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## **Design as a framework for innovative thinking and learning: how can design thinking reform education?**

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The need for educational reform has led to much research documenting the value of experiential learning and creative problem solving to increase relevance and motivation in learning. Design, which may be succinctly defined as purposeful thought and action, can serve as a framework and catalyst for teaching and learning strategies that promote innovative, high end thinking, cooperative teamwork, and authentic, performance assessment.

This keynote will feature research findings and two models of large-scale applications of design education in the K-12 curriculum. Both projects are funded by major grants from the National Endowment for the Arts and by the Department of Education in the United States. As models of best practices and applied research that have been assessed and documented, they can provide useful and valuable examples for other art educators and educational sites. This research was conducted through the “Design for Thinking Teaching Institute, at The University of the Arts, Philadelphia, Pennsylvania, USA, which also was the host site for the National Design for Thinking Network and the Design Link for Teaching the Arts, Link-to-Learn projects. Other sites and research will also be addressed.

*Keywords: Design, thinking, research, teaching, learning, model*

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As the complexities of our technology-driven society intermix with the erosion of traditional lifestyles and values, it is only natural to look to education for answers on how to prepare children to cope with these new demands. After all, it is the young child who is the most vulnerable and affected by societal changes and, next to parental or family influence, formal education commands the largest block of a child’s time and attention for more than a decade of his or her early life.

As educators grapple with their new role and inherited responsibilities, it has become increasingly challenging to find a pedagogical strategy that addresses not only content but context, in a world that is changing faster than our antiquated educational systems can handle. This scenario raises big questions which we must study from a new perspective. What are the basic skills and knowledge that should be the priorities of education? What does an educated person need to know to succeed in a career and daily life? What subjects are most important in the crowded school curriculum? What is the best strategy for teaching critical skills and knowledge? Are the “3 Rs” - reading, writing and arithmetic, still the foundation of our fundamental school system, or are other subjects, including technology, now part of that essential list of content disciplines? The questions are daunting, but even more complicated by the fact that many students have become

disenchanted with the value of education, as evidenced by the continually growing drop-out rate of 30 - over 50% in the U.S., especially in our urban and rural high schools. The reason most consistently cited by students who drop out is that school is not relevant to their needs and lives, is often considered boring, and, in general, it is often perceived as a negative, meaningless experience.

International awareness of the need for effective educational reform has led to an increased interest in research on the brain and strategies for teaching and learning that are more motivating and relevant to students of all ages. How can students be taught to be more creative in their thinking and more capable of integrating knowledge and skills learned from diverse subject areas into practical and inventive solutions to daily problems? How can learning be more relevant and meaningful, touching the soul of education? What current research can be used to guide this process of educational reform and where will it lead us?

This keynote presentation will share several examples of pertinent and current research findings which point to design-related solutions, followed by a proposed “Design for Thinking” model, and illustrated by examples of programs that have proven to be effective pedagogical strategies, including two programs from The University of the Arts. Both of these projects were funded by major grants from the National Endowment for the Arts and by the Department of Education in the United States.

Design, as I am using the term, may be succinctly defined as “purposeful, problem solving thought and action,” or “creative thinking and problem solving action, which has no single answer, but may result in one of many effective solutions.” Design in education can apply to the discrete discipline, as taught in industrial, graphic, interior, architectural or clothing design, to name a few. In this case it is usually found within the art department as part of that curriculum. However, a second and perhaps even more provocative way of viewing design is in the context of a pedagogical model involving “design thinking.” This is a more generic application of the thinking that is inherent to the art-related, creative process of invention.

To examine educational research that is related to the most urgent needs in educational reform, we must first look at the science of learning studies on how the brain learns. This cutting-edge research will profoundly impact teaching and learning strategies in the future, replacing much of the trial and error wisdom, accumulated through years of practice in the traditional classroom. From these studies we will examine a new paradigm that may better accommodate students’ physical, emotional, and mental needs for the future. Although many educators are reluctant to abandon the familiar practices of traditional instruction, some are cautiously grappling with innovative but unproven elements of reform in hopes of finding a more effective approach to teaching and learning. These educational pioneers are eager to develop new ways of teaching and learning as a modern equivalent to the “Renaissance ideal.” This ideal person is one who is able to meet the rapidly changing needs of the “Information Age” and the demands for a new kind of educated worker, who is flexible but rational, an “out-of-the-box” thinker and problem solver. This kind of inventive thinker is a throwback to the Renaissance

where an artist also functioned as a designer and creative thinker like Leonardo da Vinci - whose work harmoniously spanned the disciplines of art, science, anthropology, maths, and technology.

