1994). Special issue on designing for human performance. *Performance Improvement Quarterly, 7*(3).

Schutz, W. (1994). Self-deception: The first explanation. *Training, 31*(9), p. 110.

Wedman, J., & Tessmer, M. (1993). Instructional designers' decisions and priorities: A survey of design practice. *Performance Improvement Quarterly, 6*(2), 43- 57.

Walter Dick is Professor of Instructional Systems in the Department of Educational Research, Florida State University, Tallahassee, Florida.

3

Instructional Design and Creativity II

Editor's Note: Rowland, G. (1995). Instructional Design and Creativity: A Response to the Criticized. *Educational Technology, 35*(5), 17-22.
In his recent essay in this magazine, *Instructional Design and Creativity: A Response to the Critics* (1995), Walter Dick seeks to combat a particular form of criticism relating to the creative attributes or "creativeness" of instruction produced through systematic instructional design. Since I have criticized traditional ISD methods and was listed in the references to his article, I must assume that·1 am one of "the critics" to whom he was responding. I would not previously have described myself as part of what he describes as the "Situated Cognition/Constructivist/Anchored Instruction crowd," but I do find merit in much of the work in these areas, so I'll accept the label for the sake of argument. Similarly, I will assume Professor Dick to represent "the criticized," i.e., those who argue for the strength of ISD methods.

Professor Dick makes a number of statements on which I would imagine critics and criticized to concur. For example, he says that creativity can be enhanced by designers having "broad subject-matter knowledge or access to it, as well as knowledge of the context in which the newly learned skills will be used" (p. 7), and that conditions can be set up to facilitate creative approaches. He speaks of practicing designers going beyond the sequence of tasks suggested by models, and also makes an important point regarding the "Fallacy of Self-Projection" (the false perspective obtained by seeing oneself as the audience of a design intended for others). In a number of other areas, though, the two groups would likely depart.

Professor Dick makes a variety of arguments. The two most central appear to be that (1) creativity or "creativeness," something argued for by "the critics," should not dominate the traditional criteria of effectiveness and efficiency, and (2) ISD methods do result in "creative instruction" when they are used appropriately. I'll use these statements and a few of the assumptions or claims that appear to underlie them as the organization for my response below. I hope they do not somehow distort Professor Dick's intents. Likewise, where I refer to "the critics," I hope I do justice to the arguments of those who might identify themselves as such. First, here is a list of the statements and some associated assumptions/claims I identified. I hope they will at least frame issues in ways that foster dialogue.

1. **"Creativeness" should not dominate effectiveness and efficiency**

    1a. *"Creativeness is a criterion that can be meaningfully applied to design products.*

    1b. *Designers must balance criteria and not allow one criterion to dominate all others.*

    1c. *If "creativeness" were to dominate other criteria, the result would be edutainment or infotainment—engagement and fun rather than learning.*

    1d. *Effectiveness and efficiency are the appropriate criteria for instruction.*

    1e. *"The critics" argue for "creative instruction."*

2. **ISD methods do result in "creative instruction" when they are used appropriately.**

2a. *Following a particular process has predictable results.*

2b. *High-quality instructional products result from following high-quality procedures.*

2c. *ISD methods lead to boring instruction no more than any other methods.*

2d. *Appropriate use of ISD includes careful learner analysis, various instructional strategies, and extensive formative evaluation.*

2e. *ISD methods involve more than linear representations suggest.*

1. "Creativeness" should not dominate effectiveness and efficiency.

For circumstances where effectiveness and efficiency are appropriate and are sought, I believe that the critics and criticized would agree. It's tough to argue with a desire to do the right things right. However, the critics would probably ask for clarification on what is meant by "creative instruction" or "creativeness," and would likely say that the criticized base their response on a misunderstanding of the critic's arguments. I'll try to explain the concerns that might be raised with this statement more clearly by exploring the assumptions/ claims that appear to underlie it.

1a. *"Creativeness" is a criterion that can be meaningfully applied to design products.*

Professor Dick suggests that "creative" or "creativeness" could be added as a third criterion to effectiveness and efficiency, and refers to "creative instruction" at the opposite end of a continuum from "boring instruction." He avoids giving a precise definition for "creative" or "creative instruction," choosing instead to offer at different points that to be creative, instruction might be interesting, engaging, motivating, fun, and, of course, not boring. He adds that creative instruction might keep learners on task, go beyond expectations, and be unusual.

The critics and the criticized would probably agree with Professor Dick that it would be challenging to define to the agreement of many, a complex construct such as "creative." Some might push for it to be done and refer to the large body of literature on creativity for a starting point. This literature, at least that with which I am familiar, tends to address process more often than product, i.e., creativity in designing as opposed to creativeness of designs. For example, Akin (1994) talks of problem setting as opposed to problem solving as an area where creativity might be important in designing. But some sort of definition could be selected nonetheless. (Tardif & Sternberg, 1988, provide an excellent summary that would be useful.)

A couple of points that one might consider in doing this come to mind. First, designs are by definition creative. That is, to design is to initiate change and to create something new-a unique pattern for a situation (Holt, Radcliffe, & Schoorl, 1985; Jones, 1992). So if "boredom," "motivation," or something related is the construct to be examined, it would be better to call it that rather than "creative" or "creativeness." My personal view is that "creative" applied to a design product would better focus on elegance and uniqueness, for example, on the parsimony of a product's form or the degree or unique ways in which it brings powerful and beneficial change to a problematic situation. Earl's (1987) notion of a design respecting but outwitting constraints would seem especially appropriate.

Second, Professor Dick's argument mirrors the debate of style versus substance in many design fields. I imagine that the critics and the criticized would strongly agree with the admonitions that he cites regarding the importance of emphasizing substance (Norman, 1988). So investigating the conditions and potentially negative consequences of a dominating "style" criterion in instruction ("style" describing outward appearances or form, as in fields such as industrial or interior design) could be worthwhile and beneficial. As I will address below, however, the critics would argue that taking "creative instruction" or "style" as the defining characteristic of their philosophy (or any philosophy) is awkward.

1b. *Designers must balance criteria and not allow one criterion to dominate all others.*

I cannot think of an authentic situation where I or other critics would disagree. The nature of such balance will vary according to the situation and the needs and desires of the client, of course, but there will always be some competing criteria to be considered and balanced.

lc. *If "creativeness" were to dominate other criteria, the result would be edutainment or infotainment—engagement and fun rather than learning.*

I like being engaged in tasks, having fun, and learning, and associate all three with my more powerful learning experiences. I'm not sure that the criticized or critics would argue that these characteristics are exclusive, but Professor Dick seems to load "creative" with a sort of "dominating evil" that has to be combated (in response to the "dominating evil of ISD" opinion held by the critics?). I suspect that the groups would agree on the statement that designers should focus on treating people with respect—helping them to have powerful experiences from which they learn—not on entertainment. They might differ on just what "respect" and "powerful experiences" might mean, of course, but would agree on learning being the primary purpose of designs.

1d. *Effectiveness and efficiency are the appropriate criteria for instruction.*

Whether this claim read the appropriate criteria or just appropriate criteria, the critics would likely agree, but with one important caveat relating to the assumptions underlying the statement. When one assumes, as the criticized appear to do, that there is knowledge in the world that can be communicated to a learner through instruction, the designer should attempt to do so as well and as easily as possible. She or he should define up front what skills are to be obtained and how they will need to be demonstrated, select the best strategies for teaching them, then measure what is accomplished. This may even include situations where "creativeness" is explicitly sought, i.e., where creative" objectives are defined and strategies selected accordingly.

But the critics would argue that when one does not accept the assumptions of knowledge being "in the world" or independent of the knower, or the possibility of knowledge being somehow "communicated to" learners, then "instruction" with its connotation of furnishing learners with knowledge is not a very useful construct. And "effectiveness" and "efficiency" (the degree and cost of communicating a set body of content) are not appropriate criteria. They are biased to the view that knowledge can be defined precisely prior to the learning experiences of a class of people, thus held as a standard for post-measurement.

I certainly do not claim to be an expert on constructivism, and would defer to other critics for a response. But I do recognize that it refers to a philosophy, in particular to a set of epistemological assumptions about how humans come to know things, not merely to methods or to the properties of designs (Jonassen, 1991). There are designs that are better matched to constructivism (e.g., those that support situated learning), as there are designs that better fit the assumptions of an objectivist view (e.g., those that stress behavioral or information-processing principles). But criticizing designs created from a constructivist view in terms of criteria derived from an objectivist view, and vice versa, is fruitless. It makes no more sense than judging the quality of a naturalistic study in terms of objectivist criteria such as validity and reliability (Lincoln & Guba, 1985). So criticizing designs that are created by an individual or team that has chosen (either explicitly or tacitly) to make constructivist epistemological assumptions with the objectivist criteria of effectiveness and efficiency makes no sense. And adding "creative" or "creativeness" as another objective criterion does not help.

le. *"The critics" argue for "creative instruction."*

I cannot claim to have read everything that we critics have written (or to even know who "we" are). I'll simply refer to my statements above. The "Constructivist/Situated Learning/Anchored Instruction crowd" may be proposing alternative features for learning environments based on their differing epistemological assumptions. But the term "creative instruction" is itself so confusing from what I understand constitutes a constructivist view that I doubt they would argue for such.

1. ISD methods do result in "creative instruction" when they are used appropriately.

There are many parts to this statement, making it difficult to respond to the whole. In general, the critics would likely see it as an overstatement born of overconfidence in methods.

2a. *Following a particular process has predictable results.*

This is, perhaps, the central reason for being systematic. If a particular pattern of thought and action are taken, then a particular result can be expected. In terms of instructional design, this means that valid instructional prescriptions can be made based on what is known to have worked in the past. The critics would probably agree with this claim as long as it is made in reference to designers and design teams who hold an objectivist view and to situations where it is productive to treat problems as well-defined or “tame.” By well defined I mean situations where one can assume that a fairly complete understanding of a problem or the initial conditions of a situation will be achieved prior to engaging in solution specification, where appropriate and efficient paths to the solution can be identified up front, and where single correct or optimal solutions can be obtained (Rittel, 1972).

The criticized seem to argue that the large majority of the situations instructional designers face can be effectively treated in this manner. The critics, and based on my own experience I am certainly a critic in this area, argue that situations effectively treated as well-defined represent a minority of those encountered. And with the increasing pace of change in the workplace, they are growing less common rather than more. We would argue that with increasing frequency, designers are called upon to create for unique and complex circumstances, where standard answers to predefined categories or classes of problems are ineffective. In a recent issue of Performance Improvement Quarterly (Rowland, 1994), these situations were said to require transformation rather than elimination of differences.

From the critics’ perspective, designers are required to solve ill-defined or “wicked” problems. Or, more accurately, they find it necessary to treat situations as such (Buchanan, 1992). Rather than reducing complex situations to a set of values for variables in order to apply known rules (prescriptive principles applied to the results of an “analysis phase”), the designer needs to “see through” complexity, propose alternative models that may lead forward, and invent the forms that bring new definition. He or she finds it necessary to maintain a posture of reflective skepticism throughout the design process, giving only weak and tentative faith to definitions of the situation derived at the outset through “performance analysis” or “needs assessment” processes. (Senge, 1990, does a nice job of explaining this point with regard to organizational change.) Unfortunately, the latter approach is not yet well developed in the educational technology field. Maybe the criticized would call it something besides instructional design? (Perhaps the domain of the “learning systems designer”?) We critics would argue that this manner of thinking falls more clearly under the umbrella of “design” than the technical task of applying rules in solving well-defined problems. If nothing new is needed, then design is unnecessary.

2b. *High-quality instructional products result from following high-quality procedures.*

This adds the notion of “high quality” to 2a above. It suggests that procedures exist, high-quality procedures presumably, that lead with a degree of certainty to high-quality products. If one defines quality (or “creative instruction”) in terms of motivation, for example, then learner analysis is assumed to result in facts about what will motivate learners; strategies for motivating these learners can be systematically selected using these facts as data (i.e., applying known principles such as those of the ARCS Model); and motivation can be insured through formative evaluation. Professor Dick states that “The routine use of the ARCS strategy should insure that even the least creative of designers can develop instructional experiences that are engaging to learners. Keller’s ARCS model can be interpreted as a set of specific strategies for designers to use in order to be creative in their designs” (p. 6). Elsewhere he states “It is nearly impossible to think about a situation in which the designer could fail to create engaging instruction” (p. 9). The latter statement is made in the context of a discussion regarding the widening range of alternative technologies and delivery systems, but both statements illustrate the strong confidence the criticized have in systematic methods.

I won’t repeat what I stated above, but the well defined versus ill-defined distinction is important here again. The critics might agree that faith in determinism underlying claim 2b is well founded, or at least not especially harmful, for simple, routine situations where well-defined and independent problems can be identified and solved. However, they would argue that such faith is not warranted for more complex, unique (and today, more common) situations where a perception of ill-definedness is more appropriate. Some would even say that these latter situations represent all instances of designing (see Buchanan, 1992).

What I can add to the debate here is a brief reflection on studies of designing and systems thinking. While results are certainly preliminary in the instructional design context and should be viewed with skepticism (as should any other results in preliminary form), the views that appear to dominate traditional models and pedagogy do not seem to match practice well, at least not in terms of what is revealed from o serving experts solving problems. Experts appear to make a conscious choice based on experience to treat problems as ill-defined (see Thomas & Carroll, 1979). For example, solution ideas seem to be proposed in concert with inquiry into problem details rather than being determined by prescriptive principle after such details are established. Is that because the knowledge base of prescriptive principles is immature? Studies in other fields, such as architecture, that have been around for many years longer than instructional design have similar results (Cross, 1982), so perhaps not.

Similarly, the literature of systems science reflects a brief period, primarily the 1960s and 1970s, where deterministic methods were applied in the "human activity" or social systems context. Such methods are today often given the label "hard systems thinking," meaning that systems are treated as hard or concrete entities. The most salient characteristic of hard systems thinking is the reduction of complex situations to manageable, simple representations that can be treated as those situations (Checkland & Scholes, 1990). Such methods were generally ineffective in the social systems context and have been supplanted by "soft systems thinking," something having much in common, both methodological and philosophical, with the approach to treating design problems as ill-defined (Rittel, 1972). For example, in soft systems thinking, systems models are seen as relevant to debate about situations, or as a means to consider the nature of an ill-defined situation, not as those situations or as truthful definitions (Checkland, 1995).

2c. *ISD methods lead to boring instruction no more than any other methods.*

Professor Dick says that the critics argue that ISD methods reduce creativity and lead to boring instruction. I'm not sure that I am one of the critics here. While I agree with Jones (1992) that systematic design processes tend to artificially separate logic and imagination, and problems and solutions, if I have said or implied that ISD resulted *necessarily* in a loss of creativity or in boring instruction, shame on me. There is nothing inherent in ISI methods that results in either. But in contrast to what Professor Dick seems to imply, the critics would likely argue that there is nothing in ISD that leads to "creative instruction" either. He states that examples of boring instruction that were not prepared using ISD methods exist. I would add that plenty of examples of "creative instruction" (to use his ideas for definition, examples of interesting, engaging, and motivating instruction) that were not prepared using ISD exist also. In fact, in my classes when we begin to engage in generating ideas for new designs I have made a habit of asking my students to recall their "best learning experiences" and the "features that made them so good." Since starting to ask these questions, I have received close to 400 responses, and I have yet to be able to make a direct link in any single response from what is cited as responsible for high quality to the use of ISD, or to systematic methods in general. Am I blinded by a critic's perspective? I don't believe so. Are methods invisible in the recall of design artifacts? I'm not convinced that they are, since I find it quite easy to recall features from my own learning experiences that indicate that systematic methods were used.

I believe that the issue is that ISD methods do not in and of themselves provide the core creative elements of the best designs, those that people recall as being especially good. So if these core ideas that result in the best experiences are not to be found in systematic development processes, I (and perhaps other critics) am forced to conclude that ISD may be helpful, but it is insufficient and apparently unnecessary. (And if someone wants to say that ISD is not intended or in many circumstances able to produce "best experiences," and wishes to cite time and cost constraints, for example, then I would ask "Why not?" and suggest that the critics and criticized had begun a useful inquiry into creativity in design!) As Glenn Wilson and I have noted elsewhere, where ISD is most helpful may be more in managing design processes, for example, in communicating among team members than in designing (Rowland & Wilson, 1994). Is it great tool that gets misinterpreted and therefore misapplied?

2d. *Appropriate use of ISD includes careful learner analysis, various instructional strategies, and extensive formative evaluation.*

Professor Dick argues that the critics may be responding to inappropriate use of ISD when they say it has undesirable results. He identifies three elements that would constitute at least part of "appropriate use" in contexts where creative instruction was desired. I believe that the critics would agree that "extensive use of learner analysis, various instructional strategies, and extensive formative evaluation" (p. 7) are appropriate. They might counter that what remains of "appropriate use" in the thinking and acting within these elements and outside of them is unclear. My own impression is that "appropriate use" severely underestimates the task. I believe that carried out expertly—with expertise that we have just begun to understand—ISD can be helpful and can, in situations where such is sought, result in "creative instruction." To say that it does help and that it does result in creative instruction from appropriate use seems quite a stretch.

2e. *ISD methods involve more than linear representa tions suggest.*

Professor Dick states that no designers think linearly (i.e., follow lock-step linear processes in their thinking), and that the critics who use this in their arguments against systematic development are employing a "straw man argument of the first magnitude" (p. 9). In defense of this position, he says that the Dick and Carey Model is a pedagogical tool, never intended to be used in practice. I won't presume to answer for the critics here; I can only reflect on my own experience (which I readily acknowledge to be far less than Professor Dick's). The majority of my own design experiences, and the reports I have received from students and other colleagues tend to reinforce Professor Dick's position. However, I have seen and heard about a number of settings where ISD models, often the Dick and Carey Model, are in fact imposed as strict controls over designing. They are employed as lock-step linear patterns consistent with their graphic representations. In such circumstances, the intent may be to provide a tool to help achieve control over designing, say by helping the designer to manage the complexity of many factors and many tasks to accomplish, but the effect is to place constrictive control in designing, for example, to constrain the designer's ability to pose solution ideas as a means to better understanding problems. So from my perspective, the argument may be relevant in a minority of situations, but it is no straw man.

For example, outside of major corporations (and, in a couple of cases, inside) I have seen design fal l entirely to inexperienced individuals, those who have taken a single course in design or a single workshop, or even to those just given a book to read. As Professor Dick suggests, some are able to adapt processes to their situations and work in the manner they find works best. Others attempt to "follow the rules" precisely and expect those rules to be sufficient in and of themselves. My own students often return and say that "we follow the Dick and Carey Model in our organization," and when I probe to understand what that means, I learn on occasion that they have been required to carry out a series of independent steps, one after the other with little thought and no room for discussion given to the next until the time for that step has come. To emphasize this point, I recall in my work with a Fortune 100 company a few years ago, a team that had modified the company's systematic process of 9 steps to include 70 sub-steps, most to be completed in a prescribed order. They boasted of a more detailed version that included several hundred independent tasks to be completed one after the other. As Professor Dick argues, a hundred steps in a model does not translate directly to thinking about step 95 only after step 94, etc., but the designers in this setting gave every indication that they had placed considerable faith in creating instruction by doing just that.

As an aside, I was pleased to see Professor Dick's description of the use of his model, in print. I have heard him say such things in person, but worry that others have not. When I look at a linear representation, I imagine a variety of interpretations: a lock-step sequence, starting and ending points or milestones for overlapping activities, or placeholders that are filled iteratively like blank pages tacked to the wall). The first interpretation emphasizes acting systematically, while the last emphasizes thinking systemically. Professor Dick would have us interpret his model as systematic and systemic. Apparently "appropriate use" implies such.

Regardless, I believe that the critics will find "linear" versus "non-linear" or "iterative" to be a deceptive framing of the issue. Perhaps more profitable would be a discussion of determinism and definedness. Traditional ISD models are built on assumptions of determinism {see Buchanan, 1992). They assume the capability of calculating the features of the best possible design by thoroughly analyzing a situation to identify its definite conditions, then applying the correct "if-then" principles and prescriptions (i.e., prescriptions of the form: if X conditions exist and Y outcomes are desired, then Z methods will work best). That sort of thinking may be helpful where principles are known and where problems are productively treated as well-defined. Otherwise not. And this is a special cause for concern where someone interprets a situation as well-defined (e.g., instruction is the answer) when in fact the defining statements have oversimplified a complex of interdependent factors. I believe that the field of human performance technology grew out of such concern.

In Closing

I hope that my thoughts expressed here are useful in furthering the debate on issues relating to instructional design and creativity. The criticized argue the power of ISD methods and the quality (e.g., "creative" attributes) of products resulting from their appropriate use. I believe that the critics would argue that such power lies more in the experience, expertise, and creativity of the designer than in ISD methods. They would find the posing of constructivism versus a "creative" criterion awkward, also.

My own view is that our understanding would be enriched by clearer distinctions between epistemological and methodological issues, and by inquiry addressing determinacy, indeterminacy, and perceptions of definedness in design thinking. I believe there is much more to designing than what we currently know, that methods need to be reconsidered, and that creativity is an area where we would benefit from careful definition, dialogue, and research. A few of the questions that come to mind include:

- Where and when should designers choose to view situations as ill-defined?
- Is there room for both determinacy and indeterminacy in designing? In what areas and contexts?
- Whose point of view is most important, and how can this perspective be best respected in designing? Can a designer who holds a constructivist view design well for a client wanting objectivist instruction and vice-versa? Where and how are the learners' and other stakeholders' views involved?
- How much faith should we have in methods? For what?
- If creativity is not encouraged by current methods, what sort of alternative tools would do so? Would these alternatives necessarily constrain or de emphasize other criteria?

References

Akin, O. (1994). Creativity in design. *Performance Improvement Quarterly, 7*(3), 9-21.

Buchanan, R. (1992). Wicked problems in design thinking. *Design Issues, 8*(2), 5-21.

Checkland, P. (1995). Model validation in soft systems practice. *Systems Research, 12*(1), 47-54.

Checkland, P., & Scholes, J. (1990). *Soft systems methodology in action.* New York: John Wiley & Sons.

Cross, N. (1982). Designerly ways of knowing. *Design Studies, 3*(4), 221-227.

Dick, W. (1995, July-August). Instructional design and creativity: A response to the critics. *Educational Technology, 35*(4), 5-11.

Earl, T. (1987). *The art and craft of course design.* New York: Nichols.

Holt, J. E., Radcliffe, D. F., & Schoorl, D. (1985). Design or problem solving: A critical choice for the engineering profession. *Design Studies, 6*(2), 107-110.

Jonassen, D. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology Research & Development, 39*(3), 5-14.

Jones, J. C. (1992). *Design methods* (2nd ed.). New York: Van Nostrand Reinhold.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry. Beverly Hills*, CA: Sage.

Norman, D. A. (1988). *The design of everyday things.* New York: Doubleday Currency.

Rittel, H. (1972). On the planning crisis: Systems analysis of the 'first and second generations.' *Bedriftsokonomen, 8*, 390-396.

Rowland, G. (Ed.) (1994). Special issue on designing for human performance. *Performance Improvement Quarterly.*

Rowland, G., & Wilson, G. (1994). Liminal states in designing. *Performance Improvement Quarterly, 7*(3), 30-45.

Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization.* New York: Doubleday Currency.

Tardif, T. Z., & Sternberg, R. J. (1988). What do we know about creativity? In R. J. Sternberg (Ed.), *The nature of creativity: Contemporary psychological perspectives* (pp. 429-440). New York: Cambridge University Press.

Thomas, J. C., & Carroll, J. M. (1979). The psychological study of design. *Design Studies, 7*(1), 5-11.

Gordon Rowland is Assistant Professor in the Corporate Communication Department, Ithaca College, Ithaca, New York.

4

Creativity and Innovation in Instructional Design and Development

Editor's Note: Caropreso, E. J., & Couch, R. A. (1996). Creativity and Innovation in Instructional Design and Development: The Individual in the Workplace. *Educational Technology, 36*(6-), 31-39.

This article considers ways to enhance individual creativity and how a creative individual can help develop a more creative workplace that utilizes creative approaches to instruction and instructional products. The nature of creativity is discussed from several perspectives, including: (1) the problem of definition and a general point of view; (2) some basic elements of creativity; (3) enhancing the creativity of individuals; and (4) roadblocks to individual creativity and how to overcome such obstacles leading to more productive, creative individuals and work environments.

Creativity seems "fluffy," that is, unsystematic and hard to define. In many settings, particularly training environments, creativity is often discouraged as a seemingly inappropriate waste of time and money. However, instructional designers in businesses and other settings, as well as scholars, are re-evaluating this notion of creativity, particularly in the area of product innovation and product development. For example, a recent series of articles by Dick (1995a, b), Rowland (1995), and Willis (1995) has explored the relationship between systematic design and creativity. We noted with interest the dialogue between these authors regarding what can be termed as constructivist vs. behaviorist approaches to instructional design.

We share some of these authors' questions and concerns. For example, we are concerned about issues related to defining terms and concepts, but we don't believe that creativity can be defined, as seems to be done by Dick, by reducing it to the opposite of boredom (see Dick, 1995a, b). In fact, in this paper, we directly address the issue of unmotivating and uninteresting instruction; this is one of our specific purposes. We also share the concerns about meeting client needs, but we believe that clients as well as managers and designers/developers can be educated about the nature and impact of creative design. In this vein, we'd like to share some of our concerns that have not been addressed in this dialogue.

We are concerned about the levels of learning and the types of knowledge and skills that designers/developers target in their instructional design. If instructional designers believe that their job is limited to the development of declarative knowledge and basic procedural skills, a behavioral approach to instructional design will suffice. We base our presentation on a belief that there exists a need to target and develop complex learning outcomes, together with the skills needed to apply these learnings in real-world settings. Despite our shared concerns, our point of view in this paper is beyond these philosophical issues; our purpose is to present an applied approach to developing and supporting creativity in the instructional design/development process.

Especially as businesses seek new sales strategies, more desirable employee relations, and more innovative products, management has discovered the need for more innovative products and for more innovative training. Unfortunately, most of the instructional materials and methods being produced in industry are repetitive and therefore often unengaging and uninteresting; from company to company, they often look identical. This lack of innovation can create three distinct and inappropriate results: (1) ineffective instruction/training (we didn't meet our instructional outcomes);

(2) undermining of learner motivation and, concurrently, of design team motivation; and (3) lack of sustained improvement in both the learner and the designer[1].

Interestingly enough, for years business people have respected intuition when it occurred, but typically relied on logic and analysis for problem solving. Successful business people have demonstrated a keen sense of intuition, "knowledge which exists without some sort of conscious reasoning" (Ray & Myers, 1986, p. 8). But this behavior was never labeled as creativity; it was considered to be an instinct, and as such, was perceived as difficult to explain and impossible to teach to others.

In an effort to avoid this unexplainable "quality" and to try to keep product development simple and cost-effective, many businesses overemphasize analysis. This is no less true in the field of training. Once a problem has been identified, not merely acknowledged (the step in problem solving that is most often left out), problem solvers tend to approach problem situations in several non-creative ways. For example, problem solvers might analyze a problem until it goes away, refusing to deal with it directly, expecting others to solve it, or allowing it to become a "lower priority," which they never get to. Occasionally, the problem is "miraculously" solved, that is, no one knows exactly what became of the problem, or through top-down management, the manager "solves" the problem. This lack of focus on creativity combined with an overreliance on analysis forces designers and/or developers to limit and restrict their instruction rather than use a design model as a heuristic. In many companies, this over-analysis tends to be the most important step toward a solution. The team leader (or boss) defines the problem and soon the rest of the team will generate 20 solutions. A solution will be identified and attempted and/or some product will be developed. Unfortunately, and often at a later time, it is discovered that "the" problem wasn't really solved because the "real or actual problem" wasn't identified in the first place; this is especially true since most "real-world problems" often involve complex problem situations rather than single "problems."[2] Unlike this analysis approach, which is focused only on a solution and/or the product, a creative approach to problem solving is an ongoing process.

The systematic design model as developed by authors such as Dick and Carey (1990) and Gagne and Briggs (1979) is like a road map. When you take a trip, you can travel the most direct route and get there in the shortest time, which can lead to an uninspiring trip and often an uninspired traveler, especially after many trips down the same road. On the other hand, travelers can change their travel plans by deciding to leave at a different time, using a different vehicle, taking an alternate route, taking more time to arrive, etc. Though the destination may be the same, the experience is different. In instructional design/development terms, when creativity is used to develop a "richer" and more personally motivating instructional product, the trainee is trained more richly and fully, and his or her attitude about the training is likely to be more positive, which, in turn, pleases that client. The traveler arrives more refreshed and excited about the trip.

The heuristic which is the instructional design/development process requires creativity, the specific epistemology, constructivism vs. behaviorism, notwithstanding. The need for creativity must be recognized by management as well as by instructional designers. This perception must also be developed by clients, because client satisfaction leads to further business opportunities. But if clients have a limited understanding of and appreciation for creative products, they will not appreciate the time and resource demands necessary for their development and therefore the necessary time and resource demands to develop creative instructional design. Creative behavior should be an integral part of the design/development process because this behavior is useful, resourceful, correct, and valuable to the process. Creativity is not simply being different for the sake of difference. The end product, the instructional materials or methods, for example, is important. However, designers must start to explore their own creativity as well as the environment within which they work in order to develop more innovative instruction. This can and perhaps should entail a lifetime of exploration, not a series of isolated or random "good ideas."

In his recent article, Dick (1995a) suggests that a principal condition for producing creative instruction involves the development and maintenance of a supportive climate. He indicated that new skills, especially what can be termed creative skills, require the support of an appropriate environment, including the recognition and encouragement by management. We couldn't agree more. In fact, this summarizes our basic position. What we attempt to describe are what we perceive to be some of the essential elements in this relationship between the individuals attempting to develop creative instructional design products and the work environment that enhances their creativity.

It's easier to be creative in a company whose policies and management encourage creativity, but it is not a requirement for individual creative expression. Through the years, researchers have explored two different ways to infuse creativity into a variety of settings: (1) change the environment or (2) change the individual.[3] Many authors have advocated the social psychology of creativity (e.g., Amabile, 1983; Csikszentmihalyi, 1975; Simonton, 1975), in which the work environment is altered to allow for more innovation and creativity (see Couch & Miller, 1991). This makes sense, especially when most psychologists would agree that it is easier to change the work place than it is to change individuals. However, this does not mean that individuals cannot change, becoming more aware of their own and others' creative potential.

This article addresses ways to enhance individual creativity and how a creative individual can help develop a more creative workplace that utilizes more creative approaches to instruction and instructional products. We will discuss the nature of creativity from several perspectives, including: (1) the problem of definition and a general point of view; (2) some basic elements of creativity; (3) enhancing the creativity of individuals; and (4) roadblocks to individual creativity and how to overcome such obstacles leading to more productive, creative individuals and work environments. In his response to Dick, Rowland (1995) notes in his closing remarks, "…there is much more to designing than what we currently know; that methods need to be reconsidered, and that creativity is an area where we would benefit from careful definition, dialogue, and research." We believe that Rowland is suggesting that a useful construct of creativity can be identified, one that is applicable to individuals in unique circumstances, yet which can be interpreted to be global and generally applied. This is in stark contrast to Dick's (1995a) claim that the meaning of creative design is so idiosyncratic and individualistic that any type of general but flexibly applicable construct is unspecifiable. Our perspective directly addresses some of Rowland's (1995) concerns.

The Nature of Creativity: A Definition

Creativity is an essential skill necessary to meet the needs of future designer/developers of instruction, yet creativity is one of the most elusive and therefore variously defined concepts in psychology and education (see Tardiff & Sternberg, 1988). For example, Dick (1995a) does not attempt to operationalize creativity, but he certainly suggests an interpretation when he connects it to individual and domain-specific perception, then anchors it to one end of a continuum of instruction, the other end of which is boredom. With concepts such as this, it should come as no surprise when people wonder if creativity in art is the same as creativity in business, or if creativity in science is the same as in the theater. We believe, along with many others (e.g., Amabile, 1983; Amabile & Gryskiewicz, 1987), that the difference between the artist and the business person or the instructional designer/developer is not necessarily in the nature of creativity but rather may be found in the interactions between the individual, the environment, and content of one's work. Many factors apparently influence the potential for creative outcomes, regardless of the particular definition of creativity used in a given situation. Some of these influential factors will be presented in the following sections.

What is creativity? Typically, creativity has been considered in terms of the following four categories: process, product, person, and place (Stein, 1969, cited in Simonton, 1988; Tardiff & Sternberg, 1988). No simple or singular answer has yet been identified, but the following components seem to be frequently specified by many theorists and researchers alike (for example, Amabile, 1983; Caropreso & Andres, 1994, 1996; Sternberg, 1988): (1) **Novelty or newness with usability.** [4] Whether general and cross-disciplinary or discipline-specific, creative behavior or outcomes defy traditional, conventional, or previously accepted expectations for behavior or products; for example, solutions to problems which are unexpected or have been outwardly rejected at some point will be seen as the only appropriate solution to the problem through the efforts of someone's creative vision; and (2) **Freedom** to play, to manipulate ideas, and/or objects, to experiment, to take risks, to conform to normative expectations when necessary, to make many trials and many errors without regret, all as part of a creative problem-solving process. Amabile and her colleagues (e.g., 1983; Hennessey & Amabile, 1988) have confirmed through their research that a response will be judged to be creative to the extent that (a) it is both a novel and appropriate, useful, correct, or valuable response to the task at hand, and (b) the task is heuristic rather than algorithmic. Even routine activities can be approached creatively.

The Nature of Creativity: Some Basic Elements

Creativity is a very complex process. Unlike Dick's (1995a) suggestion that it can be interpreted as the opposite of boredom, few theorists or researchers have agreed on all features of creativity. Davis (1992, 1995) has described some fundamental factors influencing the development of creativity that seem to be generally agreed upon.

- Creativity is not restricted to any domain or activity; any part or all of an individual's life can be creative.
- Creative activities vary by degree; creative acts or outcomes can be small, as in the drawings of children, or grand and sweeping, as in scientific theories.
- Creativity can be "forced"; Davis cites many examples in which highly creative outcomes resulted from intentional, almost artificial circumstances. For example, the use of analogy to develop new associations was represented by the invention of *velcro* while the inventor was plucking burrs from his dog.
- Creative inspiration and insight can occur spontaneously and lead to unexpected awareness, realizations, associations, images, etc.
- Logical thinking and analysis are required to consider and evaluate the outcomes of creative thought and action.
- Creative potential is normally distributed, that is, like intelligence, everyone has some degree of creative potential, and can therefore behave creatively to some extent, at some times, or under some circumstances.
- Average intelligence, especially verbal ability, is a necessary but insufficient condition for creativity, but these two characteristics are essentially independent. High intelligence will not necessarily lead to high creativity and may even impede its expression.

The Nature of Creativity: The Individual

Traits and Characteristics

Davis (1992, 1995) surveyed the literature on descriptive characteristics of creative individuals and identified 12 fundamental categories of creative characteristics. From this set of 12 categories, we can create a working model of creative individuals. The 12 categories include:

- awareness and valuing of creativity;[5]
- originality, non-conformance, challenging assumptions;
- independence, self-confidence, internally controlled;
- risk-taking, willingness to try something new, copes well with failure;
- energetic, enthusiastic, driving absorption, goes beyond expected levels of performance;[6]
- aesthetic, artistic;
- curiosity, questioning, open to experiences;
- humor, playfulness, plays with ideas;
- attraction to complexity, tolerance of ambiguity and disorder;
- open-mindedness, receptive of new ideas and ideas from others;
- needs time alone, reflective, introspective; and
- intuitive, perceptive, sees relationships.

Based on his research, Davis noted that two essential features mark creative individuals: (1) intense intrinsic motivation and persistence; (2) remarkable, yet expectable differences in the manifestations of creativity, that is, no two individuals will necessarily be or act alike in expressions of their creativity. These are important and useful characteristics in a design/development context. Managers and/or supervisors able to support and encourage creative behavior will develop conditions that will allow for solutions to a much broader range of design/development problems. A creatively functioning design/development team or work group might behave in some or all of the following ways:

- Welcome problematic situations and tolerate ambiguity rather than striving for certainty.
- Be self-critical and critical of others; look for alternative sources of information and problem solutions; seek information and evidence on both sides of an issue and resist being satisfied with first attempts.
- Deliberate, reflect, and search extensively, rather than being impulsive, giving up prematurely, or being overly confident of the correctness of initial ideas and solutions.
- Remain open to multiple possibilities, consider many alternatives, be reflective and postpone judgment while analyzing possibilities.
- Finally, search for and use evidence that challenges favorite possibilities, search for evidence in favor of those possibilities that are initially weak, and consciously search for evidence against possibilities that are at first strong.

Abilities and Skills

There has yet to be a consensus regarding the relationship between intrinsic traits and the influence of the environment and learning to develop the individual's creative potential. Whereas the features of creative individuals reported by Davis are probably not directly subject to training, many creative skills can be learned and developed. The following list presents some of the skills typically demonstrated by creative individuals that have been shown to be influenced by training and practice (see Davis, 1995, for a list of 21 abilities). For the sake of space, each skill is connected to "ideas" as a general category, though we could have just as easily used "products," "problems," "solutions," etc. (see note #2).

- ideational fluency, having many different ideas;
- flexibility, having many different categories of ideas;
- originality, novelty, or unusualness of ideas in a given context (when measured empirically, this has typically been statistically determined as the relative infrequency of a particular response given a set of responses);
- elaboration, adding detail to or developing ideas;
- analogical and metaphorical thinking, recognizing or generating relationships among different ideas;
- logical thinking, rational analysis, and evaluation of ideas (while remaining nonjudgmental, open to possibility, and resisting prematurely concluding the process); and
- evaluation and decision-making.

We would like to point out two features of this list of skills. First, only seven of Davis's list of 21 skills have been presented; similar descriptions exist, as creative skills are considered to be numerous and various (e. g., Amabile, 1983; Barron, 1969; Guilford, 1986; Sternberg, 1988; Torrance & Safter, 1990). No one individual possesses them all or at high levels, necessarily, but *most skills can be practiced and with practice and support they can he enhanced*. Second, high levels of creative output that reflect both unique and useful behavior or responses to problems require a combination of the expansive, free-flowing, unrestricted processes, often described as divergent thinking, and analytic, evaluative decision-making processes, often described as convergent thinking. True creative production rarely occurs in a vacuum, without context or application, but it just as rarely occurs without freedom, playfulness, and the ability to view situations or problems from many different perspectives.

Individuals can identify and develop these abilities and skills in themselves. The first step in developing them is to decide that a need for them exists. The second step is to simply start working on improving one's creative potential by working on one or more skills. Often, these skills interact, necessarily, and can be practiced together, though it may be easier to learn one or a few skills at a time before moving on to others. Trying to change everything at once is often difficult. Finally, you must try to avoid certain "roadblocks to creativity." The next section presents descriptions of some of the most common and damaging limitations to developing and using one's creative potential, and some effective approaches for circumventing these constraints on creativity based on changing the work environment.

The Nature of Creativity: individual and Environmental Roadblocks

Creativity can be constrained and individual potential can be deadened by experiences or factors related to both individuals and the workplace environment. Amabile and her colleagues (e. g., Amabile, 1983, 1989; Amabile & Gryskiewicz, 1987; Hennessey & Amabile, 1988) have uncovered a number of factors that will virtually guarantee that creative outcomes will either not occur or not reach high levels when they do occur. Combined with an individual's potential lack of confidence in or insecurity about his or her personal creativity, such workplace factors will surely inhibit individual creativity.

Evaluation and Reward

Research on evaluation and its effect on creativity indicates that creative people create for the sake of the intrinsic reward, not for external praise or rewards, particularly financial reward as the only or primary extrinsic motivation (Amabile, 1983; Amabile & Gryskiewicz, 1987). This notion reflects the passionate drive or commitment of creative people (Torrance, 1979, 1987). If you want to be creative, find projects which appeal to your intrinsic motivation, and avoid working exclusively for external reward (remaining aware that extrinsic factors are often present and that we all need the "rewards" of our efforts to survive economically). Additionally, constant evaluation, especially if the evaluator is not trusted, stifles creativity. Evaluation is often unavoidable in most business settings; however, to avoid the stifling element of evaluation, try to get top management to evaluate after the project is over rather than during the formative phase of the project. Or simply build a trusting relationship with management which allows one to develop creative products without their external evaluation. Ultimately, the client is the final judge of the product and thus one can't avoid evaluation totally; this reinforces the need to inform clients about the role of creativity in design and development. Also, avoid falling into the trap that managers may inadvertently use to motivate people, financial reward (business people have a strong sense of financial reward as being the most important reward). Most creative people say they do their job so well because they are internally motivated. Many very creative people feel that they lose their intrinsic motivation, or it's threatened, after receiving external rewards. For example, Albert Einstein claimed to have lost much of his motivation after having received the Nobel Prize.

Competition

The by-word in business today seems to be "competition." You hear about competition from everyone from car manufacturers to pyramid sales people. "We need to be more competitive in the world market." This may be true from the perspective of "gaining market share," but in the design/development process, creativity is hampered or even destroyed in a competitive environment.

Though creative people may also act for extrinsic reasons, they are typically intrinsically motivated; therefore, they are often not motivated by competition, or they may be seriously constrained by high levels of competition. One way to maintain creative potential is by trying to avoid being put into a situation where you are required to compete for your ideas to be heard. A design/development team is created because no one person is capable of knowing everything necessary to produce a quality learning product. Cooperation is essential to produce a unique product.

Restricting Choice

An overly structured environment may hamper or even destroy individual creativity, for example, by limiting individuals' opportunities to arrange their own work spaces, most productive times, types of materials, etc. Many creative people do their most creative thinking at times which might not conform to those of their business colleagues, such as late at night when they are alone, or while working on tasks unrelated to the problem at hand, not during team meetings or at their desks at the office. Einstein, for example, felt strongly that creativity could not be promoted by force and rigid regimentation. He felt this way, at least in part, due to his schooling, which was militaristic and which stressed memorization and severe discipline at the expense of personal decision-making, reflection, and problem solving.

Rigidity in the work place can interfere with the creative process. Managers often hire designer/ developers who think like the manager. This may make the manager's job easier in terms of controlling staff and working conditions; the designer/developer knows what the manger is thinking and what the manager likely wants. Some managers hire only those graduates of certain universities, an extreme example of hiring "like-minded" people. The new employees were all trained by the same people and often may have the same "workplace" values and attitudes.

You can gauge the potential rigidity of your workplace by asking two simple questions: "Is the work force diverse?" and "Are the hours flexible?" Diversity and flexibility are essential environmental features that support workplace creativity. And such flexibility is not just one-sided. Creative people willingly work intensively for hours each day to complete an important task or create a worthwhile project. This type of intense work will not happen in a setting that structures work hours or in a setting where fellow workers are worried about "looking bad" or being compensated for long hours. Try to find a job which allows you to be flexible rather than a job where management and employees are "hung up" on arbitrary rules.

Conformity

Alternative perspectives on problems and their potential solutions are not always apparent or even desirable in many work situations. It is often difficult to know how, where, or when to look for alternatives, especially if a solution to a problem at hand is proposed by a team leader, manager, or the "boss." The designer must look for alternative solutions which do not conform to standard, conventional, or "easy" solutions; constantly being aware of the potential pressures to conform and resisting such constraints will promote the circumstances that stimulate creativity. If you feel pressure to conform when you don't think it is appropriate or timely, you must recognize it for what it is and oppose it, especially by trying to remain free and flexible (Amabile, 1989). Opposition can occur simply by considering and suggesting alternative views of the situation. In this way, you will be: (1) contributing to the development of a work environment that promotes creative thinking and action; (2) containing or limiting the potential for resentment and hostility; and (3) helping others to find their own sense of creative flexibility and productivity.

