Educational Methodologies for Multi-Intelligent Online Learning

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Introduction

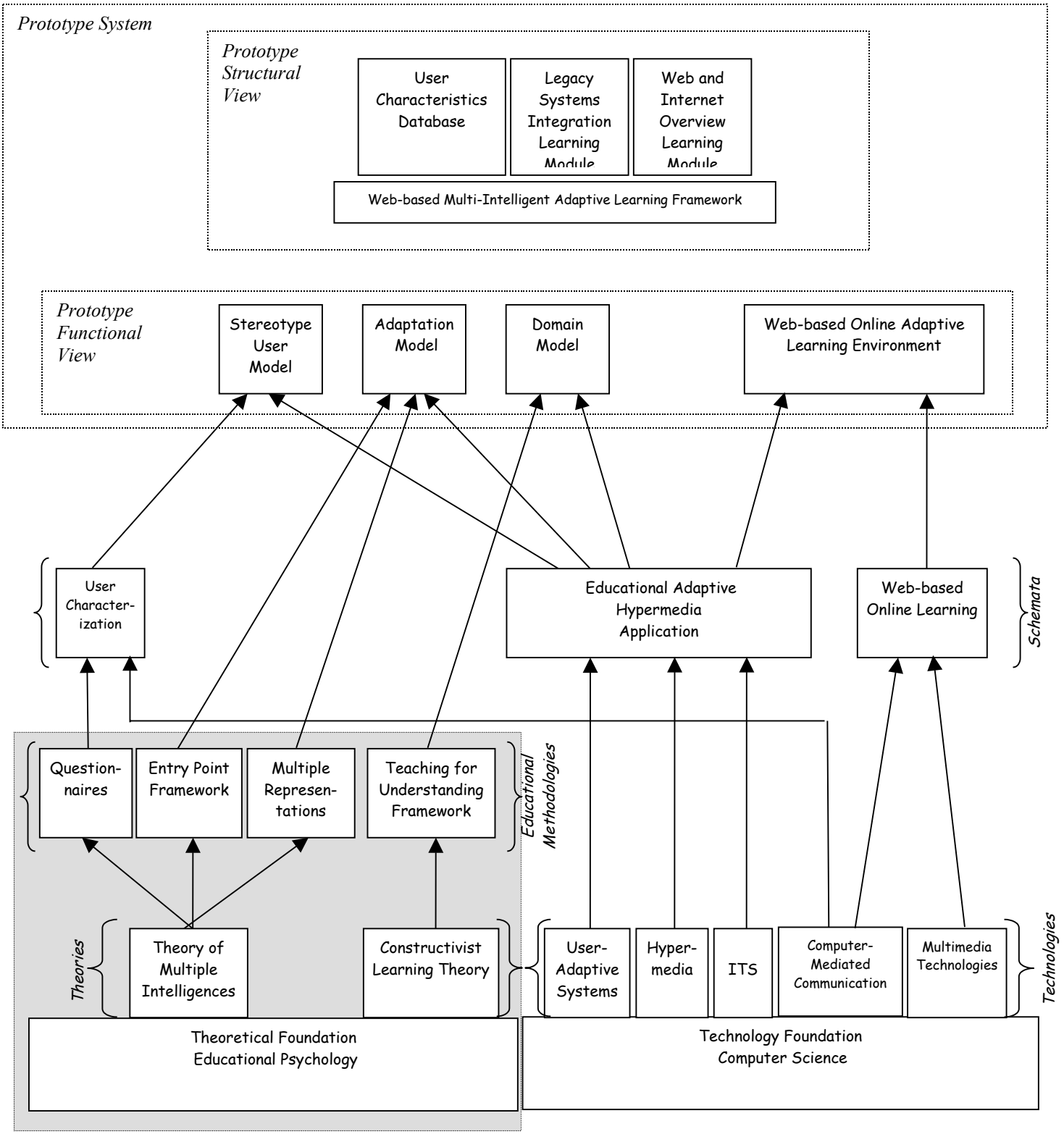
The theoretical foundation for Multi-Intelligent Online Learning lies in the areas of cognition and learning theory in the field of Educational Psychology as discussed in the companion paper entitled the *Theoretical Foundation in Educational Psychology of Multi-Intelligent Online Learning* (Dara-Abrams, 2002c). The Theory of Multiple Intelligences (Gardner, 1983/1993) and the learning theory of cognitive constructivism (Chen, 2000) provide the theoretical foundation for the online learning research conducted for the dissertation entitled *Applying Multi-Intelligent Adaptive Hypermedia to Online Learning* (Dara-Abrams, 2002a). This paper discusses the educational methodologies built on these theories of learning and cognition.