It is interesting and perhaps insightful that models of creative genius, problem solving, and intellectual and moral balance are often symbolically represented in the work of artists, such as Leonardo da Vinci, Rodin's, "The Thinker," or in the unique architectural creations of Frank Lloyd Wright. For centuries the work of visual artists and designers has been referenced as visible evidence of innovative thinking and brilliance. Yet, ironically, this "design thinking" has never been translated into educational practice. The presence of teaching design in basic education is minimal at best. The value of design thinking in education is often overlooked for its potential as a dynamic and experiential strategy for teaching creative problem solving, reflective, analytical thinking, and the process of "learning to learn." These attributes are becoming increasingly important as the proliferation of information makes memorization impossible, and in some cases detrimental and inaccurate.

Another pertinent example of educational skills needed in the new workplace is evidenced in the published dialogue of James S. Houghton, Chairman, National Skills Standards Board, and Retired Chairman and CEO, Corning Incorporated. In his words

... the importance of 'thinking skills' to the new workplace is evident in the high-performance teams that are today bridging the divide between manual and mental work in corporations throughout America (and globally), handling all facets of project coordination, group dynamics, and consensus building. (The Getty, 1997)

Houghton further refers to another study which revealed the estimate that six to seven million jobs were expected to be created in the U.S. in the last years of the century, but it was also estimated that less than half of those entering the workforce at that time would be equipped for these newly created high-skill jobs (The Getty, 1997). Unfortunately, this has proven to be true.

To accommodate the needs of learners today, and in the decades to come, a new "paradigm shift" is needed for education. In comparing the practices of the 1980s to the emerging paradigm of today, there are dramatically sweeping changes that are being acknowledged as examples of "best practices." The new paradigm shift includes the following:

- Instruction vs. Construction

Teachers have long relied on the practice of lecture and written content as the primary method of instruction. Students were taught by being told or perhaps shown, but students seldom learned by making and doing, and through their own exploration. Not only has research on learning styles and multiple intelligences promoted the need to expand the modes of instruction, but these findings have also supported the greater effectiveness achieved through the constructivist approach to learning, in which the student pursues an

experiential discovery of knowledge by using information in a relevant, hands-on context. This reinforcement of making and doing in a way that is related to personal interests and needs makes the learning experience rich and memorable.

- Linear vs. Hypermedia

There are distinct differences in students' interests and habits of learning that can be largely attributed to the influence of television, multimedia, and the internet. The sensory overload and fast paced bombardment of visual images has affected the students' attention span and habits of learning so that students no longer think and operate only with linear logic and singular focus. Students must learn to selectively process and deal with visual overload and to quickly and effectively evaluate and respond to stimuli that are pertinent and appropriate to their needs and values.

- Teacher Centered vs. Learning Centered

The traditional paradigm places the teacher in the role of selecting and directing the discipline content and thematic applications, in time blocks he or she thought to be most appropriate. Students were passive learners with little influence in directing their own destiny for learning. In the new paradigm students determine the context and appropriate ratio for learning in the various disciplines, drawing upon information and skills as needed to complete the interdisciplinary task at hand. Such thematic learning is not only relevant and motivating, but highly effective in empowering the student to take responsibility for his or her own learning process and performance outcomes.

- Absorbing Material vs. "Learning to Learn"

For decades the measure of a student's intelligence was his or her proficiency in memorizing and reiterating facts and information on primarily cognitive verbal and mathematical tests. This process, described as 'teaching the basics,' relied on the assumption that there was an identified and accepted universal canon of knowledge that was fundamental and comprehensive to each academic discipline. As information exponentially multiplies, it is no longer possible or practical to memorize all the factual knowledge considered basic to any one subject. Students are better served by "learning to learn," so that they can ably retrieve and use information in response to a need or an interest. This process emphasizes understanding of information in a relevant context and encourages learners to use metacognition as a process for reflecting on and understanding their own thinking and creative problem solving.