Fear

The most insidious of all the roadblocks to creativity is fear. Fear distracts us from the task at hand and directs our focus away from the problem(s) to be solved. Fear consumes the energy which would fuel our creativity. Fear manifests itself in many ways, both from within an individual unrelated to the environment and as a direct result of environmental factors, including the people with whom we live and work. Fear, which prohibits a person from functioning creatively, may be experienced in any or all of the following ways:

- fear of being criticized;
- fear of losing the security of habit;
- fear of disturbing traditions;
- fear of losing the love of the group;
- fear of truly being an individual;
- fear of being associated with taboos;
- fear of being misused or misguided;
- fear of feeling foolish or odd;
- fear of making mistakes;
- fear of being "successful"; and
- fear of being excluded or left alone.

Fear is often simply a reluctance to deal with the unexpected. It might be experienced as anxiety related to the unknown, or it might be the result of a lack of preparation to deal with what is expected. But fear impedes creativity by misdirecting our energy. Highly creative people demonstrate remarkable resilience and persistence despite threats to creative functioning, such as these fears. One way to combat the limitations related to fear would be to maintain a focus on being creative and not to worry about what is perceived as right or correct by others. This positive point of view can help one to overcome fear as a roadblock to creativity (Koberg & Bagnell, 1981).

Developing Individual Creativity

How can I be more creative in my job as an instructional designer/developer? When Amabile (1989) talks about heuristics in her definition of creativity, she means it in much the same way that Gagne and Briggs (1979) discuss the systematic approach to instructional design. The design model is meant to be a heuristic. Unfortunately, many people who use the design model use it algorithmically, that is, inflexibly and unthinkingly, or without adaptation and modification for the tasks or problems at hand. Regardless of the instructional approach, whether it be a constructivist-interpretist model (Willis, 1995) or a behavioral approach [as suggested by a "rigid interpretation" of the Gagne & Briggs (1979) or Dick & Carey (1990) models], we believe that instruction and learning can be enhanced and improved by increased awareness of the conditions that support individual and environmental creativity.

In addition to the suggestions offered above regarding changes in the workplace intended to support creativity, the following suggestions, drawn from Torrance (1979), are being offered in an effort to encourage and guide individuals in their pursuit of increased creativity. In order to practice and apply these behaviors, the highest levels of learning are required. They are not the result of rote memory or experiences involving repetitive practice without opportunities for complex thinking and problem solving.

- **Problem awareness and definition:** No creative thinking is likely to occur without recognition or awareness of a problem, some definition of the problem, and commitment to work through it. Be persistent. Given a "mess," find the essence of the problem and write one sentence which can define the problem. Continue to generate possibilities of what the problem is; do not be satisfied with the first choice.
- **Produce and consider many alternatives:** The more alternatives a person or group produces or considers, the more likely it is that the essential problem will be identified and a viable, appropriate solution achieved. Resist being judgmental; produce as many alternatives as circumstances will allow before making judgments about what to include and exclude. Resist "premature closure," that is, stay open to possibilities and changes of perspective; don't conclude the process too soon; don't jump to conclusions. Consider all relevant factors, look at the consequences, be clear about objectives, assess the priorities, and identify possible alternatives.
- **Be original:** Originality often requires risking being different, unexpected, unusual, non-conforming, "abnormal," but this is exactly what creative alternatives are all about. Three conditions involving both individuals and environmental factors support original thinking: (1) allowing for adequate time to produce alternatives; (2) playing with ambiguities and uncertainties (providing time to generate "paradoxes" and then time to clarify them); and (3) heightening the concern about the seriousness or importance of the problem.
- **Highlight the Essence:** This type of thinking involves a process of synthesis, of discarding erroneous or irrelevant information, abandoning unpromising facts or solutions, refining ideas, establishing priorities, and allowing a single idea or problem to become dominant. Be willing to set an idea aside and come back to it later if it seems appropriate or give it up entirely and throw it away if it is deemed inappropriate.
- **Elaborate:** Successful creative problem solving requires that chosen alternatives be expanded or developed, that plans for implementation of the solution(s) or idea(s) be developed; of course, the initial alternative must itself be valuable, relevant and related to the problem. Ideas being expanded, plans and organization developed, selling of ideas all require elaboration.
- **Be Aware of Emotions:** Non-rational, emotional experiences can lead to breakthrough illuminations. They can enhance rational processes and provide experiences and information useful in problem solutions. Play with analogies and metaphors, verbally, visually, and kinesthetically. Creative dramatics and scenario writing promote and develop emotional awareness. Role play with colleagues, write and act a skit in which a client or even a product become characters. Put ideas into context; look for and make clear the context, the "bigger picture" for ideas; make connections between individuals' ideas and the world in general.
- **Combine and Synthesize:** Integrate the disparate; bind the unbindable; reconcile the irreconcilable; force-fit parts that don't fit. From out of unexpected combinations, new and surprising revelations occur. This can be the essence of creative illumination.
- **Visualize Richly and Colorfully:** Individuals should try to create and/or use pictures, drawings, and images of their ideas to convey the essence of a problem. Richness of imagery involves intensity and vividness; colorfulness equals sensory appeal and unusualness. Both features reflect an individual's ability to create and develop ideas, concepts, processes, and systems visually or through imagery.
- **Look at It Another Way:** Try to assume new and/or unusual perspectives. Often, breakthroughs come from those who see in new ways, ideas, issues, products, processes, etc. that have been viewed previously from routine or typical perspectives. Break away from habitual and practiced ways of seeing. Turn pictures or photographs on their sides or upside down and describe what you actually see, not what you recall or expect to see. Drive different ways to work or have someone else drive you and actually look at your environment as you travel through it.
- **Visualize the Inside:** Try to look beyond the surface, seek the unseen or unseeable, find hidden aspects of objects, events or ideas, consider the internal dynamics, open up a problem situation. This often leads to the discovery of new, unusual ideas and alternatives. Create a mental image of the inside of the problem. Use mental imagery to create a fantasy world of the problem or of an ideal world.
- **Be Aware of Sound and Movement:** Stimulating kinesthetic and auditory involvements with ideas and experiences can lead to a deeper grasp of the information and therefore to the production of more and more useful, valid alternatives. New insights often occur by experiencing something through multiple sensory modalities. Set aside a problem or task and engage in some type of physical activity alone or with the work group; for example, play a

sport together or practice yoga as a group. Listen to music alone or together as a way of promoting new thoughts or insights.

- **Fantasy:** Transform fact into fiction; suspend your sense of disbelief and judgment. Use fantasy as a means of bridging gaps, making new combinations, discovering the essence of ideas or new ideas, finding deeper meanings leading to new awareness and going beyond the expected and ordinary. Frequently ask yourself and your colleagues, "What would happen if…?"
- **Use and Enjoy Humor:** Humor involves many of the elements of creative thinking, such as synthesis of unexpected elements, surprise, unusual combinations, integration of social, personal, and psychological processes, insight, playfulness, fantasy, etc. Humor often leads to new views and unexpected insights into problems. Humor must be spontaneous; it defies conformity.
- **Get Glimpses of Infinity:** This is especially related to developing and using images of the future and learning to project ideas and perspectives of ourselves and others into the future. For Torrance, focusing on the future is one of the best ways to be prepared for the unexpected, to actively participate in the creation of what will be before it is, to identify and overcome potential limitations to your vision of the future before an unanticipated future controls you. The future is waiting to be shaped by what we think and do every day.

Although many of these suggestions may seem esoteric, one must remain open to possibility. Remember to resist making a judgment and drawing conclusions prematurely. Start by simply practicing one or a few of the skills for several weeks or until you feel comfortable with the skill. Let it sit and try another, or let it spring naturally into one or more of the other skills to which it seems linked. Eventually, these experiences will seem normal or natural and become a part of your work-skills repertoire. As you become more skilled and confident in your creative skills, encourage those around you, whether at home or in the workplace, to share in these experiences with you. Share your thoughts and feelings with whomever is interested in creativity or prepared to experience the exhilaration of thinking and working creatively.

Simply being aware of the need for creativity and trying to become creative on a conscious level will help you to become more creative. You have already taken the first step, that is, recognizing the need to become more creative. As you increase your creative potential and demonstrate the power and usefulness of creative thinking and behavior in your design and development efforts, your colleagues will see the difference and join you in the effort to promote and develop both individual creativity and a creative workplace.

References

Amabile, T. M. (1983). *The social psychology of creativity.* New York: Springer-Verlag.

Amabile, T. M. (1989). *Growing up creative: Nurturing a lifetime of creativity.* New York: Crown Publishers

Amabile, T. M., & Giyskiewicz, S. S. (1987). *Creativity and innovation in the R & D lab.* Greensboro, NC: Creative Leadership Foundation.

Barron, F. X. (1969). *Creative person and creative process*. New York: Holt, Rinehart, & Winston.

Caropreso, E. J., & Andres, B. E. (1994, March). The representation of thinking skills in educational psychology texts: Some of what future teachers are taught about thinking skills. Paper presented at the annual meeting of the Eastern Educational Research Association, Clearwater, FL.

Caropreso, E. J., & Andres, B. E. (1996). *The representation of thinking skills in educational psychology texts: What future teachers are taught*. Manuscript submitted for publication.

Costa, A. L. (Ed.) (1991). *Developing minds: A resource book for teaching thinking* (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Couch, R. A., & Miller, H. B. (1991). Implications of creativity research for the managers of instructional design. In Beauchamp, D.G., Baca, J.C., and Braden, R.A. (Eds.) *Perceptions of Visual Literacy* (pp. 201-216). International Visual

Literacy Association, Scottsdale, AZ.

Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety*. San Francisco: Jossey-Bass.

Davis, G. A. (1992). *Creativity is forever* (3rd ed.). Dubuque, IA: Kendall/Hunt.

Davis, G. A. (1995). Portrait of the creative person. *The Educational Forum, 59,* 423-429.

Dick, W. (1995a). Instructional design and creativity: A response to the critics. *Educational Technology, 35*(4), 5-11.

Dick, W. (1995b). Response to Gordon Rowland on “Instructional design and creativity.” *Educational Technology, 35*(5), 23-24.

Dick, W., & Carey, L. M. (1990). *The systematic design of instruction* (3rd ed.). New York: HarperCollins.

Gagne, R. M., & Briggs, L. J. (1979). *Principles of instructional design.* New York: Holt, Rinehart, & Winston.

Guilford, J. P. (1986). *Creative talents: Their nature, use and development*. Buffalo, NY: Bearly Limited.

Hennessey, B., & Amabile, T. M. (1988). The conditions of creativity. In R. J. Sternberg, (Ed.), *The nature of creativity*. New York: Cambridge University Press.

Koberg, D., & Bagnell, J. (1981). *Universal traveler: A soft-systems guide to creativity, problem solving, and the process of* design (2nd ed.). Los Altos, CA: W. Kaufman.

Ray, M., & Myers, R. (1986). *Creativity in business*. New York: Doubleday.

Rowland, G. (1995). Instructional design and creativity: A response to the criticized. *Educational Technology, 35*(5), 17-22.

Simonton, D. K. (1975). Sociocultural context of individual creativity: A transhistorical survey. *Journal of Cross-Cultural Psychology, 32,* 1119-1133.

Simonton, D. K. (1988). Creativity, leadership, and chance. In R. J. Sternberg (Ed.), *The nature of creativity*. New York: Cambridge University Press.

Sternberg, R. J. (Ed.). (1988). *The nature of creativity*. New York: Cambridge University Press.

Tardiff, T. Z., & Sternberg, R. J. (1988). What do we know about creativity? In R. J. Sternberg (Ed.), *The nature of creativity*. New York: Cambridge University Press.

Torrance, E. P. (1979). *The search for satori and creativity*. Buffalo, New York: Creative Education Foundation.

Torrance, E. P. (1987). *The blazing drive: The creative personality*. Buffalo, NY: Bearly Limited.

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

Willis, J. (1995). A recursive, reflective instructional design model based on constructivist-interpretist theory. *Educational Technology, 35*(6), 5-23.

Edward J. Caropreso and **Richard A. Couch** are with the Department of Education at Clarion University, Clarion, Pennsylvania.

1. Many businesses find a large portion of their profit is spent on training. Part of our job as trainers is to encourage long-term learning and the desire to learn. It is much more cost-effective to train employees once and to have trainees who willingly participate in inservice types of activities. We assume that a more creative approach to instructional development and training will encourage employees to pursue further training. ↩
2. Creativity has been explored for a long time. Some of the methods of developing creative products have been developed through the years and are recognized as being effective, e.g., brainstorming, synectics, analogical thinking. But individual creativity is much more than simply being able to use a problem solving strategy. It is, first, the recognition of a need to be creative, and second, the total immersion of the self; the expressing of an inner vision or even a passion for life. This is a vision which comes out of an individual's innate curiosity, sense of adventure, and willingness to experiment and take risks. Everyone has these traits in varying degrees. Different personalities demonstrate these traits more than others, but everyone has the essence of creativity within. Many factors destroy or subvert creative thinking--schooling is one of the most insidious destroyers (many of the roadblocks to creativity are present in schools). But no matter where you start on the road to creativity, if you want to become more creative, there are some steps which can lead to a more creative self. The first step is to learn more about creativity and how it is determined. But learning about something does not mean that your personality will change. You have to commit to change. The second step Is to recognize the roadblocks to creativity. And, finally, you must start applying simple techniques to your own life and your instructional design/development methods. ↩
3. What needs will business have in the near future and beyond? Many futurists think that the skills we are teaching in schools are not those which will be needed in the future. As fast as knowledge is changing and increasing, how can we teach all the facts necessary to survive in the world? The Education Commission of the States (1982, cited in Costa, 1991, p. 3) indicated that the "basics of tomorrow" are the following:
    - Evaluation and analysis skills
    - Critical thinking
    - Problem-solving strategies (including mathematical problem-solving)
    - Organization and reference skills
    - Synthesis
    - Application
    - Creativity
    - Decision-making given incomplete information
    - Communication skills through a variety of modes.

   Do you have these "basic" skills? The need for more designers, as well as students, managers and clients, who have these "basic skills" seems evident. However, where will these design/developers get the training to be able to perform the essential skills? It is unlikely they will get them in traditional graduate schools; it is more likely they will have to train themselves in these skills. ↩
4. Originality or novelty has typically been defined empirically in statistical terms as the relative frequency of a particular response given a set of responses to a stimulus, prompt, situation, etc. For example, any response occurring at a rate of less than 1% of responses would be considered "original" for the given set of responses. ↩
5. Awareness seems to be an important factor. Individuals must be open to the possibility of and the need for creativity. Creative thinking won't occur if one does not perceive the need for it. ↩
6. Research on creative people has consistently identified their ability to be persistent, to go on in spite of overwhelming obstacles regardless of whether these obstacles are real or perceived. This persistence requires a passion or love for the process, activity or intended product. It also requires a sustained focus on the goals or outcomes of interest. Passion or vision doesn't have to be limited to work experiences; a passion for living can mean taking different routes to work or changing daily routines which become confining rituals. ↩

5

Generativity Theory and Education

Editor's Note: Epstein, R. (1993). Generativity Theory and Education. *Educational Technology, 33*(10), 40-45.
It's not easy to fault Albert Einstein, but on one matter, anyway, he was wrong. Einstein believed that creativity was beyond objective, scientific analysis—and hence, beyond our ability to engineer. "One can organize," said Einstein, "to apply a discovery already made, but not to make one" (quoted in Winokur, 1984, p. 69).

Every subject matter that science has tackled has appeared mysterious at first. The ancient Greeks credited Helios with the task of moving the sun across the sky each day. Every morning Helios left a magnificent palace in the east and crossed the sky in a golden chariot. At night he rested in a lesser palace and then took the river-route home. An appealing image, to be sure, but a spurious explanation for the sun's apparent movement across the sky. After all, the sun isn't even moving. The Helios story is way, way off.

In its pre-scientific stage, creativity, too, has given rise to spurious explanations and mythical tales, tales that proliferate to this day. For example, corporate trainers now tell us that creativity resides in one side of the brain and claim that they can train you to use the appropriate side.. The image, once again, is powerful, but it has no basis in fact. Right-brain, left-brain distinctions are based on a minuscule number of cases of people with seriously defective brains; it's not at all clear that these distinctions, if valid, have any implications for normally functioning brains. Normal people have one brain, not two, thanks in part to a huge structure—the *corpus callosum*—that connects the two hemispheres.

"Spontaneity," said Samuel Butler, "is only a term for man's ignorance of the gods." When something seems to come from nothing—*ex nihilo*—there's one thing we can be sure of: It doesn't. We just don't know enough yet to understand the phenomenon.

Over the last decade or so, creativity has finally begun to give way to a more rigorous understanding. The behavior we call "creative" has been studied in laboratory settings with both animals and people, and that behavior has proved to be orderly and predictable—understandable in objective, scientific terms. The implications for a struggling educational system, for lackluster business and industry, and for personal growth and productivity, are enormous. A thorough understanding of creativity will do nothing less than put us in the driver's seat of that golden chariot that crosses the sky each day.

Generativity Research and Theory

Origins of the Theory

Generativity research began with pigeons, who proved, contrary to popular belief, that a sow's ear can be turned into a silk purse. In the late 1970s, B. F. Skinner and I set about to make fun of some research that was being conducted with chimpanzees. Some rudimentary accomplishments of chimps were being glamourized and anthropomorphized to an extreme, we believed. We thought we could make the point by producing comparable performances in lowly pigeons. Our approach, at least sometimes, was as follows: A pigeon was provided with some human-like training and then placed in a new situation like one a child might face. If new, human-like behavior emerged, we argued that comparable human and chimp performances could be attributed to a simple training history. Somewhat to our surprise, we were able to produce a number of spectacular examples of human-like behavior in pigeons: problem solving, cooperation and competition, even "moral" behavior.

For example, as we reported in *Science* in 1981 (Epstein, Lanza, & Skinner, 1981), a pigeon that has been trained to use a mirror to locate objects in real space can subsequently—and without additional training—use a mirror to locate an object on its body which it cannot see directly. Such behavior in chimps and children has been attributed by some researchers to "self-awareness." We argued that "self-awareness" was a fuzzy idea that only called attention away from the real origins of complex behavior.

Over time, I realized that our simple "Columban simulations"—*Columba livia* is the taxonomic name for pigeon—had other, larger implications. We had provided training, to be sure, but in our test situation, *the pigeons always did something new, sometimes something dramatically new*. The training was the starting point for novel performances. How were those performances related to previous training? Could a new performance be predicted, and, if so, to what extent?

I began, over the next decade, to study many novel performances, ultimately with human adults and children. Other researchers have followed suit. An increasingly clear picture of the creative process has emerged (Epstein, 1985a, 1990, 1991).

Multiple Repertoires

People have long speculated that creativity was a "coming together" of some sort. Arthur Koestler (1964) thought it was the result of "bisociation"—the merging of two distinct ideas. Rothenberg (1971), a psychiatrist, attributed it to "Janusian thinking," after Janus, the god of two faces. In a little known scientific article published in 1935, the eminent psychologist Clark Hull attributed novelty in behavior to "the assembly of behavior segments." So-called "creative" people often describe their creative moments in similar language: Einstein spoke of "combinatory play," for example, and paleontologist Stephen Jay Gould has attributed his creativity to his ability to "make connections" (Shekerjian, 1990).

Generativity research elucidates the dynamics of the combinatorial process. In one study, published in Nature in 1984 (Epstein, Kirshnit, Lanza, & Rubin, 1984), pigeons with various training histories proved able to solve the famous "box and banana" problem of Wolfgang Köhler, who studied how apes solved the problem, and attributed their solution to "insight"—another mystery. In our experiment, a pigeon has received food for pecking at a small facsimile of a banana, and it has also learned to climb and to push a small box toward targets at ground level. Jumping and flying toward the banana when it's out of reach has been "extinguished"—that is, food has been withheld for jumping and flying. In the test situation, the banana is suspended out of reach, and a box is placed on the floor about a foot away.

A pigeon with appropriate training behaves in a remarkably human-like fashion in this situation. At first, it appears to be "confused": It stretches repeatedly toward the banana, motions toward the box, turns in circles, and so on, and then, quite suddenly pushes the box directly toward the banana, climbs, and pecks the banana (Figure 1).

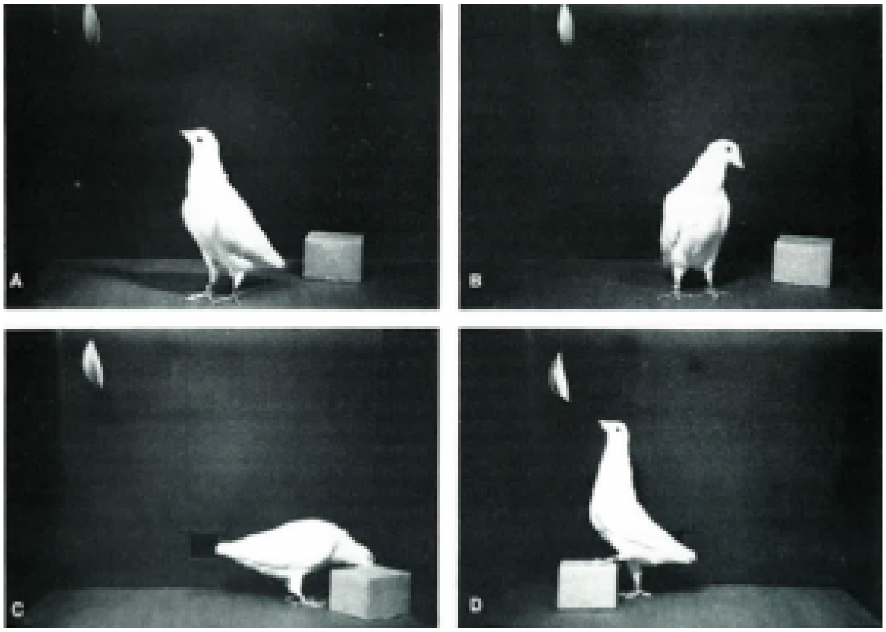


Figure 1. “Insight” in the pigeon. (A, B) The bird looks back and forth from banana to box. (C) It pushes the box toward the banana. (D) It climbs and pecks. (Photo by R. Epstein.)

Altering the training histories of different birds allows us to see how various components contribute toward success or failure in this situation. For example, if you never train climbing, the bird pushes the box until it’s beneath the banana, and then the bird stretches toward the banana and stumbles. One bird we tested mounted the box briefly and then fell off before pecking the banana. If jumping and flying have not been extinguished, a bird jumps and flies to ward the banana for several minutes before finally pushing the box and climbing.

Detailed analyses of videotapes of such performances reveal the dynamics of competition and combination as the various repertoires compete, and more complicated performances, involving up to four separate repertoires and five types of training have been studied (e.g., Epstein, 1985, 1987). The analyses have allowed moment-to-moment accounts of the emergence of novel performances (Epstein, 1990, 1991).

Generativity Theory

Generativity Theory can only be stated precisely as a series of equations or as a computer algorithm. Stated roughly in words, the theory is as follows: *Various processes operate simultaneously and continuously on the probabilities of many behaviors. Novel behavior is an outcome of the resulting dynamics.*

If that is unclear, try thinking about “ideas” or “neural circuits in the brain” instead of behaviors. Typically, many ideas compete for our attention at the same time. Sometimes the competition is fierce-we feel the competition as “confusion”—and sometimes not. Similarly, many neural circuits are active simultaneously in the brain; again, sometimes the competition is intense and sometimes not. The dynamics of competition operate according to certain rules, which I call “transformation functions,” and these rules, specified in a computer program, can be used to simulate or to make predictions about real behavior.

Two Strings

One of several problems I’ve studied with adult humans is Maier’s (1931) famous “two string” problem. Two long strings are suspended from a high ceiling, perhaps 10 meters apart. The subject is informed that it is her task to connect the ends of the strings together. She is also shown a small object—sometimes, a long stick with a hook at the end of it—and told that she may use the object to help solve the problem.

The following performance is typical in this situation: The subject will pull one string toward the other and reach, but the second string is too far away to grasp. The rules of geometry notwithstanding, most subjects will then grab the second string and try pulling it toward the first. Subjects will often repeat these futile steps several times, although less and less frequently as the minutes pass.

Eventually, the subject will pick up the stick to try to extend her reach. That also fails. At some point the subject will tie the stick to one string, often still trying to use the stick to extend her reach. The subject may give up at this point, letting the stick, now tied to the string drop toward the floor. The string, weighted at the end, swings slowly in a small arc, pendulum-style.

Aha. The subject immediately swings the stick in a large arc, walks to the other string, grasps it and walks back toward the swinging string, catches the stick when it swings near, and ties the ends of the strings together.

This fascinating performance proves to be remarkably orderly when the tools of generativity are applied. Moment-to-moment accounts of such performances are possible. For example, the “aha” portion of the example described above exemplifies the simple process called Automatic chaining: Behavior often changes the world in a way that occasions other behavior. When you open a refrigerator door seeking a glass of water, you may find a chocolate cake on the top rack, which suddenly makes eating more likely. When a subject drops the stick and accidentally sets the string swinging, relevant behaviors, such as throwing and catching, are immediately made more likely.

Processes such as automatic chaining, cast into a series of simple equations—the *transformation functions*—have been used to simulate performances on the two-string problem and many others (Figure 2). Computer simulations of novel, problem-solving performances, often look very much like real performances. In other words, novel, problem-solving performances—the kind we sometimes call “creative”—are orderly and predictable.

Current Research Strategy

Currently, generativity research consists of the following:

1. A human subject, either a child or an adult,, s given a simple, mechanical problem to solve, and the performance is videotaped. Problem solving is a good context in which to study novel behavior, because, by definition, one is faced with a “problem” when one must behave in a new way to succeed. The new problems we study are similar to the two-string problem and the box-and-banana problem. They require people to move around and manipulate objects. Alas, to reveal the details of new problems here would lessen their value in the laboratory. The fewer savvy people, the better.
2. From a detailed analysis of each videotaped performance, a behavior chart is created. The chart is a kind of checklist that shows whether each of many different behaviors occurred during various brief, successive time intervals—time “bins.”
3. The behavior chart can be used to derive a *frequency profile* (Figure 3), a set of curves that describes a unique performance by a single individual. The frequency profile gives us a visual picture of the dynamic relations among the many behaviors we have observed.
4. Finally, the generativity model is used to simulate the performance we have studied. The model generates a *probability profile*, like the one shown in Figure 2. When the simulation is successful, the probability profile (generated by the model) resembles the frequency profile (generated by the subject).

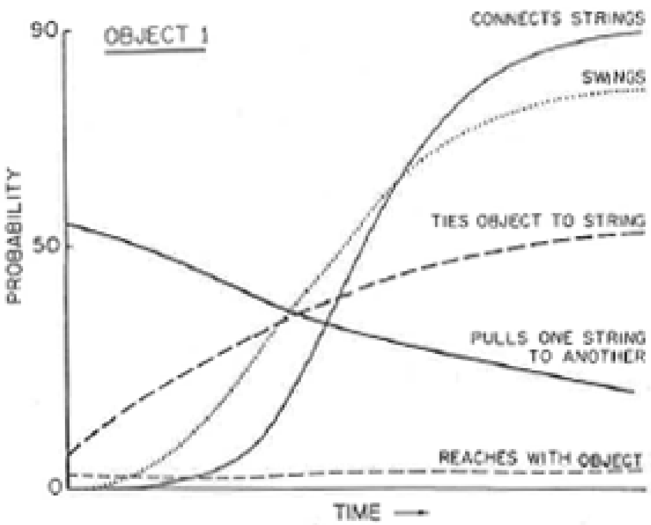


Figure 2. A Probability profile generated by the transformation functions described in the text, shown for five behaviors relevant to Maier's two-string problem. The profile was generated with parameters for a short object (Object 1), which produced rapid solutions to the problem and no irrelevant reaching. Note that pulling one string to the other decreases steadily in probability and that other behaviors increase in probability in an orderly sequence. Tying the object to the string makes swinging more likely, which, in turn, makes connecting the strings more likely.

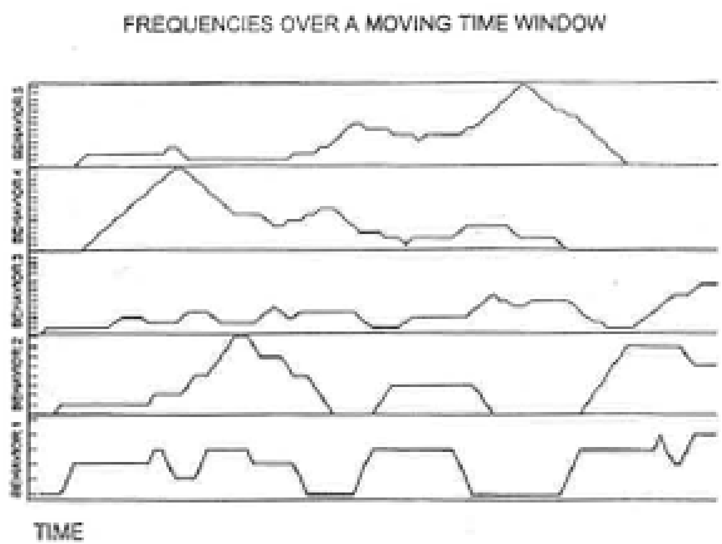


Figure 3. The frequency Profile. A profile is obtained by plotting the frequencies of each behavior over successive, overlapping time windows. In the figure above, five concurrent behaviors are plotted for a single individual solving a problem on a computer screen. The first 118 seconds of the performance are shown, with a 15-second moving window, shifted in successive 1-second increments. The graph shows a smooth transition from behavior 4 to behavior 2, followed by a period of confusion and then a transition to behavior 5. Behavior 3 eventually begins to dominate. The window size, resolution, and increment size can all be varied. At one extreme, when the window size equals the number of observations, the profile yields a traditional "cumulative record." At another extreme, when the window size equals 1, the profile shows a simple frequency count for each behavior.

Real-Time Simulation

Programming is well underway that will take this approach to creativity a step further. On a computer touch screen, a subject can now solve simple mechanical problems by tapping areas on the screen. Every response is recorded and monitored by another computer, which is running the generativity equations. The model will eventually be used to predict subsequent behavior in real-time. After every response, the predictions will be refined, just as predictions are continually updated in real-time simulations of missile trajectories. This approach may some day allow the moment-to-moment prediction of novel performances in real time.

Applications

In recent months, I've written the words and music to twenty-three songs. As I've learned to understand the creative process, I've also learned to harness the process productively in my own life, and so, I believe, can everyone.

Generativity Theory has clear implications for our everyday conceptions about creativity. People believe, for example, that· creativity is rare, but generativity research shows, without question, that everyone is creative. Generative processes are operating all the time in every person. Then why do we label so few people "creative"? And why do so few people seem to produce "creative" works?

The answer has to do with skills. The people we label "creative" have stumbled onto skills that utilize generative processes efficiently. Anyone can learn such skills, and the skills can be taught in our schools.

Four Skill Categories

The skills that tap generative processes can be grouped into four broad categories.

(1) **Capturing.** New and interesting ideas pop into everyone's head all the time. So-called "creative" people have developed skills of various sorts to capture new ideas. Even ideas that don't seem very good might lead to great things later. The key is to preserve the new and unusual.

Artists carry sketchpads, and writers carty notebooks. Composers carry pocket tape recorders or composition books. I have composition software installed in all of my computers, including the notebook computer I carry when I travel.

Simple capturing skills can be taught to anyone even to small children. The simplest skills involve making small change, in one's environment. Primary school children can be encouraged to keep "idea boxes" on their desks or "idea holders" inside their notebooks or lunch boxes. An idea holder is a special place where interesting ideas—interesting designs, funny word combinations, even ideas for new inventions—are captured and preserved, for use later.

People who excel at capturing take note of the conditions under which ideas flow, and they deliberately arrange these conditions as often as possible. Salvadore Dali, the great surrealist painter, deliberately induced the hypnogogic state—the semi sleep state we all experience briefly just before falling asleep—to capture bizarre images. At times he lay on a sofa with his hand balancing a spoon on the edge of a glass on the floor. Just as he drifted off, he dropped the spoon. The sound of spoon against glass startled him, at which point he immediately sketched out the bizarre images he was seeing.

Many people find the "three B's of creativity" to be helpful: the bed, the bath, and the bus. These are settings with relatively few distractions and even fewer demands. Children and adults can easily be taught to identify such settings in their lives. Once identified, the ideal conditions can be sought or constructed.

(2) **Challenging.** Extinction or non-reinforcement—in other words, failure—produces an outcome called resurgency (Epstein, 1983, 1985c): When current behavior is ineffective, all other behaviors that were effective in similar situations in the past tend to recur. When a door is stuck, every behavior that has ever gotten you through a door tends to recur. You pull, push, kick, and eventually shout for help, depending on your particular history.

Failure is a potent fuel for the generative process, because it causes many behaviors to compete, almost immediately, and competing repertoires are the stuff of creativity. Creativity can be induced, therefore, through the careful management of failure—that is, by *challenging yourself* or your students in controlled ways.

(3) **Broadening.** The more repertoires that are available to compete, and the more diverse those repertoires, the more fertile the possible combinations. Therefore, creativity is potentially enhanced whenever we learn something new. The newer the knowledge—the more it differs from what we already know—the more interesting the possible combinations. Our students can and should be taught to broaden their knowledge as a deliberate step toward creativity.

(4) **Surrounding.** Finally, multiple, simultaneous repertoires of behavior are stimulated when we are surrounded by diverse stimuli. If you are driving toward a broken stoplight on which both red and green are illuminated, you feel confused, much as the pigeon might have felt when faced with the box-and-banana problem. The confusion you feel is a symptom of competing behaviors: pressing the brake vs. pressing the gas pedal. Again, our students can and should be taught to arrange multiple stimuli as a deliberate means of spurring the generative process.

Creativity Training in the Curriculum

Each of the four skills categories described above capturing, challenging, broadening, and surrounding can easily be incorporated into school curricula at every level. Even five minutes a day of creativity training would have profound effects. It would allow each child to tap his or her creativity on a daily basis, in every setting, for the rest of his or her life. It would also make many classrooms more interesting and "fun" places to spend the weekdays.

Fully developed, generativity theory may some day be helpful in designing efficient, powerful "discovery curricula." A discovery curriculum is one in which students are taught essential skills that allow them to discover higher-order knowledge on their own, rapidly and efficiently. Moreover, with essential components established, generative processes wi II automatically yield certain predictable, higher-order skills. Curricula designed with generative processes in mind will use teachers in efficient new ways. Many now view the teacher as a facilitator; in the creative classroom, the teacher will facilitate learning, discovery, and creativity, using proven methods. With generative processes doing much of the work, the teacher's efforts will be multiplied greatly.

Johnson and Layng (1992) recently described an approach to "generative instruction" with both children and adult learners who use this approach. They focus on establishing "fluency" in various component behaviors. When students are presented "with new environmental requirements, these behaviors can recombine in new ways that correspond to the higher level complex skills shown by experts. For example, basic number writing, addition, subtraction and multiplication skills are the fluent components necessary to learn how to correctly factor an equation with ease" (p. 1476). Generativity theory may help to optimize such training.

Conclusions

With American education in dismal shape, and educators still obsessed with figuring out how to teach more than a fraction of our high school graduates to read, generativity and creativity would seem to be luxuries. Why worry about the three B's when we still can't teach the three R's?

Generativity Theory is not a solution to the problems in American education. For one thing, these problems are mere symptoms of much larger social ills; new curricula of any sort will not make more than a small dent in such cultural chaos. The theory does, however suggest two simple, powerful, efficient ways to improve curricula and teaching: First, optimal repertoires can be established which will allow children to discover important information on their own—and to feel great about the discovery process. Second, skills for enhancing creativity can and should be taught. Creativity training will impact a child for a lifetime with enormous benefits to society as the ultimate outcome.

References

Epstein, R. (1983), Resurgence of previously reinforced behavior during extinction. *Behaviour Analysis Letters, 3*, 391-397.

Epstein, R. (1985a), Animal cognition as the praxist views it. Neuroscience and *Biobehavioral Reviews, 9*, 623-630.

Epstein, R. (1985). The spontaneous interconnection of three repertoires. *Psychological Record, 35*, 131-141.

Epstein, R. (1985c). Extinction-induced resurgence: Preliminary investigations and possible implications. *Psychological Record, 35*, 143- 153.

Epstein, R. (1987). The spontaneous interconnection of four repertoires of behavior in a pigeon (Columba livia). *Journal of Comparative Psychology, 101*, 197-201.

Epstein, R. (1990). Generativity theory and creativity. In M. A. Runco & R. S. Albert (Eds.), *Theories of creativity.* Newbury Park, CA: Sage Publications.

Epstein, R. (1991). Skinner, creativity, and the problem of spontaneous behavior. *Psychological Science, 6*, 362- 370.

Epstein, R., Kirshnit, C., Lanza, R. P., & Rubin, L. (1984). “Insight” in the pigeon: Antecedents and determinants of an intelligent performance. *Nature, 308*, 61-62.

Epstein, R., Lanza, R. P., & Skinner, B. F. (1981). “Self-awareness” in the pigion. *Science, 212*, 695-696.

Hull, C. (1935). The mechanism of the assembly of behavior segments in novel combinations suitable for problem solution. *Psychological Review, 42*, 219-245.

Johnson, K. R., & Layng, T. V. J. (1992). Breaking the structuralist barrier: Literacy and numeracy with fluency. *American Psychologist, 47*, 1475-1490.

Koestler, A (1 964). *The act of creation.* New York: Macmillan.

Maier, N. F. F. (1931). Reasoning, in humans. II. The solution of a problem and its appearance in consciousness. *Journal of Comparative Psychology, 12*, 181-194.

Rothenberg, A. (1971), The process of Janusian thinking in creativity. *Archives of General Psychiatry, 24*, 195-205.

Shekerjian, D. (1990). *Uncommon genius: How great ideas are born.* New York: Penguin Books.

Winokur, M. (1984). *Einstein: A portrait,* Corte Madera CA: Pomegranate Artbooks.

Robert Epstein received his Ph.D. in psychology from Harvard. He is the author of more than.sixty scholarly papers and several books, including the forthcoming Cognition, Creativity, and Behavior. He also writes for Reader’s Digest and other magazines. He is currently Professor and Chairman, Department of Psychology, National University, San Diego, and Director Emeritus of the Cambridge Center for Behavioral Studies in Massachusetts.

6

Technology and Educational Structure

Editor's Note: Boocock, S. S., (2012). Educational technology classics: Technology and educational structure. *Educational Technology, 52*(1), 55-56.

Most current debate on instructional technology is characterized either by grandiose speculation on the salvation of education through automation (without specification of ***what*** *and* ***how*** *technological innovations will actually be introduced in specific classroom situations, and how the changes will be financed), or by jargon-filled hairsplitting over the relative merits of different types of "hardware." The objective of this article is to bring some order to the debate, by pinpointing what seem to be the most important ways in which technological innovations can have impact upon both the content and structure of education, with major emphasis on the latter.*

Content

The potential contribution of instructional technology is to make the subject matter of the curriculum more immediate and relevant to students' own lives and view of the world. Curriculum developers and educators in general have for the most part failed to take into account the real differences in the media experience of the present school population compared with previous generations, in particular the sophistication of virtually all children, even among the so-called "culturally deprived," with respect to television, film, and computer-related technology.

In the area of the humanities and fine arts, most teaching is still in the form of reading and writing, and because these activities have not played a large part in the family and neighborhood lives of many students, they dismiss the subjects themselves as irrelevant. On the other hand, experimental curricula incorporating sophisticated cinema and television materials (i.e., as opposed to traditional "educational" films, which seem, at best, humorous to children daily exposed to the technical perfection of TV commercials) and the handful of experiments in which young people have produced their own films or TV tapes have suggested that children's own media experiences and preferences can be channeled toward the achievement of academic goals.

In the natural and social sciences, a variety of technological innovations can provide more realistic models of real-life processes for analysis in the classroom.

Simulation games are an example of a technological innovation that seems to have particular relevance in this respect for the social sciences. Because a game is a kind of miniature social system, incorporating many of the roles and role expectations, motivations, and behavior patterns characteristic of real-life situations, simulation games can constitute a kind of laboratory for the social sciences on the one hand, surrounding the student with an environment which gives him the **feeling** of what it is like to be in a variety of social situations; on the other hand, allowing him to observe, manipulate, and interpret his own and his classmates' behavior, under relatively controlled conditions, in much the same way that students of the natural sciences can observe, manipulate, and interpret physical phenomena in the laboratory.

The main point with respect to content is that, to make the curriculum meaningful to children, it must have some visible links to the world as they perceive and experience it. This will require much more attention to and imaginative use of models of communication than previously considered necessary.

Structure

The remaining discussion is based upon two general premises: (1) That **the structure of education is as important as its content**—indeed that the effective transmission of any particular information to students is dependent upon their motivation to learn this information and that the necessary motivation is in turn dependent upon a learning environment which makes learning attractive and rewarding. (2) That the importance of specific types of equipment lies less in the details of their mechanical operation than in their **effects upon the structure of the learning situation.**

For example, one of the most intriguing findings in connection with Omar Moore's "responsive environments" is that the major appeal of the "Talking Typewriter" is the **increased social interaction** facilitated—a voice always responds to the child's behavior. In fact, Moore has found that many of the impressive learning results occur just as regularly when the child works at a regular typewriter with a teacher beside him as when he uses the computer-based equipment.

Our experience with simulation games has been similar. While our original belief was that computer games would raise both motivation and learning, field tests showed that not only was it the social restructuring of the classroom (in particular being able to talk with peers and help each other to learn) that appealed to the participants, but that the complexity of the computerized versions of most games confused students, making it more difficult for them to analyze the causal relationships in a given sequence of play and thus to learn the general principles built into the game model. (My purpose here is not to downgrade technology—on the contrary, the theme of this article is a plea for more systematic exploration of its possibilities—but to underscore the claim that we cannot understand its capabilities and liabilities by studying only the purely mechanical features.)

First, it can make the student more active and autonomous with respect to his own learning. In contrast to the conventional classroom situation, in which the teacher lectures to all students or questions one at a time (while the rest of the class wait in varying degrees of attention and anxiety) or students silently read or do written exercises, devices such as teaching machines, language labs, and simulations allow all or most students to be actively and simultaneously involved. In the first two devices, student autonomy lies in the power of the individual student to set his own pace and sometimes to choose what he will study. In a simulation or game, the locus of control lies with the students as a group, in that all participants must agree upon and obey the rules if play is to continue and they can evaluate their own performance by the outcome.

Second, relationships between students and teachers and among students with each other can be both fuller and more informal. In contrast to one-way lecturing by the teacher (or textbook), teachers and students can work together to grasp the "message" of a film or TV program or to master a new piece of equipment or the rules of a new game. At its best, instructional technology can free the teacher from the functions of disciplinarian, judge of the adequacy of students' performance, and dispenser of rewards and punishments, thus reducing the formality, distance, and mutual distrust characteristic of the student–teacher relationship. (It should be noted that while these changes may be one of the most valuable consequences of many technological innovations, the shifting to greater activity for the student with less control by the teacher may be **initially difficult for the teacher.**)

With respect to student–student relationships, technological innovations which allow a high degree of student interaction and cooperation tend to reward rather than punish individual students for superior performances and effective interpersonal communication. For example, the whole group is rewarded by a spectacular play in a team game or for an especially imaginative detail in a student-produced film. A research implication is that we need to give much more attention to the ways in which children learn informally from each other.

