Developing Process Skills and Content Knowledge through Multi-Intelligent Problem-Based Hybrid Learning

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Abstract. Adult learners enter the MSIS (Master's in Information Systems) program at the University of San Francisco with a number of years of experience in high-technology industry. The MSIS program has been designed to accommodate the needs of working adults, offering evening classes at regional campuses close to areas containing a large concentration of high-technology companies. These adults bring to the program a wealth of experience that has been hitherto largely untapped in their courses. Research in adult learning has demonstrated that adult students benefit from problem-centered, relevant educational approaches that make use of their past experiences. Students enter the program with a wide variety of backgrounds, needs, skills, knowledge, and ways of learning. In order to help students develop both the process skills and content knowledge they need to advance in their careers in high-technology industry, a hybrid problem-based learning approach, utilizing student experience, has been developed. To address the wide range in learning approaches, preferences, and needs of the adult student body, online course components have been designed to activate various intelligences. The Entry Point Framework and Multiple Representations, two educational methodologies based on the Theory of Multiple Intelligences, have been employed in conjunction with Problem-Based Learning to deliver relevant content in multiple ways to different types of adult learners. Initial feedback from both students and faculty has been encouraging and will be used to increase the effectiveness of multi-intelligent problem-based online components.

Keywords: problem-based learning, multiple intelligences, hybrid learning

1 Introduction

"True learning is based on discovery guided by mentoring rather than the transmission of knowledge." John Dewey

John Dewey, an American philosopher and educator (1859-1952), considered thought to be the product of the interaction between an organism and the environment, and knowledge, guiding and controlling the interaction between the organism and the environment (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 experiential, interactive projects in order to support authentic learning by students. Dewey theorized that knowledge results from a process he called engagement, the active manipulation of the environment throughout the learning process (Dewey, 1938/1963).

While problem solving, engagement, and applying active questioning have long been recognized as increasing motivation and leading to effective learning experiences, Problem-Based Learning (PBL) has only recently re-emerged as a pedagogical strategy in post-secondary education. An educational methodology for posing significant, contextualized, real world situations, PBL provides resources, guidance, and instruction to learners as they develop content knowledge and problem-solving skills (Mayo et al., 1993). First introduced in medical and professional schools, PBL has now spread to other disciplines, particularly in the sciences. Using PBL, students collaborate to study the issues of a problem as they strive to create viable solutions.

The Master's degree program in Information Systems at the University of San Francisco has been designed to accommodate the needs of working adults. Courses are offered in the evening at regional

campuses that are located in close proximity to areas with a high concentration of high-technology companies. The schedule and location allow students to continue working at their full-time jobs in industry while obtaining a Master's degree. These adult students respond positively to PBL approaches to learning the content knowledge and process skills they seek to acquire as part of their Master's degree program in Information Systems.

This paper discusses the use of a PBL pedagogical strategy that has been designed to reach adult learners through two important enhancements: 1) an understanding and application of the Theory of Multiple Intelligences, and 2) a hybrid face-to-face and online delivery model. The instructional design is based on the application of the Theory of Multiple Intelligences and incorporates an understanding of constructivist learning theory and adult learning theory, employing educational methodologies based on these theories. Therefore, the paper starts by explaining the theoretical foundation underlying the multi-intelligent problem-based hybrid learning model. The paper then presents the strategies employed in the learning model. With an understanding of the theoretical foundation and the educational methodologies, the paper proceeds to describe the instructional design of the learning components. The paper closes with a discussion of feedback from the formative evaluation as well as limitations of the current approach.