- Teacher as Transmitter vs. Teacher as Facilitator

In contrast to the teacher as the "sage on the stage" and primary source of knowledge, the focus is now on student with the teacher as the facilitator of learning. His or her role is to guide and support the student in self directed research and exploration. This approach individualizes instruction to accommodate students' preferred learning styles and thematic preferences.

- Learning for School/Work vs. Learning for Life

Closely related to individualized instructional approaches is the need to customize curriculum content to a “real life” context for the learners. Students value and remember information that is perceived to be useful and relevant to their lives. This knowledge then provides a foundation on which they can build over a life time, drawing upon the skills and knowledge that are needed in an integrated context. This approach is critical to equip students to become life-long learners, both in a formal academic setting and through professional development in the work place and home. Learning for life is also congruent with the need to continually learn new information, technology, and skills to adapt to the needs of industry and society.

- Evaluation vs. Performance Assessment

Measurement of accomplishment in learning information or skills has traditionally been conducted by the teacher with the focus on the effectiveness of the final outcome or product. Rubrics, or guidelines for measurement, were generally set by the teacher or other external sources, with the students having little knowledge or understanding of how their product or answers were graded. In the new paradigm the emphasis has shifted from product to process, with the analysis of how a student learns and progresses being perceived as more important than the end result. This concept also assumes that the student will be a part of the reflective assessment process and that he or she will be charged with the responsibility of articulating what they have learned, what worked and what did not, and why. In answering these key questions, students are required to employ higher order, critical thinking and problem solving, measuring and comparing the outcomes at each stage of development and then ultimately judging the final results in the context of real life applications. Another benefit of this approach is that it acknowledges that students can learn as much, and perhaps more, from what was not a successful result as they can from an outcome that meets the intended goal. Students can gain confidence and independence by learning to analyze their own learning and from having to articulate and defend their evaluation of the final outcome.

- Verbal and Textual Communication vs. Visual Communication

Although dependence on visual imagery to formulate our thinking has always existed, the priority of teaching students to communicate through text has long dominated our educational paradigm. This approach is changing, however, due to the influence of globalization and the competition of visual imagery in the marketplace. As world cultures interact more fluently through physical travel, television and the internet, the hindrance of not knowing each other’s respective languages has prompted the necessity to design international visual icons to symbolically communicate information. The motivation of conducting business on a global scale has also been a catalyst for accelerating the need to communicate more effectively through the visual medium in both an overt and subliminal way. The sophistication of visual communication and graphics has benefited and been guided by findings in research and brain studies. Scientists,

psychologists, artists and designers acknowledge and explore the pervasive nature of “visual thinking,” which “pervades all human activity, from the abstract and theoretical to the down-to-earth and everyday” (McKim, 1980).

In summarizing the focus of the new paradigm for learning, continually changing global access to information through technology, along with the perpetual evolution of research findings, are factors that erode the constructs of basic knowledge, making process rather than product the logical emphasis for students’ education. In short, students must “learn to learn.” By understanding their modes of thinking and developing skills for analyzing a need or *intention*, they can learn how to *define* available resources and parameters, *explore* creative options, *plan* and organize a potential solution, adaptively *produce* an outcome, and *evaluate* the results compared to the set standards of the intention. Optimally the students must also be able to *integrate* and relate this information with other relevant applications. This is designing! It is also high end thinking which draws upon both hemispheres of the brain, composites of learning styles, and ways of knowing. This is also the attainment of knowledge to the most applicable and memorable degree, and is facilitated by the “Design for Thinking” model known as I/DEPPE/I (Burnette, 1996; Norman, 1996).

In identifying the desired outcomes of an effective education, the American public and educators are in agreement on one issue: what students most need to gain from education is the ability to demonstrate higher order thinking, not only on standardized test scores, but more importantly in the contest of life. This goal for achievement in life is measured more broadly in the quality of how people work, play, interact, and live in our global and increasingly visual, high-tech society. As committed educators who strive to engage students, provide practical, relevant skills, and help them creatively integrate knowledge in the context of future careers, perhaps we need to rethink the “Da Vinci model.” Research studies support the strategies and processes used in art and “design thinking” as skill developers critically needed to hone the desirable characteristics of humanity - to think, reason, communicate and create innovative and appropriate solutions.