The paper presents the constructivist approach to teaching and learning and the use in classroom environments of educational approaches based on the Theory of Multiple Intelligences (Gardner, 1995), the Teaching for Understanding Framework (Perkins & Blythe, 1994), and the Entry Point Framework (Gardner, 1999). These methodologies and frameworks were developed at the Harvard School of Education by the Project Zero team under Howard Gardner, the originator of the Theory of Multiple Intelligences and the project co-director, David Perkins. The paper also considers styles of thinking in the classroom (Sternberg, 1997). The paper ends with a discussion of constructionism, a term coined by an MIT researcher to connote the combination of constructivist learning theories with the creation and development of individually-designed learning projects (Resnick, 1998).

Many people undertaking the task of developing an online learning system rely on a pure technology approach. However, the approach taken in Multi-Intelligent Online Learning (Dara-Abrams, 2002b) is one that uses educational psychology to inform the design of the online learning framework and modules. The shaded section of Figure 1 shows the educational methodologies employed in Multi-Intelligent Online Learning and the theoretical foundation that underlies these educational methodologies.

Coupled with a theoretical understanding from the companion paper (Dara-Abrams, 2002c), this overview of educational methodologies provides readers with background knowledge in Educational Psychology to lay the groundwork for Multi-Intelligent Online Learning.

Figure 1 Theoretical Foundation in Educational Psychology



Educational Methodology

Let us focus on the educational methodologies that can be employed in online learning situations. This section explores a constructivist approach to teaching and learning.

Constructivist Approach to Teaching and Learning

Recent research on the learning process and the capabilities of the human brain provides a foundation for constructivist teaching. The underlying premise is that students learn through active construction of their own knowledge rather than by memorizing or absorbing ideas from oral presentations by their teachers (Hanley, 1994). According to constructivist theory, repetitive rote practice of facts does not support learning since learning occurs through an inventive process of assimilating new information into pre-existing conceptual frameworks and modifying understanding to incorporate new information. Through an active learning process, the students' ideas become increasingly powerful and complex. With appropriate guidance and support, students deepen their understanding of the world as well as of their own thinking processes. To lay the foundation for teaching, the constructivist approach considers the processes that students employ to build and develop their ideas. Constructivist theory suggests that educational curricula match, and at the same time, challenge the understanding of students, thereby helping students grow and develop in their thinking and understanding.

In the field of education, learning theories from psychology have implications for:

- The role of the student in the educational system
- The role of the teacher in the classroom environment
- The structure of learning materials to support constructivist learning
- The presentation of learning materials in a constructivist classroom setting

Roles of student and teacher.

Constructivist learning theory focuses on the student rather than the teacher since it is the student who develops an understanding of the aspects of events and the features of objects through his/her interaction with such events and objects. Accepting and encouraging learner initiative and autonomy, constructivist educators help learners construct their own conceptualizations and solutions to problems (Hanley, 1994).

According to the constructivist learning approach, the teacher is considered to be a facilitator or coach. The job of the teacher is guide the student, asking questions, encouraging the student to analyze, synthesize, and think about the subject matter he/she is engaged in learning. Actively engaged him/herself, the teacher also participates in the learning process as a co-learner.