My work with simulation games has indicated that by far the most effective way to teach a new game is to have students work out the rules for themselves, to use older or more experienced players to help new ones, and in general to put as many students as possible into a combination teacher–learner role. However, with the exception of a few isolated examples—e.g., the Penn Sate Pyramid Plan, and some experiments in the poverty program in which teenagers, often themselves school failures, have been given responsibility for persuading younger children to stay in school and even for tutoring them—we have little hard data on how children learn outside of formal, involuntary situations.

Third, it can get students into the education act sooner—that is, let them become creators as well as consumers of educational materials. The boredom experienced by many users of programmed instruction may be partly because most of the real learning was done by the programmer, leaving the student with a pre-chewed product for which the excitement was removed along with the "errors." Again, I must draw largely from my experience with simulation games, since there has been so little serious experimentation in this area.

While it is still an open question what and how much various students learn from participation in a completed simulation game, there is no doubt that those of us involved in the **design** of games have learned a great deal about the subject matter of a given game and about group decision-making processes in general. Thus, some game designers are now experimenting with increasing student participation in the **developmental** phases, by having them validate or revise an existing game or construct one of their own. This kind of activity obviously has relevance to the first and second points above as well as to this one.

Participation by students in the development of learning materials is emphasized here because while few teaching techniques now in common use incorporate it to any marked degree, there is a growing body of evidence showing that this is the kind of activity which is closest to the actual working behavior of scientists, artists, and other creative persons, and that to gain a real understanding and appreciation of any field it is necessary to have some feeling for how new knowledge in this field is produced.

Moreover, it is in this area that instructional technology, imaginatively used, may be most valuable, since by their very nature computers, audio-visual equipment, and the other accoutrements of the new media encourage the sort of "tinkering" that is an important component of the creative process.

Summary and Conclusion

Technological innovations can have impact upon both the content and the structure of education. In connection with the former, they can make the subject matter of the curriculum more realistic and relevant. In connection with the latter, they can restructure the learning environment:

— to allow the student more autonomy with respect to his own learning;

— to change the student–teacher and student–student

relationships in ways conductive to learning; and

— to involve students in the actual development of their own learning materials.

The significance of any particular teaching innovation lies more in the way it affects the structure of the learning situation than in its purely mechanical details. Whether or not the new media will have any real impact upon American schools depends upon whether educators simply try to fit them into the present classroom structure or use them as means of discarding what is obsolete and moving toward more self-directed learning, oriented toward goals that students themselves see as exciting and relevant.

This article appeared originally in the January 1969 issue of this [*Educational Technology*] magazine. The author, **Sarane S. Boocock,** at the time of writing was Professor, Laboratory for Organizational Research, University of Southern California in Los Angeles.

II

Fostering Individual and Group Creativity and Innovation

7

Improving Creative Thinking Using Instructional Technology

Editor's Note: Shank, G., Ross, J.M., Covalt, W., Terry, S., & Weiss, E. (1994). Improving Creative Thinking Using Instructional Technology: Computer-Aided Abductive Reasoning. *Educational Technology, 34*(9), 33-42.
"How do we conduct ourselves when we are faced with what thinking will not solve (Brent , 1993, p. 343)?" This question is answered through a creative approach that C. S. Peirce called abductive reasoning. Unfortunately, cultivating creative thinking skills faces considerable difficulties that are associated with developing and practicing the necessary techniques. To broaden the use of abductive techniques, the authors created a computer program to both teach and serve as a real world tool for finding novel solutions to problems that "thinking will not solve." Discussed are the problems, the tools, and initial feedback and findings from early adopters.

This article has two purposes. Our first purpose is to briefly introduce the concept of abductive reasoning and to argue for the importance of this type of reasoning for instructional designers in education. Our second purpose is to document the processes of developing a computer program we call the Abductive Reasoning Tool (ART) and to describe our efforts in testing and refining its operation.

In relation to our first purpose, abduction per se can and should play an important role in instructional design and delivery. While we will detail an introductory overview to abductive reasoning later in the paper, we would like to briefly describe three key benefits that abductive reasoning can bring to the instructional design process. The first benefit is that abduction is not some arcane and obscure mode of cognitive operation but is instead a mode of reasoning that all of us use on a regular basis in an unreflective and unarticulated way. Therefore, by gaining a richer understanding of abductive processes and activities, we gain a deeper insight into types of cognition that, up to now, have been lumped together in such amorphous and unsystematic categories as "intuitions," "hunches," and "guesses."

The second benefit is that abductive thinking allows us to pursue design strategies that are inherently nonlinear. Since abductive conclusions are, by their nature, hypothetical, they allow more flexibility than is currently found in most instructional design procedures. We can concentrate on designing instructional systems that are plausible at the outset, instead of having to make sure our systems conform to strict logical rules of linear development. The third and final benefit is that abductive methods can be used to develop research tools that allow us to study the instructional design process in new and creative ways (Shank, 1987).

In relation to our second purpose, the ART program itself is beneficial for at least three reasons. First, ART allows educators to help students learn and understand the basics of abductive logic-a topic that is not well known in the educational research literature but whose importance as a mode of reasoning will most likely increase as awareness of the power and usefulness of abductive reasoning increases. Second, research into the use and operation of ART sheds light not only on ways to use the program itself, but also on areas of cognition which have been hard to assess and examine using more traditional modes of thinking and reasoning. Finally, ART demonstrates one of the ways that technology and education can be combined to encourage and enhance higher order thinking and creative skills.

In 1991, Shank and Ross developed the first version of ART for use on MS-DOS personal computers (cf. Ross & Shank, 1993). As a result of a development grant in 1993, we were able to create and field test the Macintosh version of the program, or MacARf. For all intents and purposes, ART and MacART are identical, and so we will refer to both programs under the generic “ART” label. ART is an example of a computer program called “freeware” in that anyone who wishes to have a copy can have it and use it for free, and can distribute it to others, so long as identification and liability waivers for use remain attached to the program. Since its development, ART has been distributed to over 160 beta users in the United States , Canada, England, Scotland, Denmark, Austria, Germany, Hungary, Hong Kong, Japan, and Australia.

Basic Principles of Abduction

ART was designed to allow users to understand the basics of abduction and practice the use of abductive reasoning. Because abductive reasoning is relatively unknown in educational research circles, some clarification of the nature of this logical process will be offered.

Abduction was first systematized in the late 19th and early 20th centuries by the American logician and philosopher, C.S. Peirce (Peirce, 1955; Sebeok & Umiker-Sebeok, 1983; Tursman, 1987). At various places in his writings, Peirce calls the logic of hypothesis formation and discovery by a number of names, including hypothetic inference, hypothesis. and retroduction. His roost common coinage, though, is that of abduction (cf. Fann, 1970). Peirce defined abduction as the way that people are able to resolve surprising states of affairs into ordinary circumstances (Peirce, 1955):

> *The surprising fact, C, is observed:*
>
> *But if A were true, C would be a matter of course,*
>
> *Hence, there is reason to suspect that A is true. (p. 151)*

Peirce also thought of abduction in terms of the concept of hypothesis, as reflected in the following passage:,”…[a]ny proposition added to observed facts, tending to make them applicable in any way to other circumstances than those under which they were observed, may be called a hypothesis” (Peirce,1955, p. 150). For Peirce, an hypothesis is ultimately an account of how ordinary circumstances are understood. The end product of such an account is an intuitive “guess” as to the reason that a particular pattern of experience was found, and that “guess” can then serve as the basis for empirical test. Therefore, Pierce is systematizing a mode of reasoning that may describe processes we might initially think of as being inherently unsystematic. In other words, Peirce’s definition of abduction allows us to get a handle on such processes as “following a hunch,” “making an educated guess,” or “trusting one’s intuitions.”

At first glance. there does not appear to be much difference b tween Peirce’s account of abduction and the project of modern educational research. We make theoretical guesses that are then tested. Where Peirce advances the project is in the step of moving from the realm of ordinary experiences to the development of an hypothesis in the first place. This systematic application of abduction has been called “the logic of discovery” (Hanson, 1958). This type of logic attempts to unify the process of hypothesis formation with the subsequent use of deduction and induction to test and modify those hypotheses. Even more importantly, Peirce showed that abduction is systematically related to the more traditional modes of reasoning (i.e., deduction and induction). Peirce felt that the role of abduction was to help develop more systematic and adequate hypotheses from experiences.

The following example can help illustrate the nature of the abductive syllogism in more concrete terms. The following simple syllogisms are modified from an actual example used by Peirce. First, let us look at a *deductive* syllogism:

> *All the beans in this bag are white.*
>
> *This bean is from the bag.*
>
> *This bean is most certainly white.*

His version of an *inductive* syllogism is:

This bean is from the bag.

This bean is white.

All the beans in this bag are probably white.

Finally, the *abductive* syllogism would take the form:

This bean is white.

All the beans in this bag are white.

This bean is possibly from the bag.

Deductions operate toward certainty through true statements, induction operates toward verification through meaningful observations, and abduction operates through experiences as given in order to establish some meaningful hypotheses about the states of affairs behind the observations. The first two modes of logic have been explored extensively in education and research, but abduction is comparatively unexplored.

There has been some inquiry, however, into the nature of abduction. In addition to being described as the logic of discovery (Hanson, 1958), abduction has also been characterized as the logic of reasoning to the best possible explanation (Harman, 1965), as well as the logic of inference used by detectives and diagnosticians (Bonfantini & Proni, 1983; Caprettini, 1983; Ginzberg, 1989). Recent efforts have attempted to link abduction to other modes of reasoning (Holland, Holyoak, Nisbett, & Thagard, 1986) to establish procedures for using abduction as a problem-solving algorithm (cf. O'Rorke, 1990) and to detail the role of abductive thinking and strategies in the development of an educational semiotic (Cunningham, 1987; Cunningham, 1992; Shank, 1992; Shank, in press).

The Development of the ART Program

The implications of ART to instructional design and educational settings have been discussed in some depth elsewhere (Ross & Shank, 1993), but they bear some consideration here. First, ART can help address the need for creativity, albeit a focused type of creativity in instructional design. Second, ART can help instructional design students tackle design tasks both creatively and systematically. Finally, ART allows both the designer and the classroom teacher the chance to use a self-directed tutorial-driven tool for incorporating abductive reasoning into ordinary educational settings.

Abduction and Creativity

If we look at the original statement defining abduction, we see that Peirce insisted that we "do" abduction in those cases where we find ourselves dealing with surprising circumstances, and we need a rule to account for those circumstances. This definition, however, is too restrictive in specifying what abduction actually is. Shank (October, 1993) argued that abduction is actually the default mode or ground state of cognition, in that anytime we "perceive" some experienced thing as an example of a category, then we are abducing the nature of that thing. For instance, if a person walks into a room and sees an object with four legs and a seat, then the person abduces that the object is not some unique and puzzling and surprising phenomenon in the world, but unreflectively applies the rule "things with four legs and a seat are chairs." The person thereby concludes, in a perfectly straightforward and non creative way, that the object seen is a case of a chair. Therefore, many if not most actual abductions that people perform are fairly mundane and non-creative.

Given that most abductions are not particularly creative, then creative abductions represent a subcategory of the general set of abductions. What makes creative abductions creative, and how can we foster the development of these creative abductions? The key lies in the source of the rules for making the abductive inference. If the rules are part of our generally held domain of understandings about the world and the ways that we function in that world, then our abductions will be straightforward and non-creative. So, rules such as “things with four legs and a seat are chairs” lead to such abductions as “this thing I see is a chair.” Therefore, if we want our abductions to be out of the ordinary, then we need to use rules that are also out of the ordinary.

One way to try to make sure that a particular rule is out of the ordinary is to select that rule which is less commonly used. When we are trying to categorize an object, such as a chair, then it helps to have a tried and true rule. When we are trying to think of something new about a familiar concept, such as learning, then tried and true rules lead us down old, familiar, and well-trodden paths. Consider the following pair of examples. In each case, the question “how can students learn about history?” is asked.
In the first example, the question is addressed by using a traditional rule about learning, to yield the following quasi-syllogism:

> Situation: What can students learn about history?
>
> Rule: Learning is the passage of facts from teacher to students.
>
> Case: Learning about history involves the passage of historical facts from the teacher to the student.

This is a perfectly sound abduction, and it describes the ordinary way that history learning occurs in schools. But suppose we want the learning of history to be a different phenomenon than the passage of historical facts from teachers to students. In this case, we need a new rule. Furthermore, the further the rule is from the “ordinary” case of transmission of facts, the more unique and creative the abductive resolution will be. As an example, consider the much less common rule that learning is “the extraction of information from narratives.” Then, our quasi-syllogism might look like:

> Situation: What can students learn about history?
>
> Rule: Learning is the extraction of information from narratives.
>
> Case: Learning about history involves the extraction of information about history from stories that they experience.

Two things are of immediate importance. First, to the extent that the second rule is less common, the results of instantiating that rule will be more creative for students and teachers alike. In this case, the learning of history via the extraction of information from narratives will be perceived a being more creative for the students and will involve a more creative pedagogical approach for teachers. The second point is that the nature of the rule and the resultant abductive inference will affect the role of the instructional designer who is trying to facilitate either process. In the first case, the designer is concerned with the efficient and effective transmission of information, while in the second case, the designer has to be concerned with helping the students extract information from narratives.

The final stage of the creative process, and one that directly involves the ART program, is to move all the way to the end of the “less common” process. The best way to ensure that a rule is uncommon in an abductive setting is to apply it arbitrarily. In this fashion, the abductive inference becomes more of a case of discerning something fundamental about the meanings of cognitive processes themselves, because the arbitrary application of a rule requires a profound and extended reflection into the phenomenon at hand in order to get anywhere at all. This can be demonstrated with a final example. In this case, the rule of learning is arbitrarily determined to be that “learning is like watching waves roll onto the beach.” So, the quasi-syllogism is:

> Situation: What can students learn about history?
>
> Rule: Learning is like watching waves roll onto the beach.
>
> Case: Learning about history involves the extraction of information about history as if that information were waves that roll onto the beach.

On one hand, this logical conclusion seems nonsensical. There is no *a priori* reason to consider learning as if it involved information that was analogous to waves rolling onto a beach. But since human beings are compelled to render propositions about the world into meaningful formats, then what has been called the Law of Juxtaposition is operating here. This law implies that human beings will automatically strive to abduce meaningful connections between any two ideas, no matter how arbitrary their connection (Shank, 1988; Shank, in press).

The use of arbitrary rules to create new insights into the nature of a process puts an additional burden on any instructional designer. Can a designer use an arbitrary rule such as the idea of "waves on the beach" to design instructional materials to help students learn in new and more insightful ways? And, if this is a useful endeavor for instructional designers, can we facilitate their access to these arbitrary rules? These are the twin goals of the ART program.

Learning Abductive Reasoning via the ART Program

ART allows the user unfamiliar with abduction to learn about this mode of reasoning from a self-contained tutorial and to practice the mode of reasoning. Figure 1 illustrates a typical set of hypertext tutorial and help screens.

It sets up abductive practice by randomly and arbitrarily juxtaposing the user's stated area of interest with a generic aphorism from the program's database of over 1000 such statements. These aphorisms were taken from collections of aphorisms that are in the public domain to avoid copyright infringement complications. Once the juxtaposition has been made, it is the task of the user to forge an insight that correlates these two arbitrarily linked statements. According to theory in educational semiotic, this juxtaposition will lead users to come up with more creative insights into topics, by virtue of the natural human tendency to try to resolve two meaningful statements in terms of each other (Shank, 1987; Shank, 1988; Shank, in press).

In order to show how the ART program works, the following example was generated from the program itself. The user starts by defining a "Topic" which is a statement about which the user desires some fresh insight.

For example, a **Topic** might be:

> *"How can abduction be used in education?"*

The computer then randomly selects a "Reflection" aphorism from its database and pairs it with the original topic statement. In this case, the **Reflection** selected by the computer was:

> *"Knowledge of manners does not bring with it knowledge of [human]kind."*

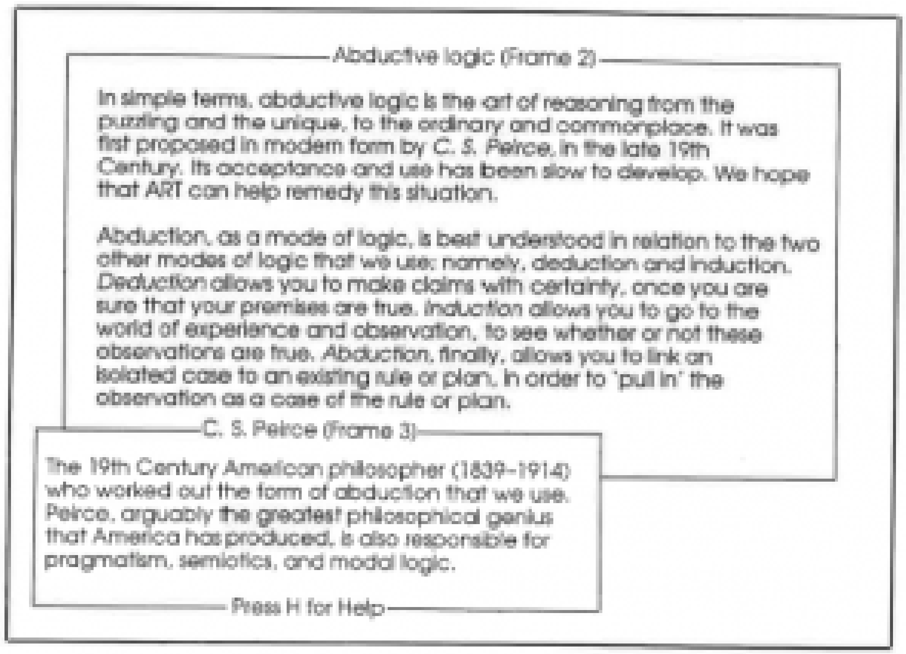


Figure 1. Tutorial screen from the MS-DOS ART program.

The whole point of pairing an arbitrary reflection with the original topic is to allow the user to feel the compulsion of meaning in trying to reconcile two statements in terms of each other. Through that compulsion toward meaning, quite often the user does find something fresh and new to say about the topic. When that happens, the new statement is recorded in the "Insight" box. An **Insight** here might play off the idea of manners as a formal system and conclude:

> *"Neither abduction as a formal system, nor education as a formal system can tell us separately all we need to know about students. We need to combine knowledge and practice from both to broaden our understanding."*

Note that there are many other possible insights that could be derived.

The following examples illustrate actual screens from the MS-DOS version of ART. In these examples, the same topic is used, first with one reflection (see Figure 2) and then with another reflection (see Figure 3).

At the end of the process, all three statements can be printed out as labeled. In the MS-DOS version, the output is routed to a notepad for printing. An example of such a notepad for the first reflection follows in Figure 4.

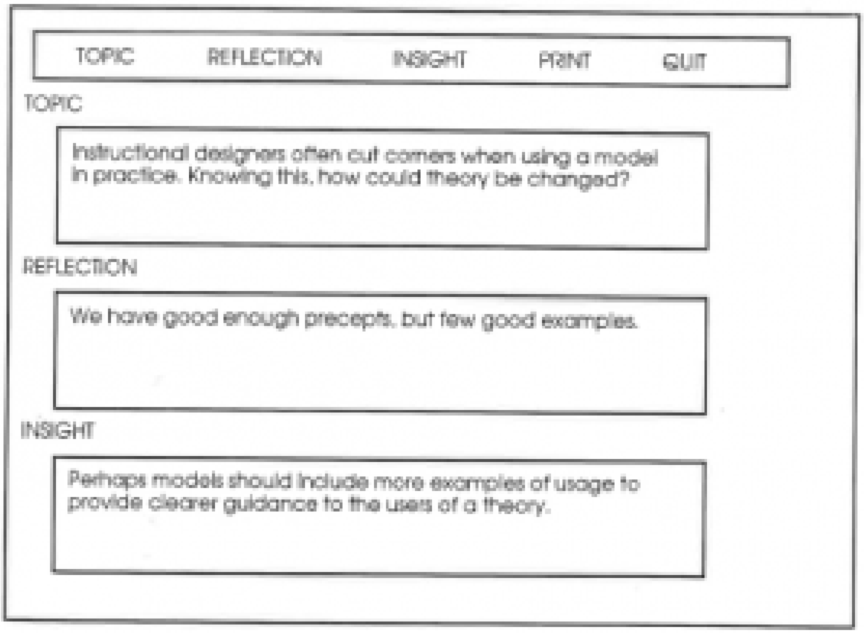


Figure 2. Program screen for first reflection from the MS-DOS ART program.

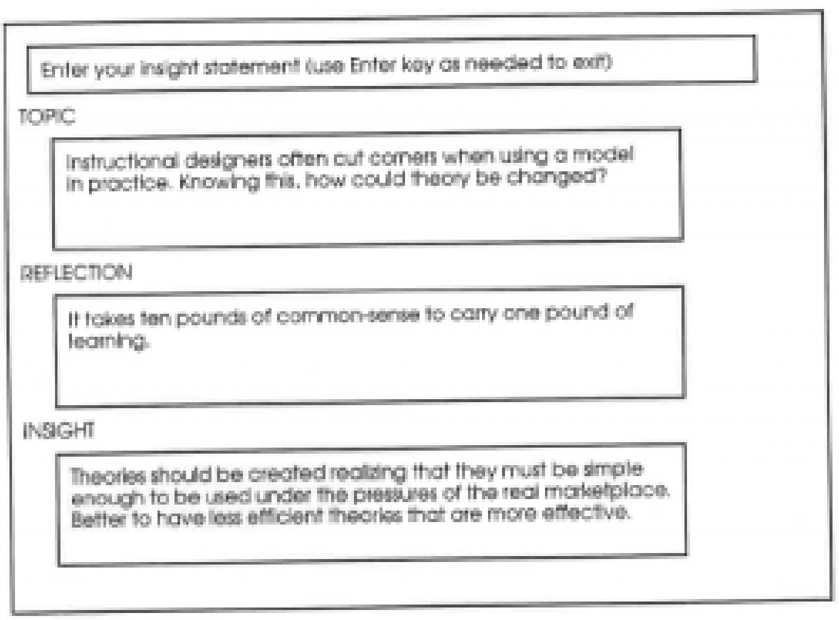
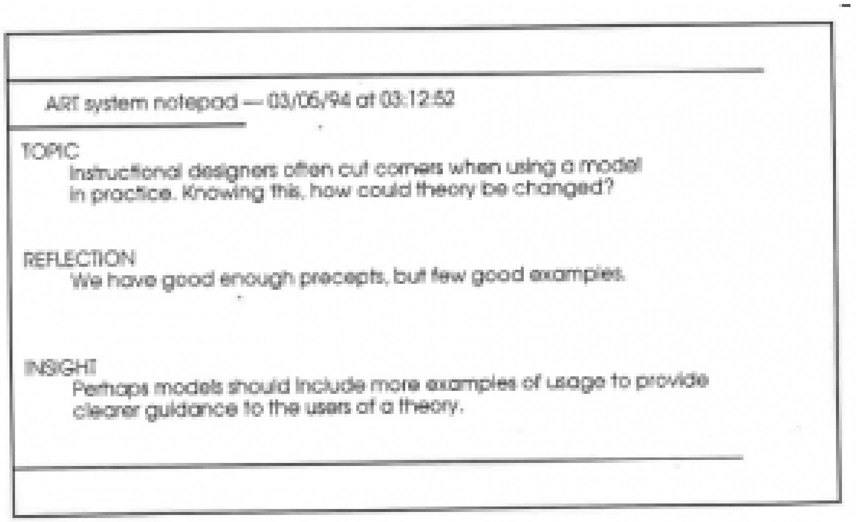


Figure 3. Program screen for second reflection from the MS-DOS ART program


ART system notepad — 03/06/94 at 03:12:52

TOPIC
Instructional designers often cut corners when using a model in practice. Knowing this, how could theory be changed?

REFLECTION
We have good enough precepts, but few good examples.

INSIGHT
Perhaps models should include more examples of usage to provide clearer guidance to the users of a theory.

Figure 4. Notepad output for second reflection from the MS-DOS ART program.

Field-Testing the ART Program

As noted earlier, over 160 beta versions of ART were sent out world-wide. Most of the input dealt with revising and improving the actual ART program. Suggestions included the use of more contemporary quotes in the database, eliminating sexist language, more careful proof-reading, and suggestions for improving the help screens and tutorial. In addition to these suggestions, two remote sites agreed to test ART qualitatively with students, and to report upon the results of these tests. In addition, a local site test was performed. The local site test and one remote test worked with undergraduate students, and the second remote site dealt with adult learners. We decided to use “ordinary” students rather than instructional design students, primarily due to the greater availability of regular students, but also to establish the general utility of the program. If the program presented problems of use, we wanted to find those problems at the most general level. These results are presented next in some detail.

Testing ART with Undergraduates

Ben Ostrov, an English professor in Hong Kong, implemented the remote undergraduate test site. He used the program with three students. Two of the students (“Helen” and “Winnie”) were Chinese, and one (“Johnny”) was a visiting American student. In this test, Ostrov generated two reflections for each topic. It is important to keep in mind that the two reflection statements are drawn at random from the computer databank. Below is an example of one of the Hong Kong ART runs with the student named “Johnny”:

> ***Type your Topic statement below and press Start***
>
> ***Topic Statement:*** *Humor*
>
> ***Reflection #1:*** *The surest sign of being born with great qualities, is to be born without envy.*
>
> ***Reflection #2:*** *To speak little and to say enough is the first difficulty of an orator.*
>
> ***Type your Insight below and then press Print, if you want to print, or Second Reflection, for more reflections***
>
> ***Insight #1:*** *Don’t think too highly of yourself, it could be fatal.*
>
> ***Insight #2:*** *Mean what you say and say what you mean.*

Insight #3: *Never take yourself too seriously, life is too short.*

Ostrov points out that ART was very difficult for his sample. He says:

> *I think this software is too challenging for students, they had great difficulty. Despite my explanation, Helen did not understand it during the first trial. I then explained it again. On her second attempt, she seemed to handle it much better than the other two. Watching the three of them working with ART, I found I could discover insights much more easily than they did. If ART is meant primarily for student use, I believe that it is not adequate because the reflections are too remote from the topics for them. I say this even though only one of the three is a native speaker of English [Johnny]. He did have difficulty, and while the other two are not native speakers, their English is at a high level of fluency. Helen is a member and stage speaker of the victorious Chinese University English Debate Team and Winnie's English ability is even better than that of Helen. Of course, three people is a very limited sample from which to make a generalization. However, as I claimed before, I find ART useful. It works as you intend. The remoteness of the reflection from the topic does stimulate insight. I think the utility of the software depends on one's age and educational level, if not analytical skill. (Ostrov, personal communication)*

From these findings, it seems as if ART might be a difficult tool for students to use independently of professorial feedback. This may be due to the novelty of the mode of logic, or it may suggest that the tutorial needs to be enhanced. If the problem were due to the complexity of the logic alone, then simply presenting students with reflections when the students give their topics should be a difficult challenge.

To test this possibility, we selected five local undergraduates. One of the co-authors and each of the undergraduate test students sat at a computer monitor and sent the senior author a Topic statement via e-mail. The senior author then submitted the Topic statement to ART, which generated two reflections. We used two reflections per student in order to replicate the Hong Kong conditions. These reflections were then sent to the student sent to the student as an e-mail message, and the co-author at the scene relayed each reflection in tum to the student.

Our data suggest that students can at least deal with the logic, even if they could not master the tutorial segment of the program. An example of one of the abductive sequences follows:

Student: *Greg*

Type your Topic statement below and press Start

Then press Second Reflection

Topic: *What are existential concerns?*

Reflection #1: *[Humankind] never rises to great truths without enthusiasm; the cold heart argues and constructs nothing; it may be that warmth of feeling is as necessary as clear thinking to the making of a true philosopher.*

Reflection #2: *The performance of duty is only guaranteed to the extent to which nature has made it a want, or society an interest.*

Type your Insight below

Insight: *Yes, but without some inspiration, even "warmth of feeling" may be somewhat worthless. Enthusiasm and desire are great, but unfortunately, we are forced to operate within our limitations. Oh well, who said that life was gonna be fair. Just an afterthought, consider those who have the ability to appreciate/love good music, art, literature, etc., but have no ability to create any of their own.*

The irony seems to be that students, when presented with the task apart from the realization that it is a particular exercise in logic, seem to do much better than when they feel that it is part of a task in logical analysis. We need to do further research to see if it is the act of labelling the logic that seems to make the task harder, or whether there is a problem with the “user-friendliness” of the interface itself.

Testing ART with Adult Learners

The last field test in this sequence comes from the work of Glenn Humphreys, who used ART with adult learners in Canada. His findings are fascinating and are presented at some length:

> *Last week, I had an interesting episode with a student where ART was used as an ancillary support device within an English course. A student named ‘Bill’ was working on a unit which required him to make a set of observations on his reading of a book. Specifically he was asked to record and analyse patterns in the ‘miscues’ (re. Ken Goodman’s work on reading) he noticed himself making. He was then to analyse any ‘trends’ that he thought he could see in these miscues. The idea of this unit is to help students generate a set of common language terms which they can use to become consciously aware of their reading practices in reference to certain text genres. These terms are generated. of course. through the student’s inspection of the trends in the miscues in consultation with the teacher. In effect, there are two objectives to this work: (1) assist the student to develop insights into his/her reading characteristics, (2) assist the student to develop an understanding of, and some facility with, the sense-making process of analysis itself. In short, the unit involves instruction in the use of common language as a tool for ‘thinking.’*
>
> *Anyway, Bill had a hell of a time with this assignment. He told me that when he first tried the assignment on his own he was recalling his days as a young kid in English classes. He was apparently (he said) used to the kind of simple assignment where you read a story. and then did questions which only involved looking up the answers In the story Itself. In short. he simply wasn’t used to English assignments with a strong creative thinking component. I suppose that you might wish to loosely identify this type of thinking as a close approximation to a very simple form of ‘deductive’ thinking?*
>
> *In any case, I launched into a conversation with Bill where I attempted to explain the idea of surveying a field of observations that one has originally created. One then attempts to spot ‘trends’ for which one then invents descriptive ‘labels’ (category terms). Bill didn’t seem to be catching on. Clearly this ‘metacognitive’ discourse was not useful.*
>
> *The next day, I decided to try him out on ART in order to see whether this would provide him with an activity which could be used as a basis for further ‘metacognitive’ discussion. So, I set Bill up on the computer, and he went through just a couple of the sequences. It seemed to help, because when we took a look at the work he was doing on the assignment the following day, he was starting to accept the step in the assignment where the miscues were listed and described.*
>
> *During discussion with him, we discussed further the way category terms were to be generated for similar miscues. We talked about it in terms of ‘inventing labels’ for the groups of similar miscues. (NB. This was a term used in an earlier unit of a roughly similar sort). Bill very definitely was less frustrated and confused by the assignment. It seemed to be making sense to him at this point.*
>
> *I asked him, after this, whether ART had helped at all. His comment was that ‘It is just a way to help you figure things out for yourself.·*
>
> *What I am fascinated by is the very complex relationship between action, thought, and language in this particular episode. It seems as if ART provided us with a common activity which provided some sort of exophoric reference for the ‘metacognitive’ language in our conversations—which then allowed us to collaboratively create a vocabulary which the student found suitable for articulating an understanding of his reading/thinking processes. (Humphreys, personal communication).*

In the example above, we see some of the same types of difficulties that Ostrov had reported with his Hong Kong students, yet here the difficulties were ameliorated by the use of ART as a cognitive "freeing" process. In the following example, we can see how Humphreys works with another adult learner in using ART several times to help the student work through some issues:

> *I was up in Fran's 'Personal Life Management' classroom today. Fran had gotten interested in experimenting a bit with ART after our presentation on this program earlier today. One of her students was attempting to work with the program.*
>
> *Apparently the student was attempting to use the program as a sort of 'dialogue partner' for a discussion topic related to productive attitudes that students might wish to adopt as job seekers. I gather that Fran had a seminar (or something) on the topic of how one might try to present oneself to prospective employers.*
>
> *The student had originally started with a very general question: 'What is a good attitude?' I noticed this written up in the topic box of the computer. I suggested to Debby (student) that the computer program might be more productively interactive if she were to try rephrasing her question. I explained to the student that the best way to regard the ART program might be as a 'creative thinking, problem solving' procedure, a form of 'brainstorming.' In other words, the program would NOT provide the student with 'right or wrong answers,' but would encourage the student to articulate her own ideas. Consequently, the best type of question would be a personal question related to the specific life experience of the questioner.*
>
> *As a result of this short discussion, Debby produced the following computer screens (my observations are included in square brackets):*
>
> *TOPIC: What am I going to do when I graduate?*
>
> *[Student's reformulated question. This reformulated question was the result of an 'instructional conversation' (see Ron Gallimore) between student and teacher where the computer program was defined as a certain type of semiotic tool used to mediate the student's personal reflection.]*
>
> *REFLECTION: That which we acquire with most difficulty we retain the longest.*
>
> *[Debby actually looked through, and dismissed, four previous comments before deciding that this item was useful. The student is exercising personal control over the computer program. This may have resulted from the unique way in which the program-as-semiotic-tool was defined during the initial instructional conversation between student and teacher in this particular activity setting. In other words, the initial instructional conversation between teacher and student defined the ART program as a SUBSERVIENT semiotic tool. This is quite different from the controlling role which many "drill-and-test" computer programs seem to assume.]*
>
> *INSIGHT: Even without a job you have accomplished a challenge. The harder you work for something, the more you appreciate it. (Glenn added this: So even if you didn't get a good job, you will be proud of finishing your education.)*
>
> *[What was interesting here is that the student came up with the first sentence. The teacher, as another partner to this discussion, couldn't resist talking to Debby about this. This led Debby to 'dialogically' (see Jim Wertsch) spin off what I said to produce the second sentence. I then spun off this to produce the third sentence. This illustrates the way the ART program was used within this activity setting as one component within a three way instructional conversation between (1) student. (2) computer program, and (3) teacher.]*
>
> *This particular episode again seems to illustrate how the ART program may be used as an ancillary learning tool within a school program—in this case as part of a 'life management' course. In this particular episode the teacher helped the student to define the computer program as a semiotic tool which had a*

specific, but limited, function within a larger ongoing process of 'instructional conversation' between teacher and student. (Humphreys, personal communication).

In both of Humphrey's examples, we see that he plays a crucial role in serving as a moderator and interpreter for his students. This, along with Ostrov's findings, seems to suggest that ART may indeed be a bit premature as a finished reasoning tool. In other words, we may need to develop materials in abductive reasoning that are more tutorial, more rote-oriented, and less free form. Alternatively, we may use something like the ART program as a tool to enhance our ability to work with students on such difficult topics as the formal presentation of abductive reasoning. The computer program can help us by selecting reflections at random—a task that is often very difficult for meaning-oriented humans to do. We feel that the second alternative represents the most effective use of ART at this current time.

Current Directions in Refining ART

We have already modified the MacART version of ART to reflect some of the concerns shown in our findings. MacART 2.0.1 is currently in final development. Some of the key features of MacART 2.0.1 is its enhanced visual interface, its improved tutorial segment, and the fact that it allows users to create and use their own databases of reflections. By allowing the user to create and use a personal database, MacART 2.0.1 becomes more user-friendly, since the problems with usage based on the unfamiliar nature and meaning of many of the reflection aphorisms can be avoided.

We believe it is important to address the topic of abductive reasoning within current instructional design programs. Abductive thinking can help foster and enrich creative and insightful reasoning. An understanding of abduction in relation to the other two modes of reasoning can also help students realize that creative thinking is not idiosyncratic or the result of a gift of talent, but can be dealt with as systematically and formally as any other mode of reasoning. The advantage of tools such as ART is that they allow teachers the opportunity to direct students to these activities at an individual level, and still provide room for the teacher to interact and enhance learning. In short, the strengths of ART are the strengths of educational technology in general. That is, they expand, rather than limit, the crucial role that teachers play in the learning process.

Note: MacART 2.0.1 has been installed at NIU.

To access a copy of the program, FTP to: nirvana.acs.niu.edu. There you can locate the program in: utilities/mac/Hypercard/MacArt2.0.1.sit.hqx The file will need to be unstuffed and binhexed.

References

Bonfantini, M.A., & Proni, G. (1983) To guess or not to guess? In T. A. Sebeok & U. Eco (Eds .). *The sign of three*, Bloomington, IN: Indiana University Press.

Brent, J. (1993). *Charles Sanders Peirce: A life*. Bloomington, IN: Indiana University Press.

Caprettini, G. P. [1983) Peirce, Holmes, Popper. In T. A. Sebeok & U. Eco (Eds.), *The sign of three*, Bloomington, IN: Indiana University Press.

Cunningham, D. [1987) Outline of an education semiotic. *American Journal of Semiotics, 5*, 201-216.

Cunningham. D. (1992) Beyond educational psychology: Steps toward an educational semiotic. *Educational Psychology Review, 4*, 165-194.

Fann, K. T. (1970) *Peirce's Theory of Abduction*. The Hague, Netherlands: Martinus Nijhoff.

Ginzberg. C. (1989) Clues: Roots of an evdential paradigm. In J. & A. C. Tedeschi (Trans.). *Clues. myths, and the historical paradigm*. Baltimore, MD: The Johns Hopkins University Press, 96- 125 .

Hanson, R. N. (1958) The logic of discovery. *The Journal of Philosophy, LV* (25), 1073-1089.

Harman, G. H. (1965). The inference to the best explanation. *The Philosophical Review, LXXN*, 88-95.

Holland, J. H., Holyoak, K. J., Nisbett, R. E., & Thagard, P. R. (1986) *Induction.* Cambridge. MA: MIT Press.

Humphreys, G. (1992). *Personal communication.*

O'Rorke, P. (1990). *Working notes of the 1990 spring symposium on automated abduction* (Technical Report 90-32). Irvine, CA: University of California at Irvine

Ostrov, B. (1993). Personal communication.

Pierce, C. S. (1955) *Philosophical writings of Peirce,* J. Buchler (Ed.). New York: Dover.

Ross, J. M., & Shank, G. D. (1993). What Instructional designers should know about abductive reasoning … and why. *Performance & Instruction, 32*(9). 6-10.

Sebeok, T. A., & Umiker-Sebeok, J. (1983) "You know my method": A juxtaposlllon of Charles S. Peirce and Sherlock Holmes. In T. A. Sebeok & U. Eco (Eds.). *The sign of three*, Bloomington, IN: Indiana University Press.

Shank, G. (1987) Abductlve strategies in educational research. *American Journal of Semiotics, 5*(2). 275-290.

Shank, G. (1988) Three into two will go: The juxtapositional method of research in empirical semiotics. In Deely (Ed.). *Semiotics*: 1987, Washington, DC: University Press of America, 123-127.

Shank, G. (1992) Educational semiotic: Threat or menace? *Educational Psychology Review, 4*, 195-209.

Shank, G. [October, 1993). The extraordinary ordinary powers of abductive consciousness. Invited plenary address at the *I Conferencia Internacional Sabre Los Nuevos Paradigmas de la Ciencia*. Convened at the Universidad de Guadalajara, Mexico.

Shank, G. (In press). Shaping qualitative research in educational psychology. To appear in *Contemporary Educational Psychology*.

Tursman. R. (1987) *Peirce's theory of scientific discovery*. Bloomington, IN: Indiana University Press.

Gary Shank is at Northern Illinois University. **John Minor Ross** is at Indiana University-Kokomo. **Wesley Covalt**, **Scott Terry**, and **Elaina Weiss** are at Northern Illinois University.

8

Developing Critical and Creative Thinkers

Editor's Note: Combs, L. B., Cennamo, K. S., & Newbill, P. L. (2009). Developing Critical and Creative Thinkers: Toward a Conceptual Model of Creative and Critical Thinking Processes. *Educational Technology, 49*(5), 3-14.
Critical and creative thinking skills are essential for students who plan to work and excel in the 21st-century workforce. This goal of the project reported in this article was to define critical and creative thinking in a way that would be useful for classroom teachers charged with developing such skills in their students. To accomplish their goals, the authors conducted an extensive literature review to distill critical and creative thinking skills into teachable components. Based on their findings, the authors developed a model of critical and creative thinking that is accompanied by a table of skills, objectives, and references. Future work will involve developing instructional materials and training teachers in critical and creative thinking skills for use in their classrooms.

Developing Critical and Creative Thinkers

If we think about a major goal of schooling as preparation for the world of work, "we need to be concerned about whether schooling requires and develops creative thinking, because for [students] to stay competitive in most jobs, it is and will be necessary for them to come up with their own ideas" (Sternberg & Spear-Swerling, 1996, p. 8). However, in their study of student abilities, Sternberg and Spear-Swerling concluded that while the students were "excellent at remembering and analyzing other people's ideas, [they were] not very good at coming up with ideas of their own" (p. 8). In a recent report on skills of the American workforce, the National Center on Education and the Economy (NCEE) stressed the importance of students gaining skills beyond mere content knowledge. They state:

> *…strong skills in English, mathematics, technology, and science, as well as literature, history, and the arts will be essential for many; beyond this, candidates will have to be comfortable with ideas and abstractions, good at both analysis and synthesis, creative and innovative, self-disciplined and well organized, able to learn very quickly and work well as a member of a team and have the flexibility to adapt quickly to frequent changes in the labor markets as the shifts in the economy become ever faster and more dramatic. (NCEE, 2007, pp. xxiv-xxv)*

Thus, the challenge among schools is to develop within students the ability to engage as 21st century thinkers.

To meet this challenge, critical thinking and creative thinking have surfaced as essential skills for all students, regardless of level or ability, to possess in order to position them to address the complex needs of the 21st century. These priorities are evidenced in changing educational standards, such as those defined by the International Society for Technology in Education (ISTE). The new, revised version of the National Educational Technology Standards (NETS) for students, teachers, and administrators "define what students need to know and be able to do with technology to learn effectively and live productively in an increasingly digital world" (ISTE, 2003a, inset). As such, the National Educational Technology Standards for Students emphasize (1) creativity and innovation; (2) communication and collaboration; (3) research and information fluency; (4) critical thinking, problem-solving, and decision-making; (5) digital citizenship; and (6) technology operations and concepts (ISTE, 2003a, inset). These standards are quite different than those established in 1998, which had an emphasis on (1) basic operations and concepts; (2) social, ethical, and human issues; (3)

technology productivity tools; (4) technology communication tools; (5) technology research tools; and (6) technology problem-solving and decision-making tools (ISTE, 2003b, paragraph 1).

In comparing the two versions of the technology standards, it is clear that the shift has been made from simply teaching students how to operate technology to using technology to encourage problem-solving, innovation, and collaboration. But how do we develop students who are critical and creative thinkers, able to

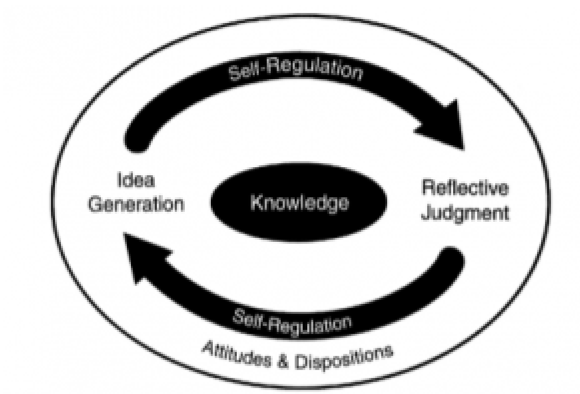


Figure 1. Conceptual model of critical and creative thinking processes.

meet the challenges of 21st century thinking, learning, and doing?