2 Theoretical Foundation

2.1 Constructivism

There are three major schools of thought on the nature of learning and on the properties of knowledge: Behaviorism, Cognitivism, and Constructivism. Whereas the behaviorist school views knowledge as passive, primarily automatic responses to stimuli in the environment, and the cognitivist school views knowledge as abstract symbolic representations in the minds of individuals, the constructivist school views knowledge as a constructed entity developed by each individual learner (Goodman, 1978). Based on constructivist theory, knowledge cannot be transmitted from teacher to student; rather, it is (re)constructed by each individual in his/her own mind. This is a fundamental difference from the view of knowledge as given and absolute held by behaviorists and cognitivists. Individuals learn by actively constructing their own understanding, incorporating new information into the base of knowledge they have already constructed in their own minds. In addition, the context of the learning experience and the beliefs and attitudes of the learner affect his/her learning (Spivey, 1995). Cognitive constructivists postulate that learning occurs as a result of the exploration and discovery by each individual learner whereas social constructivists stress the collaborative efforts of groups of learners as sources of learning (Confrey, 1995).

2.2 Theory of Multiple Intelligences

Based on evidence from psychology, biology, and anthropology, Gardner defines intelligences as biopsychological potentials for processing information, solving problems, and developing products valued by the culture in which the person resides, and delineates eight distinct human intelligences (Gardner, 1999a):

- Linguistic Intelligence: ability to learn and use spoken and written language to process information.
- Logical-Mathematical Intelligence: ability to conduct logical analysis of problems as well as scientific investigations and to carry out mathematical operations.
- Spatial Intelligence: capacity to recognize and manipulate patterns in both wide spaces and confined areas.
- Bodily-Kinesthetic Intelligence: capability to use one's body for processing information.
- Intrapersonal Intelligence: potential to understand oneself and to construct an effective working model of personal capabilities and difficulties as well as to employ such knowledge for managing one's life.
- Interpersonal Intelligence: ability to understand the intentions, motivations, and desires of other people and, therefore, to relate effectively with other people.
- Musical Intelligence: ability to perform, compose, and appreciate musical patterns.
- Naturalist Intelligence: ability to recognize and classify many species that constitute the flora and fauna of a person's environment.

A Multiple Intelligence (MI) view of learning has several distinguishing features with particular implications for educational practice (Kallenbach & Viens, 2002):

- There exists a plurality of intelligences, each with a distinct symbol system and way of knowing and processing information.
- The theory focuses on how intelligences operate in practice, thereby locating intelligence in real world problem-solving and product-making.
- All eight (or more) intelligences are universal.
- Individuals have unique profiles of intelligence that develop and change over time.
- Intelligences have different manifestations, symbol systems, and sub-abilities.
- Intelligences are used in combination, rather than in isolation.

2.3 Adult Learning Theory

Malcolm Knowles is credited with initiating the specialized study of adult learning with his theory of Andragogy (Knowles, 1998). Most adult learning theorists cite the following characteristics of adult learners: dedication to lifelong learning; problem-centered and self-directed in their learning; seeking relevant and immediate application of new knowledge; and entering the learning experience with a wealth of past experiences on which to draw. Since Knowles, researchers have identified a wide variety of learning preferences for adults, and have described the critical role of self-concept as a motivating factor in seeking additional formal learning experiences. A problem-centered, relevant approach to learning may prove critical to the retention of non-traditional adult students, particularly those who are returning to higher education after earlier unsatisfying educational experiences.

Certain educational methodologies assist adults in developing both their content knowledge and their process skills.

3 Educational Methodologies

3.1 Problem-Based Learning

Problem-Based Learning (PBL) is a pedagogical strategy, which consists of posing significant, contextualized, real world situations, and providing resources, guidance, and instruction to help learners develop content knowledge and problem-solving skills (Mayo et al., 1993). Applying a constructivist theory of learning, PBL helps students focus on meaning-making rather than on fact-collecting. In PBL, students work together to study the issues of a problem and to devise viable solutions. Learning via contextualized problem sets and situations, along with the dynamics of group work and independent investigation, result in the achievement of higher levels of comprehension as well as the development of meta-learning and interpersonal skills. PBL makes use of prior knowledge and fosters learning that adapts to new situations and related domains quickly. With a significant reduction in the amount of direct instruction provided by PBL, students assume greater responsibility for their own learning (Barrows, 1996). The instructor's role is to encourage participation, help students stay on track, and assume the role of fellow learner (Aspy et al., 1993).