Instructional design.

Learning materials should be structured in such a way that they support active participation by students in a constructivist classroom setting. The idea behind constructivist learning materials is not to prescribe the steps of an exercise to find the "right answer" but to allow students the freedom to experiment and construct their own answers. Such materials provide guidance and structure for hands-on activities and interactive problem-solving, helping students apply approaches they already know, integrating old and new approaches in order to build their own understanding of the subject matter. New approaches may be presented through research materials, instructional support materials, and other team members if students are working together. The student develops his/her own new approaches through his/her interactive experiences with instructional materials. Rich resources and learning materials are made available for students to use in their experimentation and testing efforts. These resources support students in applying trial and error approaches to balance pre-existing views and approaches with their new experiences in order to develop a new level of understanding (Houghton Mifflin, 2001).

John Dewey and progressive education.

As a founder of the progressive movement in education, John Dewey's emphasis on relevant experiential learning established the foundation for constructivist education (Dewey, 1938/1963). According to Dewey, the learning process occurs through the application of concepts to relevant, meaningful, and engaging activities on the part of each individual student. Therefore, Dewey proposed an educational curriculum based on hands-on, interactive projects in order to support authentic learning by students.

Jean Piaget and active, authentic learning.

Jean Piaget developed two basic principles for teaching and learning that underlie constructivist education (Piaget & Inhelder, 1969):

- Teaching and learning are both active processes. In order for the learning processes of assimilation and accommodation to occur, students must engage in direct learning experiences, exploring through trial and error, and seeking to devise their own solutions to problems. Presentation of information is important. Rather than considering information to be a set of isolated arbitrary facts, information is viewed as a supporting foundation for the problem solving efforts of students.
- Learning should be authentic, whole, and relevant to the learner. Piaget's research indicates that students construct their own meaning through meaningful interactions with their environment. Piagetian classrooms focus on projects and whole activities, such as writing a school newspaper or running a classroom banking operation rather than drilling students in skills such as punctuation or basic arithmetic operations. Instead of insisting that students memorize dates of historic events or miscellaneous facts in science, Piagetian classrooms offer students an opportunity to dress up as historic figures and act out historic occasions or gather scientific data on a field trip.

In infant, preschool, and elementary school settings, Piaget's developmental theory suggests specific approaches for each stage of cognitive development. Infants in the sensorimotor stage learn through moving their bodies as well as touching, tasting, and playing with many types of objects in a stimulating environment. In preschools with children in the preoperational stage of cognitive development, pictures can be used to illustrate concepts. In elementary schools where children are in the concrete operational stage of cognitive development, appropriate learning activities involve locating, classifying, and ordering various types of concrete objects as well as experimenting with physical objects in order to develop logical deductions.

According to David Perkins, "research conducted in the 1960s, 1970s, and 1980s confirmed the ingenuity of many of Piaget's questions and methods of inquiry but undermined

many of his principal tenets. Contrary to Piaget's belief that stage advance comes at its own pace, a number of teaching experiments have accomplished stage advance by using a variety of instructional methods" (Perkins, 1992, p.62).

Lev Vygotsky and social constructivism.

Vygotsky developed a social constructivist approach to learning, recommending that the classroom environment support a high level of interaction among students and teachers (Cole & Wertsch, 1996). According to Vygotsky, learning occurs through opportunities to interact with more experienced peers. Therefore, students develop higher levels of cognitive functioning when they learn in an environment that encourages exploration of subject matter with their peers. In addition to group projects, Vygotsky suggested the use of such instructional practices as graphic organizers and guided practice to support learning.

A paper presented at the 1995 SIGGRAPH conference (a technical conference held by the Special Interest Group on Graphics) compared Piaget's individual learning approach to a personal computer and Vygotsky's social constructivist approach to the interconnections of the World Wide Web (Edgar, 1995). Some researchers and educators, including William Damon and Erin Phelps, distinguish between two types of social learning; cooperative learning and peer collaboration. In cooperative learning, students work together on projects, dividing up tasks among each other. In peer collaboration, pairs or small groups of students work together on the same task, an approach that Damon and Phelps suggest works better in learning new and complex concepts (Perkins, 1992).