To reach these goals, we began with an extensive review of over 200 research articles and books written on critical thinking and creativity. As we reviewed the literature, we found that critical thinking and creativity were often defined and explained as complicated or vague concepts. For example, we understood that to be creative, one must be clever; but what does it mean to be clever, and how can you teach someone to be clever? If we simply listed clever as a characteristic of a critical and creative thinker, what could an educator do with that information? Recognizing this issue, the goal of our research is to *practically define critical and creative thinking by identifying a set of specific skills that contribute to such thinking and are teachable within any classroom.* Further, we set out to develop a set of instructional guidelines to help teachers transition their classrooms into ones that foster the development of critical and creative thinking skills among all their students.

Initially, we sought to review the literature on critical thinking and creativity separately; however, we soon recognized that there was a great deal of overlap in the skills required to be critical and creative thinkers and thus it began to make sense to combine the two skill sets into one comprehensive model. Whereas creativity is often defined as the generation of numerous original ideas, we recognize that creative thought involves the selection of appropriate ideas to move forward. Further, critical thinking is often thought of as the analysis, synthesis, and evaluation of ideas; however, critical thinking also involves the generation of ideas (Marzano *et al.*, 1988). So although critical thinking may emphasize the skills of reflective judgment, it involves idea generation as well. And although creative thinking may emphasize the generation of multiple original ideas, it involves reflective judgment as well as idea generation.

Through our year-long, team-wide review, analysis, and synthesis of literature, we were able to recognize recurring themes which led to a tentative conceptual model of the critical and creative thinking process. As we developed our conceptual model, we kept in mind our goals and target audience. With public educators as our focus, we felt strongly that we needed to represent each of these components as teachable skills. Thus, we developed a list of supporting skills and objectives that can be incorporated into any lesson plan or curriculum.

A Model of Critical and Creative Thinking

We have come to recognize that critical and creative thinking is an integrated process that involves the generation and refinement of ideas around a core of knowledge. The idea generation and refinement processes are monitored and controlled by self-regulatory behaviors that involve goal-setting as well as monitoring the obtainment of those goals, all while maintaining the necessary attitudes and dispositions. As Figure 1 illustrates, the relationship between these processes is in no way linear. The continuous, reciprocal relationship between *Idea Generation* and *Reflective Judgment* shows that there is no specific beginning or end to the thinking process. As ideas are generated, thinkers work with what they know and/or want to know to refine their ideas until they have something of value and worth. The movement between generating and refining ideas involves thinkers using analytical and evaluative measures to focus their understanding of the content and developing an outcome that most clearly and comprehensively addresses the identified problem or need.

As the thinker works to generate and refine knowledge, it is vital that he or she remains in control of both behavior and commitment to a task. The *Self-Regulation* component of the critical and creative thinking process ensures that the thinker remains active in the thinking and learning process, while monitoring progress toward identified goals. A critical component that encompasses all other processes is the exhibition of appropriate *Attitudes and Dispositions.* Sometimes referred to as learner characteristics, the essential attitudes and dispositions of motivation, flexibility, and confidence have been shown to be necessary for the development of and continuous involvement in critical and creative thinking (Black, 2005; Marzano, 1993; Raths, Wassermann, Jonas, & Rothstein, 1986). Each of the essential components *of Idea Generation, Reflective Judgment, Self-Regulation, and Attitudes and Dispositions,* as well as the accompanying instructional guidelines, is elaborated on below.

Idea Generation

A key process of critical and creative thinking, is that of idea generation. Black (2005) refers to this as productive thinking, where the thinker engages in activities encouraging the divergent process of taking previously acquired knowledge, simple ideas, and new information, and transforming those ideas into something that can be applied to a new situation or problem. The process of idea generation is supported by thinkers exhibiting skills such as fluency of ideas, originality of thought, and flexibility in thinking (see Table 1).

Fluent or prolific thinking refers to the thinkers' ability to generate a multitude of ideas and concepts. This skill can be encouraged and strengthened through activities involving brainstorming and conceptualization of ideas. *Brainstorming* allows students time to define and record as many possible solutions or ideas related to a topic as possible, while *conceptualizing* involves the use of a variety of methods to verbalize or represent ideas. Conceptualizing could include 2D and 3D representations, verbal or symbolic conceptualization, movement, or other forms of representation relevant to the context.

In addition to generating a multitude of ideas, thinkers must also generate ideas that are unique and novel. As such, key skills of the idea generation process of critical and creative thinking are producing ideas that are *original* and *flexible*. The concept of originality is demonstrated through the generation of ideas that are different, innovative, and unique. In order for a thinker to engage in the process of generating original ideas, he or she must also possess the ability to remain flexible and open-minded (Elder & Paul, 2002; Marzano *et al*., 1988; Meyers, 1986; Sternberg & Baron, 1985). Flexibility, in this case, involves the thinkers' ability to think beyond the scope of what is already known and apparent and begin to develop their own ideas through consideration of other perspectives and methods of analysis. In being flexible, thinkers not only consider multiple perspectives, but use those perspectives as they develop their own arguments.

Original and flexible work can be accomplished through activities that encourage thinkers to generate ideas both by considering existing ideas and by establishing relationships among previously and newly acquired concepts. In order to determine these relationships, critical and creative thinkers engage in *exploring, thinking through analogies and* *metaphors, examining ideas in new ways, observing, elaborating, inferring, extrapolating,* and generating *remote associations.*

Table 1 presents associated learning objectives that expand on each concept and lists the references on which we based our conclusions.

Reflective Judgment

In the reflective judgment component of critical and creative thinking, thinkers move through a convergent process of evaluating ideas and selecting a structured plan or solution based on the multitude of previously generated ideas. As they engage in reflective judgment, thinkers not only evaluate and select ideas from those generated through personal knowledge and experience, but also in the consideration of ideas gained through analysis and evaluation of other thinkers' ideas and resources. By combining such ideas, thinkers will determine the best and most feasible plan to pursue.

As shown in Table 2, the primary skills involved in reflective judgment are *analysis*, *synthesis*, and *evaluation*. As thinkers analyze knowledge and information, they work to break down information to determine relationships among elemental parts. This analytical process helps the thinker to develop the idea or concept, and occurs through activities involving *questioning* to seek clarity, *separating* information into relevant and irrelevant components, and *relating* to determine how ideas are associated.

Once relationships are determined, thinkers work to synthesize the information in order to draw conclusions. The synthesis process occurs through activities involving *organizing* information based on connections, *interpreting* to draw meaning from information, *summarizing* through combining information, and/or *generating hypotheses* that can be tested or used for explanatory purposes. For thinkers to express themselves at this point, they also engage in a process of *composing* which involves creating some form of visual or auditory representation of the information. This practice of composition helps thinkers support and justify their synthesis of information and increases the validity of their thoughts and ideas.

Table 1. Key skills and objectives of generating ideas.

Skill	Activity	Objective	References
Fluent	Brainstorming	Students will generate as many solutions or ideas related to a topic as possible within a given amount of time.	DeBono, 1985; Guilford, 1959, 1987; Isaksen & Gaulin, 2005; Jablin & Seibold, 1978; Osborn, 1963; Starko, 2005; Weisberg, 1999; Williams, 1970
	Conceptualizing	Students will verbalize or represent ideas using 2D and 3D representations, movement, or other forms relevant to the context.	Lubart, 2001; Starko, 2005; Torrance, 1962
Original and Flexible	Exploring	Students will explore a challenge using a variety of raw materials, stimuli, and experiences.	Piirto, 2004; Starko, 2005; Tardif & Sternberg, 1988; Torrance, 1962; Williams, 1970
	Analogical Thinking	Students will make associations and identify comparative relationships between two or more objects or ideas.	Black, 2005; Elder & Paul, 1996a, 1996b; Finke, Ward, & Smith, 1992; Guilford, 1987; Lubart, 2001; Marzano & Arrendondo, 1986; Partnership for 21st Century Skills, 2004; Raths *et al.*, 1986; Sternberg & Baron, 1985
	Metaphorical Thinking	Students will identify words or phrases that are symbolic or	Barron & Harrington, 1981; Black, 2005; Elder & Paul, 1996a, 1996b; Lubart, 2001; Partnership for

		representative of other ideas to which they are not literally applicable.	21st Century Skills, 2004; Raths *et al.*, 1986; Sawyer, 2006; Starko, 2005; Sternberg & Baron, 1985; Sternberg & Lubart, 1996; Tardif & Sternberg, 1988
	Examining ideas in new and varied ways	Students will engage in activities that provide others' perspectives on a challenge.	DeBono, 1985; Lubart, 2001; Starko, 2005; Wertheimer. 1938; Williams, 1970
	Observing	Students will observe things related to the challenge closely to identify details, procedures, and methods.	Raths *et al.*, 1986
	Elaborating	Students will develop ideas and information that expand on what is explicitly given.	Black, 2005; Bransford & Vye, 1989; Elder & Paul, 1997; Guilford, 1959; Lubart, 2001; Marzano & Arrendondo, 1986; Raths *et al.*, 1986; Resnick & Klopfer, 1989; Sternberg & Baron, 1985
	Inferring	Students will draw conclusions not explicitly stated based on evidence and reasoning.	Black, 2005; Elder & Paul, 2002; Marzano & Arrendondo, 1986; Marzano *et al.*, 1988; Paul & Elder, 2004; Raths *et al.*, 1986; Sternberg & Baron, 1985; Williams, 1970
	Extrapolating	Students will transfer knowledge of one topic to another.	Marzano & Arrendondo, 1986
	Remote Associating	Students will identify novel relationships among unrelated ideas.	Finke *et al.*, 1992; Guilford, 1959, 1987; Lubart, 2001; Williams, 1970

Table 2. Key skills and objectives of reflective judgment.

Skill	**Activity**	**Objective**	**References**
Analysis	Questioning	Students will identify missing or unclear information and ask questions to seek clarity.	Black, 2005; Elder & Paul, 1996a, 1996b, 2002; Halpern, 2007; Lemelson Center, 2007; Marzano *et al.*, 1988; Meyers, 1986; Partnership for 21st Century Skills, 2004; Paul & Elder, 2004; Starko, 2005; Sternberg, 2000; Sternberg & Spear-Swerlin, 1996; Williams, 1970
	Separating	Students will discard ideas that are not relevant to the context.	Finke *et al.*, 1992; Guilford, 1950, 1987; Lubart, 2001; Raths *et al.*, 1986; Sternberg & Baron, 1985; Sternberg & Spear-Swerling, 1996; Williams, 1970
	Relating	Students will identify associations between objects or ideas	Anderson, 1984 (cited in Marzano & Arrendondo, 1986); Black, 2005; Elder & Paul, 1996a, 1996b; Finke *et al.*, 1992; Guilford, 1959, 1987; Halpern, 2007; Lemelson Center, 2007; Lubart, 2001; Marzano & Arrendondo, 1986; Partnership for 21st Century Skills, 2004; Raths

			et al, 1986; Sternberg & Baron, 1985; Sternberg & Spear-Swerling, 1996; Tardif & Sternberg, 1988
Synthesis	Organizing	Students will arrange information such that connections and relationships are made clear.	Black, 2005; Guilford, 1950; Halpern, 2007; Lubart, 2001; Marzano & Arrendondo, 1986; Meyers, 1986; Partnership for 21st Century Skills, 2004; Raths *et al.*, 1986; Sternberg & Spear-Swerling, 1996; Swartz & Perkins, 1990; The Lemelson Center, 2007
	Interpreting	Students will state the meaning of a situation, process, product, or information after considering all resources.	Black, 2005; Elder & Paul, 2002; Halpern, 2007; Nickerson, 1986; Palincsar & Brown, 1989; Paul & Elder, 2004; Raths *et al.*, 1986; Resnick & Klopfer, 1989; Sternberg & Baron, 1985; Sternberg & Leighton, 2004; Sternberg & Spear-Swerling, 1996.
	Summarizing	Students will condense multiple ideas into a cohesive comprehensive summary and restate it using personal connections and interpretations.	Black, 2005; Lubart, 2001; Meyers, 1986; Paul & Elder, 2004; Raths *et al.*, 1986
	Hypothesizing	Students will develop statements or conclusions to be tested or used for explanatory purposes.	Marzano, 1993; Nickerson, 1984; Raths *et al.*, 1986
	Composing	Students will use written, oral, and symbolic language to communicate a summary of thoughts, ideas, and solutions.	Marzano & Arrendondo, 1986; Raths *et al.*, 1986; Sternberg & Baron, 1985
Evaluation	Judging resources	Students will outline the degree to which the resources on which they based their conclusions are reliable, fair, and relevant.	Black, 2005; Elder & Paul, 1996a, 1996b, 1997; Halpern, 2007; Marzano & Arrendondo, 1986; Nickerson, 1986; Raths *et al.*, 1986; Sternberg, 2000; Sternberg & Baron, 1985; Sternberg & Leighton, 2004; Sternberg & Spear-Swerling, 1996
	Judging logic	Students will describe how their conclusions were derived and the extent to which they are supported by reliable sources.	Black, 2005; Elder & Paul, 1996a, 1996b, 1997; Halpern, 2007; Marzano & Arrendondo, 1986; Nickerson, 1986; Raths *et al.*, 1986; Sternberg, 2000; Sternberg & Baron, 1985; Sternberg & Leighton, 2004; Sternberg & Spear-Swerling, 1996
	Judging value	Students will state how their product is consistent with their personal values.	Black, 2005; Elder & Paul, 1996a, 1996b, 1997; Halpern, 2007; Marzano & Arrendondo, 1986; Nickerson, 1986; Raths *et al.*, 1986; Sternberg, 2000; Sternberg & Baron, 1985; Sternberg & Leighton, 2004; Sternberg & Spear-Swerling, 1996
	Judging worth	Students will describe the usefulness of their ideas to the context of the challenge.	Black, 2005; Elder & Paul, 1996a, 1996b, 1997; Halpern, 2007; Marzano & Arrendondo, 1986; Nickerson, 1986; Raths *et al.*, 1986; Sternberg, 2000; Sternberg & Baron, 1985; Sternberg & Leighton, 2004; Sternberg & Spear-Swerling, 1996
	Generalizing	Students will identify how particular ideas apply to situations other than	Finke *et al.*, 1992; Meyers, 1986; Nickerson, 1984

		the original challenge.	

As they refine their ideas, thinkers take evaluative measures to determine the value and plausibility of ideas as related to the problem or context. Evaluation occurs through *judging* the *resources* on which conclusions were based, as well as the *logic*, *value*, and *worth* of the ideas generated. In addition, evaluation involves *generalizing* by simplifying information and developing principles and rules for applying that information to other situations.

Table 2 summarizes the skills, activities, learning objectives, and supporting references associated with reflective judgment.

Self-Regulation

Throughout the processes of generating and refining ideas, thinkers must monitor and maintain control of their thoughts, behaviors, and involvement. The skills within this self-regulative process are organized by how the learners set personal goals and *plan* how they will accomplish their goals; *monitor* attention, focus, and progress; and *evaluate* the process and results of their activities (see Table 3).

Critical and creative thinkers engage in active planning and forethought to set goals, outline strategies, and determine the best methods through which they can achieve their goals. Activities that support this planning include *recognizing the existence of a challenge*, *assessing personal knowledge*, *understanding one's own abilities*, and *allocating resources*.

Thinkers also must be skillful in monitoring the attention and focus they devote to a task as well as the results of their decisions. This occurs through actively focusing on the level and type of attention required to accomplish the task. In addition, they need to be aware of how they are *performing* and *progressing* toward meeting their goals. Monitoring also involves *identifying consequences* of possible actions in relation to the desired goals. *Revising* is a critical component of self-regulation; if through monitoring focus, performance, progress, and possible consequences, thinkers find that they are not making adequate progress toward achieving their goals, they must be willing to reconsider their course of action.

As thinkers continually monitor their attention, focus, and results, it may become necessary for them to make changes in beliefs about their level of attention, abilities, and the value of contributions being made. This process of *cognitive restructuring* occurs as thinkers make affirmative changes in their overall attitudes and seek to make alterations in personal beliefs and perceptions of the beliefs of others. Thinkers can accomplish this restructuring by making positive self-statements to help maintain awareness of such beliefs and make necessary changes.

The third and final skill of self-regulation is the need for thinkers to *evaluate* the results of their efforts. This occurs as the thinkers review the initial challenge, their goals, and the resulting products. By evaluating results, thinkers can ensure appropriate outcomes as well as value and worth of ideas as they relate to the problem or context. Through *evaluating the process* in which they engaged, critical and creative thinkers ensure that appropriate thinking processes were used to generate results. Through *evaluating the product*, they ensure that those final results are in line with the initial goal.

Table 3 further illustrates the skills within the process of self-regulation with related objectives and associated references.

Attitudes and Dispositions

In addition to engaging in idea generation, reflective judgment, and self-regulation, critical and creative thinkers must exhibit certain attitudes and dispositions; specifically this means they must be perceptive and flexible, motivated, and confident (see Table 4).

Thinkers maintain a *perceptive and flexible* attitude through *avoiding impulsivity, rejecting stereotypes and prejudices, embracing multiple points-of-view, judging their assumptions,* and *remaining sensitive* to the thoughts and actions of others. In addition, it is vital that thinkers allow many aspects of experiences to penetrate and influence their thinking by *remaining open-minded* to seeking alternative influences. *Tolerating ambiguity* is also essential, as, with any thinking process, vaguely established ideas will often penetrate their thinking.

Critical and creative thinkers must be *motivated* to solve the problem at hand. They must exhibit a general interest in their learning, recognize the value of their participation, and see the applicability of the task to their personal interests. This motivation is exhibited through *demonstrating autonomy, persisting* at the task*, maintaining intrinsic motivation,* and *recognizing the relevance* of their work to their personal interests.

Successful critical and creative thinkers are also *confident* in their involvement and position within the problem or context. In this context, confidence involves maintaining a positive perception of self-efficacy, exhibiting a high level of comfort in interacting with the thinking process, and exhibiting a general feeling of self-worth and certainty. Thinkers who do not fear being different and do not seek conformity are able to maintain high levels of confidence and become active participants in the critical and creative thinking process. Throughout, successful critical and creative thinkers demonstrate confidence by actively *identifying the worth or applicability of their ideas, exhibiting courage of convictions* that allows them to publicize their thoughts without fear of rejection, and the willingness to engage in *risk-taking* that allows them to work outside their comfort zone and engage in tasks in which success is not certain.

In Table 4, we summarize the attitudes and dispositions necessary for critical and creative thinking, list related learning objectives, and identify the references on which we based our conclusions.

Conclusions and Future Work

As we developed this model and supporting instructional guidelines, we became aware that we were going through the exact process we wanted to communicate to other educators. In reviewing the literature, we generated a multitude of ideas and conclusions about the critical and creative thinking process and practiced reflective judgment to refine those ideas. Throughout the process, we engaged in self-regulation and adopted the necessary attitudes and dispositions. The revelation that we were applying the critical and creative thinking process as we attempted to define it was exciting and empowered us to move toward our goal of informing educators about how to develop critical and creative thinking skills within their students.

We began by engaging in the planning stage of self-regulation. We clearly identified our challenge to define critical and creative thinking as a set of teachable skills, assessed our current knowledge on the topic, and mobilized our available resources. As we generated ideas to meet our goal, we explored the many ways others had described creative and critical thinking in order to generate a large number of possible solutions. We attempted to identify the relationships among the various concepts we had identified in order to see patterns and associations. As we generated ideas, we frequently diagramed our ideas and the relationships among them. These diagrams would often cause us to see connections among the ideas as well as gaps in our knowledge. As we refined our ideas, we engaged in reflective judgment. Guided by our goal, we attempted to look for gaps in our knowledge, and when we identified them, to explore further.

We engaged in the process of analysis by separating information into related and unrelated categories and looked for relationships among the ideas. As we attempted to synthesize our knowledge, we begin to cluster, organize, and summarize our ideas. We also composed our thoughts using visual representations such as diagrams, tables, and written narratives. At a

Table 3. Key Skills and objectives of self-regulation.

Skill	Activity	Objective	Reference
Plan	Recognizing the existence of a challenge	Students will state the challenge and outline related conditions and scope.	Guilford, 1959, 1987; Halpern, 2007; Marzano *et al.*, 1988; Sternberg & Spear-Swerling, 1996; Tardif & Sternberg, 1988; Torrance, 1962
	Assessing knowledge	Students will identify prior knowledge and describe the degree of familiarity with that knowledge.	Marzano *et al.*, 1988; Nickerson, 1984
	Understanding ability	Students will identify personal abilities that are helpful to meeting goals.	Nickerson, 1984
	Allocating resources	Students will outline all available resources and develop a timeline for action.	Halpern, 2007; Sternberg & Spear-Swerling, 1996
Monitor	Focusing	Students will identify the level and type of attention they are devoting to a task, and describe any adjustments needed.	Marzano & Arrendondo, 1986; Marzano *et al.*, 1988; Nickerson, 1984; Paris & Winograd, 1990; Raths *et al.*, 1986; Swartz & Perkins, 1990; Tardif & Sternberg, 1988
	Performing	Students will outline steps they are taking/have taken to achieve their goals.	Nickerson, 1986; Paris & Winograd, 1990; Starko, 2005
	Progressing	Students will describe their progress related to goals and any adjustments needed.	Marzano & Arrendondo, 1986; Marzano *et al.*, 1988; Paris & Winograd, 1990; Starko, 2005
	Identifying Consequences	Students will list possible outcomes and their consequences as decisions are made and describe how they will affect goals and progress.	Black, 2005; Starko, 2005
	Revising	Students will evaluate progress regarding the plan of action and alter activity as needed.	Marzano *et al.*, 1988; Paris & Winograd, 1990
	Cognitive restructuring	Students will verbalize positive thoughts about their performance and abilities.	Baron & Harrington, 1981; Marzano & Arrendondo, 1986; Paris & Winograd, 1990; Sawyer, 2006
Evaluate	Evaluating the process	Students will identify the critical and creative processes used to generate results and describe how the process aligns with the goal.	DeBono, 1985; Starko, 2005
	Evaluating the product	Students will describe how the final product is relevant, appropriate, and valuable to the initial challenge and context. Students will make revisions to the product as needed to align with their goal.	DeBono, 1985; Marzano & Arrendondo, 1986; Williams, 1970

Table 4. Key skills and objectives of attitudes and dispositions.

Characteristic	Activity	Objective	References

Perceptive and Flexible	Avoiding impulsivity	Students will exercise control over thoughts and reactions by pausing to think, ask questions, and talk through ideas.	Marzano, 1993; Marzano & Arrendondo, 1986; Marzano *et al.*, 1988; Meyers, 1986; Raths *et al.*, 1986
	Rejecting stereotypes and prejudice	Students will identify preexisting ideas and opinions regarding a challenge and how they might affect decisions and progress toward goals.	Arnabile, 1983; Guilford, 1987; Torrance, 1962
	Embracing multiple points-of-view	Students will present ideas and arguments through the lens of multiple perspectives.	Arnabile, 1983; Black, 2005; Elder & Paul, 1996a; 1996b, 1997, 2002; Greenlaw & DeLoach, 2003; Guilford, 1987; Landsman & Gorski, 2007; Lemelson Center, 2007; Marzano, 1993; Marzano *et al.*, 1988; Meyers, 1986; Partnership for 21st Century Skills, 2004; Raths *et al.*, 1986; Resnick & Klopfer, 1989; Richardson, 2007; Starko, 2005; Sternberg & Baron, 1985; Swartz & Perkins, 1990; Torrance, 1962; Williams, 1970
	Judging assumptions	Students will identify assumptions and describe their validity as they relate to the context.	Arnabile, 1983; Black, 2005; Guilford, 1987; Halpern, 2007; Marzano *et al.*, 1988; Paul & Elder, 2002, 2004; Raths *et al.*, 1986; Swartz & Perkins, 1990
	Remaining sensitive	Students will describe the thoughts, feelings, and perspectives of other students.	Black, 2005; Elder & Paul, 1997; Halpern, 2007; Marzano, 1993; Marzano *et al.*, 1988; Meyers, 1988; Nickerson, 1984; Palincsar & Brown, 1989; Paul & Elder, 2004; Raths *et al.*, 1986; Resnick & Klopfer, 1989; Starko, 2005; Sternberg & Baron, 1985; Swartz & Perkins, 1990; Torrance 1962
	Remaining open-minded	Students will identify how ideas from multiple experiences (to include senses, fantasy, aesthetics, feelings, and actions of others) influenced their ideas.	Colangelo & Davis, 2002; Runco, 2007; Starko, 2005; Sternberg & Lubart, 1991, 1995; Tardif & Sternberg, 1988; Torrance, 1962; Williams, 1970
	Tolerating ambiguity	Students will be receptive to all ideas and perspectives regardless of degree of completeness or complexity.	Arnabile, 1983; Barron & Harrington, 1981; Guilford, 1950, 1959, 1987; Marzano, 1993; Raths *et al.*, 1986; Sawyer, 2006; Starko, 2005; Sternberg, 2000; Sternberg & Lubart, 1991, 1995; Tardif & Sternberg, 1988; Torrance, 1962; Williams, 1970
Motivated	Demonstrating autonomy	Students will initiate activity and exercise self-direction and self-discipline.	Guilford, 1987; Starko, 2005; Torrance, 1962
	Persisting	Students will continue to work until goals are met.	Barron & Harrington, 1981; Black, 2005; Marzano, 1993; Marzano *et al.*, 1988; Paris & Winograd, 1990; Sternberg & Lubart, 1991, 1995; Tardif & Sternberg, 1988; Torrance, 1962

	Maintaining intrinsic motivation	Students will identify how the task or problem provides personal satisfaction.	Adams, 1951; Sawyer, 2006; Tardif & Sternberg, 1988; Torrance, 1962
	Recognizing relevance	Students will identify personal beliefs and values relating to the context.	Paris & Winograd, 1990; Torrance, 1962
Confident	Identifying worth/applicability of ideas	Students will make positive statements about the value of their ideas to the context.	Barron & Harrington, 1981; Colangelo & Davis, 2002; Sawyer, 2006; Torrance, 1962
	Exhibiting courage of convictions	Students will publicize thoughts or ideas and accept criticism from others.	Barron & Harrington, 1981; Sawyer, 2006; Starko, 2005; Sternberg & Lubart, 1991, 1995; Torrance, 1962; Williams, 1970
	Risk-taking	Students will describe how the challenges faced in the process of meeting their goal encouraged them to work beyond their comfort level.	Barron & Harrington, 1981; Colangelo & Davis, 2002; Raths *et al.*, 1986; Sawyer, 2006; Starko, 2005; Sternberg & Lubart, 1991, 1995; Torrance, 1962; Williams, 1970

time our ideas made perfect sense, but at other times, our reflective judgment caused us to question what appeared to be gaps or inconsistencies in our ideas, stimulating another phase of idea generation, where we would look again to the literature to identify additional ideas, to clarify or refine our ideas, or to see things in new ways.

As we began to draw conclusions, we frequently revisited our resources to determine to what extent our conclusions were consistent with the literature, and to look for information that confirmed or disputed our conclusions. We would attempt to evaluate the value and worth of our ideas by “mentally testing” our conclusions by using the ideas generated to think through an incident of critical and creative thinking. As we refined our ideas, we investigated the extent to which they would generalize to multiple creative domains by discussing them with experts in visual design and theater arts.

Throughout, our self-regulation processes guided our work. We quickly recognized the importance of maintaining awareness of our overall goal of *defining critical and creative thinking as a set of teachable skills.* As we engage in the idea generation and reflective judgment processes, we continually monitored whether we were making progress toward solutions that were appropriate for our goal. We often recognized and accepted when we came to a problem, sought clarity of our thoughts and ideas, and engaged in constant revision of our plans and processes to reach our goal.

As we neared our goal of developing a conceptual model and instructional guidelines, we were able to evaluate all the work we had done and the process we went through to achieve this goal. Our work continued as we evaluated how the end result, or our product, addressed our original goal. We made several revisions, continuing the analysis, synthesis, and evaluation of our ideas until each team member was comfortable with the resulting work.

As we reflected on the processes of generating the model and associated instructional guidelines, we found that the attitudes and dispositions we identified in the literature were essential to our progress. Throughout the struggle to analyze, synthesize, and evaluate an abundance of ideas, we found that it was critical to remain motivated by our belief in the value of our goals and to proceed with the confidence that we would be able to solve the problem through persistence. Additionally, working as a team, we often encountered ambiguity in our ideas and conclusions, yet we recognized the important of accepting this ambiguity and remaining flexible in our thinking.

More specifically, this flexibility enabled us to work as a team. We easily recognized that each of us brought a different type and level of expertise to the conversation and had differing perspectives, assumptions, and opinions. Through this recognition, we knew it was important that all of us remained open-minded to the thoughts, ideas, and interpretations of other team members.

Our current work is focused on the idea that in order to successfully develop these skills in their students, educators will need experience at developing their own critical and creative thinking skills. Our future plans include workshops for educators in which they will practice using and developing their own critical and creative thinking skills. In addition, we are in the process of developing instructional materials intended to foster critical and creative thinking skills through engagement with the arts and emerging technologies.

Ultimately, it is our hope that by fostering these skills among educators, and by providing teachers with a variety of materials and resources they can use to develop these skills in their students, teaching and learning will begin to address the need for students who are able to solve problems, think critically, and excel as global competitors in the 21st century through their creativity and ingenuity.

Authors' Note: We gratefully acknowledge Miriam Larson and Sunha Kim, for their contributions to the literature reviews and lively debates that ultimately led to this model, and Somiah Muslimani, for her expert graphic design work and insight in refining the instructional guidelines.

References

Adams, F. H. (1951). Education for the creative personality. *Educational Leadership, 9*(2), 94-97.

Amabile, T. M. (1983). Social psychology of creativity: A componential conceptualization. *Journal of Personality and Social Psychology, 45*(2), 357-376.

Barron, F., & Harrington, D. M. (1981). Creativity, intelligence, and personality. *Annual Review of Psychology, 32,* 439-476.

Black, S. (2005). Teaching students to think critically. *Education Digest, 70*(6), 42-47.

Bransford, J. D., & Vye, N. J. (1989). A perspective on cognitive research and its implications for instruction. In L. Resnick & L. E. Klopfer (Eds*.), Toward the thinking curriculum: Current cognitive research* (pp. 173-205). Alexandria, VA: Association for Supervision and Curriculum Development.

Colangelo, N., & Davis, G. A. (2002). *Handbook of gifted education* (3rd ed.). Boston: Allyn and Bacon.

De Bono, E. (1985). *Six thinking hats: An essential approach to business management.* Boston: Little, Brown & Company.

Elder, L., & Paul, R. (1996a). Critical thinking: A stage theory of critical thinking: Part I. *Journal of Developmental Education, 20*(1), 34-35.

Elder, L., & Paul, R. (1996b). Critical thinking: A stage theory of critical thinking: Part II. *Journal of Developmental Education, 20(*2), p. 34.

Elder, L., & Paul, R. (1997). Critical thinking: Crucial distinctions for questioning. *Journal of Developmental Education, 21*(2), 34-35.

Elder, L., & Paul, R. (2002). Critical thinking: Distinguishing between inferences and assumptions. *Journal a Developmental Education* 25(3), 34-35.

Finke, R. A., Ward, T. B., & Smith, S. M. (1992). *Creative cognition: Theory, research, and applications.* Cambridge, MA: MIT Press.

Greenlaw, S. A., & DeLoach, S. B. (2003). Teaching critical thinking with electronic discussion. *Journal of Economic Education, 34*(1), 36-52.

Guilford, J. P. (1950). Creativity. *American Psychologist, 5,* 444-454.

Guilford, J. P. (1959). Traits of creativity. In H. H. Anderson (Ed.), *Creativity and its cultivation* (pp. 142-151). New York: Harper & Row.

Guilford, J. P. (1987). Creativity research: Past, present, and future. In S. G. Isaksen (Ed.), *Frontiers of creativity research: Beyond the basics* (pp. 33-65). Buffalo, NY: Bearly.

Halpern, D. F. (2007). The nature and nurture of critical thinking. In R. J. Sternberg, H. L. Roediger, & D. F. Halpern (Eds.), *Critical thinking in psychology.* New York: Cambridge University Press.

Isaksen, S. G., & Gaulin, J. P. (2005). A reexamination of brain-storming research: Implications for research and practice. *Gifted Child Quarterly, 49*(4), 315-329.

International Society for Technology in Education. (2003a). NETS for Students; *http://www.iste.org/Content/NavigationMenu/NETS/ForStudents/NETS_for_Students.htm* .

International Society for Technology in Education. (2003b). NETS for Students 1998; *http://www.iste.org/Content/NavigationMenu/NETS/ForStudents/1998Standards/NETS_for_students_1998.htm* .

Jablin, F. M., & Seibold, D. R. (1978). Implications for problem-solving groups of empirical research on brainstorming: A critical review of the literature. *The Southern Speech Communication Journal, 43,* 327-356.

Landsman, J., & Gorski, P. (2007). Countering standardization. *Educational Leadership, 64*(8), 40-44.

Lemelson Center. (2007). Invention at play; *http://invention.smithsonian.org/centerpieces/iap/* .

Lubart, T. (2001). Models of the creative process: Past, present, and future. *Creativity Research Journal, 13*(3/4), 295-303.

Marzano, R. J. (1993). How classroom teachers approach the teaching of thinking. *Theory into Practice, 32*(3), 154-160.

Marzano, R. J., & Arrendondo, D. E. (1986). Restructuring schools through the teaching of thinking skills. *Educational Leadership, 43*(8), 20-26.

Marzano, R. J., Brandt, R. S., Hughes, C. S., Jones, B. F., Presseisen, B. Z., Rankin, S. C., & Suhor, C. (1988). *Dimensions of thinking: A framework for curriculum and instruction.* Alexandria, VA: Association for Supervision and Curriculum Development.

Meyers, C. (1986). *Teaching students to think critically.* San Francisco: Jossey-Bass.

National Center on Education and the Economy. (2007). *Tough choices or tough times: The report of the new commission on the skills of the American workforce* (2nd ed.). San Francisco: John Wiley & Sons.

Nickerson, R. S. (1984). Kinds of thinking taught in current programs. *Educational Leadership, 42*(1), 26-36.

Nickerson, R. S. (1986). Reasoning. In R. F. Dillon & R. J. Sternberg (Eds.), *Cognition and instruction* (pp. 343-373). San Diego, CA: Academic Press.

Osborn, A. F. (1963). *Applied imagination: Principles and procedures of creative problem solving* (3rd rev. ed.). New York: Scribner.

Palincsar, A. S., & Brown, A. L. (1989). Instruction for self-regulated reading. In L. B. Resnick & L. E. Klopfer (Eds.), *Toward the thinking curriculum: Current cognitive research* (1st ed.). San Francisco: Jossey-Bass.

Paris, S. G., & Winograd, P. (1990). How metacognition can promote academic learning and instruction. In B. F. Jones & L. Idol (Eds.), *Dimensions of thinking and cognitive instruction.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Partnership for 21st Century Skills. (2004). The partnership for 21st century skills; *http://www.21stcenturyskills.org/* .

Paul, R., & Elder, L. (2002). Critical thinking: Teaching students how to study and learn, Part I. *Journal of Developmental Education, 26*(1), 36-37.

Paul, R., & Elder, L. (2004). Critical thinking…and the art of close reading, Part III. *Journal of Developmental Education, 28*(1), 36-37.

Piirto, J. (2004). *Understanding creativity.* Scottsdale, AZ: Great Potential Press.

Raths, L. E., Wassermann, S., Jonas, A., & Rothstein, A. M. (1986). *Teaching for thinking: Theory, strategies, and activities for the classroom* (2nd ed.). New York: Teachers College Press.

Resnick, L. B., & Klopfer, L. E. (1989). Toward the thinking curriculum: An overview. In L. B. Resnick & L. E. Klopfer (Eds.), *Toward the thinking curriculum: Current cognitive research.* Alexandria, VA: Association for Supervision and Curriculum Development.

Richardson, C. P. (2007). Engaging the world: Music education and the big ideas. *Music Education Research, 9*(2), 205-214.

Runco, M. A. (2007). *Creativity theories and themes: Research, development, and practice.* Burlington, MA: Elsevier.

Sawyer, R. K. (2006). *Explaining creativity: The science of human innovation.* New York: Oxford University Press.

Starko, A. J. (2005). *Creativity in the classroom: Schools of curious delight* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Sternberg, R. J. (2000). Patterns of giftedness: A triarchic analysis. *Roeper Review, 22*(4), p. 231 (ERIC Document Reproduction Service No. EJ609729).

Sternberg, R. J., & Baron, J. B. (1985). A statewide approach to measuring critical thinking skills. *Educational Leadership, 43*(2), 40-43.

Sternberg, R. J., & Leighton, J. P. (2004). *The nature of reasoning: Teaching for thinking.* Washington, DC: Cambridge University Press.

Sternberg, R. J., & Lubart, T. I. (1991). An investment theory of creativity and its development. *Human Development, 34*, 1-32.

Sternberg, R., & Lubart, T. (1995). *Defying the crowd: Cultivating creativity in a culture of conformity.* New York: Free Press.

Sternberg, R. J., & Lubart, T. (1996). Investing in creativity. *American Psychologist, 51*(7), 677-688.

Sternberg, R. J., & Spear-Swerling, L. (1996). *Teaching for thinking.* Washington, DC: American Psychological Association.

Swartz, R. J., & Perkins, D. N. (1990). *Teaching thinking: Issues and approaches.* Pacific Grove, CA: Midwest Publications.

Tardif, T. Z., & Sternberg, R. J. (1988). What do we know about creativity? In R. J. Sternberg (Ed.), *The nature of creativity.* New York: Cambridge University Press.

Torrance, E. P. (1962). *Guiding creative talent.* Englewood Cliffs, NJ: Prentice-Hall.

Weisberg, R. W. (1999). Creativity and knowledge: A challenge to theories. In R. J. Sternberg (Ed.), *Handbook of creativity.* Cambridge, UK: Cambridge University Press.

Wertheimer, M. (1938). Laws of organization in perceptual forms. In C. Green (Ed.), *Classics in the history of psychology; http://psy.ed.asu.edu/-classics/Wertheimer/Forms/forms.htm* . (Reprinted from *A source book of Gestalt psychology,* pp. 71-88, by W. Ellis, Ed., 1938. London: Routledge & Kegan Paul.)

Williams, F. E. (1970). *Classroom ideas for encouraging thinking and feeling.* Buffalo, NY: D.O.K Publishers, Inc.

Liesl Baum Combs is Instructional Design Project Manager, Creative Technologies in the Arts, School of Education, Virginia Tech, Blacksburg, Virginia.
Katherine S. Cennamo is Professor, Learning Sciences and Technologies and Coordinator of Educational Research and Development, Creative Technologies in the Arts, School of Education, at Virginia Tech.
Phyllis Leary Newbill is Assistant Coordinator of Educational Research and Development, Creative Technologies in the Arts, School of Education at Virginia Tech.

9

Transmergent Learning and the Creation of Extraordinary Educational Experiences

Editor's Note: Honebein, P. C. (2009). Transmergent learning and the creation of extraordinary educational experiences. *Educational Technology, 49*(1), 27-34.
Transmergent learning is a macro instructional strategy that increases the likelihood of exceptional educational experiences, where creativity and innovation reign. By blending the principles of transformational experiences with evolutionary and emergent properties of complexity theory, instructional designers are able to craft an educational experience weaving ten instructional tactics that together simulate a neural network. The result is an environment in which students can create new knowledge and tangible results that are more than the sum of the parts, that is, extraordinary learning.

Wow! That's what I say when my students, whether they be undergraduates or working professionals, do something in class that is truly extraordinary and inspiring. It may be a project they complete, a question they ask, or a statement of perspective they make. Whatever it iss, I (and most likely the other students in the class) sit in silence for a moment while the full impact of what we've just witnessed is absorbed. It is brilliant, enlightening, and provocative. I say to myself, "That's much better than I could have done."

Imagine, the instructor, a recognized expert in the field, being outperformed by his or her own students! Some people might resent such an event. I find it to be Wow! Extraordinary!

In this article, I share my research from the past five years into something 1 call transmergent learning. Transmergent learning is an instructional strategy that blends the transformational qualities of learning experiences and the evolutionary and emergent characteristics of complex systems. I'll explore the foundations of this instructional strategy and the tactics that might- be used in instruction by teachers, designers, and facilitators to trigger transmergent learning.

Transmergent Learning

One of the first things new instructional designers learn about instructional strategies is the concepts of expository learning and discovery learning (Romiszowski, 1981). Expository learning is generally described as a strategy in which an instructor presents content, concepts, rules, principles, examples, and so on, which a learner receives and internalizes. The classic lecture, where a professor waxes philosophically about a particular topic while the student diligently listens, takes notes, and asks questions, is an example of expository learning. So is an instructor demonstrating how to perform a task with a software application, or a basketball coach demonstrating the proper way to shoot a free-throw.

Discovery learning, on the other hand, reverses things. Rather than passively receiving content, learners are given a task or a problem to solve. Learners take actions to complete the task, and under the guidance and facilitation of an instructor, learn from their actions. An example of discovery learning is a role-play simulation in which one student plays the role of customer and another plays the role of salesperson, where they must negotiate a price for a product. The debriefing that follows the role-play elicits the key learning principles.

While discovery learning's efficacy as an instructional strategy has strong critics (Kirschner, Sweller, & Clark, 2006; Mayer, 2004), this criticism focuses on "unguided" or "minimally guided" implementations of discovery learning, in situations where learners do not have prior knowledge in a domain. If one views discovery learning through a Vygotskian lens tied to the "zone of proximal development" and then integrates it with cognitive apprenticeship's prescriptions for coaching and scaffolding (Collins, Brown, & Newman 1989; Vygotsky, 1978), it is clear that one should provide learners whatever guidance those learners need to achieve the desired outcomes of a learning experience, whether the desired outcomes are fluency, creativity, excitement, or even failure.

As shown in Figure 1, expository and discovery learning form a continuum, illustrating that a learning experience can have varying degrees of expository and discovery qualities. Transmergent learning stretches this continuum, suggesting that there is a region beyond discovery which is focused on creativity, invention, and innovation. A discovery learning experience, by its very nature, allows for exploration of a domain to discover facts, relationships, and truths. A transmergent learning experience, on the other hand, enables new knowledge to emerge and evolve through a learner's explorations, resulting in valuable transformations. In other words, transmergent learning is an instructional strategy that generates new constructions of knowledge and skill that are more than the sum of the parts.