When problems are engaging, difficult, and useful, higher levels of comprehension and skill development occur than in traditional instruction (Albanese & Mitchell, 1993). Transferability is increased when students are able to practice the knowledge and skills in a functional context, allowing students to better imagine what it will be like using the content knowledge and process skills on the job (Bridges, 1992). PBL approaches promote student interaction and teamwork, thereby enhancing students' interpersonal skills (Bernstein et al., 1995; Pincus, 1995; Vernon, 1995).

Improved retrieval and use of knowledge results from PBL approaches for three reasons: 1) students are better at activating prior knowledge, 2) students learn in a context resembling their future context, and 3) students elaborate more fully on the information presented (Barrows, 1996).

3.2 The Entry Point Approach

While the Theory of Multiple Intelligences describes different aspects of the learners, the Entry Point Approach provides a useful schema for different pathways into meaning making, appropriate to different types of learners. The Entry Point Approach accommodates individual differences by providing

multiple ways to introduce a topic. According to Gardner, "the decision about how to introduce students to a rich generative topic or a provocative question proves pivotal" (Gardner, 1999b, 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. Envisioning knowledge located in the center of a house with the learner on the outside looking in, entry points can be thought of as windows shedding different lights into the room (Davis, 1996):

- 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.
- 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. Philosophical issues invite certain learners to engage on a deep level, which piques their interest in studying a topic.
- The Aesthetic Entry Point engages the senses through art that relates to the subject matter being studied. Concepts and examples have their own aesthetic properties, which can be examined and discussed in conjunction with the topic at hand. The Aesthetic Entry Point activates a learner's Spatial Intelligence through a visual presentation of material.
- The Experiential Entry Point engages learners in constructing experiments with physical materials or through computer simulations. Through the Experiential Entry Point, learners have an opportunity to practice applying new concepts to real-life situations.
- The Interpersonal/Collaborative Entry Point engages learners with each other so that they can interact, cooperate, and work together. Students learn from each other through group projects, in which each student contributes to the overall effort.

The Entry Point Approach embodies three educational objectives:

- Inquiry: providing a structure with a range of open-ended questions without right or wrong answers
- Access: providing access (delineated by the different entry points) for a range of different learners with different profiles of intelligence and experiential backgrounds
- Reflection: providing tangible ways for students to reflect on their learning.

3.3 Multiple Representations

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. The pedagogical strategy of multiple representations is used to convey the definitive aspects of an idea or topic, by representing or modeling core concepts 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 (Gardner, 1999b). Multiple representations allow students to choose elements from known reference areas to represent and model the new topic.

3.4 Understanding Pathway

The Understanding Pathway applies the Theory of Multiple Intelligences (MI) to create diverse strategies for teaching and learning (Kallenbach & Viens, 2002). Students are given opportunities to access material and demonstrate their understanding of content knowledge and process skills in multiple ways, including:

- MI reflections, using MI theory as a basis to reflect on and identify students' strengths and preferences, emphasizing student participation in MI-based reflections.

- Bridging students' areas of strengths to areas of challenge, thereby creating a "bridge" from students' MI strengths to appropriate learning strategies, using students' particular strengths to assist in areas of particular difficulty.
- Entry/Exit points, providing a range of MI-informed entry points into a topic along with various exit points for students to demonstrate their learning, using students' identified strengths to develop both entry and exit points.
- Projects, developing a project-based curriculum using MI theory as a framework, emphasizing authentic problems and activities.

4 Instructional Design

Courses in the MSIS program at the University of San Francisco are currently moving from a face-to-face model to a hybrid model of learning. As a first step, two courses were chosen to incorporate an online learning component. Supporting materials are provided online, including the syllabus, reading list, assignments, lecture notes, faculty information, and links to additional resources. Busy, often preoccupied adult students benefit from the availability of such materials online, particularly copies of lecture notes and presentations. Such materials allow students to reinforce their learning, particularly if their Linguistic Intelligence is not as well developed as some of their other intelligences. The Understanding Pathway is used to make materials available online in different presentation formats (using multiple representations) for students to digest at their own pace, allowing students to bridge from their areas of strength to areas of challenge. If a student didn't understand a concept explained orally in class, the student can review the lecture material after class.