Jerome Bruner and cognitive psychology.

Jerome Bruner is considered to be one of the founders of cognitive psychology as well as an innovative researcher in education (Perkins, 1992). Bruner uses an understanding of human thinking and learning from cognitive psychology as the basis for a constructivist approach to instruction (Bruner, 1960, 1966, 1996). Bruner suggests that a theory of instruction address four major features of the educational process (Bruner, 1966):

- Establishment of a good attitude and predisposition toward learning

- Structuring subject matter in such a way that students can understand the body of knowledge to be learned
- Ordering the presentation of materials in an effective way
- Determination and planning of both positive and negative consequences.

Bruner further suggests that efforts to structure knowledge should result in an increase in manipulation of information as well as simpler, overarching concepts that help students build their own conceptual frameworks.

Bruner established three basic principles for effective instruction (Bruner, 1966):

- Instruction should establish readiness, offering both the context and the experiences that enable students to learn.
- A spiral organization of instruction structures subject matter so that students can readily incorporate and understand new information.
- Assisting students to go beyond the information provided, instruction should be designed in a way that enables them to fill in gaps and to extrapolate from the basic subject matter.

Summary of Constructivist Education.

In constructivism, the focus is on learning rather than teaching. The constructivist educational approach encourages and accepts learner autonomy and initiative, considering learners to be creatures of will and purpose. Viewing learning as a process, constructivism encourages learner inquiry and recognizes the importance of experience in learning. In addition, constructivist education nurtures the natural curiosity of learners. Basing the constructivist approach to education on the principles of the constructivist theory of cognition, constructivism considers the mental model of the learner. Constructivist classrooms assess learning through performances of understanding, considering how each student learns as well as the beliefs and attitudes held by the learner (Perkins, 1992).

Through constructivist classroom teaching, learners are encouraged to work together, learning through cooperative projects, interacting with and engaging in dialogue with the teacher as well as other students. Constructivist instruction describes learning activities using cognitive terminology, such as predicting, creating, and analyzing. “Recently, cognitive psychologists such

as Allan Collins, John Seely Brown, James Greeno, Lauren Resnick, and others have underscored a troubling feature of typical classroom learning: its decontextualized character" (Perkins, 1992, p.67). These cognitive psychologists recommend the use of "situated learning" (Brown, Collins, & Duguid, 1989). With an emphasis on the context in which learning occurs, constructivist instruction helps students participate in real life experiments and projects, thereby providing learners with the opportunity to construct new knowledge and understanding through authentic experiences.

Multiple Intelligences in the Classroom

Gardner feels that it is important for schools to cultivate a range of skills and capacities that are valued in the community as well as in society at large. Such skills may include performing on a musical instrument, developing awareness of other people's feelings, purposeful planning of one's own life through ongoing reflection, or figuring out how to find one's way to a new location. While most school environments focus almost entirely on the use of Linguistic and Logical-Mathematical Intelligences, emphasizing skills such as those listed previously would involve cultivating Musical, Interpersonal, Intrapersonal, and Spatial Intelligences respectively, capacities that are often ignored in classrooms today.

Gardner recommends focusing on key concepts, generative ideas, and essential questions rather than attempting to cover an extensive amount of material in a superficial manner. With a focus on core topics, pedagogically appropriate approaches can be devised that make use of multiple intelligences. It is unnecessary to approach every topic through each and every intelligence though a variety of perspectives may be employed, including such techniques as telling a story, presenting a formal argument, engaging in an artistic exploration, or developing a "hands-on" experiment or simulation. Approaching a topic from several different perspectives allows each individual child to learn in his/her own way, reaching more children than would otherwise be reached. In addition, the classroom experience of a teacher representing knowledge in multiple ways encourages children to realize that they too are capable of more than one representation of some specific content. Encouraging students to demonstrate their

understanding in various ways provides an opportunity for students to learn from each other and to use their multiple intelligences to exhibit their new-found knowledge.