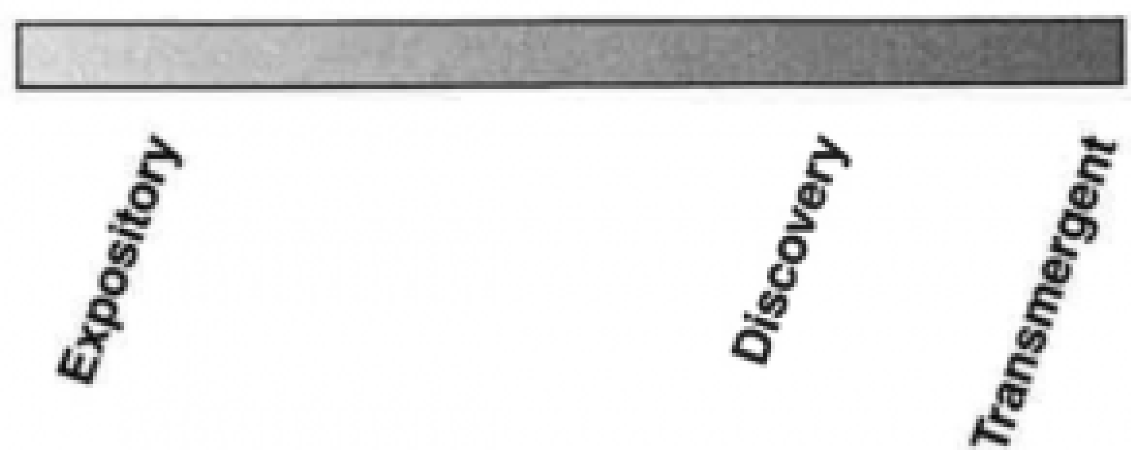


Figure 1. Expository-Discovery-Transmergent Continuum.

Let us clarify the two principles described in the previous paragraph. First, "new constructions of knowledge" reflects incremental improvements to things that are known. Thus, "new knowledge" applies to the creative application of "known knowledge" to create improvements in specific contexts. For example, one might design an activity to teach qualitative research methods in which students will contribute the "known" methods—video, photographs, tracking, and so on. But these same students might also invent something new by mashing together these known components in a unique way. That's where authentic activities come in, because they offer the freedom to explore, invent, and create. The theory that drives this is Csikszentmihalyi's principles of creativity, specifically, "…creativity generally involves crossing the boundaries of domains" (Csikszentmihalyi, 1997, p. 9). Thus, the creation of new knowledge is defined as when known knowledge from one domain is grafted into another domain to create a new approach or idea.

Second, the principle of "more than the sum of the parts" reflects how elements of a learning experience are leveraged. Typical learning experiences are often hierarchical. Figure 2 depicts the structure of a learning experience on the expository side of the continuum. Each node represents a person in an instructional experience. The dark node at the top is the instructor, and the lighter-colored nodes below are the learners. The instructor interacts with each learner linearly, such as through a lecture. If we added together what each node learns, we get the sum of the parts.

As we move toward the discovery learning side of the continuum, the arrows in Figure 2 might reverse, the learners might form small groups, and there would be some interactions between the groups and the instructor—with the instructor supporting the learners' thinking. However, the relationship between the different nodes is still linear.

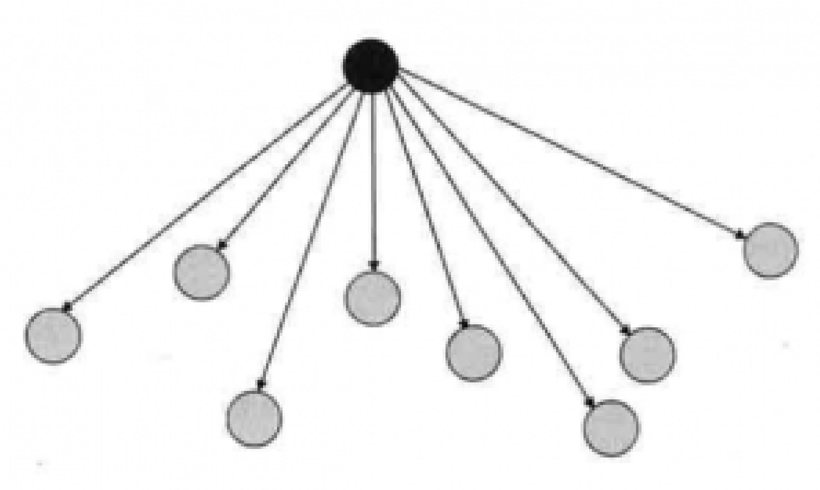


Figure 2. A typical expository structure.

Now, a transmergent learning experience is much different. Instead of creating a linear experience, what we do is create a dynamic experience. We design the experience to simulate a neural network, as shown in Figure 3. In a neural network, a task is handed off to a group of nodes, in this case, the students (light circles) and the instructor (dark circle). The nodes interact in a dynamic fashion, taking the task and processing it. Each node adds or subtracts information, insights, opinions, decisions, knowledge, skill, and so on, until a result is achieved. Furthermore, any node can have a role in guidance, coaching, and scaffolding. This can involve lecture by any member, group work by any group, private conversations between pairs, and individual reflection. If the conditions are right, the expectation is that the outcome will be Wow!—evolutionary and emergent results that are more than the sum of the parts, that is, extraordinary learning experiences.

Transmergent learning offers the possibility of some amazing breakthroughs when it comes to the creation of new knowledge. Given the right conditions, strong models of exceptional performance can emerge. These models define exemplary performance, which can then be further analyzed and examined by students and instructors alike to derive critical attributes and heuristics. Even the weak models offer learning opportunities, in the form of what one should avoid. After all, if you want to be a great photographer like Ansel Adams, you just don't look at his work that hangs on the walls of museums. You also take a look at what sits in his trash can. J. K. Rowling, author of the bestselling "Harry Potter" books, writes that, "Failure gave me an inner security that I had never attained by passing examinations. Failure taught me things about myself that I could have learned no other way" (Rowling, 2008).

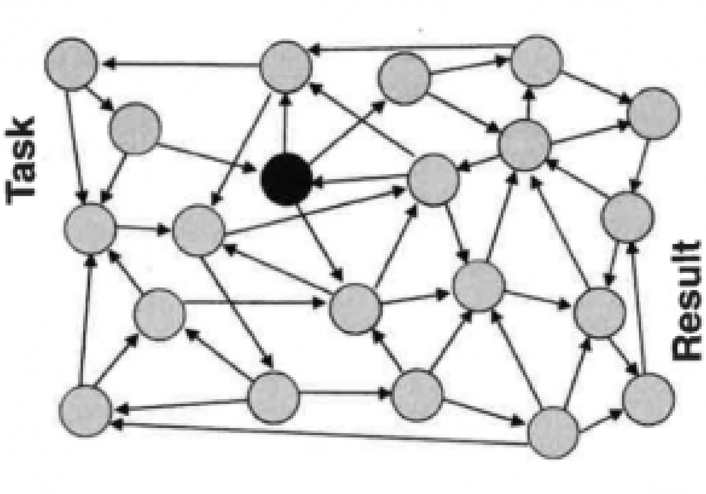


Figure 3. A Transmergent Learning Neural Network.

The most important quality of transmergent learning is that it increases the likelihood that learners can experience *transformation*. Transformation is an experience that significantly changes an individual in a positive way, resulting in a high level of economic value not only for the individual, but for the sponsor of the learning experience as well (Pine & Gilmore, 1999).

Complex Foundations

Transmergent learning owes its emergence to a branch of scientific inquiry called Complexity Theory (Lewin, 2000). Perhaps the reader is familiar with Chaos Theory, which describes nonlinear systems that are mechanistic, unpredictable, and without memory (for example, weather). Complexity Theory was developed to explain phenomena that Chaos Theory couldn't, such as systems that embrace the element of life. Ecosystems, living things, the brain, social structures, language, organizations, companies, and economies are often quoted as exemplars of complex systems, in that they develop over time in nonlinear ways, maintain a history of their development, and are somewhat stable.

Complex systems are emergent systems, in that they are shaped and developed over time through an evolutionary process. Thus, a learning experience, if it embodies the qualities of a complex system, has the capacity for emergence and transformation. It can enable learners to generate new constructions of knowledge and skill that are more than the sum of the parts. But the trick is creating a learning experience in which emergence and transformation can flourish. To do this, the literature suggests that the evolution of complex systems is influenced by two primary variables, a social variable called *framing* and a physical variable called *structure* (Cilliers, 1998).

Framing

Because complex systems become complex in the eye of the beholder, *framing* describes whether a system is perceived as being *simple*, *complicated*, or *complex* by a human observer. Each concept is relative, governed by the *frame*, the level or distance from which one perceives a system. For example, a small room aquarium may acquire the definition of *simple* when seen from afar, being nothing more than a home decoration. As one changes frame and sees a large number of components associated with the aquarium (heater, filter, chemicals, and organisms), it becomes *complicated*, but in a way in which the system can still be accurately analyzed and interpreted. However, as one changes frame yet again, looking even closer at an aquarium, one can see an ecosystem, and its *complexity* becomes evident.

In a learning experience, framing reflects the lens an instructor helps learners develop through many common instructional strategies (lecture, readings, practice, and so on) in terms of “seeing” the nature of a task. That is, if a learner can view a system at a complex level, then the learner has more degrees of freedom in manipulating the variables associated with that system.

Structure

Structure reflects the physical or conceptual nature of the system. While complex systems are by no means simple to identify, analyze, and interpret, Cilliers (1998) provides a useful model that suggests a set of qualitative attributes that define complex systems. A system is thought to be complex (and more likely to evolve) if it embodies the following structure:

- **A large number of elements.** This is the quantitative count of the number of elements that comprise the system.
- **Interaction between the elements.** This describes to what degree the elements interact or communicate with one another.
- **Interactions are rich.** This describes the amount of information shared between elements when they interact.
- **Interactions are non-linear.** This describes the expected outcomes of interactions as being predictable (linear) or not predictable (nonlinear).
- **Interactions have a short range.** This describes the relative physical distance between elements that are communicating.
- **Interactions have loops.** This describes the effect occurring when an element communicates with another element; the receiving element can provide feedback to the communicating element, and vice versa.
- **The system is open.** This means that the system can interact with other systems and can be directly modified and enhanced.
- **Disequilibrium rules the system.** Disequilibrium means that the system is in a constant state of change, where new forms may appear at any time.
- **The system has a history.** This means that the system keeps track of time, actions, events, and other data, and uses that data to manage interactions.
- **Each element is ignorant of the behavior of the system as a whole.** This means that no single element holds the key to the purpose, behavior, or structure of the whole system.

In transmergent learning, structure reflects the instructional strategy that forms the backbone of that experience. For example, if there is more potential for emergence with a large number of elements, then perhaps the designer should increase the number of learners in a class, rather than decreasing them. The next section describes the instructional tactics that correlate with these structural principles.

Instructional Strategies and Tactics for Embracing Transmergent Learning

The first thing one needs in the quest of Wow! is a task and a tangible outcome associated with that task. This should be an authentic task, something that is related to the work done by learners on the job (Honebein, Duffy, & Fishman, 1993). For example, in a university marketing course that I teach, the authentic task is the creation of a marketing plan. This document (and subsequent presentation) encapsulates all the performance goals and objectives associated with the course. In a corporate sales training course that I designed, the task for sales people is to develop a PowerPoint presentation for a simulated client meeting. This presentation is a work product that reflects customer analysis and product knowledge. Note that for Wow! to happen, the learners must create a tangible outcome.

Once the authentic task and outcome are defined, instructional designers who desire to make learning experiences more transmergent do so by integrating specific instructional tactics into those experiences. These tactics are applicable for both instructor-led training and e-learning, but as can be seen, the most ideal context is a blended learning experience. Table 1 introduces some of the example or generic instructional tactics that link with the instructional strategies associated with transmergent learning.

Application of Transmergent Learning in the Field

For the past five years, I have been experimenting with transmergent learning in two contexts. The first involves the university courses I teach at the University of Nevada, Reno and at Indiana University. The second context involves the instructional design work I do for corporate and government clients. This section discusses how I have integrated transmergent learning into various course designs.

Table 1. Instructional Tactics for Transmergent Learning.

Instructional Strategy	Example Instructional Tactics
1. Large number of elements.	• As many learners as possible. • As many books as possible. • As many information resources (literature databases) as possible. • Variety of guest speakers.
2. Significant interaction between the elements.	• Organize learners into reasonably-sized groups. • Enable groups to collaborate. • Allow classroom time for face-to-face interactions. • Provide technology (e-mail, threaded discussion, chat) for remote asynchronous and synchronous communication.
3. Interactions are rich.	• Focus communication on verbal, visual, and kinesthetic representations. • Reinforce synthesis and extension of ideas. • Encourage alternative representations (such as drawings, photographs, and multimedia).
4. Interactions are non-linear.	• Avoid communication templates. • Keep communication open-ended.
5. Interactions have a short range.	• Keep communication at the individual or group level. • Facilitate and coach at the individual or group level.
6. Interactions have loops.	• Facilitate and guide discussions so that they build and improve. • Engage learners to critique each other’s work. • Allow iterative designs of learner work products.

7. The learning environment is open.	• Everyone sees each other's work. • Guests move freely in and out of the learning environment. • Work products of the learning environment are migrate and shared outside the structure of the class.
8. Disequilibrium rules the learning environment.	• Introduce new data or content at strategic times. • Disrupt groups by adding or removing members. • Change the nature of tasks to fit the context or situation. • Add new constraints or remove existing constraints.
9. The learning environment has history.	• Learners maintain logs of their actions • Learners maintain journals of their thoughts and ideas. • Discussions are conducted in online threaded discussion groups. • Learners maintain portfolios of their work. • Work from previous classes is accessible.
10. Elements are ignorant of the whole	• Learner's task must be clear, but ill-defined. • No one learner should dominate a group's work. • Instructor must facilitate, not dominate.

Transmergent Learning in a University Course

MKT 210 is an undergraduate marketing principles course at the University of Nevada, Reno. Upon first glance, the course is perceived as a large lecture course accommodating up to 200 students. It is taught in an auditorium-style lecture hall that features two big-screen projection systems and a media console that can present media from computer, DVD, video, document camera, and other devices.

The structure of the course, however, is much different from other large courses at the university. On day one, learners immediately assume the role of a marketing manager. Their task is clear: take a product from idea to marketing plan. This authentic activity forms the backbone for the learning experience. To accomplish this task and provide a bit of escapism to the student's roles, the class divides randomly into two competing companies (A and B), with each company having 16 teams of four to seven students (32 groups total). Over 3000 new-product ideas are elicited from students, from which eight are selected from a student-driven synthesis process. Two groups from each company work on the same product idea. Thus, four different marketing plans are generated for each product. Through a series of competitions, only one plan for each product will reign superior, and the winning teams are rewarded with extra credit. This attempts to simulate the vetting process companies use to develop and fund new product ideas (and the natural-selection process organisms and social systems use to gain strength).

During class sessions (which are once weekly for three hours), students experience a variety of instructional tactics that blend framing and structure. There is a bit of lecture involving core content, a couple of interactive learning activities, fluency practice, and sometimes a guest speaker or face-time for students to work with their groups. Outside of class, students use a WebCT discussion thread to collaboratively work on their projects. Each week, students post research and ideas to a blog, in the form of a private folder that only members of a team may access. For example, the Market Analysis Blog requires students to find and post research that supports the market need for their product. These postings are coached and scaffolded by my graduate assistant and myself. Toward the end of the semester, each student uses the data collected in their group's blog to write a five-page marketing plan. Plans then go through three rounds of peer-review competition that let the eight best plans emerge, one for each product idea.

The MKT 210 learning experience incorporates the principles of transmergent learning in many ways. Table 2 explores the linkages between the instructional strategies and their corresponding tactics:

One of the goals of the course is that students will be able to recognize a good marketing plan, and distinguish it from one that is not so good. In the final round of the competition, the top 16 plans in the class go head-to-head in a formal competition, two for each product idea (one from each "company"). Winners are determined by a best out of three vote: my vote, the students' collective vote, and, in case of a tie, my graduate assistant's vote. The agreement between my vote and the students' vote has been .86. And, in the cases where we didn't agree, the quality of the plans being presented was relatively equal.

Transmergent Learning in the Corporation

There is no doubt that the freedom a university environment offers an instructional designer allows for significant exploration and experimentation of transmergent learning principles. Applying transmergent learning is more challenging in corporate and government environments, due to numerous constraints. For example, resources are limited, especially in terms of instructor engagement and the time allowed for train-ing. However, my colleagues and I have had opportu-nities to apply the principles of transmergent learning in both e-learning and instructor-led projects in corporate settings, with favorable results.

Table 2. Linkages between instructional strategies and tactics.

Instructional Strategy	Instructional Tactics
1. Large number of elements	• 200 students. • Access to books in the UNR library. • Access to library databases. • Multiple guest speakers (experts and members of the business community).
2. Significant interaction between the elements.	• Students organized into cohorts of 4 to 7. • WebCT Learning Management System to manage discussions, e-mail, assignment postings, and so on. • Product brainstorming activity that yields 3000 new product ideas.
3. Interactions are rich.	• Content presentations incorporate verbal, visual, and kinesthetic encoding strategies. • All significant interactions between students are written in threaded discussion groups called Product Blogs. • In-class activities (such as distribution channel design) are documented on paper. • Groups are in competition with other groups, motivating deeper interactions and contributions. High-performing groups are rewarded with bonus points at the end of the semester.

4. Interactions are non-linear.	• Discussion postings do not have a rigid form or structure. • When worksheets or job aids are used, they are open-ended.
5. Interactions have a short range.	• WebCT discussions are between facilitator-students, student-student, and student-group.
6. Interactions have loops.	• Threaded discussions are visible to group members. • Facilitator monitors discussions and provides process/depth feedback as required. • Students must read and critique each other's plans. • Facilitator conducts marketing plan review sessions where groups exchange draft plans and discuss the strong and weak points of the various pans.
7. The learning environment is open.	• Posting to discussion boards are visible to all members of a group. • Book reports are posted to discussion boards and to the Amazon.com site.
8. Disequilibrium rules the learning environment.	• Course facilitator provides market data (such as previously unknown competitive products) to groups throughout the semester. • Group members can be fired; groups can be disbanded.
9. The learning environment has history.	• All discussion posting and e-mail are maintained in the WebCT system. • All assignments are maintained in the WebCT system. • Students maintain project folders for har-copy artifacts.
10. Elements are ignorant of the whole.	• Project involves inventing a product or service that doesn't yet exist. • Facilitator does not coach students in the form or design of their product or plan. The facilitator coaches process, depth, and generally-accepted practices.

No corporate project we have completed has seen a wholesale application of transmergent learning. i don't see this as prudent, since any course that relies on one kind of strategy, whether it is expository, discovery, or transmergent, in the corporate setting, will likely not achieve its intended goals. Instead, what a designer looks for in these contexts is niches or islands of opportunity, whereby transmergent learning may be integrated in certain strategic places that stimulate a Wow! factor from time to time.

As I mentioned above, the first thing that enables a learning experience to be transmergent is a task and a tangible outcome associated with that task. For example, in a sales training course we developed, as noted above, the task for sales people was to develop a PowerPoint presentation for a client meeting. This presentation was a work product that reflected customer analysis and product knowledge. In a systems analysis course, the task was to prepare a user requirements document for a simulated product. Again, this was a work product that represented the acquisition of knowledge and skill related to systems analysis.

Once one has the task, the next step is to find ways to create neural networks in the course, however small or large, persistent or fleeting. The sales training course is a self-paced e-learning program. Resource constraints prohibited us from including peer-to-peer discussion groups or other forms of direct asynchronous communication between learners. However, we convinced the client to allow learners to submit their finished presentations to the subject-matter expert for review. The presentations the SME found particularly good were recycled back into the course in the form of authentic examples. These examples became the inspiration for learners to adapt and improve, and the cycle became self-feeding.

In the systems analysis course, transmergent learning is a recurring theme in the activities learners complete to accomplish their task: creation of a user requirements document. One especially transmergent task is a requirements-writing activity. In the context of a multi-day simulation, we give learners the task of writing individual requirements for several user needs. Each learner writes a requirement for each need on an index card. A group of three to five learners then collates their cards by need, resulting in multiple stacks of cards—one stack for each need. The learners then pass the stacks, reading and ranking the cards in each stack. The result is what the group thinks is the "best" requirement for each need, which is then presented and compared with the work produced by other groups.

Conclusion

The selection of macro and micro instructional strategies is dependent upon the conditions the designer faces and the outcomes the designer desires (Reigeluth, 1983). With regard to conditions, my research suggests that transmergent learning is appropriate for:

- high-level cognitive skills;
- ill-defined or ill-structured domains;
- goals or problems "owned" by the learner;
- learning objectives related to creativity and invention;
- learner tasks that accommodate authentic activities, active learning, and more subjective forms of performance evaluation; and
- environments that incorporate learning management systems or similar collaboration tools.

As far as desired outcomes for transmergent learning are concerned, the answer is an extraordinary Wow!

References

Cilliers, P. (1998). *Complexity and postmodernism: Understanding complex systems.* London: Routledge.

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing and mathematics. In L. B. Resnick (Ed.), *Knowing, learning and instruction: Essays in honor of Robert Glaser* (pp. 453-494). Hillsdale, NJ: Lawrence Erlbaum Associates.

Csikszentmihalyi, M. (1997). *Creativity: Flow and the psychology of discovery and invention.* New York: Harper Perennial.

Honebein, P. C., Duffy, T. M., & Fishman, B. F. (1993). Constructivism and the design of learning environments: Context and authentic activities for learning. In T. M. Duffy, J. Lowyck, & D. H. Jonassen (Eds.), *The design of constructivist learning environments.* Heidelberg: SpringerVerlag.

Kirschner, P., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist,* 41(2), 75-86.

Lewin, R. (2000). *Complexity: Life at the edge of chaos.* Chicago: University of Chicago Press.

Mayer, R. (2004). Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction. *American Psychologist,* 59(1), 14-19.

Pine, B. J., & Gilmore, J. H. (1999). *The experience economy.* Boston: Harvard Business School Press.

Reigeluth, C. M. (1983). *Instructional-design theories and models.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Romiszowski, A. J. (1981). *Designing instructional systems.* London: Kogan Page.

Rowling, J. K. (2008). The fringe benefits of failure, and the importance of imagination. *Harvard University Commencement Address*; https://edtechbooks.org/-QBiA .

Vygotsy, L. S. (1978). *Mind in society.* Cambridge, MA: Harvard University Press.

Peter C. Honebein is President, Honebein Associates, Inc./Customer Performance Group. He is also an adjunct professor at Indiana University and the University of Nevada, Reno, and serves as a Research Scientist for the Academic Edge, Inc.

10

Sustaining Research Innovations in Educational Technology through Communities of Practice

Editor's Note: Hung, D., Lee, S.S., & Lim, K. Y. T. (2012). Sustaining research innovations in educational technology through Communities of Practice. *Educational Technology, 52*(4), 33-37.
The diffusion of innovation is critical to societal progression. In the field of education, such diffusion takes on added significance because of the many stakeholders and accountabilities involved. This article presents the argument that efforts at diffusion which are designed from a top-down perspective are not sustainable over the long term because such a perspective does not sufficiently acknowledge the importance of tacit knowledge in the successful adoption and adaptation of innovations. Using examples drawn from the trialing and implementation of a suite of research innovations in the Singapore education system, the argument is made that tacit understandings of any given innovation are attained through dialogue and embodied practice within authentic contexts, and that these very contexts and opportunities for dialogue are precisely the affordances of Communities of Practice. The article draws some tentative conclusions about systems-level moves and strategies which might nurture the dialectic of theory, practice, and epistemology by leveraging existing social structures.

Lessons Learned from the Recent Seeding of Educational Technology Innovations in Singapore

When an innovation is mature, attempts are usually made to translate that product into use benefitting the masses. Such an approach adopts a linear upstream to downstream flow of innovation diffusion.We argue for an alternative and non-linear conception of the diffusion of educational technology by adopting a more ecological metaphor to this issue. We argue why such an ecological approach is possible due to communities as networks of people, thereby enabling this diffusion. We also posit that the Communities of Practice (CoP) approach is a more sustainable innovation diffusion strategy, as the crux of innovation is the leveling up of human capacity to adopt the innovation appropriately.

Over the past seven years, the Ministry of Education (MOE) in Singapore has generously supported the research efforts by awarding the National Institute of Education (NIE) a five years' block of funding amounting to around US$10 million dollars per year. Many of these projects study the baseline states of current teaching and learning practices, both in local schools and the teacher education practices, and another significant allocation goes to intervention projects in the schools. Table 1 shows the research grants and the cluster of projects we have done through our analysis of these grants. The analysis is done based on data we have collected from the principal investigators of the grants, where we sought data relating to years of implementation and the specific intervention for a particular year; the funding amount supported; the schools involved; and the nature of the research work with respect to research methodology (for example. Design research) and teacher professional development issues. Interviews were also conducted with the research teams when more information was needed with respect to their interventions.

From the data collected from over 250 research projects, consisting of a wide range of educational issues across the system and with differing methodologies, we categorized these projects into 12 research clusters or themes. The 12 clusters are: (1) applied cognitive development, (2) bilingual language development, (3) scaling and professional development, (4) user generative designs, (5) values and 21st century learning, (6) special needs, (7) early childhood, (8) learning by inquiry, (9) teacher education, (10) problem solving, (11) systematic studies, and (12) international benchmarking.

The projects are placed in Table 1 according to the nature of the research: basic, applied (schools and teacher education), and evaluation/implementation (local system and international benchmark comparisons).

Table 1. Classifying research projects into clusters.

<table>
<tr><th></th><th>Basic research</th><th>Applied research on schools</th><th>Applied research on teacher education</th><th>Evaluation/Implementation of local system</th><th>Evaluation/Implementation with International benchmark comparisons</th></tr>
<tr><td rowspan="5">Research Clusters</td><td>Applied cognitive development</td><td>User generative designs</td><td>Teacher education</td><td>Systematic studies (for example. leadership of school principals, baseline studies of teaching and learning practices)</td><td>International benchmarking (for example, TIMSS and PISA)</td></tr>
<tr><td>Bilingual language development</td><td colspan="3">Values and 21st century learning (in and out of school)</td><td rowspan="4"></td></tr>
<tr><td rowspan="3">Scaling and professional development</td><td>Special needs</td><td rowspan="3">Problem solving (in Mathematics)</td><td rowspan="3"></td></tr>
<tr><td>Early childhood</td></tr>
<tr><td>Learning by inquiry (for example, applied to teaching and learning science)</td></tr>
</table>

Not all projects had an intervention orientation, but the whole range of studies would provide us with the context to understand the sustainability of the research. One major criterion we observed in research projects having the potential to scale up was that projects had a sustained historical development and resulted in an active dialectic between theory, practice, and epistemology. These studies would typically have adopted varying methodologies, from baseline studies to interventions, and, to some extent, have done some degree of scaling. A second important consideration is that these studies, which have a sustained trajectory, would also have built up strong human capital and teamwork both among the ‘ researchers and with schools and teachers.

In terms of scaling up, the research projects which conceptually took into account scaling considerations from the onset stood a higher chance of success. These projects often began as ‘blue sky’ research (Braben, 2004, 2008) and worked their way through years of implementation in schools. Such research with strong theoretical underpinnings was more successful with respect to scaling up. All the research grants that experienced success with scaling up had the schools as their partners in research engaged from the beginning, although there were projects with varying degrees of teacher ownership and agency involved.

Table 2 shows a sample of educational technology and inquiry related innovations from projects undertaken—which were mainly oriented towards interventions. Projects in Table 2 had demonstrated success in diffusion among schools because partnerships with schools were established in early stages of the research.

The design research approach used on educational innovations—in which teachers and researchers worked in partnership in Singapore schools—have succeeded because the journey was taken long-term over three to seven years. There was sustained research interventions of learner-centered designs and pedagogies seeded in many local schools. The research journey had processes to make sure that when things did not work well, researchers were always around to ameliorate the situation until it became a productive learning experience. Thus, it was a hands-on approach to research. It was challenging for researchers to work with the schools, and these challenges were mitigated when the school principal was supportive; teachers were given resources and time to participate in innovations. The innovation could subsequently spread from one class in a level to the entire level, followed by multiple levels in a school to multiple schools in a district.

The key value of having researchers and teachers work together is that there is diversity of perspectives and skills. This enables them to think in out-of-the-box ways, and diversity drives innovations. Using an ecological perspective creates incremental evolutions towards 21st century practices. If CoPs are used as a resource for diffusion and a mechanism to encourage dialogue among teachers and principals in different schools, the entire education system may slowly progress towards 21st century literacies.

Table 2. Analysis of intervention projects.

Intervention projects	Number of schools	CoPs	Intense ownership by teachers	Courses Infusion	Sustained	Translation efforts
Seamless collaborative learning	20	Yes	Yes	Yes	Yes–team is stable; funding is also stable	Yes
Games for learning	5	No	No	Yes, but gradually introduced	Not stable–no stable co·PIs; funding not stable	No
Constructive activities	4	Yes	Yes	No	No–no succession planning	No
Learning in virtual worlds	17	Yes	Yes	No	Yes–team is stable; funding is also stable	Yes
Storytelling	2	No	No	No	No	No
Science inquiry	3	No	No	Yes	No–no succession planning	No
Historical inquiry	5	Yes	Yes	Yes	Yes–team is stable; funding is also stable	Yes

Math problem solving	10	Yes	Yes	Yes	Yes–team is stable; funding is also stable	Yes

Scaling up issues and sustainability cannot be divorced. In fact, we argue that they are two sides of the same coin. For research projects which have been sustained, the presence of CoPs (or some form of professional learning community, whether in schools or in our teacher-education institution) was evident. Within the CoPs, teachers:

1. had much ownership working closely with researchers on authentic tasks and real practice in the classrooms—integrated as part of the teachers' professional life;
2. were also heightening their professional practice by presenting their work in conferences and in school and cluster sharings; and
3. were recognized for what they contributed.

Discussion: The Pipeline Versus an Ecological View of Innovation Diffusion

The traditional way of thinking about scaling innovations has been from the pipeline perspective (Godin, 2006). Researchers conceptualize innovations, and these are tested out in constrained laboratory settings and then rolled out. As discussed earlier, these creations are not authentic to the original innovations because they foreground the product over process.

In this article, we have sought to introduce an alternative view of innovation diffusion from an ecological metaphor. Such a view is more consistent with the concept of CoPs. It is based on creating CoPs to support innovations as they get seeded. CoPs are formed in parallel with these seeding efforts. Tacit knowledge (Polanyi, 1967) involving the social and interactional dimensions is exercised in situ with the development of the innovation. CoPs are groups of people gathered around a common interest and interacting in a sustained manner to dialogue and engage in meaningful activities around the issues at hand (Lave & Wenger 1991; Wenger 1998; 2000; Wenger, McDermott, & Snyder 2002). Lave and Wenger (1991) brought to prominence this concept and began to probe further into why learning in CoPs work. The prominence of such theories arose as a contrast to school-based learning, which was criticized as less authentic due to the de-contextualized nature of how the latter represented knowledge.

Moore (2002) has depicted the adoption of innovations as sometimes being stymied by a chasm. For any given innovation, there will be early innovators and early adopters, but some of these innovations may never get out to the masses. Many of the innovations that happen in a laboratory or university are research-based and never clear the innovation chasm. In this article, we argue that innovations that are developed for and by CoPs stand a better chance at crossing the chasm.

It is our position that funding agencies have tended to assume that the provision of hard (that is, policy-and resource-, as opposed to social-) structures would help push the innovation across the chasm. In contrast, from an ecological view, innovations are seeded across society and environment (Kao, 2009; Moore, 1993). In a naturalistic way, the majority of these ideas would likely not gain traction. For those that succeed, more funds are provided to support them further. This can be characterized as the business ecological way of looking at innovations.

A central tenet of this article is that such a business-ecological view cannot be simplistically applied to education. This is because schools and educators are accountable to parents, students, and society. How then might the ecological metaphor be used to enable many more pedagogical innovations to be seeded organically?

In the past, consistent with the industrial age, scaling was synonymous with generalization, and in turn this resulted in much de-contextualisation. Innovations were initiated in the laboratory and then spread to the masses. Today innovations—such as smartphone applications—grow with the ecology and community over time. The collective majority in the ecology is creating and driving the innovation rather than a small minority who creates the innovation in the laboratory. Foundations and tacit knowledge are established right from the onset in the ecology and evolve within communities; such an ecological perspective rejects the stance of waiting until the innovation is tested and proven before attempting diffusion.

The ecological view of educational technology innovations, as argued in this article, is about developing and spreading innovations contemporaneously. If such is the case, few innovations will be left behind. It is the responsibility of the education fraternity to try to enable most if not all of the educational innovations to succeed.

From the ecological view of educational technology innovations, research starts at the school, rather than in a laboratory, using a design research approach, where researchers and teachers work in close partnership right from the onset of the intervention. In other words, these interventions do not originate from the research laboratories but begin as innovations with research rigor on the practice grounds. In this way, they stand a better chance of crossing Moore's (2002) chasm.

For example, the technologically-mediated research projects (such as Chen & Looi, 2011; Lim, 2011; Wong, Chin, Tan, & Liu, 2010) outlined in the first half of this article were all co-designed with practitioners because teachers were willing to work with researchers to create innovations and change. The researchers did not conduct non-participatory research or sideline observations. They walked the journey with the teachers through three to five years of research interventions. They worked with teachers until the latter felt sufficiently confident to conduct the interventions on their own. In turn, by having walked the entire research journey with teachers, the researchers were confident that teachers could sustain these innovations by themselves, as they had appropriated the tacit dimensions of the innovation. In order to sustain the innovation in a particular school, the knowledge about the innovation was dialogued among the CoP members there. If that same innovation were to be diffused to other schools, the CoP would grow and evolve with it.

Whenever there is some degree of success in seeding educational technology innovations, the response from policy-makers is to focus on how to scale up. This usually defaults to an issue of how to generalize the principles involved in the educational technology innovation and to create some policy imperative to roll out the innovation to more schools and also to the system as a whole. We argue that this thinking is flawed and under-estimates the process-oriented nature of knowledge.

Conclusion

We therefore wish to conclude this article by highlighting the following areas in which further work is needed.

First, the readiness of schools with respect to innovations in educational technology needs to be articulated. While schools should remain as the primary elector for the respective innovations, there should be a matching of the readiness of a school and the complexity of the innovations proposed. In our past years of innovation seeding, we had research agendas from complex situated games which required a radical redesign of curricular and other technologies that could be more readily infused into curricula but would require lessons to be more collaborative and inquiry-based.

Second, we need to develop a framework for translating and scaling (or diffusing) research such that subsequent iterations remain authentic to the design principles. This requires attention to be paid to how innovations might he adopted and adapted across different demographics, disciplines and organizational levels.

Third, efforts in teacher professional learning—both by the MOE and the NIE—have to close the loop by infusing case studies of successful research innovations which have been sustained in schools. Although teacher education/training programs are not the ideal ways to encourage tacit knowledge developments, they are nevertheless possible avenues to prepare the minds of teachers and their knowledge base. in Singapore, the MOE conducts a holistic curricular review for the school system every six to seven years. These new curricular redesigns should also be part of the holistic review process.

It is our hope that with these three systemic strategies, educational innovations would be spread more successfully, and students in the school system would benefit and be enculturated into 21st century literacies and dispositions.

References

Braben, D. W. (2004). *Pioneering research: A risk worth taking. Hoboken*, NJ: John Wiley and Sons.

Braben, D. W. (2008). *Scientific freedom: The elixir of civilization.* Hoboken, NJ: John Wiley and Sons.

Chen, W. & Looi, C. K. (2011). Active classroom participation in a Group Scribbles primary science classroom. *British Journal of Educational Technology, 42*(4), 676686.

Godin, B. (2006). The linear model of innovation. *Science, Technology, and Human Values, 31*(6), 639-667.

Kao, J. (2009). Tapping the world's innovation hot spots. *Harvard Business Review*, *87*(3), 109-117.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation. Cambridge:* Cambridge University Press.

Lim, K. Y. T. (2011). Towards a situative view of extending and scaling innovation in education: A case study of the Six Learnings framework. *Educational Review for Policy and Practice, 10*(2).

Moore, J. F. (1993). Predators and prey: A new ecology of competition. *Harvard Business Review, 71*(3), 75-86.

Moore, G. A. (2002). C*rossing the chasm: Marketing and selling high-tech products to mainstream customers (rev. ed.).* New York: HarperBusiness.

Polanyi, M. (1967). *The tacit dimension*. New York: Doubleday.

Wenger, E. (1998). C*ommunities of practice: Learning, meaning, and identity.* Cambridge: Cambridge University Press.

Wenger, E. (2000). Communities of practice and social learning systems. *Organization, 7*(2), 225-246.

Wenger, E., McDermott, R., & Snyder, W. M. (2002). *A guide to managing knowledge: Cultivating communities of practice.* Boston: Harvard Business School Press.

Wong, L.-H., Chin, C.-K., Tan, C.-L., & Liu, M. (2010). Students' personal and social meaning making in a Chinese idiom mobile learning environment. *Educational Technology & Society, 13*(4), 15-26.

David Huang, a Contributing Editor, is a Professor at the National Institute of Education, Singapore.
Shu-Shing Lee is a Research Fellow at the Office of Education Research, National Institute of Education, Singapore. **Kenneth Y. T. Lim** is a Research Scientist at the Office of Education Research, National Institute of Education, Singapore.

III

Implementing Creativity and Innovation

11

Role-Based Design

Editor's Note: Hokanson, B., & Miller, C. (2009). Role-Based Design: "A Contemporary Framework for Innovation and Creativity in Instructional Design". *Educational Technology, 49*(2), 21-28.

This is the first in a series of four articles presenting a new outlook on the process of instructional design. Along with offering an improvement to current practice, the goal is to stimulate discussion about the role of designers, and more importantly, about the nature of the process of instructional design. The authors present in this article a brief overview of current instructional design processes and an illustration of a contemporary framework for design created to foster innovation and creativity throughout the instructional design process.

Introduction

Current practice in instructional design is focused on generic descriptions of phases, rather than the nature of people and philosophical values (e.g., Hoadley & Cox, in press; Silber, 2007; Visscher-Voerman & Gustafson, 2004). Most design processes followed in the field are derivations of the same sequential models often referred to as "ADDIE"—Analysis, Design, Development, Implementation, Evaluation. These processes tend to concentrate on the completion of technological and pedagogical requirements rather than on the quality of the learning experience or innovation. We contend that much of the shorfall in advancing education with technology is due to a limiting design process that centers on *completing the work*, with only incremental increases in production and educational efficiency.

Although we do not necessarily share the unenthusiastic and somewhat pessimistic expectations about technology and education (Zemsky & Massy, 2004), we do believe that educational technology, as is currently used, would benefit from a substantial infusion of creative, innovative, and artistic ideas. Often restricted by rigorous and sequential design processes, the current practice of instructional design has experienced only limited improvement over the years. A change in process is needed from the early phases of conceptualization through the final steps of production and integration. This will require a reshaping of the processes and models of instructional design to challenge our philosophy and help shape our designs.

We propose the exploration of an idea that will help encourage substantial innovation in instructional design, a design process that focuses on context and design qualities, on aesthetics and creativity, and one which is based on the *roles* a designer must play, as part of a complete design process.

Design Processes, Methods, and Frameworks: A Brief Critique

Jonassen (2006) holds that instructional design is historically regarded as a linear series of steps and phases that constructs models and processes "based on principles that are applied uniformly to all contexts," leading to the conclusion explaining why "instructional design is so seldom successful" (p. 26). Ultimately, we agree. A design process that is linear, constrained, and separated from context is limited in its potential. In contrast, current educational theory urges new teachers to be holistic and creatively adjust to classroom and societal change; educational challenges are urged to be authentic and innovative. In parallel, our instructional design process should employ these same values: creativity, innovativeness, and authenticity, as well as an understanding of the contemporary research ideas of the field.

Our concern centers on defining how the work of design is addressed: Is the work one of dealing with well-structured problems, those that can be simply and convergently answered through an algorithm or codified process? Or, is the work of (instructional) design focused on divergent problems,[1] those that are ill-structured, or wicked problems which seek solutions, but have no single answer? We contend the problems of instructional design are complex and are not well addressed by simple algorithmic processes.

Algorithms are valuable in that they are step-by-step means of reaching generally reproducible results. They are codified means of production, and, we argue, this is the essence of ADDIE in the design process. ADDIE, like most other algorithms, seeks an anticipated solution, a single answer that all designers can achieve, and one which is context and participant independent.

Algorithms do have value in a knowledge-based society: Moldoveanu & Martin (2008) describe the modern use of algorithms as one reason, combined with technological computing, for the advances in late 20th century thought:

> *The power of the algorithm lies precisely in the fact that it makes efficient the translation of knowledge into action. As knowledge structures progress in levels of precision and specificity, from pictures to heuristics to theories to models to algorithms, they also become more easily translatable into predictable, output oriented, behavioral patterns or routines. Not surprisingly, the development of algorithmic agents—both human and artificial—has been a natural outgrowth of the recognition of the power and use of the algorithm and a key driver of the decreasing marginal value of algorithmic tasks and skills. (p. 40)*

Heuristics, in contrast, are guidelines or "informal judgmental rules" (Lenat, 1983, p. 243). More complex tasks, particularly those described as 'ill-structured' or 'wicked,' cannot be addressed through a codified sequence of steps or sub-routines. Larger, more value-based guidelines or heuristics must be employed to analyze, understand, and resolve these problems. Heuristics are generalizable in their flexibility and recognition of the complexity of problems. Moreover, heuristics are often embedded in the values and experiences of designers as a tacit form of knowing (Cross, 1982; Lawson, 2004).

The ADDIE Paradigm

Within the field of instructional design, the term ADDIE is used to describe generally the design process and to structure formally the work of designers into a sequence of steps leading to a completed design. ADDIE, as noted above, consists of five phases (i.e., analysis, design, development, implementation, and evaluation) and appears to be a formalization of vernacular design practices in the field of instructional design, with a wide variety of minor variations to the process in existence (Molenda, 2003). It is comparable to a wide range of design processes in other fields; for example, Osborn's Creative Problem Solving model of 1953.

Over recent years, a wide variation in design processes has been documented in the field of instructional design. Many in-depth explorations of these design methods are readily available (cf., Becker, 2007; Jonassen, 2006; Visscher-Voerman & Gustafson, 2004). "At least a dozen authors have variations of this basic theme with 4-10 stages that portray design linearly as a progression from the less determined exploratory work to the more constrained final production of designs" (Hoadley *&* Cox, in press). It is not our intent here to re-evaluate the historic and current fluctuations of models and processes in our field. Rather, we begin by sharing a selection of frameworks that we believe provide fresh perspectives for designers fatigued from sifting through antiquated and weathered design processes that do little more than present the phases of ADDIE with creative new titles. Furthermore, it is important to note that it is not our attempt to build these models up for failure, casting them as strawmen in an attempt to illustrate prospective benefits of a contemporary design approach and supplant the existing landscape. Therefore, we will not disassemble and evaluate each process or model individually, but rather expand upon what we believe to be a general shortcoming in relation to fostering creativity and innovation in instructional design. Ultimately, we conclude, with Becker, that most instructional design models "…are far from new, the processes have been given a 'new coat of paint' and formal names, and so are treated as new ideas" (2007, p. 88).

Jonassen's Iterative Model

Jonassen (2006) describes instructional design as "most often a cyclical process of decision-making based upon constraint satisfaction that is modified by personal or corporate beliefs and biases" (p. 26). In Jonassen's Iterative Design Model, after conceptualizing the initial constraints and functional specifications of the project, the designer embarks on repeated sets of decisions closing in on the design solution. During each phase of the process, the role of the designer is to satisfy emerging and dynamic constraints in order to advance holistic understanding of the problem and context. Hoadley and Cox (in press) characterize "good" design as iterative by definition, using a constant cycle of improvement and feedback. Likewise, Jonassen's process can be described as a convergent spiral toward a successful design solution.