In this “decade of the brain,” recent psychological and neuropsychological research provides a growing body of scientific evidence and related literature, which could inform and influence how art education is designed. Numerous studies support and identify the attributes of a strong art and design education for developing the skills of creative and analytical thinking, perceptual sensitivity, perseverance, communication, and inventive problem solving. Among the most provocative of the research studies is the work of Howard Gardner, related to his theory of “multiple intelligences.” His definition of “intelligence” is “the ability to solve problems, or to create products, that are valued within one or more cultural settings” (Gardner, 1983). Having initially identified seven, now eight and a half, comprehensive categories for “intelligences,” he adamantly describes each as being distinct and definitive. Included in these are spatial and bodily-kinesthetic intelligences, which are deviations from the commonly perceived idea of intelligence as a blend of logical-mathematical and linguistic abilities. These art and design-related ways of learning recognize the unique characteristics, which are inherent

in art making and “design thinking” and the benefits and importance of cultivating the full range of cognitive, affective, and psychomotor skills.

“Design Thinking,” is a term defined by consensus in the National Design for Thinking Institute (August, 1998), supported by the National Endowment of the Arts, attended by designers, architects, administrators, and educators in higher education, K-12 art and general education. The Institute also included directors of art and design related museums, representatives of departments of education, as well as editors of two national magazines and an educational publishing company. After analysis, discussion, and careful weighing of each word and its meaning within the context of the design process, the following definition was adopted: “Design Thinking” is an inventive process, through which problems are identified, solutions proposed and produced, and the results evaluated. This concept of design is also based on the underlying principles of art making with practical application. Succinctly stated, it is purposeful, problem solving thought and action (Burnette, 1996; Norman, 1996).

Another thought provoking interpretation of design is provided by David Perkins in his book, *Knowledge As Design* (1983). Perkins describes design as “a structure adapted to a purpose.” He further explains that “knowledge as design poses a provocative metaphor. Indeed, perhaps knowledge is not just *like* design but *is* design in a quite straightforward and practical sense.” Acknowledging that higher order thinking and integration of information into a relevant context are part of the design process, Perkins’ metaphor offers a compelling argument for the value of incorporating design thinking into the fundamental educational curriculum.

Intelligence, not unlike design, is also an ambiguous term with multiple meanings and interpretations. Both words are used to describe aspects of human uniqueness and function that are fundamental and essential to our very survival. The confusion that clouds the two terms, intelligence and design, stems in part from the definers’ personal perspectives and experiences, which, in turn, colour their meaning and context. The interpretations are further hindered by our limited human knowledge about the rather magical processes of complex creative thinking and related human feelings and actions. We are still mystified by our ability to reason, to invent, and to solve problems at all levels in our daily lives and are consequently uncertain as to how to facilitate that level of learning.

Ironically, it is the characteristics of creative design and intelligence that distinguish humans from other animals, and yet we have much to learn about how these processes are cultivated and impacted by teaching and learning. The knowledge base to inform our teaching practices is expanding, however, with educational researchers adapting findings of brain research to theories of educational philosophy and applied practice (e.g., Bogan, 1969; Gardner, 1982, 1983; Jensen, 1998; and Sylwester, 1995). Concepts such as multiple intelligences, brain based or brain compatible education are direct manifestations of this hybrid of neuroscience psychology and educational research, with some studies focussing more specifically on discipline domains, such as art and design.

As educators across our nation contemplate options for more effective teaching and learning, the science of learning and the influence of brain research are of paramount importance in setting priorities, policies, and pedagogical practices. This is true for all levels and disciplines, including design. However, to put theory into practice with effective results, teachers must be flexible learners and risk-takers, who are facilitators of knowledge and who coach and promote high level thinking using all forms of creative intelligence.