Gardner encourages the personalization of education. In his paper, *Reflections on Multiple Intelligences*, Gardner states that "one of the reasons that MI theory has attracted attention in the educational community is because of its ringing endorsement of an ensemble of propositions: we are not all the same; we do not all have the same kinds of minds; education works most effectively for most individuals if these differences in mentation and strengths are taken into account rather than denied or ignored" (Gardner, 1995, p. 208).

Whether or not a school is even aware of Multiple Intelligence Theory, key characteristics for the success of the students include:

- the fact that teachers take differences among students seriously
- the school shares knowledge of such differences among students and parents
- students are given responsibility for their own learning in an age-appropriate manner
- useful concepts and materials are presented via multiple approaches, allowing various students to master the materials and demonstrate their understanding to themselves as well as to others (Gardner, 1995).

The Teaching for Understanding Framework

David Perkins, Co-Director of Project Zero with Howard Gardner, has developed the Teaching for Understanding (TfU) Framework to assist teachers in planning and discussing their lesson plans or course development. The starting point in teaching for understanding is to develop generative topics. Generative topics are defined as those that are central to a discipline, accessible to a variety of students, interesting to the teacher, and connected to other topics both within and outside the particular discipline. Thus, generative topics tend to be broad in scope. It is therefore important to establish clear understanding goals for a topic to provide focus to the instruction. Understanding goals should be stated clearly and explicitly. The goals that are set should be central to the discipline (Perkins & Blythe, 1994).

Establishing specific subgoals supports continued focus and progress through a course or a program. Understanding performances are critical for students to connect their

understanding to the achievement of the original understanding goals. These goals should relate directly to the understanding goals established at the beginning of the class. In this way, students can develop and apply their understanding through demonstration and practice. Performances and planned exhibitions of understanding allow students to engage in multiple approaches to learning and expression of ideas. These performances also encourage students to engage and reflect on challenging tasks while publicly demonstrating their understanding (Perkins & Unger, 1999).

Another component of the Teaching for Understanding Framework is the practice of ongoing assessment. Criteria established for ongoing assessment should be relevant as well as explicit and public as are the understanding goals. Such assessment should occur on a regular basis, providing multiple forms and sources of feedback. Ongoing assessment is helpful in monitoring individual and class progress toward the achievement of understanding goals. Through feedback from ongoing assessment, plans can be modified as needed to progress toward developing real understanding of a chosen topic (Perkins & Unger, 1999).

Entry Points, Analogies, and Multiple Representations

In *The Disciplined Mind: What All Students Should Understand*, Gardner offers three approaches to understanding based on the Theory of Multiple Intelligences:

- Varied points of entry
- Analogies and metaphors
- Multiple representations of core concepts

The Entry Point approach provides an educational framework that accommodates individual differences by providing multiple ways to introduce a topic. While certain entry points activate particular intelligences, a one-to-one correspondence does not exist between entry points and intelligences. According to Gardner, “the decision about how to introduce students to a rich generative topic or a provocative question proves pivotal” (Gardner, 1999, p. 191). An engaging point of entry into a topic piques the interest of students and invites them into the learning experience to delve more deeply into the subject matter. Due to what psychologists refer

to as the primacy effect, students are particularly apt to remember the starting point in a learning experience (Gardner, 1999).

The Entry Point Framework offers seven different points of entry into any topic: Narrative, Numerical, Logical, Existential/Foundational, Aesthetic, “Hands-on” and Interpersonal.