To ensure successful design work, Jonassen argues that designers must "address the constraints imposed by the context" (p. 26) through employing an iterative, cyclical series of decision-making processes with the goal of design to *satisfice*[2] rather than optimize. This model, while it is rooted in the basic ADDIE structure, begins to dissolve some of the rigid, sequential steps of previous forms.

Kirschner's Six-Stage Model of Interaction Design

Kirschner's model of interaction design continues this interactive and reflective process through a series of phase-based questions. Interaction Design is a discipline focused on creating useful and engaging experiences that appeal to and benefit the user (Kirschner, Strijbos, Kreijns, & Beers, 2004) and is a framework specifically anchored in utility, usability, and aesthetics. Whereas utility is defined as the array of functions and features incorporated by a system (i.e., the tools present in the software that satisfy the outlined requirements), usability is concerned with the effectiveness, efficiency, and satisfaction with which learners can accomplish a set of tasks. Distinct from instructional design, the field of interaction design is also concerned with aesthetics and, more precisely, how the design appeals to and benefits users.

To foster acceptance of the utility, usability, and aesthetics equilibrium desired in interaction design, Kirschner *et al.* (2004) introduced the six-stage model of interaction design. Using this method, designers challenge themselves with a series of questions throughout the process to further understanding of the problem. Initially, designers must explore the realistic actions and needs of learners in order to identify areas of potential support and pinpoint constraints (i.e., physical, logical, and cultural) that will ultimately shape the final design. Once the design has been implemented, designers explore how the solution is perceived and used by learners in an authentic context. The process concludes with an investigation and description of what learning has actually been achieved through use of the design.

The process relies heavily on an integrated system of questions that apply values to a standardized design sequence. Similarly, Silber (2007) examined the instructional design process and advocated for a principle-based design process. Although we believe these efforts represent a fresh course for the field, we contend that the inherent values of the system should be more overt, and specifically integrated into the roles of the design participants, instead of simply part of their adopted activities; they must *become* designers.

Ten Faces of Innovation

In what we believe was a sizeable stride forward in this direction for creative processes, Kelley & Littman (2005) presented ten roles that designers and design teams can use to foster creativity and innovation. Their roles include the anthropologist, the experimenter, the cross-pollinator, the hurdler, the collaborator, the director, the experience architect, the set designer, the caregiver, and the storyteller. From contributing insights by observing human behavior (i.e., the *anthropologist),* to bringing people together to get the job done (i.e., the *collaborator),* to generating persuasive stories relative to context (i.e., the *storyteller),* Kelley & Littman's ten players illustrate a unique set of values, beliefs, characteristics, skills, and attributes that a design team should embrace when attempting to design innovative solutions for the contemporary marketplace. Most importantly, their design framework focuses on the type of designers needed to harness a successful and innovative project, rather than a series of phases, processes, and models that describe how such a project might evolve; in essence, successful innovation stems from *people, not processes.*

Role-Based Design

We believe the process of instructional design is in need of foundational transformation, from one of following a codified algorithm to a new way of designing that uses specific roles to define project values, responsibilities, and activities. In our description of Role-Based Design, we present a series of archetypes, that is, a selection of real professions which are applicable perspectives for professional behavior in instructional design. We describe an instructional design process that includes the ***artist,*** the ***architect,*** the ***engineer,*** and the ***craftsperson***. These are professions and descriptors that are well known to all in society.

As archetypes, these selected roles are exemplars of behavior and practice, personifications of value sets and philosophies, and are infused throughout a design project. “These values may not yield a specific chronological progression of stages, but instead may manifest in a stance that is taken in all the activities in design” (Hoadley & Cox, in press). While every metaphor is not an exact match, we seek to apply to instructional design the best qualities from each profession. For example, complementary to the artist’s divergent world view is the convergent and research based understanding of the engineer.

Each of the four roles (see Figure 1) will be presented here in the general order of a design process; each role, in turn, leading the project and applying their own values and expertise. For example, the artist explores creative ideas for a project; the architect examines the challenges and context of the problem from a systemic and strategic viewpoint; the engineer applies scientifically based logic to the development and integration of the solution; and the craftsperson invests fine attention to detail and aesthetic discipline to the execution and production of the design.

Each role, from the creativity of the artist, to the care and completion of the craftsperson, is critical at some point in the process; each serves as check and balance for the other roles. At the same time, each exemplar participates throughout the design process. Role-Based Design is both sequential and concurrent—the craftsman bringing the artist back to earth while understanding the creative nature of the work; the architect reminding the engineer of the broader and aesthetic needs of the project. Each role is constant and integrated into the entire process, not taking the lead all the time, but present and engaged throughout.

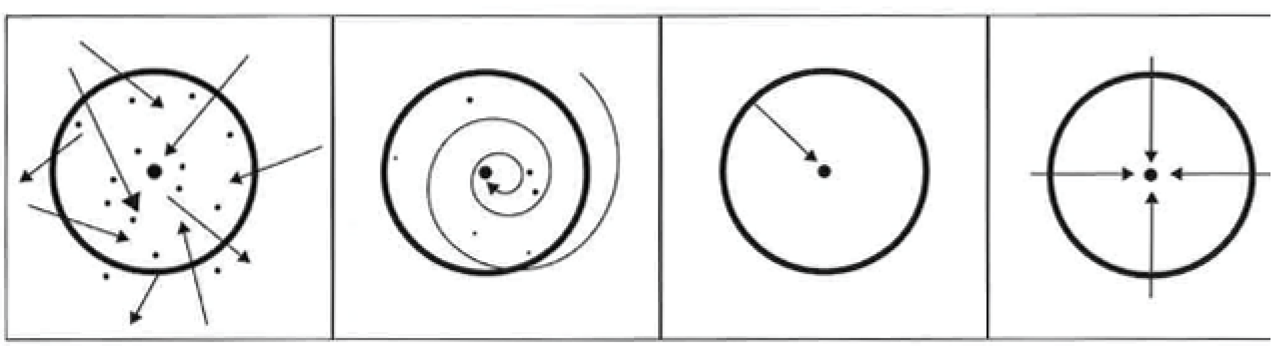


Figure 1. Role-Based Design: The four roles of Artist, Architect, Engineer, and Craftsperson are represented visually through a series of problem spaces (the outer circles) and potential solutions (the inner dots). The various arrow-tipped lines depict how each role explores the problem space to design and implements a solution (or solutions); these will be discussed in greater detail throughout the following sections and in subsequent articles in this series.

The Instructional Artist (Playful Experimentation)

In many design projects, under time or budget constraints, a single driving concept is selected very early in the process and essentially “passed down through the ranks.” These preconceived, but well-tested, ideas are often built from experience and used without the rigor of a challenging design process.

We believe successful design processes require a dedicated period of experimentation, of development of divergent and unusual ideas, and the ability to embrace failure as a means to innovation. In short, the instructional designer must also work as an artist. A corporate credo of IDEO, a highly successful design firm, is “Fail early, fail often” (Kelley & Littman, 2005, p. 52). IDEO’s corporate culture has embraced the role of the iconoclast artist in their work; creativity by definition differs from the norm.

Artists often begin their practice with a skill in their chosen medium, from drawing to painting to digital interactivity; similarly, many in the field of instructional design begin with a skillset in electronic media development. Artists are advocates for user/viewer experiences and aesthetics, both areas with vast potential for improvement in the field instructional design. Artists often have a high level of creativity, and in many cases work outside of mainstream society. Furthermore, artists embrace unexpected results, uniqueness, and, at times, the disturbance of the status quo. The goal is to advance the understanding and development of new ideas and not necessarily to complete a finished product. In most cases the artist works without a client or direct patron, independently advancing the work.

In Role-Based Design, the *instructional artist* (see Figure 2*)* is responsible for stimulating divergent thinking both at the beginning and throughout the project, for advocating aesthetic qualities on a continuous basis, and as the “what if” person on the design team. As an educational explorer, the artist uses instructional challenges as stimuli to explore media and their potential affordances. Self-criticism plays a significant role in the thought pattern of the instructional artist, hoping to better understand one’s self and the design challenge. Within instructional design, this phase would allow for an exploration of ideas that could prove unsuccessful, but could also lead to innovative leaps. Accepting greater risk in the design process, the wager is to gain substantial increases in the value of design work.

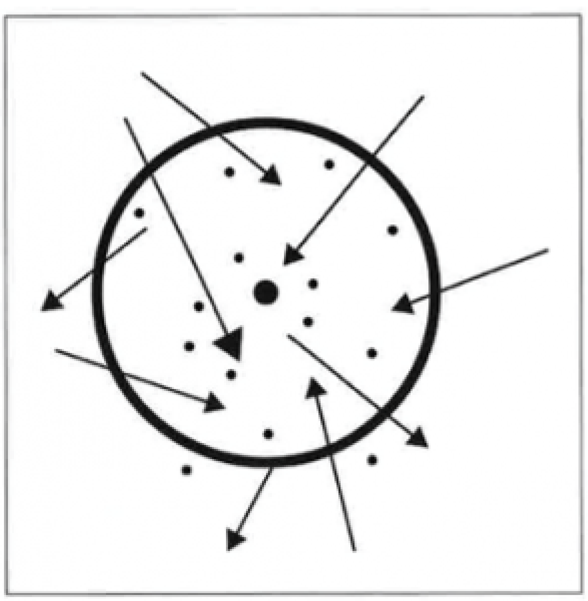


Figure 2. The artist explores all facets of the problem space by starting within and outside early problem specifications and context. Ultimately, many solutions, some potentially successful and some potentially detrimental, are explored and generated through an open-ended, dynamic process of playful experimentation.

Design projects often do not have extensive teams for the design of a project, and may be completed by a single individual. In this case, each of the roles of design is adopted in turn, repeatedly, throughout the project. Even at the conclusion of a project, the role of the artist must remain in evidence.

The Instructional Architect (Holistic Conceptualization)

Central to any design process is an understanding of the whole project, in other words, a view of the project in conceptual, theoretical, and contextual terms. Design processes must identify and recognize the assumptions of both the design problems and the designer, and to be truly effective, must question the nature of the design challenge in itself. The question that must be asked by the designer or design team is “What is the nature of *this* design problem?”

A balanced approach is needed in any design project, including those in instructional design; we call this broad role the *instructional architect* (see Figure 3). The instructional architect values aesthetics and user experiences, research-proven results, and technical capability. We view the architect role as one that

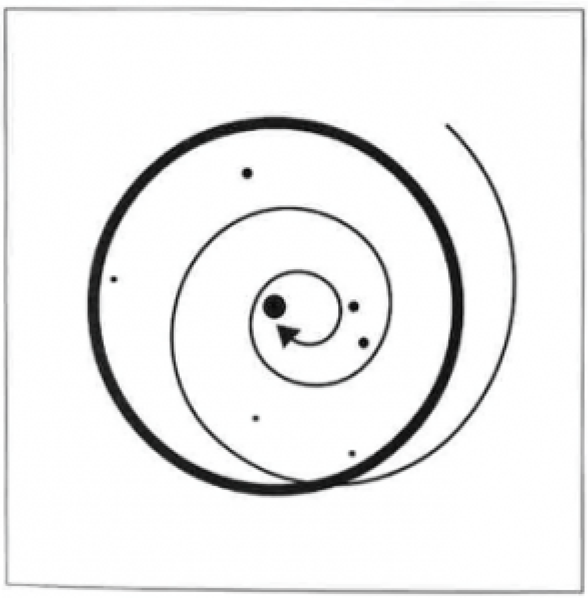


Figure 3. The architect explores the problem space through a holistic process of continuous context examination and discovery. Essentially responsible for creating ‘place’ out of ‘space,’ the architect represents a thorough conceptualization of both problem and user contexts.

Journeys beyond merely solving the problem to extending the boundaries of project resources past the technical and educational specifications of the project. The instructional architect seeks projects that transform the whole educational experience, having a long view of design and one which is not merely project centered.

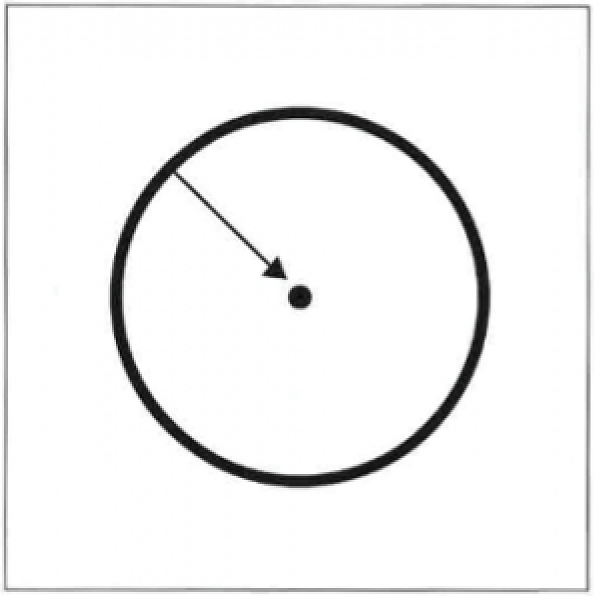


Figure 4. The engineer explores the problem space through a research-driven path that begins with initial problem specifications, ultimately zeroing in on the development of a single solution through application of scientific and theory-based methods.

The Instructional Engineer (Scientific Realization)

Much of the current practice of instructional design deals with the application of research-based principles and theories; these are used to organize, assemble, create, order, and work for the benefit of our society. Within this writing, we use the term *instructional engineer* (see Figure 4) to exemplify the most common perception of the main role in instructional design; the application of educational theory to develop materials, curriculum, and structures for learning through computers and related media.

> *The scientific method is employed to discover the nature of what exists, while design methods are employed to invent things which do not exist. Science is essentially analytic, and design is constructive (Rowland, 2005, p. 81).*

There are those in the field of instructional design that believe, explicitly or implicitly, that the field should be differently named: “Some object to the word ‘design,’ suggesting as it does a rather arty orientation, and insist that what we really need is ‘instructional engineering’ (Shepard, 2003). The argument is that this would lead to a more rational and systematized method of producing instructional materials; a strict, algorithmic process with guaranteed results. In contrast, however, as the design process is non-algorithmic and without guarantees, richer and more innovative results are produced out of apparent disorder.

Both within the field of instructional design and in the broader description of design, we value the work of engineers, as highly trained professionals with logical and empirical standards. Specifically, the engineering responsibilities within instructional design include product usability, audience understanding, and reaching educational goals. The theories and ideas of research drive the development of instructional materials through the role of the engineer, balanced with efficiency and technical soundness. We expect engineers, within instructional design or in alternate domains, to be logical, rational, inventive, and efficient. These are universal goals and are the essences of the engineer role.

Within the current practice of instructional design, most work initiated by the instructional engineer is completed by technicians with little input as to design ideas or values or change. The conceptualization, the planning, and the strategic view have all been completed, and the task of implementation and development must occur. During project production, however, there is a choice, between rote work and engagement, between craft and mere completion.

Unfortunately, we believe that most design work does not evolve during the implementation phase, as it is manufactured by others separated from ideas or aesthetics.

The Instructional Craftsperson (Experienced Evolution)

Instructional design materials are often produced by a *manufacturer* and not by an engineer. The manufacturer frequently is a technically skilled individual applying a pre-defined design template to solve an educational problem, delivering results as efficiently as possible. The solution to an educational problem is given or dictated to the manufacturer, whose responsibility is one of formatted production. Production consistency and stability are of primary value, resulting in products that are predicable and functional. As one expects a recipe from a cookbook to be predictably good but also what was intended, one should expect the results from a manufacturer to produce consistent, but not innovative, work.

We seek to replace the role and inherent perspective of the instructional manufacturer with that of an *instructional craftsperson* (see Figure 5).The values of the craftsperson are critical to the quality of the end artifact as part of the full design process. For the health of the design process and the participant designers, we argue that this portion of the work be positive, additive, generative, and ultimately forward thinking to ensure an ongoing improvement of quality in future designs.

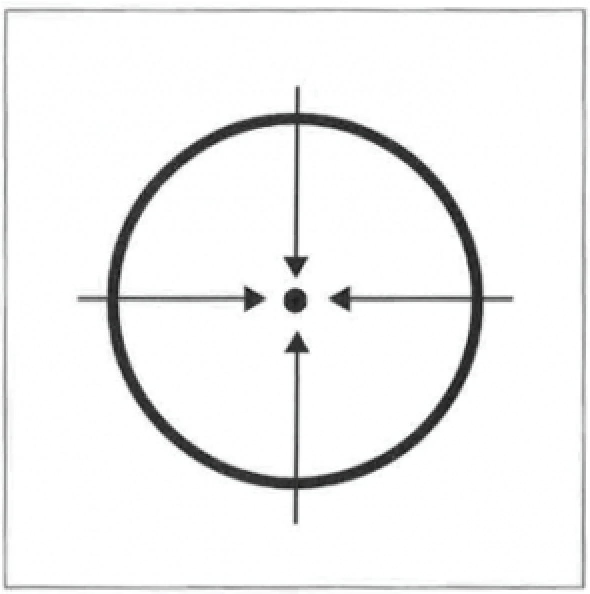


Figure 5. The craftsperson explores the problem space with experience, efficiency, and care for the quality of the final solution. Beginning outside the problem specifications to ensure no stone has been left unturned, the craftsperson develops and implements the solution with fine attention to detail from all angles of the problem.

We envision the instructional craftsperson as a designer with a high level of implicit knowledge gained through experience, and one who seeks quality both in aesthetic and technical terms. The instructional craftsperson may value the final product more than the client or user; analogously, furniture craftspersons may have a similar affection for their designs as well, earned through patience and calluses.

This is not a semantic change for the instructional design process, changing the terminology from “manufacturer” to “craftsperson,” although the characterization would be easy to. adopt. A mere change of title would not change the process nor the end product; there would be no design improvement. As with the late project use of a graphic artist to apply surface aesthetics to an interface, there is little to no value in the change. For the instructional craftsperson role to be valid, for there to be a role of craft in the instructional design process, craft must be immersed within the entire design process. The craftsperson should have specific responsibility for completion, to be sure, but as with each of the other roles, remaining part of a fully integrated design methodology.

Many in the field may share the values of the crafts-person, but are still constrained by practice, economics, or choice. Our goal is to encourage thoughtful and engaged completion of instructional design projects; we want instructional design projects to be crafted, designed, and completed with engagement and care, which may be possible with a more formal designation of this role.

> *As a verb, 'to craft' seemingly means to participate skillfully in some small-scale process. This implies several things. First, it affirms that the results of involved work will still surpass the results of detached work. To craft is to care. Second, it suggests that partnerships with technology are better than autonomous technology. For example, personal mastery of open-ended software can take computers places that deterministic software code cannot. Third, to craft implies working at a personal scale—acting locally in reaction to anonymous, globalized, industrial production—hence its appeal in describing phenomena such as microbreweries. Finally, the usage of 'craft' as a verb evades the persistent stigma that has attached itself to the noun. (McCullough, 1998, p. 21)*

We share today, a modern view of the "craftsperson," a positive conception of a skilled worker creating quality work, an artisan. The concept was developed out of specialized guilds, and relied on quality standards and a mission of training the next generation. Picture a current-day craftsperson, an artisan baker, for example, and we understand the quality of their work. Although bread can be made through highly mechanized methods, the quality and the experience of the artisan loaf may be unmatched. The baker is personally engaged with the work, somewhat isolated from "the product as commodity," working at their own pace but still efficient, and the schedule is not of prime importance. Each bread rises at its own rate.

Practical Implementation for Design

As a means to structure the work of instructional design, Role-Based Design is meant to be flexible and easily applicable to most design situations. Role-Based Design can be used in a large team where members of the design team are assigned specific roles in the process.

Roles can be assigned to individuals or to sub-teams, for example, with one as the designated "artist" on a project, advocating for creative and novel solutions, or with one team being principally responsible for ongoing qualitative improvements at the completion of the project.

One challenge for implementing RBD in a traditional design team is that habitual procedures and processes would continue; time pressures still exist, research findings can dominate design ideas, and failure (the valuable byproduct of experimentation) is discouraged.

Alternatively, Role-Based Design can be effectively integrated within small groups or as part of the process of a single designer. In these cases, the roles would be assumed at various times in the design process, beginning with the artist and continuing to the craftsman. However, to be effective, the roles should reoccur and be integrated throughout the process; for example, the mental voice of the artist should always be present in the design process, advocating for more creativity and exploration.

Creativity is an important goal of Role-Based Design, and titling a role "artist" implies sole discretion for creativity and innovation. On the other hand, many engineers successfully go beyond the reductionist process of engineering in reaching a single solution. Each of the roles, architect and craftsman as well, has the responsibility to ensure creativity in the design project.

If creativity is solely the responsibility of one role, such as the artist, then the project will not benefit from the unique experience and vision of the other members of the team. To some extent, all designers, from artist to engineer, architect to craftsman, are creative. These roles are all involved in solving problems.

Through Role-Based Design, we seek to build in a role for creativity and aesthetics throughout the project, not simply as a tertiary addition to the end of a project. We seek to ensure that each phase of a project does not settle for "done," but rather continuously seeks to improve and innovate.

References

Becker, K. (2007). Wicked ID: A contemporary framework for considering instructional design as a wicked problem. *Canadian Journal of Learning and Technology,* 33(1), 85-108.

Cross, N. (1982). Designerly ways of knowing. *Design Studies,* 3(4), 221-227.

Hoadley, C., & Cox, C. (in press). What is design knowledge and how do we teach it? In W. DiGiano, S. Goldberg, & M. Chorost (Eds.), *Educating learning technology designers.* New York: Routledge.

Jonassen, D. H. (2006). A constructivist's perspective on functional contextual ism. *Educational Technology Research and Development,* 54(1), 43-47.

Kelley, T., & Littman, .J. (2005). *The ten faces of innovation: Ideo's strategies for beating the devil's advocate and driving creativity.* New York: Doubleday Business.

Kirschner, P., Strijbos, J., Kreijns, K., & Beers, P. (2004). Designing electronic collaborative learning environments. *Educational Technology Research and Development,* 52(3), 47-66.

Lawson, B. (2004). *What designers know.* Oxford, UK: Architectural Press.

Lenat, D. (1983). The role of heuristics in learning by discovery: Three case studies. In R. S. Michalski, J. G. Carbonell, & T. M. Mitchell (Eds.), *Machine learning: An artificial intelligence approach* (pp. 243-306). Palo Alto, Tioga.

McCullough, M. (1998). *Abstracting craft: The practiced digital hand.* Cambridge, MA: MIT Press.

Moldoveanu, M., & Martin, R. (2008). *The future of the MBA. New York: Oxford University Press.*

Molenda, M. (2003). In search of the elusive ADDIS model. Performance Improvement, 42(5), 34-36.

Nelson, H. G., & Stolterman, E. (2003). The design way: Intentional change in an unpredictable world: Foundations and fundamentals of design competence. Englewood Cliffs, NJ: Educational Technology Publications.

Osborn, A. (1953). Applied imagination: Principles and procedures of creative problem solving. New York: Charles Scribner's Sons.

Rittel, H., & Webber, M. (1973). Dilemmas in general theory of planning. Policy Sciences, 4, 155-169.

Rowland, G. (2005). Shall we dance? A design epistemology for organizational learning and performance. Educational Technology Research and Development, 52(1), 33-58.

Shepard, C. (2003). Engineering e-learning; http://www.fastrak-consulting.co.uk/tactix/features/engineer.htm .

Silber, K. (2007, Sept.—Oct.). A principle-based model of instructional design: A new way of thinking about and teaching ID. Educational Technology, 47(5), 5-19.

Simon, H. A. (1973). The structure of ill structured problems. Artificial Intelligence, 4(3), 181-201.

Visscher-Voerman, I., & Gustafson, K. (2004). Paradigms in the theory and practice of educational and training design. Educational Technology Research and Development, 52(2), 69-89.

Zemsky, R., & Massy, W. (2004). Thwarted innovation: What happened to e-learning and why; http://www.irhe.upenn.edu/Docs/Jun2004/ThwartedInnovation.pdf .

Brad Hokanson is Associate Professor of Graphic Design in the College of Design at the University of Minnesota and a Registered Architect in the State of Minnestoa.
Charles Miller is Assistant Professor of Learning Technologies in the College of Education and Human Development at the University of Minnesota.

---

1. Ill-structured problems are those with unclear problem and solution states. Wicked problems are similarly defined but in addition are contentious, contextual, subjective, and completion-critical (Becker, 2007; Nelson & Stolterman 2003; Rittel & Webber, 1973; Simon, 1973). ↩
2. Simon (1993) describes satisficing as "the process of finding alternatives by heuristic search with the use of a stop rule based on adjustable aspirations" (p. 46). ↩

12

Undefining Learning

Editor's Note: Visser, J. & Visser, Y. L. (2002). Undefining learning: Implications for instructional designers and educational technologists. *Educational Technology*, *42*(2), 15-20.
The guest editors of this special issue of Educational Technology Magazine have asked authors to reflect on "the implications that broadening of the definition of learning would have for educators and educational technologists." In this article, we shall refer to a redefinition of learning earlier developed by one of us and look at its implications for the instructional design and educational technology fields. In passing, we shall refer to a line of research currently underway that makes it possible to get a better insight into the meaning of learning from the perspective of those who learn, rather than the point of view of those who design or facilitate learning.

Negotiating the Environment

More than 10,000 years ago, hunter-gatherers populated the Tibetan highlands. They shouldn't have been there, but they were. Recently established archeological evidence from high-elevation environments of the Tibetan Plateau suggests that portions of the late Pleistocene or early Holocene" (Brantingham, Olsen, & Schaller, 2001, p. 326). The environmental conditions of that region, today's Chang Tang Nature Reserve, are among the harshest of the planet. At an elevation of 12,000 feet, severe cold, cutting winds, water scarcity and sparseness of vegetation are the order of the day. In an account of these findings in Science News (Bower, 2001), one of the scientists involved, Jeff Brantingham of the Santa Fe Institute, New Mexico, comments: "We've probably underestimated the diversity of hunter-gatherer adaptations to extreme environments during the late Stone Age" (p. 7).

Why would people decide to live more than 10,000 feet above sea level, like the Stone Age folk referred to in the above paragraph? Why would other folks decide to live, like a considerable part of the Dutch population, at 10 to 20 feet below sea level? Most other animals would rather walk away. They might never even have come close and given it a try. A possible answer to this question is that human learning is qualitatively different from animal learning. Poorly prepared biologically to adapt to its natural environment, the human species has perfected learning to beyond the level we have so far been able to fully understand. It has given humans the ability to adapt the circumstances to them, rather than for them to merely adapt to the given circumstances. Humans problematize[1] and transform their environment, producing change that benefits them and those close to them, but also affecting, positively or negatively, others—and other life forms—in the process.

At the time when the populations studied by Brantingham and his colleagues populated the Tibetan highlands, the total world population is estimated to have been around eight million. It had probably remained at that level, fluctuating around it, for a long time since, three million years earlier, hominid development began. However, shortly after our foraging ancestors populated the Tibetan Plateau, agriculture was invented, which rapidly overtook hunting and gathering as a primary activity. It caused the human population to rise exponentially ever since (Tudge, 1998). So, we were three billion in 1960, and we added another three billion before the twentieth century was over.

Not only did we grow in number, we also became cleverer and cleverer. With what we know now we could, as a species, probably decide to live comfortably, retiring from our historical business of transforming the world, but somehow that is

not in our genes. Having put the process in motion, we can no longer stop it. What we can do, though, is manage it better, becoming metacreative, so to say.
Metacreativity, we suggest, is the capacity to creatively intervene in our creativity, to apply our creative energy to addressing problems that emerge from our creativeness. It requires reflectiveness, autonomy of thinking, solidarity with one's fellow human beings, the capacity to perceive of one's world as made up of problems, and the desire and ability to take charge of one's life in a problem-oriented fashion. In short, it requires the development of learning at a higher, more comprehensive level than what is foreseen in most textbook approaches to the development of designed instruction. One could also say that it requires a broadening of the set of competencies and attitudes with which instructional designers come equipped, a broadening that should be based on a more complete perspective of the contribution that learning in an instructional context can make to human learning in general.

Not by Instruction Alone

People can change their performance capability by being instructed. It makes sense, therefore, to carefully design instructional processes if one wants to ensure specific gains in human performance. Thanks to the decades-long history of the development of the instructional design discipline, great advances have been made in our ability to shape processes of human performance development in a controlled manner, i.e., in ways that allow us to predict the performance change when we put certain conditions in place.

Before there was instructional design, there was instruction. Instruction originally developed out of the largely intuitive practice of exposing novices to the expert performance of elders, allowing the former to model their behavior after the latter, in a reduced-risk environment, before facing real-life circumstances alone. When particular abilities became essential requirements for all members of a community to fully participate in the life of that community, these same processes became institutionalized (initiation, schooling) and formalized, so as to ensure that members of a new generation would all have the required abilities they would need in adult life. The institutionalization and formalization of instruction greatly expanded during the industrial era. Educational systems developed in which instruction became a centrally planned phenomenon, ensuring uniformity of outcome. The schooling practice started to universalize as people became more and more aware of the ethical responsibility (and probably also of the socioeconomic wisdom) that every citizen should be given the same chances in society.

With the increase in and development of the schooling practice, it is not surprising that learning has become identified, in the minds of many people, with "being instructed" and all the various connotations that go with that phrase. It has thus become less evident that learning also occurs in non-instructional contexts, pertaining to the social, economic, cultural, historical, and spiritual spaces, in addition to the school, in which people operate. As a consequence, the awareness in society about where to invest its creative and material resources to promote and facilitate learning became highly focused on—if not obsessed with—formal institutionalized instruction, particularly the school system. This coincided with a growing neglect—also occasioned by other transformational processes in society—of, for instance, the important role for the development of learning at both the cognitive and metacognitive level, as well as in terms of its—often unrecognized—emotive dimension, played by the family environment, the broadcast media (in more than their mere educational use), as well as in exploratory spaces such as provided by museums, nature, libraries, reading rooms, the Internet, community centers, and clubhouses for the young and the old.

Not only is the strong focus on instruction problematic because it keeps resources and attention away from other contexts in which people learn, there is also another problem with particularly the schooling practice, at least when interpreted as a way to prepare young people for life, providing them with the kind of skills that are the standard offering of most schools around the world. The existing conception of the school is based on the premise that the past generation is able to determine what the new generation should learn and that change is sufficiently slow so that the evolution of how humans deal with change can occur at the pace with which generations replace each other, i.e., a timeframe of approximately 20 years. That premise no longer holds. Change has become so rapid that it has overtaken the pace of generational change. Consequently, there is now an essential need for people to take their learning life in their own hands.

If the school still has an important preparatory function, and we believe it has, then it must prepare people for the autonomous development, throughout their lives, of their capacity to learn. When we say "autonomous," we mean that to include awareness of one's being part of social settings and thus to reflect on the learning individual in his or her ever changing social environment. That objective is poorly served by programs and curricula that deal with skills in isolation; compartmentalize knowledge; encourage and evaluate learning emphasizing individual achievement; dissociate learning from its context of application.

What we are saying here does not mean that we think the school should no longer have a role in the development of such important basic skills as reading, writing, and the ability to deal with numbers. Nor do we say that the school should not give to those graduating from it a broad frame of reference in history, geography, and the arts and sciences, in addition to knowledge about their own body and the ability to maintain and develop its adequate functioning. What we are saying is that the development of such important faculties should be undertaken with the foresight that people, during their entire lives, will be dealing with problems that mostly transcend the boundaries between disciplines. We are also saying that the development of these faculties should be integrated with the development of other important abilities that allow students to take charge, in an increasingly autonomous manner, of their own learning.

What applies to the school, applies no less to any other instructional setting, as any such setting is an opportunity to enhance the development of learning of the individual benefiting from the instruction. It is, in our view, an ethical responsibility of the instructional designer to have that opportunity in mind and to act on it. Consequently, we argue that the training of instructional designers should include the creation of awareness of this more complex world of learning in which designers intervene as well as provide designers with relevant competencies that allow them to intervene more wisely in that world of learning.

One may compare this with how in the field of medicine the attention ought to be on the well-being of the whole human being rather than on some technical procedures that restrict a medical intervention to dealing with a specific piece of tissue or a particular organ. Much is still to be developed for the suggested change in the training of instructional designers. Among other things it requires recognizing the importance of context as well as understanding context as a multifaceted concept (e.g., Tessmer & Richey, 1997; J. Visser & Berg, 1999). It equally requires introducing in the training of instructional designers (and thus also in the evaluation of their training outcome) of a continuous focus on real-life problems, in a similar fashion as innovative medical schools and schools of architecture apply this concept (J. Visser & Y. L. Visser, 2000).

The Undefinition of Learning

The changed perspective on instructional design we alluded to above requires a different vision of learning. School-based learning has so much become part and parcel of every generation's lifecycle that most other planned learning events are modeled after it. Most people thus think that it is the only modality of learning worth that name. Consequently, few people question the concept.

Often, when asked what learning really means, people are embarrassed to discover that they have difficulty to say more than a few superficial things about it. It is one of those words we use, assuming that everyone understands what we mean without having to check the dictionary. Taking the trouble to look it up in, for instance, Webster's Collegiate Dictionary, one finds that it is being defined in terms of gaining knowledge, understanding, or a skill through study, instruction, or experience, the latter with specific reference to learning a trade. Additional meanings refer to memorizing and changing behavior. We contend that such a definition insufficiently reflects on the meaning of learning in the historical perspective of the evolution of humankind, of which we provided a Stone Age snapshot at the opening of this article.

A subsequent snapshot is that of today's world, described by Lederman (1999, April) as one of unprecedented change,

> *so much so that it differs, in the requirements on the participants, from the world of teachers, parents, school officials, legislators. It is a world of information technology and the challenge of access. It is a*

world of globalization, of a paradox of unprecedented global interdependence and, at the same time, of defensive local cultures, nationalism, and community coherence. (p. 2)

This is a world that calls for deep understanding and wisdom. As the events of the day on which these lines are being written, September 11, 2001,[2] show, it is a world in which relatively small human entities are able to wreak unprecedented havoc on their fellow human beings, doing so consciously and by design. It is also a world in which our collective behavior is able to cause even greater disaster—unwanted by anyone, yet resulting from the cumulative effect of the actions of us all—as together we contribute to slowly developing demographic, socioeconomic and environmental instability. As Lederman goes on to comment:

Projections of the human condition, the strength of family, the level of moral and ethical behavior, the economic health, social and political stability are all subject to the explosive advance of science and of technology. Major global problems of population, of environment, the dwindling of natural resources, including fresh water, the habitation of fragile land areas, sensitive to flooding, natural and man-made catastrophes, new pandemic diseases, all speak to the need for a greater understanding and control.... Advances in our understanding of molecular genetics and of human cognition open vistas of opportunities, which include the possibility of rational manipulation of human evolution. (p. 3)

In order to deal with the challenges and opportunities of our time, and more so even of the future, we are insufficiently equipped if our learning continues to have too strong and exclusive a focus on gaining specified knowledge, particular ways of understanding the world, specific skills, prescribed sets of memorized facts, or well-defined behavioral change. What we need most, in addition to all those things, is the ability to see ourselves using all those faculties we gained and then to reflect on what we are actually doing with them. In other words, we must look for points of view that lift us above ourselves as mere organisms able to do clever things without ever questioning our own behavior. For that to happen, we must liberate our ideas about learning from their current narrow focus. In short, we must “undefine” learning (J. Visser, 2001). The following five considerations are in order.

First it needs to be recognized that learning is not something one does every now and then, with periods in between when one does not learn. The faculty to be reflective of what we do with what we learn can only be turned off to our peril. We thus better keep it on and think of learning as a lifelong disposition.

A second important point is that for anything we do we are always impacting on the lives of others. Being now more than six billion on a small planet, using technologies that can extend the radius of impact of any individual’s action to the entire planet, the rate and cumulative effect of interaction has dramatically increased. This must once again make us realize that learning is what it always was: dialogue. The emphasis on learning as dialogue is clearly present also in the work of, for instance, John Shotter (1997, 2000). It transpires from John-Steiner’s (2000) work on “creative collaboration.” It is a corollary of the emphasis that Tessmer and Richey (1997) put on “context” as an important factor in the design of learning environments as well as of the idea that learning and activity are inseparable concepts (Jonassen, 2000). It is also embedded in how Cole & Engestrom (1993) see the building of knowledge as a cultural-historical process.

In the third place, and as exemplified by, for instance, the development of the arts and sciences, the learning dialogue is not only a dialogue with other human beings. It is in general a dialogue with our human, social, biological, and physical environment. As in the case of any true dialogue, we are talking here about a reciprocal process. Not only do we, as individuals, interact with our environment; that same environment also interacts with us.

One realizes immediately, and this is our fourth point, that if, as we said above, our environment interacts with us, we are ourselves also part of that environment and are integrated in it not as isolated individuals, but at different levels at which we organize ourselves socially. We should thus perceive of the dialogue as one that has multiple dimensions; takes place at different levels of complex organization; and is engaged in by both individual human beings, and all manner of social entities to which they pertain. By logical extension, this means that learning is an ecological phenomenon (see also J. Visser, 2001).

Finally, and in the fifth place, it is a dialogue engaged in with a purpose. That purpose is concerned with our ability to interact constructively with change. The adverb "constructively" is deliberate and essential. The faculty to choose between being constructive and destructive, to reflect on whether we enhance existence or subtract from it, is a profoundly human faculty. We thus conclude, as one of us already proposed elsewhere, that human learning should be undefined as follows:

> *Human learning is the disposition of human beings, and of the social entities to which they pertain, to engage in continuous dialogue with the human, social, biological and physical environment, so as to generate intelligent behavior to interact constructively with change. (J. Visser, 2001, p. 453)*

The Story of Learning Told by Those Who Learn

As part of the Meaning of Learning (MOL) project of the Learning Development Institute, both authors are involved, together with researchers at collaborating institutions, in collecting and analyzing learning stories. We mentioned above that people often react awkwardly when asked to explain what learning means. However, giving them the time, and encouraging them to reflect on their entire learning life experience, they are able to generate helpful insight into the importance of learning for human development and clarify the conditions that help such development along.

We have reported elsewhere on the initial results of our research (Y. L. Visser & J. Visser, 2000), which is still ongoing. Because of space limitations, we encourage readers to explore the Web site of the Learning Development Institute for further detail about the Meaning of Learning project and the Learning Stories Research project that is part of it. The same Web site also features some sample learning stories. While the sample stories on the Web are written accounts of people's learning experience, we note that not all learning stories are in the form of written documents. One of our associate researchers, Cole Genge at the University of Massachusetts at Amherst, is currently collecting such accounts from largely illiterate Aymara and Quechua speaking communities in the highlands of Bolivia, making audio recordings of the stories as they are being told. We also have stories expressed in the form of drawings and one in the form of a poem (in Hindi).

Standing out in our initial analysis of people's accounts of their most meaningful learning experiences is the low incidence of references to the school or similar instructional contexts. What is referred to as playing a significant role in initiating and sustaining people's most meaningful learning experiences is curiosit—such as a child's interest in exploring principles of electronics by taking apart and reassembling electronic equipment, and challenge– such as working through a seemingly impossible problem, or developing alternative solutions in the face of resource constraints. Equally of interest in the research findings is the considerable number of cases in which reference is made to constructive and conscious involvement in someone else's learning—for instance as a teacher, parent or sibling—as a powerful way of learning oneself in a meaningful way. Not unrelated to this is also the identification of the presence of a role model or emotionally significant support as an important condition for learning to take place.

Whither Instructional Design?

We highlight the above five specific elements because of their relevance for the argument presented in this article. The fact that instruction is apparently not seen as dramatically important for learning, should, in our view, not be interpreted as a negative perception about the importance of instruction. Within the ecological vision of learning referred to above, no specific learning context may be dramatically important, but all are essential. Relative importance of each of them will vary across members of the audience surveyed. We therefore suggest that our findings should lead to a rethinking of the importance and relevance of instruction in the wider and vastly diverse context and varied configurations in which people learn.

The emphasis on the role of curiosity and challenge as conditions present in people's most meaningful learning experiences speaks directly to the design of learning environments and instructional materials. In recent years, the increasing emphasis has been put on integrating opportunities for authentic practice into the learning environment as a way to address the element of challenge in instructional design. However, we argue that there is a need to more fully integrate the notion of “challenge” into the learning environment, by integrating challenge and curiosity as related concepts in learning. Curiosity can be viewed as the basis for Initiating and sustaining both learning and inquiry. It makes it possible for people to overcome difficulties, and respond to challenges in creative and constructive ways, so that learning can be more meaningful, allowing the learner to feel empowered both while participating in the learning process and as a consequence of what was being learned. In other words, we must identify and respond to the learners’ innate curiosities, rather than simply designing instruction to elicit curiosity. Furthermore, challenges should be integrated into the learning experience in a way that is natural in the framework of the learners’ intrinsic curiosities and actual learning contexts. At present, there is a tendency for instructional designers to integrate the element of challenge by placing the learner in a performance context, rather than the learning context. Designing challenging environments where the basis for the challenge is learning (and reacting to the feedback from the learning process) may be a more appropriate response.

The highlight on conscious and constructive involvement in someone else’s learning sustains our reasoning that learning is best interpreted as dialogue, and thus that instructional design should emphasize opportunities for creative collaboration. Moreover, such conscious and constructive involvement is only possible when those involved in the learning situation are consciously engaged, in other words, when they reflect on the learning situation. This supports our emphasis on the inclusion among the concerns of the instructional designer of metacreativity, metalearning, and metacognition, requiring inventiveness in identifying opportunities and relevant mechanisms in the instructional setting for instructors and students to become conscious of and assess how learning happens.

The reference to emotionally significant support in the learning context points to two important recommendations. The designed instructional environment should have ample opportunities for people to be collaboratively involved in the shared attainment of both individual and collective learning goals. Due attention should be given, by the designer, to ways in which students and instructors can attend to each other’s emotional needs. Motivational design (Keller, 1983) is part of this concern, but not all of it (see also Driscoll, 2000).

At the broadest level, the nature of the learning stories research speaks to the merits of integrating the learners’ perceptions of the meaning of learning into the instructional design process. Instructional design emphasizes careful analysis and evaluation throughout the planning and implementation of instructional interventions, with particular emphasis on such things as determining performance outcomes, salient learner attributes, and prior knowledge, skills, and attitudes. However, learners’ perceptions are rarely integrated into the analysis and evaluation processes, since the instructional designers and subject matter experts are often regarded as having a better sense of learners’ dispositions and attitudes than the learners themselves. We would propose, however, that instructional designers give more careful consideration to the learners’ perceptions of what constitutes meaningful learning, and that they integrate this information into all major phases of the instructional design process, with particular emphasis on the analysis and evaluation phases.

In general, a focus on problems and integration with real-life situations (for instance Marshall, 2000), and thus the recognition of the “purposeful act” (Kilpatrick, 1918, p. 3) as the typical unit for instruction, are, in our view, among the most natural, and also most adequate ways to attend to the totality of concerns expressed in the above recommendations.

References

Bower, P. (2001). Stone Age folk in Asia adapted to extremes. *Science News, 160*, 7.

Brantingham, P. J., Olsen, J. W., & Schaller, G. B. (2001), Lithic assemblages from the Chang Tang region, northern Tibet. *Antiquity, 75*, 319-27.

Cole, M., & Engestrom, Y. (1993). *A cultural-historical approach to distributed cognition. In G. Salomon (Ed.), Distributed cognitions: Psychological and educational considerations.* Cambridge, UK: Cambridge University Press.

Driscoll, M. P. (2000). *Psychology of learning for instruction.* Needham Heights, MA: Allyn & Bacon.