“Design for Thinking” is one model for investigation and exploration of multiple creative solutions. The I/DEPPE/I acronym, which stands for intending, defining, exploring, planning, producing, evaluating, and integrating, is basic and practical as a tool for learning both with individuals and groups. With groups it can facilitate team-building and group consensus.

The “Design for Thinking” model, initiated at The University of the Arts in Philadelphia, PA, USA, is based on more than a decade of intense and sustained studies of design thinking and ways it can be effectively applied to the education process. A sequence of projects have led to major sponsorship by the Department of Education for two consecutive grant projects based on the “design for thinking,” I/DEPPE/I model, as developed and implemented through technology. The first of the two projects was Design Link for Art and Science, which involved four testbed middle schools, an art museum, a science museum and University faculty in a collaborative effort to apply the “design for thinking” model to the teaching of art and science using electronic media, the internet and videoconferencing technologies. As an Infrastructure Investment grant, the one-year project required development, technology training, classroom application and assessment.

The Design Link for Teaching the Arts project, which overlapped the Design Link for Art and Science project in the planning phase, built on the foundation of the previous project. It continued partnership with the four schools and it added museums and an Instructional Unit from the Pennsylvania Department of Education, which serves many schools in the rural, mountainous northeast portion of Pennsylvania. Retaining the “mentor teaching teams” from the original four testbed schools, the project expanded to include five additional urban schools in the Philadelphia area and eight rural schools in the northeast, mountainous part of Pennsylvania. Participating teacher teams from a total of 17 schools were provided with regular bi-weekly professional development classes and additional on-line support to help them learn and apply the I/DEPPE/I, design for thinking model, facilitated by technology, and focussed on ways in which the arts could be integrated into the curriculum. In addition to the emphasis on professional development for K-12 teachers, the project also provided regular instructional sessions and teaching mentorship for college education faculty and the pre-service teachers in Art Education. Curriculum was developed and implemented for each of these groups and large and small-scale assessment was conducted to measure the impact and effectiveness of design thinking and technology in teaching and learning.

The assessment of both of these projects yielded similar results. Both teachers and students found technology and the “Design for Thinking” model to be motivating, a facilitator to interactive, cooperative learning, and that they were helpful in organizing thought and actions. The challenge of not fully understanding and knowing how to use either was daunting at first, but became more comfortable as they progressed. Ultimately they felt that both design and technology were critical to their teaching and learning in the new paradigm and endorsed their inclusion strongly with comments such as the samples below:

Although challenging, this experience has taught me a lot regarding the benefits of project-based learning, team-teaching, and continuously assessing work based on teacher, peer, and self-evaluation (teacher assessment, Design Link for Teaching the Arts, 2000).

This program has really focussed on 'process.' I so appreciate the I/DEPPE/I model and it was a key teaching tool for me this year. Students have constantly referred to it and often point their peers back to the model when something doesn't work out in a scene or presentation. At last, something that is complete, simple and applicable. (theatre teacher assessment, Design Link for Teaching the Arts, 2000)

In the first grade, the I/DEPPE/I model was utilized by asking questions pertaining to each letter, since this was the first introduction. The art project with the students went well with wonderful results. (first grade teacher assessment, Design Link for Teaching the Arts, 2000)

To quote an anonymous statement by a Philadelphia high school music teacher who learned and used the model in this past year:

The (I/DEPPE/I) model was the best part of the program for me because I could take the critical thinking model right back to my class in everything we did. The students started to call it the 'peanut butter and jelly' (basic structure for how to learn) model! Our final project was to design a musical that addressed teenager issues. The students worked in five teams and developed their musicals based on the model. They wrote and rewrote, they rehearsed and performed and completed their pieces. They evaluated the process and expressed how they would incorporate it in future work. At last! A technique that makes sense of learning.

Design, when taught within the structure of the “Design for Thinking” approach, is a means of creative problem-solving, that relates thought and action in a very direct and dynamic way. It involves the exploration of needs and functions to be considered; the context in which the problem exists; the audience or participants to be served or affected; the scope of the results you wish to achieve; and the means of evaluation that will measure the solution's effectiveness, either through conscious or unconscious judgment. Design, a visual art form with a practical outcome, offers a means of conceptualizing and visualizing, from problem to solution, a process essential to learning in life.

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