- The Narrative Entry Point engages students in learning through relating stories. Linguistic, Intrapersonal, and Interpersonal Intelligences are activated through verbal storytelling, with additional intelligences activated through symbolic narrative forms, including movies and mime.
- The Numerical Entry Point offers students who like to deal with numbers and numerical relations the opportunity to learn through measurement, counting, listing, and determining statistical attributes of the topic being studied.
- The Logical Entry Point allows learners to deduce the cause and effect of certain occurrences and apply deductive reasoning to understand relationships among various factors involved in the study of a particular topic.
- The Existential/Foundational Entry Point allows individuals to approach a topic through addressing fundamental questions, such as the meaning of life. Philosophical issues invite certain learners to engage on a deep level, which piques and holds their interest in studying a particular topic.
- The Aesthetic Entry point engages the senses through works of art that relate to the subject matter being studied. Also, concepts and examples have their own aesthetic properties, which can be examined and discussed in conjunction with the topic at hand.
- The “Hands-On” Entry Point engages learners in constructing experiments with physical materials or through computer simulations. Other “hands-on” approaches invite learners to learn more by building or manipulating a physical manifestation of some aspect of the topic they are studying.
- The Interpersonal Entry Point engages learners with each other so that they can interact, cooperate, work together, or alternatively debate and argue with each other. Students learn

from each other through group projects, in which each student contributes to the overall effort (Gardner, 1999).

Entry points may be used in combination, such as “hands-on” and aesthetic, with each student creating his/her own work of art, or interpersonal and existential/foundational, with students working together in projects to debate fundamental issues.

After a topic has been introduced via engaging entry points, the next step is to encourage further penetration into a topic through comparisons to known materials. Analogies and metaphors allow students to understand a new topic in terms of familiar ideas and concepts. In order to convey the definitive aspects of an idea or topic, core concepts may be represented or modeled in abstract or natural representation systems. The form of the representation may be closely tied to the physical subject, such as a photographic record, map, or chart, or may provide a formal model. Contrary to established approaches, Gardner argues for a family of representations rather than a single representation that is considered to be the best. Multiple representations allow students to choose elements from known reference areas to represent and model the new topic. The use of entry points, analogies and metaphors, and multiple representations allow students to become engaged in a new topic, understand new material through association with familiar ideas, and understand on a deeper level through developing models of the new subject matter.

The Development of Successful Intelligence

While conventional intelligence tests do not measure the elements of successful intelligence, Sternberg feels that it is critical for each individual to develop a balanced combination of analytical, creative, and practical thinking skills. These skills can be nurtured and developed in school by providing students with projects and curricula that challenge their creative and practical skills as well as their analytical skills. Sternberg believes that the analytical, creative, and practical thinking skills that together constitute successful intelligence should not only be cultivated, they should also be taught in school from an early age. These elements of successful intelligence equip students to succeed in their careers, in their personal lives, and in the real world after they complete their formal education (Sternberg, 1996).

Sternberg's concern in the school environment is that teachers need to understand the importance of styles. If a teacher recognizes that a student is performing poorly due to a mismatch between the individual's style and the teacher's expectations, then the teacher has the opportunity to adapt parts of the learning experience to suit the preferences of individual learners. If, however, the teacher views an individual student as lacking in ability, both teacher and student may find themselves in an untenable situation. It is important for students to learn how to determine the type of thinking that is expected in various situations as well as to learn how to apply a combination of analytical, creative, and practical skills. Sternberg concludes by stating that "especially in teaching, we need to take into account students' styles of thinking if we hope to reach them" (Sternberg, 1997, p. 158).

Understanding through Constructionism

Mitchel Resnick is an Associate Professor of Learning Research and Director of the Lifelong Kindergarten Project at the MIT Media Lab. The Lifelong Kindergarten project involves the development of digital manipulatives to support individual learning of complex concepts through exploration. In a similar manner to the development by Friedrich Froebel of specifically-designed objects to support learning through manipulation in Froebel's newly-created kindergarten, Resnick hopes to provide specially-designed digitally-manipulable objects to support individual learning as students progress through school. The development of digital manipulatives is guided by the recognition of the educational value of design projects, part of the educational philosophy referred to as constructionism (Resnick, 1998).