John-Steiner, V. (2000). *Creative collaboration.* Oxford, UK: Oxford University Press.

Jonassen, D. (2000, October) Learning as activity. Paper presented at the Presidential Session on In Search of the Meaning of Learning (J. Visser, Chair) at the *International Conference of the Association for Educational Communications and Technology,* Denver, CO; http://www.learndev.org/dl/Denverionassen.PDF

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status* (pp. 383-434). Hillsdale, NJ: Lawrence Erlbaum Associates.

Kilpatrick, W. H. (1918). The project method. *Teachers College Record, 19*(4), 319-335; http://www.tcrecord.org ID Number: 3606.

Lederman, L. M. (1999, April). On the threshold of the 21st century: Comments on science education. Paper presented at the Symposium on Overcoming the Underdevelopment of Learning (J. Visser, Chair). *Annual Meeting of the American Educational Research Association,* Montreal, Canada.

Marshall, S. P. (2000, October) The learning story of the Illinois Mathematics and Science Academy. Paper presented at the Presidential Session on In Search of the Meaning of Learning U. Visser, Chair) at the *International Conference of the Association for Educational Communications and Technology,* Denver, CO; http://www.learndev.org/dl/DenverMarshall.PDF

Shotter, J. (1997). The social construction of our 'inner' lives. *Journal of Constructivist Psychology, 10*, 7-24.

Shotter, J. (2000, October). Constructing 'resourceful or mutually enabling' communities: Putting a new (dialogical) practice into our practices. Paper presented at the Presidential Session on In Search of the Meaning of Learning (J. Visser, Chair) at the *International Conference of the Association for Educational Communications and Technology*, Denver, CO; http://www.learndev.org/dl/ DenverShotter.PDF

Tessmer, M., & Richey, R. C. (1997). The role of context in learning and instructional design. *Educational Technology Research and Development, 45*(2), 85-115.

Tudge, C. (1998). *Neanderthals, bandits, and farmers: How agriculture really began.* London, UK: Weidenfeld & Nicholson.

Visser, J. (2001). Integrity, completeness and comprehensiveness of the learning environment: Meeting the basic learning needs of all throughout life. In D. N. Aspin, J. D. Chapman, M. J. Hatton, & Y. Sawano (Eds), *International Handbook of Lifelong Learning* (pp. 447-472). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Visser, J., & Berg, D. (1999). Learning without frontiers: Building integrated responses to diverse learning needs. *Educational Technology Research and Development, 47*(3), 101-114.

Visser, J., & Visser, Y. L. (2000, October). On the difficulty of changing our perceptions about such things as learning. Paper presented at the Presidential Session on In Search of the Meaning of Learning (J. Visser, Chair) at the *International Conference of the Association for Educational Communications and Technology*, Denver, CO; http://www.learndev.org/dl/DenverVisserVisser.PDF

Visser, Y. L., & Visser, J. (2000, October). The learning stories project. Paper presented at the *International Conference of the Association for Educational Communications and Technology,* Denver, CO.

Jan Visser is President and Senior Researcher at the Learning Development Institute. He is also the former UNESCO Director for "Learning Without Frontiers" and a theoretical physicist by original vocation.
Yusra Laila Visser is Vice President and Researcher at the Learning Development Institute as well as instructional designer for the Open and Distance Learning program in Florida State University's Department of Educational Research.

1. The verb "to problematize" is not commonly used in the English language, in contrast with, for instance, French or Spanish. Many dictionaries don't even list it. The Complete Oxford Dictionary defines it as "to propound problems." We use it here to refer to the mental and emotional disposition to analyze one's environment in terms of the challenges it affords and thus the opportunity to address such challenges. We think of this ability as an essential human ability. We see "questioning" as an important ability that is part of—but not equivalent to—the disposition to problematize. ↵
2. The day of the terrorist attack on the cities of New York and Washington. ↵

13

Designing Creative User Interactions for Learning

Editor's Note: Hong, Y., Clinton, G., & Rieber, L. P. (2014). Designing Creative User Interactions for Learning. *Educational Technology, 54*(2), 20-25.

Profitable creative ideas can emerge from within virtually any phase of the instructional design and development process. However, the design of user interactions is perhaps where learners can most directly experience the benefits of such ideas. In this article, the authors discuss principles of learner interaction as found in the instructional technology literature. They then present some observations about creativity from the creativity literature and attempt to contextualize creative interaction design, particularly in multimedia development, within broader aspects of creativity. Finally, they offer several suggestions for promoting the emergence of creative ideas within the work of designing user interactions for learning.

Introduction

When was the last time you were inspired to learn? It likely did not happen within a formal educational setting, but instead within some everyday context. Perhaps you stumbled across a television show, a YouTube video, or some Website that made you think differently about some important issue or topic. Whatever it was, somehow it grabbed you and made you want to know or explore more. When this happens, you probably don't even think about the fact that you are learning something, but instead allow yourself to be carried away by the feeling of adventure and satisfaction. The person or group who designed whatever it was that inspired you did something very special. Instructional designers and teachers should likewise "aspire to inspire." Of course, this is easier said than done.

In the field of instructional technology, there is a tension between the "art" and "science" of instructional design. The literature on instructional design gives mixed messages to people learning it formally for the first time. Although many instructional design scholars talk about the need to be creative and innovative, little guidance on how to be so is given. Also, one can get the feeling of creeping away from the "principles" of instructional design when approaching a design problem with a creative idea. Partly this is so because a creative act is a very personal thing—we probably rarely have the canons of instructional design in sharp focus at the moment that an original idea springs into our heads. Additionally, a creative approach to design must, in the end, be consistent with the principles of learning and good instruction. It is relatively easy to design traditional instruction that is boring, but modestly effective. Unfortunately, many designers apply models like Gagne's Nine Events of Instruction (Gagne, Wager, Golas, & Keller, 2005) in formulaic ways, leading to reasonably effective outcomes, but at the cost of disengaged learners who cannot wait for the instruction to end. This type of instruction might be fine for times when learners must be "in compliance" to complete some training for their jobs, but it falls far short of inspiration. The Roman architect Vitruvius advocated that well-designed buildings must exhibit firmness (be sturdy and not fall down), commodity (be designed to meet the functional needs), and delight (be a place where people enjoy the experience of being inside) (Kapor, 1996). So too should our instructional designs be well-built and functional, but they also should be a delight to the users.

Of all the design requirements leading to effective instruction, we focus here on interactivity, specifically designing interactions creatively. Interactivity relates to how you engage students in the instruction to make them willing and enthusiastic participants in the learning. On one level interactivity is about having the learners do something. However, just the act of clicking buttons or typing text into a field says nothing about their level of engagement. It is not the quantity of activity, but the quality that matters. Rod Sims (1997) argued in favor of considering the design of interactivity as an artistic act, especially when in the context of designing digital media:

> *The implementation of interactivity can be perceived as an art because it requires a comprehensive range of skills, including an understanding of the learner, an appreciation of software engineering capabilities, the importance of rigorous instructional design, and the application of appropriate graphical interfaces. (p. 158)*

Thus, the activity of designing learner interaction can lend itself to adopting an artist's mindset, in which one is open to —even actively looking for—creative ideas. While not all instructional designers will necessarily adopt an artistic frame of reference for their work, there appears to be a growing recognition of this approach in the literature of our field (Clinton & Hokanson, 2011; Hokanson & Miller, 2009; Rowland, 1993; Visscher-Voerman & Gustafson, 2004).

Profitable creative ideas can emerge from within virtually any phase of the instructional design and development process (Clinton & Hokanson, 2011). However, the design of user interactions is perhaps where learners can most directly experience the benefits of such ideas. In this article, we discuss principles of learner interaction as found in the instructional technology literature. We then present some observations about creativity from the creativity literature and attempt to contextualize creative interaction design within broader aspects of creativity. Finally, we offer several suggestions for promoting the emergence of creative ideas within the work of designing user interactions for learning.

Defining Interaction

Incorporating interactions in computer-based learning resources has been regarded as an effective strategy for facilitating learning (Sims, 1997, 1999; Woo & Reeves, 2007). Interaction has been defined as "lessons in which the learner actively or overtly responds to information presented by the technology, which in turn adapts to the learner… interactive lessons require at least the appearance of two-way communication" Uonassen, 1985, p. 7). Commonly recognized components of interactive lessons include the ability to promote learners' active participation and engagement and to heighten user control so that effective learning can take place (Fenrich, 1997; Hannafin, 1989; Holmes, 1995; Kristof & Satran, 1995). Also, involving learners in discovering and constructing their own knowledge enables them to participate in their learning actively (Department of Communication and the Arts, 1995; Dickinson, 1995; Holmes, 1995).

Some scholars have developed models describing multiple levels or types of interaction. These range from reactive interaction, which provides learners with little control of structure and content, to proactive interaction, which increases learners' control to explore and create knowledge (Rhodes & Azbell, 1985). Reactive interactions include page turning and clickable buttons to go over the content, limited user control of audio or video representations, and end-of-lesson quizzes with limited and undifferentiated feedback. This level of interactivity aligns with the learning "from" technology approach that Jonassen and Reeves described (1996). In contrast, proactive interaction, mainly based on the constructivist perspective (Aldrich, Rogers, & Scaife, 1998; Rhodes & Azbell, 1985), employs computers as a tool for learners to think with, explore, discover, collaborate, and actively participate in learning (Holmes, 1995; Sims, 1999). Microworlds, simulations, and educational games are often recommended for achieving this level of interactivity (Rieber, 2003, 2005). With technology that enables interactions, such as simulations or educational games, the greatest benefit to learners is safe and easy access to situations in the real world that are otherwise unsafe or inaccessible. Advanced digital media affords a high level of interactivity to learners that would be unattainable apart from the technology (Gredler, 2003).

The dramatic increase in e-learning (or distance education) made possible with advances in, and access to, Internet technology has placed significant attention on defining and supporting interaction within learning. This is due to the fact that virtually all interaction is mediated by technology, usually in asynchronous ways. In a review of interactivity within e-learning, Bannan-Ritland (2002) describes four general categories of interactivity: (a) active involvement of the learner; (b) patterns of communication among learners and instructors; (c) participation within a range of instructional activities and technologies; and (d) interactivity as a form of social exchange. In a similar review of interactivity within e-learning, Hirumi (2002) put forward a framework of interaction that takes into account how the design of learning events or strategies leads to interactions between learners and humans or between learners and non-humans (i.e., technology). These two levels of interaction lead to a third level of learner self-interactions that includes "the cognitive operations that constitute learning as well as metacognitive processes that help individuals monitor and regulate their learning" (Hirumi, 2002, p. 144).

These reviews demonstrate how interactivity encompasses all aspects of teaching and learning, from communication between and among learners and instructors, to the activities and tasks within which learners engage. Increasingly, these interactions involve decisions about the design of intervening technology.

Finally, the evolution of the instructional design process has shifted attention away from content-centered models and toward models based on whole tasks or activities (e.g., Merrill, 2002, 2007; van Merriënboer, Clark, & de Croock, 2002). These models support the idea that learning is promoted when it is situated in an authentic and complete task within which all important concepts and principles are integrated. However, little guidance is available on how 'best to design or determine these tasks or activities. There is a dependence on designers working closely with subject matter experts in creative ways to develop meaningful interactions with these tasks and activities.

Even with this understanding of different levels of interactivity, we are still a few steps away from designing high-quality instructional materials with effective interactions. Instructional design, according to Rowland (1993), has to take into account learners' needs as well as the learning context of a specific situation. Otherwise, ineffective or inappropriate design can be the result, if instructional designers only follow systematic rules, models, or fixed procedures. Rowland (1993) further explained that the design process "is intuitive, creative, or artistic, and [it] emphasizes early attempts at solution rather than complete understanding prior to solution attempts" (p. 88). All told, instructional designers should carefully observe and consider specific situations and potential creative solutions.

Creative Interactions

What kind of interactions can be characterized as a creative interaction? Previous sections have highlighted that designers should attend specifically to the needs of target audiences, consider the learning context, and possess the knowledge of different types and levels of interactivity as well as instructional design models. However, while these elements contribute toward meaningful interactions, they are not necessarily sufficient to bring about interactions that can be called creative.

A product or an idea is generally considered creative when it meets two criteria: novelty and appropriateness (Amabile & Tighe, 1993; Nickerson, 1999; Perkins, 1988; Starko, 2005). The criterion of appropriateness or usefulness appears rather straightforward: learner interactions must contribute towards desired learning outcomes and must fit aesthetically within the overall design. Aesthetic appropriateness is a matter of good visual design, which is very important but not the main focus of this article. For appropriate visual design, the reader would do well to consult sources such as Krause's *Design Basics Index* (2004) (see also Parrish, 2005).

The criterion of novelty involves several important considerations. First, if something must *ultimately* be new in order to be considered creative, extremely few human ideas would qualify as creative at any given time. However, an idea might be new only to the designer personally. if a particularly effective approach to learner interaction is a new and unfamiliar line of thought for a designer, then the cognitive mechanisms believed to be associated with creativity (e.g., Ward, Smith, & Finke, 1999) have occurred at some level. This would be the case regardless of whether the designer soon discovers that others have been working with the same idea. Novelty can therefore be considered local or relative.

Next, for whom, if not for the designer, must an idea be novel? And, for that matter, for whom must the idea be appropriate? One might seek a general answer to this question in the systems approach to creativity described by

Csikszentmihalyi (1999): ideas are judged to be novel and useful by the primary audience, those in the creator's professional field, who work in a particular domain. For example, a creative breakthrough in the domain of theoretical physics would have as its primary audience the body of theoretical physicists around the world. But in the unique case of instructional multimedia design, the audience is typically a specific set of selected learners; novelty and appropriateness therefore have meaning only in the perception and experience of the learner; creative interaction either has meaning in this sense or it has no meaning at all.

Novelty can also be viewed as happening by degrees (Mandler, 1995). In the experience of the audience or user, novelty is that which comes as a surprise (Bruner, 1962). A learning experience is novel or surprising if it has never been seen or heard-of before; it can also be meaningfully novel if it is something heard-of but not yet seen, or something rarely seen, or something merely uncommon.

Such a continuum of novelty suggests that there is a broad array of possibilities open to the designer in creating some degree of surprise and delight in the experience of the learner. Novelty for learners does not normally "wear off," because typically each instance happens with a new learner. A designer can become aware of an idea that most learners will not have seen; the designer then masters this technique and uses it to good effect for virtually all of the target learners, for whom the idea will be at least uncommon if not unheard-of.

A creative approach to designing learner interactions would therefore seek to use best practices for instructional multimedia design while trying to push into the realm of novelty to some degree for a given project. In other words, designers of creative interactions seek to surprise and delight their learners wherever they can with out-of-the-ordinary interactive experiences.

Enhancing Creativity to Design Creative Interactions

Creativity is a vital component that designers must consider in developing interactions. In this section, seven suggestions are provided to design creative interactions for learning activities.

Suggestion 1: Resolve to Be Creative

Most people assume creative people are those who are "smart." However, this idea does not find general agreement among scholars (Sternberg & O'Hara, 1999). Some scholars have reported that no distinct relation between intelligence and creativity has been identified (Perkins, 1988; Torrance, 1975). In other words, a highly intelligent person is not necessarily creative, and vice versa. Additionally, Nickerson (1999) contended that if one wants to be creative, merely possessing high intelligence will not suffice. What matters rather is whether an individual values creativity or not. If one values originality, one will constantly strive to come up with new ideas (Starko, 2005). Hence, the first step to enhance one's creativity is to resolve to be creative.

Suggestion 2: Pursue Positive Affect and Relaxation

Being relaxed and joyful can contribute to being creative (Norman, 2004; Ziv, 1983). This is especially important in the stage of brainstorming. Isen (1993) described how being happy, feeling good, and having fun can expand one's thought processes. Kelly shared that at the onset of a design project, designers should maintain a broad perspective, with openness to emerging directions, and try not to be apprehensive about moving forward efficiently toward the goal (Kelley & Hartfield, 1996). A design that is creative can emerge from designers' exploration. For example, you can invite team members to a brainstorming session, where snacks, drinks, and music are provided. Set an environment that is comfortable and relaxing. Remind your team members that any idea can be helpful and no judgment should be made during the session. The tenet for brainstorming is to let the thinking flow.

Suggestion 3: Carefully Consider Users' Experiences

To develop a product that is creative, designers need to overcome the challenge of understanding "end-users' unmet and unarticulated needs" (Norman, 2004, p. 74). In most cases, users are unaware of their true need. Thus, it is designers' responsibility to discover users' needs and combine the articulated and unarticulated needs to design a product that can satisfy end-users. Instructional designers are trained to collect information early from stakeholders or subject matter experts about learners' situations and the content. However, data gathered from these experts might still be incomplete. If the situation allows, instructional designers ought to visit learners' environments and observe the performance context and learning context. Through observation, instructional designers can learn important insights from learners.

Suggestion 4: Approach Things from Different Perspectives

Since creativity has been described as "the ability to see ordinary things differently" (Egbert, 2008, p. 130), instructional designers should train themselves to observe a situation from as many perspectives as they can. In an interview, Kelly suggested that when you look at an object, look from different angles (Kelley & Hartfield, 1996). For example, you can look down on the object from above or examine an object from an ant's point of view. Another tip is to use an object or material in an uncommon way. Taking a match box as an example, how can you use a match box other than for holding matches? You could place a candle on the top of the box as a candle holder. With different elements interplaying, creative ideas can emerge.

Suggestion 5: Use Specific Techniques for Promoting Creative Ideas

Specific techniques for reinforcing one's ability to be creative have been proposed by various authors (e.g., Gordon, 1961; Osborn, 1953; Root-Bernstein & Root-Bernstein, 1999). Osborn (1953) proposed five techniques to come up with creative ideas. The first technique, *combination*, is to put things with different functions together so as to illuminate the possible combination of each object's purposes. For example, to teach beginning photographers basic photography techniques, combining video demonstrations with the database of questions and answers posted by other members may multiply their respective effectiveness in learning photography. The second strategy is *rearranging*. Reordering the content or trying different layouts to present the materials can contribute to potential creative ideas. When you rearrange one component of an entire instruction, you may end up shuffling other components. Using the teaching of *Inspiration* software as an example, unlike traditional ways of explaining basic functions to learners at the beginning of a tutorial, an instructional designer can reorder the teaching sequence by demonstrating a completed concept map and ask learners to create the same concept map by exploring *Inspiration* themselves in a given amount of time. After learners' exploration, more explanation of different functions of the program can then be provided. The third strategy, *adapting*, is borrowing ideas from other objects and applying them to a particular purpose. For instance, for language learning, many teachers use chants to reinforce students' memorization of vocabularies. However, when applying the idea of chants to adolescents, the learners may complain that rhyming with chants is childish. Instead, they might like to use the same chant and adapt it into a rap. The fourth technique that may be beneficial to creative instructional design is *substituting*. It is an act of changing an element from A to B. While substituting, you may need to confirm that B has some similar functions as A. Putting this into the context of instructional multimedia design, if you originally design an Internet scavenger hunt activity to teach students proper use of the Internet, you may then identify other types of activities to substitute, such as a *Flash*-based scavenger hunt. Finally, *making modifications* is the last suggested technique to lead designers to creative ideas. Designers observe learners' experiences in interactive activities and then make changes to improve the learning module. For example, if a video provided in the learning module is too long, the instructional designer might want to reduce the length of the video to retain learners' attention. Creative ideas may emerge during the modifying process.

Suggestion 6: Be Reflective and Persistent

Designing a creative interaction requires various types of thinking, such as brainstorming for the creative stage and reflection for the realization stage (Norman, 2004). In the early stages, designers may focus mainly, on brainstorming to generate a great number of ideas. In contrast, after ideas are produced, designers must then shift to examine all possible alternatives, to consolidate, and then to realize the design. In this latter stage, designers' reflective thinking plays a major role. Careful consideration of learners' characteristics, situation, and their learning context followed by the evaluation of the generated ideas is indispensable to a useful creative design. However, it is not guaranteed that after a cycle of reflection you will achieve a successful creative interaction, since you are likely to experience failure at times. Creative design requires perseverance (Starko, 2005) to overcome barriers, to endure several rounds of failure, and to expose and overcome negative emotions. In a word, being reflective and persistent is one of the keys to realizing creative design of learner interactions.

Suggestion 7: Become an Experienced Professional Instructional Designer

Finally, creative work requires domain knowledge. As Nickerson (1999) noted, "people who do noteworthy creative work in any given domain are almost invariably very knowledgeable about the domain" (p. 409). However, as an instructional designer, your domain is not a specific content area; rather, it is the work of creating meaningful learning experiences. Thus, while fresh creative ideas are possible and desirable for novices, ultimately the key to increasing the likelihood of creative ideas in your work is to become an experienced professional instructional designer by doing lots and lots of instructional design. Examples of long-term fluent practice and creative output can be found in eminent creators across all domains, including musicians, painters, poets, astrophysicists, organic chemists, political leaders, etc. (Bukofzer, 1947; Csikszentmihalyi, 1996; Weisberg, 1999). The salient lesson here for the instructional designer is to become as active and as fluent as you can in designing interactive multimedia.

Conclusion

A well-designed interaction leads to learners' active participation, which enables learners to explore content and to construct their own knowledge, Additionally, a good interaction is creative so that learners can engage in learning on both cognitive and emotional levels. However, many instructional designers tend to question their creativity. The suggestions in this article are intended to help instructional designers develop their design process and facilitate their development of creative interactions.

References

Aldrich, F., Rogers, Y., & Scaife, M. (1998). Getting to grips with "interactivity": Helping teachers assess the educational value of CD-ROMs. *British Journal of Educational Technology, 29*(4), 321-332.

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

Bannan-Ritland, B. (2002). Computer-mediated communication, eLearning, and interactivity: A review of the research. *Quarterly Review of Distance Education, 3*(2), 161-179.

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

Bukofzer, M. F. (1947). *Music in the Baroque era: From Monteverdi to Bach.* New York: W.W. Norton & Company.

Clinton, G., & Hokanson, B. (2011). Creativity in the training and practices of instructional designers: The Design/Creativity Loops model. *Educational Technology Research & Development, 60,* 111-130.

Csikszentmihalyi, M. (1996). *Creativity: Flow and the psychology of discovery and invention.* New York: HarperCollins.

Csikszentmihalyi, M. (1999). Implications of a systems perspective for the study of creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 313-335). Cambridge, UK: Cambridge University Press.

Department of Communication and the Arts. (1995). *Australia on CD—Round Two: Information for Applicants.* Canberra, ACT: DoCA.

Dickinson, D. (1995). Multimedia myths. *Australian Personal Computer, 16*(10), 144-145.

Egbert, J. (2008). *Supporting learning with technology: Essentials of classroom practice.* Upper Saddle River, NJ: Allyn & Bacon.

Fenrich, P. (1997). *Practical guidelines for creating instructional multimedia applications.* Fort Worth, TX: Dryden Press.

Gagne, R. M., Wager, W. W., Golas, K. G., & Keller, J. M. (2005). *Principles of instructional design.* Toronto, ON: Thomson Wadsworth.

Gordon, W. J. J. (1961). *Synectics*. New York: Harper & Row.

Gredler, M. E. (2003). Games and simulations and their relationships to learning. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (2nd ed., pp. 571-581). Mahwah, NJ: Lawrence Erlbaum Associates.

Hannafin M. J. (1989). Interaction strategies and emerging instructional technologies: Psychological perspectives. *Canadian Journal of Educational Communication, 18*(3), 167-179.

Hirumi, A. (2002). A framework for analyzing, designing and sequencing planned elearning interactions. *Quarterly, Review of Distance Education, 3*(2), 141-160.

Hokanson, B., & Miller, C. (2009). Role-based design: A contemporary framework for innovation and creativity in instructional design. *Educational Technology, 49*(2), 21-28.

Holmes, M. (1995). Interactivity primer: Exploring the essence of good interactivity; *http://wwwmultimediator.com/publications/write014.shtml .*

Isen, A. M. (1993). Positive affect and decision making. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 261-277). New York: Guilford.

Jonassen, D. H. (1985). Interactive lesson designs: A taxonomy. *Educational Technology, 25*(6), 7-17.

Jonassen, D. H., & Reeves, T. C. (1996). Learning with technology: Using computers as cognitive tools. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 693-719). New York: Macmillan.

Kapor, M. (1996). A software design manifesto. In T. Winograd (Ed.), *Bringing design to software* (pp. 1-9). New York: Addison-Wesley.

Kelley, D., & Hartfield, B. (1996). The designer's stance. In T. Winograd (Ed.), *Bringing design to software* (pp. 151-170). New York: Addison-Wesley.

Krause, J. (2004). *Design basics index: A graphic designer's guide to designing effective compositions, selecting dynamic components, and developing creative concepts.* Cincinnati, OH: How Design Books.

Kristof, R., & Satran, A. (1995). *Interactivity by design: Creating and communicating with new media.* Mountain View, CA: Adobe Press.

Mandler, G. (1995). Origins and consequences of novelty. In S. M. Smith, T. B. Ward, & R. A. Finke (Eds.), *The creative cognition approach.* Cambridge, MA: The MIT Press.

Merrill, M. D. (2002). First principles of instruction. *Educational Technology Research and Development, 50*(3), 43-59.

Merrill, M. D. (2007). A task-centered instructional strategy. *Journal of Research on Technology in Education, 40*(1), 5-22.

Nickerson, R. S. (1999). Enhancing creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 392-430). Cambridge, UK; New York: Cambridge University Press.

Norman, D. A. (2004). *Emotional design: Why we love (or hate) everyday things.* New York: Basic Books.

Osborn, A. F. (1953). *Applied imagination: Principles and procedures of creative thinking.* New York: Charles Scribner's Sons.

Parrish, P (2005). Embracing the aesthetics of instructional design. *Educational Technology, 45*(2), 16-24.

Perkins, D. N. (1988) Creativity and the quest for mechanism In R. J. Sternberg & E. E. Smith (Eds.), *The psychology of human thought* (pp. 309-336). New York: Cambridge University Press.

Rhodes, D. M., & Azbell, J. W. (1985, Dec.). Designing interactive video instruction professionally. *Training and Development Journal,* 31-33.

Rieber, L. P. (2003). Microworlds. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (2nd ed., pp. 583-603). Mahwah, NJ: Lawrence Erlbaum Associates.

Rieber, L. P. (2005). Multimedia learning in games, simulations, and microworlds. In R. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 549-567). New York: Cambridge University Press.

Root-Bernstein, R., & Root-Bernstein, M. (1999). *Sparks of genius: The thirteen thinking tools of the world's creative people.* Boston: Houghton-Mifflin.

Rowland, G. (1993). Designing and instructional design. *Educational Technology Research and Development, 41*(1), 79-91.

Sims, R. (1997). Interactivity: A forgotten art? *Computers in Human Behavior, 13*(2), 157-180.

Sims, R. (1999). Interactivity on stage: Strategies for learner-designer communication. *Australian Journal of Educational Technology, 15*(3), 257-272.

Starko, A. J. (2005). *Creativity in the classroom: Schools of curious delight* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Sternberg, R. J., & O'Hara, L. A. (1999). Creativity and intelligence. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 251-272). Cambridge, UK; New York: Cambridge University Press.

Torrance, E. P. (1975). Creativity research in education: Still alive. In I. A. Taylor & J. W. Getzels (Eds.), *Perspective in creativity.* Chicago: Aldine.

van Merriënboer, J. J. G., Clark, R. E., & de Croock, M. B. M. (2002). Blueprints for complex learning: The 4C/ID-model. *Educational Technology Research and Development, 50*(2), 39-64.

Visscher-Voerman, I., & Gustafson, K. L. (2004). Paradigms in the theory and practice of education and training design. *Educational Technology Research & Development, 52*(2), 69-89.

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

Weisberg, R. W. (1999). Creativity and knowledge: A challenge to theories. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 226-250). Cambridge, UK; New York: Cambridge University Press.

Woo, Y., & Reeves, T. C. (2007). Meaningful interaction in Web-based learning: A social constructivist interpretation. *The Internet and Higher Education, 10*(1), 15-25.

Ziv, A. (1983). The influence of humorous atmosphere on divergent thinking. *Contemporary Educational Psychology, 8*, 68-75.

Yi-Chun Hong is an instructional Designer at Mary Lou Fulton Teachers College at Arizona State University. Her research interests include the design of learning environments for enhancing ill-structured problem solving skills and for facilitating collaborative learning in online settings.
Gregory Clinton is a Senior Lecturer and coordinator of Instructional Design and Development in the Learning, Design, and Technology program at the University of Georgia. His teaching duties encompass a variety of graduate courses in instructional design and development and instructional technology for teachers.
Lloyd P. Rieber is a Professor of Learning, Design, and Technology and Director of Innovation in Teaching and Technology for the College of Education at the University of Georgia. He is interested in interactive learning environments, such as microworlds, simulations, and games, and how they can be used to increase accessibility to education.

14

Breaking Down Walls to Creativity through Interdisciplinary Design

Editor's Note: West, R. E. (2016). Breaking Down Walls to Creativity through Interdisciplinary Design. *Educational Technology, 56*(6-), 47-52.
This article describes initial success in developing an interdisciplinary studio for teaching collaborative creativity and design, with faculty from multiple departments co-teaching and co-mentoring interdisciplinary student groups engaged in social innovation. The rationale for developing this studio has been to prepare students for the kind of interdisciplinary creativity that will be essential to their careers post-graduation. Some have argued that universities are becoming increasingly irrelevant; the author argues for the critical role of universities in preparing students for successful integration into the innovation economy. To meet this challenge, we need to evolve as institutions and individuals in how we teach and conceptualize the creative design process.

Introduction

Higher education has increasingly been judged unnecessary, as commentators cite examples of successful ungraduated entrepreneurs, point to rising tuition costs, and ask whether people really need to go to college (Anderson, 2012; Stephens, 2013). That a former United States Secretary of Education has asked if college is worth it (Bennett & Wilezol, 2013) is evidence that the matter is receiving consideration. Most of the critics base their arguments on a perception that college education provides little additional value over the free learning available via the Internet, MOOCs, and open educational resources. Because university instruction often emphasizes transmission of information and knowledge—the lowest levels of Bloom's taxonomy (Anderson, Krathwohl, & Bloom, 2001)—these critics may be right.

The uncomfortable truth for many educators is that we are no longer uniquely valuable as sources of information, insight, and knowledge. That does not mean that higher education should discontinue its role in society. It just means our role must change. Traditionally universities have had the important job of creating new scientific knowledge through research. In the future, higher education must also see the importance of creating new knowledge, innovations, products, and ideas through its teaching as well. No longer will it be sufficient for universities to be places where students come to *receive* knowledge. For higher education to survive, we need to develop campuses where students come to produce and create. This focus on creativity and innovation will be the key to providing value to future students, thus keeping higher education relevant.

The Innovation Economy

The important role of creativity and innovation in our society should not be surprising. In 1950 J. P. Guilford, in his presidential address to the American Psychological Association, argued that "psychologists have seriously neglected" the study of creativity (p. 44). He envisioned "thinking machines" (computers) completely changing the nature of society because "eventually about the only economic value of brains left would be in the creative thinking of which they are capable" (p. 36). We see a partial fulfillment of that vision now, as a third of jobs in the United States (and growing) require creativity (Florida, 2012), and as CEOs of the most successful companies are focusing on agility, experimentation, and innovation (IBM, 2016). “Creativity at all levels and across different types of jobs is increasingly necessary,” Zhou, Hirst, and Shipton (2012) argued, “to deal with the velocity and frequency of change” (p. 80). We have in effect become an *Innovation Age*, and while previous calls within the instructional design community have been to renovate educational systems for the information age (Reigeluth, 1992), we now need to expand our thinking about how we can effect change in educational systems to support the innovation age.

While Guilford may have foreseen the critical role of creativity in the modern economy, he did not expect the increasingly necessary role of collaboration in innovative thinking. Because most current problems are too big to be solved by one person or even one disciplinary point of view, we are increasingly seeing the important role of interdisciplinary thinking in business because often the “right knowledge to solve a problem is in a different place to the problem itself, so interdisciplinary innovation is an essential tool” (Blackwell, Wilson, Street, Boulton, & Knell, 2009, p. 3). Also “while it may be more romantic to believe in lone geniuses and flashes of insight, truly exceptional innovation is a team sport” (Satell, 2016, para. 22). It’s time for education to catch up by breaking down the barriers between disciplines on campus and promoting more interdisciplinary teaching, design, and research, as these are necessary skills our students must learn.

The Universities of the Future

What will keep future students coming to campus, in person or virtually, in the era of MOOCs and freely accessible open education? It will not be to hear another lecture that can’t be skipped, rewound, or sped up to meet their needs. Instead it will be (1) to learn creative/ design thinking, (2) to work on interdisciplinary teams, and (3) to have a safe opportunity to have authentic experiences where failure brings fewer consequences and where experienced faculty can mentor and provide feedback. To be relevant, universities need to embrace their “third mission” of fostering creativity (and some argue, economic development), in addition to research and teaching (Etzkowitz, Webster, Gebhardt, & Terra, 2000).

As Florida (1999) argued, in contrast to the worries about universities becoming irrelevant, “The university becomes more critical than ever as a provider of talent, knowledge, and innovation in the age of knowledge-based capitalism” (p. 68). However, universities must change their focus and curriculum to become this talent provider. As higher education faculty, are we ready to meet this challenge? To put aside our presentation slides and engage in mentored interdisciplinary design experiences with our eager students?

Current Interdisciplinary Collaboration in Higher Education

Many elite universities have already acknowledged the need to emphasize creativity, design, and innovation for their students. My analysis of the top 50 U.S. universities listed in the *U.S. News and World Report’s* ranking in 2014 found that 31 offered an undergraduate or graduate degree in innovation and/or design. Another seven universities offered a minor in innovation or an innovation related certification program. At least 47 of the top 50 universities had an innovation-related center or other innovation program.

While some focus on innovation and creativity was apparent in this list, what is missing are interdisciplinary efforts. Interdisciplinary work is challenging, particularly for universities, where there are unique, well-defined cultures and traditions within each discipline. However, we must in higher education break down these disciplinary walls. We already know that group innovation can benefit from teams representing diverse perspectives. Cognitive diversity, for example, can increase the number of new ideas within a group (Paulus, 2000). Reagans and Zuckerman (2001) completed a network analysis of 224 research and development teams, finding communication ties that cut across demographic boundaries significantly improved creative productivity (see also Baer, 2010). However, more important than demographic diversity within the group is “diversity of the mind” (Mostert, 2007), including diversity in skills, knowledge, and thinking patterns (West, 2009)—the kind of diversity that comes from interdisciplinary collaborations.

Interdisciplinary work in the academy is not new—concerning research, Metzger and Zare (1999) stated, "Interdisciplinary research is a mantra of science policy" (p. 642). As interdisciplinary research has gained in popularity on university campuses since the 1970s (Lattuca, 2001), "interdisciplinary" journals have become popular (see *http://bit.ly/Interdisciplinary Research* or search *interdisciplinary* in Google Scholar Metrics). Rhoten and Parker (2004) attributed the increasing popularity of interdisciplinary research to "the scientific complexity of problems currently under study" (p. 2046) that necessitate the collaboration.

However, interdisciplinary teaching is much less prevalent. For example, a Google Scholar search using the phrase *interdisciplinary research* with *college*, *university*, or *higher education* produced 388,000 hits. The exact same search with the phrase *interdisciplinary teaching* replacing *interdisciplinary research* produced only 11,400 hits. This seems curious because the same reasons given for needing interdisciplinary research are also true for teaching. In our teaching we train students to solve the kinds of problems they will encounter in their careers, and many of the work problems that our graduates will encounter will be too large and complex to be solved by the knowledge from one discipline, and thus they will often be working on interdisciplinary teams (particularly within the field of instructional design).

When we are attempting to teach our students how to be creative, interdisciplinary knowledge becomes even more critical, as new innovations often emerge on the boundaries of disciplines. For example, how could NASA's Jet Propulsion Laboratory benefit from working with an origami artist? On the surface, it seems like none at all—the disciplines are too different. But through working with mechanical engineers, they discovered that origami could solve some of the most perplexing problems related to astronomical work: how to get large items compact enough for launch (Hollingshead, 2013).

Similarly, many innovative design companies such as IDEO (IDEO, 2016) and W. L. Gore ("W. L. Gore and Associates," 2016) have long valued the importance of interdisciplinary teams for fostering innovation. Interdisciplinary work is already seen as essential in many industries—it is time for higher education to realize our mandate to prepare students to work in these types of careers.

An Opportunity for the Field of Instructional Design

Instructional designers have the opportunity to lead this evolution towards interdisciplinary collaborative teaching in higher education. We commonly refer to our field as a "meta-field" (Hill *et al.*, 2004) because we are integrated with other disciplines. An essential competence for instructional designers is to work with subject matter experts, evaluators, programmers, artists, and writers. Perhaps for this reason, researchers have found collaboration skills to be the second most requested category in instructional design job postings (Sugar, Hoard, Brown, & Daniels, 2012).

Instructional designers also have the benefit of frequently being in university positions where they can influence teaching on campus, as members of a faculty center, college administrators, or faculty. Because we understand (a) teaching and learning, (b) interdisciplinary collaboration, and (c) design processes, opportunities for us to influence the teaching of interdisciplinary design in higher education are tremendous. That does not mean there will not be challenges, as roadblocks to reform seem synonymous with higher education, but the benefits to overcoming these roadblocks, I believe, will be worth the efforts and risks.

Our Story: Developing a University Interdisciplinary Design Studio

For the past four years we have been striving to put this vision of interdisciplinary, design-focused teaching into practice at Brigham Young University. We began by building connections across campus among faculty who shared an interest in promoting the teaching of creativity and design. In 2012 Taylor Halverson and I formed the Creativity, Innovation, and Design Faculty Group and later launched a Website to capture our collaborative efforts (see *http://innovation.byu.edu*).

We picked the name for our group strategically in order to accommodate faculty from all disciplines on campus who were teaching similar skills but under different names. While month-to-month attendance varied, over 40 faculty joined our listserv and participated as their schedules permitted.

At first, our group met monthly during lunch to learn what kinds of courses we each taught, how we approached our research, and what activities we were Sponsoring on campus. We began discussing the potential of an interdisciplinary design center, where faculty and students from multiple departments could work together on creative projects too big for one discipline alone. The challenge was space—as it often is. If any one college hosted this design center, could it feel welcoming to other disciplines coming as visitors to the space? Could it truly be interdisciplinary if any one college owned the space or the budget? As one member of our group expressed, we needed an “academic Switzerland”—a truly neutral location where “everyone would feel equally not at home” in order to promote equality among the disciplines participating.

In 2013, the senior associate university librarian began coming to our meetings and asked how the library could further our efforts. In the 21st Century, the role of university libraries is shifting rapidly (MacWhinnie, 2003), as book circulation is dropping dramatically and scholarship is accessed online. Thus, our library was exploring how they could best contribute to teaching and learning on campus. Through our discussions, they offered up space on one of their floors for a prototype design-focused classroom. In true startup form, the classroom was created by pushing aside some of the book stacks, and filling the room with surplus furniture, temporary walls, and as many whiteboards as we could fit. This teaching space was strategically located in a corner of the floor, next to three breakout rooms for student groups and a smaller closet room for storing supplies. After only a couple of weeks of remodeling, our interdisciplinary design center was born.

Also in prototype form, the criteria for what kinds of classes would be allowed in the new space emerged through discussions and iterative collaborative writing with a steering group, advised by a council of college deans and department chairs. We sought enough flexibility in our criteria to allow for creative new courses to be taught in this experimental space, but also enough structure to establish a culture reflecting a different kind of teaching. We did not want instructors using the space to teach the way we had always done it before. This was designed to be something new and different. In developing criteria for using the space, we settled on the following guiding principles:

1. Courses must be focused on design and projects, not dominated by lecture.
2. Courses must be designed to be interdisciplinary ideally with faculty and students from multiple departments participating.
3. Courses should focus on social innovation, which aligned with our university’s mission.
4. Courses should involve library personnel integrated into the projects and courses effectively. The library was not interested in simply leasing space, but in being an active partner.

We taught several retreats to train and educate dozens of faculty members in the kind of teaching we would expect in the space. We also used the space to promote activity and innovation among the students and community, as it became the home for student clubs such as the Innovation Academy and the User Experience Club. We served the community outside of the university by hosting the Girls Driving for a Difference team from the Stanford d.School, who taught two workshops on design thinking to over 50 local middle school girls. Excitement grew as word of the space and our group spread on campus, and the design space eventually received its own official page on the library’s Website as part of their official offerings (see *http://bit. ly/COStudyGuide*).

Although many faculty have been excited to teach in this design studio, educational reform is never easy. Many faculty struggled with how to take courses with clearly defined disciplinary objectives and fit them to the interdisciplinary goals of our studio. Other faculty struggled with getting released from other assignments so they could have time to teach in this space. Departments struggled with how to offer the courses across multiple colleges and how to grant credit to students so these interdisciplinary experiences would count towards their degrees. The best solution we have found to date is to cross-list the courses in multiple departments, but this is a Band-Aid until we can solve the political curriculum issues.

Still other faculty, while valuing the interdisciplinary nature of our library studio, struggled to leave behind well-established studio spaces with specialized equipment in their own colleges. Some of these faculty have found success in using both—benefiting from the library studio for ideation and college-owned studios for product development.

Despite these challenges, we have also seen many successes. In one example, students and faculty from the colleges of education, fine arts, and engineering and technology collaborated to develop an augmented reality game to teach science process skills to middle school students. The story in this game was that after observing a meteor shower spew dust clouds onto earth, adults around the world begin dropping into comatose states, and the youth must figure out why they are sick, applying the scientific method to understand astronomical, neurological, and microbiological clues left behind by the adult scientists. Played out across social media as well as through the Website (*http://dustgame.byu.edu/*), this game merged physical and virtual game play while encouraging scientific thinking.

In addition to being an interesting example of an emerging game genre, this project represented the need for interdisciplinary collaboration because it was simply too big for any one discipline to complete effectively. Student artists, writers, science education majors, and programmers worked together as teams to complete the project—assisted by students from various other majors who wanted to participate just because it was fun!

In addition, this project showcased the powerful contribution that the library can make to collaborative teaching, as science librarians taught workshops on content areas the students needed to understand for their work. For those wishing to learn more about this project, as well as to see interviews from the participants about the experience of learning in this interdisciplinary studio, this short documentary can be accessed on our BYU Creativity, Innovation, and Design Group YouTube channel: *http://bitly/DUST game*.

Other courses taught in the library studio have sought to improve poverty in Paraguay (see *http://bit.ly/FundacionParaguay*) and improve children's engagement in classic literature (see *http://www.read. gov/readers/*), a project that involved the children's literature librarian as a consultant. Other courses have developed projects related to museum exhibit design, biotechnology, solutions journalism, recreation/experience design, and teaching Arabic through educational gaming.

We have also been experimenting with a different type of course in an effort to help students be ready to apply design thinking in their semester-long courses. BYU faculty have developed a one-day "Innovation Boot Camp" to teach design thinking as a one-credit compressed course that can easily fit in students' schedules. This course is typically conducted all day on a Saturday, with a design challenge that students complete as interdisciplinary groups during the week before sharing their results during a final event. This course was originally taught within the college of engineering and technology with great success (West, Tateishi, Wright, & Fonoimoana, 2012). We plan to incorporate the Innovation Boot Camp more in developing our studio, perhaps as a prerequisite for students before jumping into the semester-long design. More information on the nature and curriculum of the Innovation Boot Camp can be found on a video (*http://bit.ly/BootCampVid*) or our article on the course curriculum (Wright, Skaggs, & West, 2012).