Constructionism combines the constructivist theories of Jean Piaget, viewing learning as an active process in which individuals construct knowledge based on their experiences, with an understanding that people learn most effectively while constructing products that are personally meaningful. Design projects provide opportunities for students to become active participants in their own learning process. In addition, design activities support interdisciplinary approaches using the arts, mathematics, and sciences. Providing a context for reflection, design projects allow children to view and manipulate the physical manifestations of their internal models, which

they can then update and extend. Further, children are encouraged to consider how other people will view and use their constructions (Resnick, 1998).

Resnick believes that we need to move from information to knowledge to creativity. Echoing Sternberg's belief that successful intelligence combines analytical, practical, and creative skills, Resnick states that understanding is not sufficient; rather, we need to learn how to use ideas creatively (Resnick, 2001). In order to support the development of creative thinking, Resnick worked with the Girl Scouts and the Computer Museum to set up a summer program at Wellesley College. In the summer program, the girls used Resnick's Programmable Bricks to design and construct their own measurement devices and tools. One participant in the program attached her device to her rollerblades to measure the distance and speed at which she traveled around her neighborhood. Another participant designed and constructed an automatic feeding device and maze for her pet gerbil (Resnick, 2001). In a science-education initiative, Resnick and his team provided students with a smaller version of Programmable Bricks called Crickets. Science education researchers often recommend encouraging children to design and carry out their own scientific investigations. In the MIT Media Lab initiative called Beyond Black Boxes, Resnick and his team take another step on the path of constructionism by encouraging students to design their own investigations and use tools to design and construct their own scientific instruments with which they can carry out their investigations. A number of benefits accrue in the learning process from the act of designing and constructing their own scientific instruments:

- The construction process encourages students to feel personally engaged and invested in their investigations.
- Building specially-designed instruments provides students with the opportunity to move beyond standard instruments that may not meet the needs of their investigations.
- Designing the instruments encourages the students to check and question their readings rather than automatically accepting measurements of a pre-built instrument.
- Determining what to measure and how to make their measurements is an important step in the design process. Through this necessary step of the design process, the students develop a better understanding of the scientific concepts involved in their investigations.

Sternberg would most likely agree with the teaching of practical and creative skills through the build-it-yourself scientific instruments project. He might take exception if all students are required to design their own scientific instruments, regarding this activity as appropriate to certain thinking styles and possibly uncomfortable to others. Gardner would consider the build-it-yourself scientific instrument activities as offering powerful entry points to an active learning experience for students. While construction activities engage students through a “hands-on” entry point, measurement tasks invite students to learn through a numerical entry point. Experiments offer students a logical entry point. Writing or telling the stories of their inventions encourages learning through a narrative entry point while an aesthetic entry point may be used when the students examine, appreciate, and describe their constructions as works of art. If students work in teams, an interpersonal entry point is also provided. Further, Gardner would indicate that the construction of build-it-yourself scientific instruments not only provides a rich set of entry points but also encourages the development of models and representations of core concepts through the planning and design process.

Summary

The educational methodologies examined in this paper provide the practical foundation for the research study in online learning. Gardner’s Theory of Multiple Intelligences (Gardner, 1983/1993) provides the clearest evidence as well as demonstrable results when used as the basis for educational approaches employed in classroom situations. The Teaching for Understanding Framework (Perkins, 1998) based on constructivist learning theory (Chen, 2000), provides a structure in which to plan and design learning modules. Constructivist learning environments provide support for learners to develop their own understanding. Using an online learning environment encourages learners to actively participate in the development of their own knowledge. However, the content needs to be designed in such a way as to support the development of an individual’s understanding. The educational methodologies based on Multiple Intelligence Theory, including the Entry Point Framework (Gardner, 1999) and multiple representations (Gardner, 1999) offer a rich set of alternatives for designing online learning modules that consider the multiple intelligences of individual learners.

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