Reflections on Our Experience

What have been our outcomes? So far, we feel quite positive. In a chapter in the *Educational Technology Media Yearbook* (Rich, West, & Warr, 2015), we described some of our findings. To date, every college at Brigham Young University has had students and/or faculty participating in the studio, except for law and nursing, and we have had several courses offered in the space every semester since Winter 2014. Students have offered suggestions for improvement, but have generally agreed with one student who said, "It is so useful, and it is so ahead as far as education goes" and another who said, "I like the work I am doing in this class the most of any class I am taking."

Perhaps the best evidence that this interdisciplinary studio is working is how excited the students are to participate. One team told me that after leaving their ideas and prototypes in the studio, they came to the library the next day to see a note on the whiteboard from another student, asking them to call her so she could participate too. In my own class, where we designed scientific educational artifacts for the DUST game, a mechanical engineering student and a technology and engineering education student who had no relationship to the content of the project participated simply because they loved participating in group creativity experiences and didn't want to leave.

Current Challenges and Opportunities

While we feel our interdisciplinary studio has been a success, we are still experiencing growing pains. The studio is not officially sanctioned by the university, which raises questions about extra courses for students that delay their graduation, thus threatening the long-term stability of inter-departmental collaborations. In short, the disciplinary walls run deep in higher education, and do not fall down overnight in a world of courses, credits, faculty loads, and justifications for faculty positions.

We are now seeking to find solutions to these challenges. A group of us have formed a committee to explore ways that collaborative courses could fulfill degree requirements for multiple majors, thus reducing the worry about increasing time to graduation. The goal of this committee is to reduce the administrative barriers to students and faculty participating in this experience. We are also seeking to expand the library studio so that larger classes can participate, but without losing the startup, non-permanent, evolutionary feel of the space.

At this point we are not sure what our library studio may become in the future, although we have high hopes that it can become a catalyst for rethinking teaching, design, and collaboration within the university. No matter what happens, it has already successfully forged new connections involving faculty, students, and departments that have opened up new channels of communications and potential opportunities for collaborative research, teaching, and design.

Recommendations for the Future

The world our students graduate into is not the same world for which the current university model was designed to prepare them. We need to innovate the educational process in higher education, which will not only better serve our students, but also keep them engaged in higher education. I also feel that incorporating more interdisciplinary collaborative design activities into our curriculum can deepen students' understanding of their own discipline, as they gain appreciation for the wisdom in other fields.

In true design thinking fashion, we feel we are still learning and evolving as we develop our interdisciplinary library studio. However, the following are some recommendations from our chapter (Rich, West, & Warr, 2015) that we feel might benefit other universities as they begin the process on their campuses:

- Departments can build small studios and integrate curriculum within the department into the studio. Alumni and professionals can be tapped as consultants and mentors in the process.
- Many interdisciplinary efforts have to start small. For example, a collaboration between only two different departments can be beneficial, demonstrating that a collaborative model can work.
- Engaging university partners helps to situate studios within a university's culture and goals. In our experience, partnering with the library has helped the library meet its goals of better supporting teaching and learning while giving a shield of legitimacy to the studio's effort.
- Engaging university administrators can help them understand why studio-based pedagogies are important. For example, we led a group of BYU leaders from various colleges on a tour of the Stanford d.School as a way of helping them see another university-based studio in action.
- These administrative leaders are also important, as they can offer a measure of "protection" for faculty exploring the messy nature of studio-based teaching; our experience has been that it is difficult to be successful the first semester, and setbacks should be expected.
- It is critical, we feel, to identify a space that the studio can own. Studio instructors need to have some flexibility within the space for moving furniture, leaving up sketches on whiteboards, and adapting the space to meet their needs. Ideally, it is beneficial to avoid having this space isolated, so that proximity to other students, courses, instructors, and visitors can foster dialogue and creative improvisation.

Interdisciplinary collaboration is not easy, because it involves working with people who see the design problem differently than we do. For this reason, diversity can sometimes have paradoxically negative effects on creativity (Bassett-Jones, 2005). However, it is only through embracing our disciplinary diversity that we can achieve the greatest creativity of which we are capable, which will increase our abilities to prepare students for success in today's innovation age.

References

Anderson, E. (2012, August, 6). Do you really need to go to college? *Forbes; http://www.forbes.com.sites/erikaandersen/2012/08/do-you-really-need-to-go-to-college/#27b2b287269d* .

Anderson, L. W., Krathwohl, D. R., & Bloom, B. S. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* Boston: Allyn & Bacon.

Baer, M. (2010). The strength-of-weak-ties perspective on creativity: A comprehensive examination and extension. *The Journal of Applied Psychology*, *95*(3), 592-601.

Bassett-Jones, N. (2005). The paradox of diversity management, creativity, and innovation. *Creativity and Innovation Management, 14*(2), 169-175.

Bennett, W. J., & Wilezol, D. (2013). *Is college worth it? A former United States Secretary of Education and a liberal arts graduate expose the broken promise of higher education.* Nashville, TN: Thomas Nelson.

Blackwell, A. F., Wilson, L., Street, A., Boulton, C., & Knell, J. (2009). Radical innovation: Crossed knowledge boundaries with interdisciplinary teams. *University of Cambridge/NESTA Report.* Cambridge, UK: University of Cambridge Computer Laboratory; *http://www.test.cl.cam.ac.uk/techreports/UCAMCL-TR-760.pdf* .

Etzkowitz, H., Webster, A., Gebhardt, C., & Terra, B. R. C. (2000). The future of the university and the university of the future: Evolution of ivory tower to entrepreneurial paradigm. *Research Policy*, *29*(2), 313-330.

Florida, R. (1999). The role of the university: Leveraging talent, not technology. *Issues in Science and Technolgy, 15*(4), 67-73.

Guilford, J. P. (1950). Creativity. *American Psychologist, 5,* 444-454.

Hollingshead, T. (2013, November 26). BYU engineers turn to origami to solve astronomical space problem. *BYU News; https://news.byu.edu/news/byu-engineers-turn-origami-solve-astronomical-space-problem .*

IBM. (2016). Brand; *https://www.ideo.com/expertise/brand/ .*

Hill, J. R., Bichelmeyer, B. A., Boling, E., Gibbons, A. S., Grabowski, B. L., Osguthorpe, R. T., Schwier, R. A., & Wager, W. (2004). Perspectives on significant issues facing instructional design and technology. *Educational Media and Technology Yearbook, 29*, 23-43.

Lattuca, L. R. (2001). *Creating interdisciplinarity: Interdisciplinary research and teaching among college and university faculty.* Nashville, TN: Vanderbilt University Press.

MacWhinnie, L. A. (2003). The information commons: The academic library of the future. *Portal: Libraries and the Academy, 3*(2), 241-257.

Metzger, N., & Zare, R. N. (1999). interdisciplinary research: From belief to reality. *Science, 283*(5402), 642-643.

Mostert, N. M. (2007). Diversity of the mind as the key to successful creativity at Unilever. *Creativity and Innovation Management, 16*(1), 93-100; *doi:10.1111/1.1467-8691.2007.00422.x .*

Paulus, P. (2000). Groups, teams, and creativity: The creative potential of idea-generating groups. *Applied Psychology, 49*(2), 237-262.

Reigeluth, C. M. (1992). The imperative for systemic change. *Educational Technology, 32*(11), 9-13.

Reagans, R., & Zuckerman, E. W. (2001). Networks, diversity, and productivity: The social capital of corporate R&D teams. *Organization Science, 12*(4), 502-517.

Rhoten, D., & Parker, A. (2004). Risks and rewards of an interdisciplinary research path. *Science, 306*(5704), p. 2046.

Rich, P. J., West, R. E., & Warr, M. (2015). Innovating how we teach collaborative design through studio-based pedagogy. In M. Orey, S. A. Jones, & R. M. Branch (Eds.), *Educational media and technology yearbook* (pp. 147-163). New York: Springer.

Satell, G. (2016, January 20). We need to innovate the innovation process. *The Creativity Post; http://www. creativity-post.com/business/we_need_to_innovate_the_ innovation_process .*

Stephens, D. J. (2013, March 7). Do you really have to go to college? *The New York Times; http://thechoice.blogs. nytimes.com/2013/03/07/do-you-really-have-to-go-to¬college/* .

Sugar, W., Hoard, B., Brown, A., & Daniels, L. (2012). Identifying multimedia production competencies and skills of instructional design and technology professionals: An analysis of recent job postings. *Journal of Educational Technology Systems, 40*(3), 227-249.

West, R. E. (2009). What is shared? A framework for studying communities of innovation. *Educational Technology Research & Development, 57*(3), 315-332.

West, R. E., Tateishi, I., Wright, G. A., & Fonoimoana, M. (2012). Innovation 101: Promoting undergraduate innovation through a two-day boot camp. *Creativity Research Journal, 24*(2-3), 243-251.

Wright, G. A., Skaggs, P., & West, R. E. (2012). Teaching innovation in junior high and senior high technology classes. *The Technology and Engineering Educator, 72*(4), 18-23.

"W. L. Gore and Associates." (2016). *Wikipedia; https://en.wikipedia.org/wiki/W._L._Gore_and_Associates* .

Zhou, Q., Hirst, C., & Shipton, H. (2012). Promoting creativity at work: The role of problem-solving demand. *Applied Psychology, 61*(1), 56-80.

Richard E. West, a Contributing Editor, is Associate Professor of Instructional Psychology and Technology at Brigham Young University. He researches open badge credentials for education, online social learning, and strategies for fostering collaborative innovation. He tweets @richardewest, and his research is available at https://byu.academia.edu/RichardWest. He co-founded the Creativity, Innovation, and Design group at Brigham Young University (http://innovation.byu.edu).

15

Instructional Design Practice as Innovative Learning

Editor's Note: Yanchar, S. C. (2016). Instructional Design Practice as Innovative Learning: Journeys into the Unfamiliar. *Educational Technology, 56*(1), 14-21.

Critical discussions within the field of instructional design have addressed the roles and competencies of designers, as well as the nature of design work per se. This article presents an overarching metaphor-namely, instructional design as a journey into the unfamiliar that views design as a two-fold learning enterprise (i.e., innovative and maintenance learning) and characterizes designers as sojourner-learners. This metaphor places instructional design in a narrative context and emphasizes designers, rather than formalisms, as the primary drivers of the design process. The article then presents several implications of this metaphor related to the identity and innovative practices of designers in the field. Finally, the article suggests that this metaphor can serve as a framework for inquiries into everyday instructional design work, examinations of innovative design practices, and further discussion of the respective roles of instructional designers and design formalisms.

Introduction

Design practice within the field of instructional design has been the subject of critical examination and. debate over the past several decades (Dobozy, 2011; Gibbons, 2014; Gropper, 2015; Hakkinen, 2002; Maclean & Scott, 2007, 2011; Mor & Craft, 2012; Smith & Boling, 2009; Yanchar & South, 2009). Major concerns have included appropriate training and design competencies for practitioners (Arinto, 2013; Maclean & Scott, 2011; Yusop & Correia, 2012), suitable conceptual resources to facilitate their work (Der-Thanq, Hung, & Wang, 2007; Maclean & Scott, 2007; Mor & Craft, 2012; Tracey & Hutchinson, 2013; Wild & Quinn, 1998), and perhaps more fundamentally, the nature of design per se as an aspect of educational practice, especially with regard to distance education, computer-based instruction, e-learning, and so forth (Bichelmeyer, Boling, & Gibbons, 2006; Clark & Estes, 1998; Gibbons, 2014; Gropper, 2015; Rowland, 1993). It might be said, in this respect, that an ongoing conversation about the nature of work in the field has raised important issues for consideration and yielded useful insights regarding best practices.

This conversation has also raised concerns among many regarding the relationship between conceptual resources, such as design process models, and the role of instructional designers who would be expected to implement such resources (Gropper, 2015; Hakkinen, 2002; Smith & Boling, 2009; Wild & Quinn, 1998; Yanchar & South, 2009; Zemke, 1985). Traditional formalisms, such as design process models, instructional theories, design theories, and so on, have been questioned on the grounds that they are often overly simplistic, divorced from the realities of practice, and fail to offer adequate guidance to designers (for reviews, see Gibbons, 2014; Smith & Boling, 2009; Yanchar & South, 2009). These criticisms have been motivated, at least in part, by a discomfort with the view that design should be produced through the use of a systematic process, including step-by step specifications that minimize the need for designer judgment (Smith & Boling, 2009; cf. Gropper, 2015). Indeed, if one takes a systematic approach to design seri ously enough, the role of the designer becomes difficult to discern. As Smith and Boling observed, based upon their intensive study of the literature of instructional design:

… there is little to indicate how the individual designer impacts upon or influences design. The problems that initiate design, the data that serve as evidence, the theories that justify decisions, the models that guide behavior—all of these are codified and exist outside of the designer. We are left wondering what, if anything, does the designer contribute? (p. 13)

While an important conversation has taken place with regard to these issues, there is little evidence to suggest that design can be effectively reduced to a technical process of following predetermined steps to a predictable conclusion, although instructional design is often depicted in this way (e.g., Dick, Carey, & Carey, 2014; Gropper, 2015; Maclean & Scott, 2007; for a review and analysis of "prescriptive" design models, see Gibbons, 2014; Gustafson & Branch, 2002; Smith & Boling, 2009). Indeed, most studies of design practice suggest the opposite-that designers must adapt to the particularities of a given project, and that models and theories may faciliate this undertaking in some ways, but have limited applicability and underspecify what is needed to produce finished design document or learning environment (Wislon, 2013; Yanchar, South, Williams, Allen, & Wilson , 2010). As some outside of e field of instructional design have argued, designing is unpredictable, designer flexibility and adaptation are crucial, and creative problem solving is required (e.g., Cross, 1982; Lawson & Dorst, 2009; Nelson & Stolterman, 2012). In this respect, design work in the field should, at a minimum, be characterized by a satisfactory fit between design formalisms and their "intelligent" use (Lowyck & Pöysä, 2001, p. 508; see also Hakkinen, 2002). To the extent that this is the case, a scholarly focus on what designers actually do-that is, how they use conceptual resources intelligently, adapt to contextual circumstances, and make decisions-offers an important contribution to discussions of their role in the instructional design process.

A growing body of research has shed light on this topic, but there is still relatively little discussion of the functions that designers in the field actually perform and how to conceptualize their role in the work of designing learning environments. Assuming that designers do contribute something significant to the design process, and based on a view of design borrowed from narrative theorizing, I will offer a general account of the role and identity of instructional designers, first, by offering a unique metaphor for understanding instructional design practice, and second, by drawing out several implications of this metaphor for work in the field.

In presenting this metaphor and its implications, I recognize that there are many useful ways to conceptualize the activities of designers, and moreover, that the ever-increasing number of systematic process and design models (e.g., Gustafson & Branch, 2002; Scott, 2001) have much to offer practitioners in the field. However, I will suggest that framing key disciplinary considerations in terms of this metaphor allows for a different kind of conversation to take place, namely, one focused on the possibilities that arise when designers' practical knowledge and innovative learning are viewed as the primary drivers of design. What I present does not amount to a new process model, nor does it advance a strong engineering-oriented approach (e.g., Gropper, 2015). But it can be seen as a metaphor for instructional design practice in which designers use many different models—even those with an engineering orientation—in creative and effective ways.

Design as a Journey into the Unfamiliar

If one takes seriously the view of design as an unpredictable, innovative , and sometimes intuitive process, then design might be best conceptualized as a kind of exploratory work in which resources such as process models, general principles, and templates are, at best, tools in a larger and more complex endeavor. From this perspective, design might be metaphorically cast as a journey into the unfamiliar—that is, a metaphorical Journey in which designers move into unchartered territory by attempting to formulate what hasn't yet been formulated. That is, for an activity to count as design, at least some aspect of what is to be designed must not have been previously worked out; it must be unformulated and unfamiliar in some sense; otherwise, no design efforts would be required. Extending this basic proposition is the corollary notion that journeys into the unfamiliar will necessarily involve learning that fosters familiarity and, ultimately a finished product; and, without this learning, such a journey cannot be construed as design per se.

While other have briefly suggested that design can be considered a special case of learning (e.g., Rowland, 1993), and that a learning experience might be fruitfully viewed as possessing a narrative structure (e.g., Parrish, 2009), I wish to specify two relevant kinds of learning as unique and essential aspects of the design journey—what have been referred to in another context as *maintenance learning* and *innovative learning* (Botkin, Elmandjra, & Malitza, 1979, p. 10; see also Jarvis, 2006). The first, maintenance learning, refers to becoming familiar with extant knowledge, practices, and tools, such that designers can engage in the same work, in approximately the same manner, as others in the field—for example, using a software program in originally-intended ways for fairly well-understood applications relevant to design. Maintenance learning is clearly important, as it permits adaptation to circumstances using the accumulated accomplishments of others, including those of prior generations. Innovative learning, on the other hand, refers to becoming familiar with unfamiliar situations that have no clear precedent for action, or with managing familiar situations in better ways, such as seeking alternative solutions to existing problems. In the field of instructional design, innovative learning involves both major and minor excursions into the unfamiliar, including efforts to formulate, explore, and test possibilities regarding the design of a learning experience in all of its contextual uniqueness.

As should be clear, maintenance learning and innovative learning in design work complement one another; the first allows for a significant degree of convenience and continuity across time; the second allow s for exploration that can solve problems, create new knowledge, and lead to better practices. Moreover, innovative learning is central to any endeavor, such as design, in which a journey into the unfamiliar and a new formulation is required. While familiarity with extant knowledge bases—that is, maintenance learning—surely facilitates the practice of design, as it frees designers from the need to innovate all aspects of their practice; it cannot offer the breadth of knowledge needed for a given design project because that breadth of knowledge is unknown at the outset, though it will, in all likelihood, be vaguely anticipated and worked out as the design process unfolds. In this sense, maintenance learning often supports design work and should be studied as an aspect of design; but it does not drive design forward in the same manner as innovative learning.

What I have suggested here entails several concepts not present in traditional process models, but which, I suggest, contribute to discussions of the designer's roles in the work of design. This contribution is that of sojourner into the unfamiliar, or stated less metaphorically, a learner who explores and becomes familiar with situations in ways that produce the contextual (and possibly generalizable) knowledge needed to achieve a successful outcome, especially with regard to the formulation and working out of design possibilities.

Based on prior research (e.g., Yanchar & Hawkley, 2014), there is some evidence that designers must become familiar with different aspects of a design situation to effectively manage it, including: (a) course-related factors such as client expectations, the nature of the subject matter, learning objectives, and learner characteristics; (b) tools required to actually produce a learning environment; and (c) possibilities regarding how a learning environment might be actually designed—for example, exploring ways of engaging learners, presenting subject matter, and assessing learning outcomes on a particular project. Becoming familiar with such design possibilities is the primary domain of innovative learning in design—that is, formulating and testing possibilities that lead to actuality in the form of a finished design document or learning environment, as well as reflecting on what worked in the process. However, the influence of innovative learning extends beyond the confines of a given project in which it occurred. From the perspective I offer here, innovative learning in situ provides a progressing basis for improvements in designer practices, which informs how they can relate to future work, and might, in that sense, contribute to shifts in professional identity and practical wisdom over time.

Although I have emphasized the notion of designer as learner and design practice as a knowledge-accruing endeavor, I do not wish to ignore what many would consider the central issue in design, namely, the artifact that was the explicit reason for designing in the first place. Such artifacts, including plans, outlines, design documents, online courses, physical aspects of a learning environment, curricula, and so forth, might be considered one of the principal fruits of designer learning from this perspective; that is, what a designer produces will be an expression of the learning that has occurred and a manifestation of the knowledge produced. The artifact will reflect the manner in which relevant aspects of the world became apparent to the designer and how possibilities were formulated and explored. In this sense, it can be said that the artifact, as it is used (and possibly studied; e.g., Howard, Boling, Rowland, & Smith, 2012) in various ways, will reveal something about the designer; and the learning that occurred in the design process—for example, that the designer had a particular perspective, used certain techniques, made certain assumptions, and so on.

Given what I have already suggested, the related notions of "design as a journey into the unfamiliar" and "designer as sojourner-learner" can be viewed in a narrative sense. There is some precedent for viewing human learning as a narrative-oriented phenomenon in various literatures including educational technology and adult education. For example, Clark and Rossiter (2008) have argued that narrative offers a useful medium for instructing others and a frame of reference for describing learning processes per se. Parrish (2009) has argued similarly, suggesting that aesthetic experiences in education an be fostered, at least in part, by developing instruction in which the student is viewed as a protagonist in an unfolding storyline construed as a learning journey. Narrative as a framework for conceptualizing learning resources has been advocated by these and other scholars (e.g., Goldsworthy & Honebein, 2010; Pachler & Daly, 2009; Plowman, 1996) on the grounds that it provides a meaningful and possibility-filled language for interpreting human activity in general.

Based on existing views of narrative as a metaphor for learning and aesthetics (Parrish, 2009), the design journey can be thought of as having a beginning, a middle, and an ending. It can also be conceptualized as including traditional narrative elements, such as lead character(s), supporting character(s), setting, plot, and theme. This metaphor, then, offers a structure in which design activities can be situated and a tool for analyzing what transpired in a given design project. Designer, from this perspective, might be cast as lead characters, involved with supporting characters (clients, students, other stakeholders) within a twisting plot that includes a number of encounters and events, contextualized in a setting with time, place, deadlines, project requirements, and so on (other variations are possible also, for example, considering clients as main characters.) *Moreover*, any design project may bring with it a particular theme or set of themes, as in projects that entail unique challenges. For example, work on an online course might be dominated by an unusually tight deadline, which would lead to a number of time-related challenges. A major theme of the experience, then, might concern what the design team members learned about producing quality work quickly, about properly satisificing in light of client requests, and so on.

I have presented only a brief sketch of what this viewpoint on instructional design entails. More work is needed to develop this approach and study how it might facilitate scholarly and practical work in the field. For instance, designers may not view their experiences narratively in the moment it may be only later, after some reflection, that they are able to discern the narrative structure of their design experience or articulate that experience in narrative terms. However, future study in this area can address differences made by viewing one's design efforts narratively, in the moment, at least to some extent. This metaphor could not only offer a unique sense of identity for practitioners—as sojourners into the unfamiliar and innovative learners who drive the design process—but also an opportunity for self-reflection that leads to professional growth, as designers consider how they relate to other lead and supporting characters on a project, how they manage the design process in an unfolding plot, how they seek to learn in the journey of design, how they conceive of the design journey in general, and so forth. While these and other possibilities can be addressed through future inquiry, I wish to present five preliminary implications of this conception of design for practitioners in the field. These implications also create possibilities to be addressed in future inquiry.

Five Implications for Instructional Design Practice

The centrality of designer as sojourner-learner

This metaphor invites designers to view their work as more than technical rule following; it involves attempts to understand design situations from different angles (client requests, learner needs, best practices, designer judgment, etc.), explore possibilities with regard to what might work best in a given situation, and produce learning environments that are optimally responsive within contextual circumstances. From this perspective, there is no design doctrine to be followed aside from the basic injunction to create what is most useful to students. This activity can be seen as a sustained effort to manage the interplay between an overall vision of what the design journey will involve and the possible aspects of the design to be created along the way. Design practice, from this perspective, involves an initial formulation of the overall nature of what is to be designed, as a possibility to be explored, and that will be worked out as the designer grapples with details that emerge in the unfolding journey. Innovative learning is centrally involved, from this perspective, in that this “working out” of a design involves a continued effort to explore and gain familiarity regarding which possibilities work well in a given context and which do not; moreover, addressing problems that arise in the design journey will suggest more possibilities that bring the designers closer to a successful working out of the design. Encounters with unfamiliar aspects of the situation, then, propel the work forward as they invite exploration and learning that leads to the formulation of more possibilities, working toward a progressively refined product (e.g., a design document or a finished learning environment).

A designer’s innovative learning activities, and the expression of those activities in the form of an artifact, point to a conception of designer knowledge that unfolds continually in practice—lived and embodied rather than codified in a manual or textbook. In other words, from this perspective, design learning can be thought of as embodied in two interrelated ways: in the artifact produced and in the ever-developing practical capability of the designer. I though the practical knowing of designers, or its expression in artifacts, may be described in ways that allow for abstract design principles to be formulated—that is, practical knowing may be “extracted” and thematized—it extists first in a designer’s experiential sense of their craft and its design-producing capability. At bottom, this line of analysis suggests that for design to take place, innovative learning in the midst of uncertainty cannot be replaced by a pat reliance on rules or steps in a process model.

At the center of design, then, is the designer embarked on a learning journey—that is, the designer as an innovative learner who pursues the progressive unfolding of the contours of what she or he is designing. From this perspective, it is the designer who provides the energic force that allows possibilities to be formulated and worked out on the way to actuality. What I have contended here matches in many respects what others outside of education have suggested (Jahnke, 2012; Schön, 1983; Snodgrass & Coyne, 1997). This conception of design is relevant to education, however, in that it calls for design work guided principally by humans (rather than process models) for humans and thus calls for sensitivity to the needs of students in real educational settings (including those involving distance education and computer aided instruction). Moreover, this account’s focus on innovative learning as a crucial aspect of design coheres with many of the values of education as a field, including an acknowledgment of the central role of learning in life and a commitment to lifelong learning in one’s work. Design as innovative learning requires a progressive, craftsperson-like ingenuity and judgment, which translates into continual learning in order to help others learn.

Questioning authority as part of the design journey

To the extent that a design project is taken seriously as a journey into the unfamiliar, it should be relatively unconstrained by historical precedents within the discipline. That is, designers should be willing to question accepted disciplinary practices in an effort to innovate what is needed in a given situation; their personal innovative learning and practical wisdom will, at least at times, overturn textbook formalisms; and they should be willing to violate principles in an effort to create what is needed, within contextual constraints. From this perspective, the notion of design—as a journey in which possibilities are innovatively formulated and knowledge is produced—demands that some practical freedom be granted to designers.

On the other hand, conceptual tools such as process models and prescriptive theories can, at least at times, offer useful ways of managing the complexities of design projects. As research has suggested, designers do value such conceptual tools in their work, even if they are unable to use them often or as originally intended by their innovators (Yanchar et al., 2010). In this sense, it seems reasonable that designers would be willing to make use of the accumulated wisdom of the past, given its disciplinary longevity as a guide for action. However, instructional designers as innovative learners must also transcend the constraints that historical practices can impose on their ability to work through a unique design situation. Designers as innovative learners will be opportunistic when it comes to solving instructional problems and thus be opportunistic when it comes to innovative learning. This means, for example, that while traditional approaches may sometimes be totally rejected in favor of innovations, they may also, at times, be seen as having potentials that allow them to be repurposed into new resources that facilitate new practices, even if in limited circumstances. For example, behaviorist techniques originally intended to control behavior, such as reinforcement and punishment, may, with some shift in meaning and execution, be used to demonstrate how a student's own volitional choices lead to meaningful consequences, and thus should be carefully considered before taking action.

What I suggest with regard to the creative repurposing of conceptual tools need not be viewed as a form of uncritical eclecticism. It is surely possible that some designers may grasp at such tools without concern for their fit with the designer's other tools and purposes; but this is only one way to pursue innovative and contextually sensitive practices (for criticisms of eclecticism, see Bednar, Cunningham, Duffy, & Perry, 1992; Yanchar & Gabbitas, 2011). Repurposing conceptual tools may also follow a syncretic pattern, in which they are critically appraised with regard to their potential utility and modified to fit with the rest of a designer's purposes in a given project. Elsewhere, this notion has been referred to as "critical flexibility" (Yanchar & Gabbitas, 2011, p. 383), a practice which emphasizes not only the creative reformulation of what a designer needs in order to accomplish a particular task, based on his or her perspective (assumptions, values, preferred techniques, etc.), but also the need to critically reflect on his or her overall perspective. In this sense, one's questioning of authority should be directed not only toward historical practices, but also toward the "authority" (perhaps tacit) of one's personal *modus operandi* and preconceptions. A part of one's learning journey, then, is learning that comes by way of critical self-reflection.

Learning facilitates learning (and practice)

Included within this view of design is the notion that learning facilitates learning, but not in a gradual, linear sense. A designer's current *modus operandi*, made possible by prior learning in practice, offers a basis for being challenged in new ways that promote further growth and development, even if the direction of that learning cannot be predicted in advance. More specifically, prior training and practical experience will inform a designer's approach to current design tasks; and, one may assume, a designer's approach will lead to relatively effective practice. However, a designer will also encounter difficulties in the design journey—created to some extent by the practical details of their approach—that must be resolved through adjustments (possibly innovations); and those adjustments or innovations can facilitate progress on the project at hand as well as augment and refine the designer's approach in general. Learning in the midst of design, then, is based on a complex interplay of prior ability and current challenges, leading to practical wisdom; and, from this perspective, such learning is a primary means by which designer capability is strengthened as the central driver of design. Thus, journeys into the unfamiliar educate and strengthen the sojourner for future journeys; and the process continues, on and on, as designers continually develop as lifelong (or career-long) learners. In this regard, maintenance and innovative learning will enhance how a designer relates to design situations and can be seen, from this perspective, to enhance skill over time.

Designers embrace their identity as learners

Given the realities of everyday design work, what suggest should not be understood as a call for undisciplined exploration at the expense of productivity. Rather, what I suggest should be viewed as an exercise in gradual professional identity formation. Following the metaphor of design as a journey into the unfamiliar, designer-sojourners can be thought of as professional learners of a particular type. As I stated above, they not only come to participate in historical practices and utilize extant tools in the course of design; they also explore situations in ways that lead to the formulation of unique possibilities to be worked out; and such "working out" is the design process from this perspective. Challenges that arise in the midst of design projects, then, are not so much obstructions to progress, though they may be frustrating in the moment, as they are the events that enable innovative learning and professional growth over time. If this metaphor is taken seriously, designers will embrace their role as innovative learners and welcome the challenges that arise in the course of their work, viewing them as opportunities rather than inconveniences. Even if designers must strategically choose which challenges to address among the many they will encounter, this general disposition toward design work could become an important part of their professional identity. In this sense, new journeys and plot twists become seen, perhaps tacitly, as invitations for improvement, and design practice is itself a continuous process of becoming. Thus, completed work—for example, design documents, learning environments, and so on—can be viewed as artifacts derived from, and that reflect, the designers' learning activities. They are the spoils of the journey.

Professional training and organizational support

The competencies of designers, from this perspective, would not diverge radically from those already discussed in the field of instructional design. As others have suggested (Guerra, 2006; MacLean & Scott, 2011; Richey, Fields, & Foxon, 2001), a variety of skills are required to be proficient in this work, including project management, practical application of theoretical knowledge, needs analysis, creating learning outcomes, designing courses that allow outcomes to be achieved, and so on. Given what I have already suggested, these are all areas in which designers as learners should continually refine their skills, striving toward greater competence as they engage in their work. Much of this refinement may fall within the category of maintenance learning, as designers seek to enhance what are taken to be standard skills in the profession, although designers may also innovate their own unique ways to excel at such tasks.

What I have described as innovative learning, however, is more straightforwardly related to the work of designing per se—that is, formulating and testing possibilities that lead to actuality in the form of a finished product, which, in this sense, is one of the central competencies of a designer. The designer has, in this regard, become able to journey into unknown territory, negotiate its contours, and arrive at a destination that can be viewed as a successful plan for engaging learners and helping them succeed. Taking a reflexive turn, it might be said that this endeavor requires designers to learn to be innovative learners and to develop the identity I have described here. Although there is evidence that practitioners in the field design in this manner, at least to some extent (Yanchar & Hawkley, 2014), a greater emphasis on innovative learning, in addition to the attention commonly paid to design formalisms, can facilitate instructional design practice. The skills to be developed, then—beyond those often acknowledged in the literature—would involve a designer's own *learning skills*, in domains such as the following:

- Locating sources of insight to inform one's imagination when faced with a stubborn problem or in need of an alternative perspective. (Sources might include scholarly research, practitioner literature, professional conferences, design case studies, online resources, colleagues in the field, and insights from other fields, such as the behavioral sciences, engineering, litera ture, art, philosophy, and so on.)
- Learning general problem-solving and decision-making techniques; possibly participating in some form of creativity training.
- Becoming familiar with principles of group creativity in order to maximize the capability of design teams.
- Studying extant conceptual resources (e.g., design techniques, models, principles, precedents) to ascertain their utility as tools for navigating the journey into the unfamiliar—for example, learning about the affordances and limitations of particular resources and how they might enable a designer to effectively generate and test possibilities en route to a finished product.
- Learning to repurpose extant conceptual resources to adapt to situations or to make use of previously unexplored potentials. This entails an understanding of conceptual resources, but also an ability to use them in unorthodox ways or reformulate them to effectively manage unique circumstances.
- Developing one's own best practices for understanding clients' and students' context and perspectives, in order to create learning environments optimally fitted to students' unique needs. The design journey, in this sense, can be informed by a relatively thorough understanding of what students need.
- Examining one's own assumptions and values to study how they facilitate, or possibly limit, one's efforts to navigate the unfamiliar and create effective learning environments; and, relatedly, reflecting on one's prior work experiences to identify new design knowledge created in the process. Such self-study might be facilitated by journaling about one's experiences and insights and possibly sharing those insights with others.

Graduate training that includes attention to at least some of these skill areas (and possibly others) would help facilitate designers' efforts to engage in innovative learning and enhance what they already do. How these or other skills are best taught is itself a design question and could be worked out over time. Some relevant literature in the social sciences and education could aid in the development of appropriate designer training, for example, work in the areas of designer competency (MacLean & Scott, 2011), group creativity (West, 2009), critical thinking and self-reflection (Tracey & Hutchinson, 2013; Yanchar & Gabbitas, 2011; Yanchar, Slife, & Warne, 2008), narrative learning (Goodson, Biesta, Tedder,

& Adair, 2010), innovative design practices (Honebein & Goldsworthy, 2009), and design precedent (Howard et al., 2012).

The metaphor of designer-as-sojourner also suggests general implications for the organizational structures in which designers perform their labors. One rather clear issue concerns the extent to which designers or design teams are granted sufficient latitude to explore possibilities and arrive at actual learning environments that meet the needs of students. While it is reasonable to expect that such organizations will have in-house methods and procedures, it is important that such methods and procedures do not control the course-creation process altogether and obviate a crucial organizational resource, namely, the imaginative capabilities of designers who adapt to local circumstances and generate what has not been previously generated—an effective learning experience for students.

Organizational support could also come in the form of work time allocated to *some of* the learning exercises I have previously mentioned, such as self-study and access to resources that enable designers to expand their horizons, including scholarly and practitioner-based design literature, professional dialogue (conferences, Webinars, etc.), and co-worker discussion time built into the work schedule. Such resources would allow designers to have a near-continuous influx of ideas to aid and rejuvenate their innovative learning efforts in the midst of design projects.

Finally, an organizational culture that allows designers to take some risks and that places a value on the unique contribution of designers to the creation of learning environments is important. Processes, principles, and so forth contribute to the work of design, but as tools in the hands of designers who creatively navigate the contours of unique design projects.

Conclusion

I have suggested that instructional design practice can be fruitfully thought of as a journey into the unfamiliar—indeed, that any particular design project might be thought of as a journey in this sense—and that designers be viewed as sojourners who engage in this unique task of exploration through maintenance and innovative learning. While both forms of learning are important, I have suggested that the latter of these is the driving force behind design, as it emphasizes the designer's work of formulating and exploring possibilities regarding the structure of specific learning experiences.

This metaphor provides an alternative to technical, process-dominated view of d sign—which leave some doubt as to the role of designer—and provides a basis for deeper investigations of designers' roles in instructional design; as a possibility explorer, a craft worker, a theory adapter, and so on.

It would seem that there are many useful ways of understanding design and the roles of instructional designers; this approach offers one way of continuing this conversation and exploring how design in the field might be most productively conceived.

References

Arinto, P. B. (2013). A framework for developing competencies in open and distance learning. *International Review of Research in Open and Distance Learning, 14*(1), 167-185.

Bednar, A. K., Cunningham, D., Duffy, T. M. , & Perry, J. D. (1992). Theory into practice: How do we link? In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 17- 34) . Hillsdale, NJ: Lawrence Erlbaum Associates.

Bichelmeyer, B., Boling, E., & Gibbons, A. S. (2006). Instructional design and technology models: Their impact on research and teaching in instructional design and technology. In M. Orey, V. J. McClendon, & R. M . Branch (Eds.), *Educational media and technology yearbook* (Vol. 31, pp. 33- 73). Littleton, CO: Libraries Unlimited.

Botkin, J., Elmandjra, M., & Malitza , M. (1979). *No limits to learning.* Oxford, UK: Pergamon.

Clark, M. C., & Rossiter, M. (2008). Narrative learning in adulthood. *New Directions for Adult and Continuing Education*, 119, 61-70.

Clark, R. E., & Estes, F. (1998). Technology or craft? What are we doing? *Educational Technology, 38*(5), 5-11.

Cross, N. (1982). Designerly ways of knowing. *Design Studies, 3*(4), 221-227.

Der-Thanq , C., Hung, D., & Wang, Y. (2007). Educational design as a quest for congruence: The need for alternative learning design tools. *British Journal of Educational Technology, 38*(5), 876-884.

Dick, W., Carey, J. O., & Carey, L. (2014). *The systematic design of instruction* (8th ed.). New York: Pearson.

Dobozy, E. (2011). Typologies of learning design and the introduction of a "LD-Type 2" case example. *E-Learning papers, 27*, 1-11; *http://espace.library.curtin.edu.au/R?func=dbin-jump-full&object_id=183178* .

Gibbons, A. S. (2014). *An architectural approach to instructional design.* New York: Routledge.

Goldsworthy, R., & Honebein, P. C. (2010). Learner stories and the design of authentic instruction. *Educational Technology, 50*(4), 27-33.

Goodson, I., Siesta, G., Tedder, M., & Adair, N. (2010). *Narrative learning*. New York: Routledge.

Gropper, G. L. (2015). Evaluating instructional design models: A proposed research approach. *Educational Technology, 55*(5), 13- 20.

Guerra, J. A. (2006). Standards and ethics in human performance technology. In J. A. Pershing (Ed.), *Handbook of human performance technology* (3rd ed., pp. 1024-1046). San Francisco: Pfeiffer.

Gustafson, K. L., & Branch, R. M. (2002). *Survey of instructional development models* (4th ed.). Syracuse, NY: ERIC Clearinghouse.

Hakkinen, P. (2002). Challenges for design of computer-based learning environments. *British Journal of Educational Technology, 33*(4), 461-469.

Honebein, P. C., & Goldsworthy, R. C. (2009). Is your design story limiting you? Purposefully perturbing our practices through instructional design "Mashups." *Educational Technology, 49*(4), 27-33.

Howard, C. D., Boling, E., Rowland, G., & Smith, K. M. (2012). Instructional design cases and why we need them. *Educational Technology, 52*(3), 34-38.

Jahnke, M. (2012). Revisiting design as a hermeneutic practice: An investigation of Paul Ricoeur's critical hermeneutics. *Design Issues, 28*(2), 30-40.

Jarvis, P. (2006). *Towards a comprehensive theory of human learning*. New York: Routledge.

Lawson, B., & Dorst, K. (2009). *Design expertise*. Oxford: Elsevier.

Lowyck, J., & Pöysä, J. (2001). Design of collaborative learning environments. *Computers in Human Behavior, 17*, 507-516.

MacLean, P., & Scott, B. (2007). Learning design: Requirements, practice, and prospects. *Campus-Wide Information Systems, 24*(3), 187-198.

MacLean, P., & Scott, B. (2011). Competencies for learning design: A review of the literature and proposed framework. *British Journal of Educational Technology, 42*(4), 557-572.

Mor, Y., & Craft, B. (2012). Learning design: Reflection upon the current landscape. *Research in Learning Technology, 20* (supplement), 85- 94.

Nelson, H. G., & Stolterman, E. (2012). *The design way* (2nd ed.). Cambridge, MA: MIT Press.

Pachler, N., & Daly, C. (2009). Narrative and learning with Web 2.0 technologies: Towards a research agenda. *Journal of Computer Assisted Learning, 25*, 6-18.

Parrish, P. E. (2009). Aesthetic principles for instructional design. *Educational Technology Research and Development, 57*, 511-528.

Plowman, L. (1996). Narrative, linearity, and interactivity: Making sense of interactive media. *British Journal of Educational Technology , 27*(2), 92-105.

Richey, R., Field , D., & Faxon, M. (2001). *Instructional design competencies: The standards* (3rd ed.). Iowa City, IA: International Board of Standards for Training, Performance, and Instruction.

Rowland, G. (1993). Designing and instructional design. *Educational Technology Research and Development, 47*(1), 79-91.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action.* Aldershot/Hampshire: Ashgate.

Scott, B. (2001). Conversation theory: A constructivist, dialogical approach to educational technology. *Cybernetics & Human Knowing, 8*(4), 25-46.

Smith, K. M ., & Boling, E. (2009). What do we make of design? Design as a concept in educational technology. *Educational Technology, 49*(4), 3-17.

Snodgrass, A., & Coyne, R. (1997). Is designing hermeneutical? *Architectural Theory Review, 7*, 65-97.

Tracey, M. W., & Hutchinson, A. (2013). Developing designer identity through reflection. *Educational Technology, 53*(3), 28-32.

West, R. E. (2009). What is shared? A framework for understanding shared innovation within communities. *Educational Technology Research and Development, 57*, 315-332.

Wild M., & Quinn, C. (1998). Implications of educational theory for the design of instructional multimedia. *British Journal of Educational Technology, 29*(1), 73- 82.

Wilson, B. G. (2013). A practice-centered app roach to instructional design. In J. M. Spector, B. B. Lockee, S. E. Smaldino, & M. Herring (Eds.), *Learning, problem solving, and mind tools: Essays in honor of David H. Jonassen* (pp. 35-54). New York: Routledge.

Yanchar, S. C., & Gabbitas, B. W. (2011). Between eclecticism and orthodoxy in instructional design. *Educational Technology Research & Development, 59*, 383-398.

Yanchar, S. C., & Hawkley, M. (2014). “There’s got to be a better way to do this”: A qualitative investigation of informal learning among instructional designers. *Educational Technology Research and Development, 62*, 271- 291.

Yanchar, S. C., Slife, B. D., & Warne, R. T. (2008). Critical thinking as disciplinary practice. *Review of General Psychology, 12*, 265-281.

Yanchar, S. C., & South, J. B. (2009). Beyond the theory-practice split in instructional design: The current situation and future directions. In M. Orey, V. J. McClendon, & R. Branch (Eds.), *Educational media and technology yearbook* (vol. 34, pp. 81-100). New York: Springer.

Yanchar, S. C., South, J. B., Williams, D. D., Allen, S., & Wilson, B. G. (2010). Struggling with theory? A qualitative investigation of conceptual tool use in instructional design. *Educational Technology Research and Development, 58*, 39 – 60.

Yusop, F. D., & Correia, A. (2012) . The civic-minded instructional designers framework: An alternative approach to contemporary instructional designers' education in higher education. *British Journal of Educational Technology, 43* (2), 180-190.

Zemke, R. (1985, October). The systems approach: A nice theory but…. *Training, 22*, 103-108.

Stephen C. Yanchar *is Associate Professor of Instructional Psychology and Technology at Brigham Young University. His primary research interests include design practices, agency in education, and qualitative inquiry (e-mail: stephen_yanchar@byu.edu).*