An area of major concern and challenge for instructors has been the differing backgrounds of entering students. The variation in knowledge and background of the students is currently being addressed through providing additional background materials that are posted online. Background materials include graphics to make use of students' Spatial Intelligence. Some instructors also provide hands-on exercises with immediate feedback to help students use their Bodily-Kinesthetic Intelligence to build their understanding of the content. Allowing students to review these materials in between classes helps students construct their own understanding at their own pace. Providing materials through multiple representations helps students with varying profiles of intelligences to develop a solid understanding of the course principles and foundation. This contributes to their feeling of self-efficacy, which is very important for these adult students, some of whom have had unsatisfactory educational experiences in the past.

Both courses follow a PBL approach, introducing real-life problems and case studies for students to address as a group. In addition, students are required to develop their own problems and case studies. These case studies present real problems that the students have encountered or are currently experiencing in their jobs. In their case studies, students apply the principles they are learning in the class. This makes the assignment very relevant to the adult students. In order to complete the assignment, each student is required to determine a relevant problem, structure an information set, compose a case study, edit and analyze work by reflecting on previous knowledge, and integrate new knowledge and experiences. These cognitive tasks make use of Linguistic, Logical-Mathematical, Interpersonal, and Intrapersonal intelligences. Since the case study focuses on a real-life problem from the student's own experience, there is not only an Interpersonal/Collaborative entry point but also an Experiential entry point, offering immediate and relevant application to the adult learner.

Each student posts and moderates an online discussion of his/her case study, in a social constructivist approach to learning. Multiple entry points provide strategies for learning, which operate on three different levels:
- Inquiry: the student moderates the discussion about his/her case, with both the moderator and his/her fellow students posing open-ended questions, with no right or wrong answers. The Inquiry strategy involves knowledge transfer from one person to another, with learning occurring as a result of the learner's discovery, as postulated by cognitive constructivism.
- Access: the easy-to-use Web-based discussion forum provides access to learners through the Interpersonal/Collaborative entry point as well as through the Narrative entry point. In addition, an Existential/Foundational entry point allows students to address fundamental issues underlying their cases, particularly in situations that pose ethical

dilemmas. The Access strategy involves learners in interactive and collaborative modes of learning, based on social constructivism.

- Reflection: students are asked to reflect on their own experiences through both the development of the problem-based case study and through their moderation of the discussion among their classmates. The Reflection strategy engages learners in the process of self-reflective analysis.

Moderating an online discussion on his/her case helps the student develop his/her Interpersonal intelligence as well as his/her self-assessment and peer feedback skills. The process of developing the problem statement and responding to feedback from the group helps students use their Intrapersonal intelligence to reflect on the issues in the case study as well as to reflect on the feedback and ideas offered by members of the class.

The act of developing the problem not only strengthens the student's Intrapersonal and Interpersonal Intelligences but also the content knowledge gained from the case study analysis and subsequent discussion will be deeper and retained more easily because the students have constructed the problems themselves. The development and discussion of problems, which are drawn from a learner's actual work experiences, supports increased transference of both content knowledge and process skills to the student's workplace. During online discussions, instructors can model effective behaviors, provide feedback, and tie points raised in the discussion to content knowledge presented in class. The online instructional approach increases learner participation due to its availability at times that are convenient to busy professionals. In addition, students who are reluctant to voice their opinions in class are given the opportunity to participate in the online discussion forum where they can take time to reflect and compose their thoughts.

5 Formative Evaluation, Limitations, and Further Work

The courses in the MSIS program for which the hybrid model has been adopted are undergoing a formative evaluation to determine improvements that should be made to the course components. A questionnaire has been developed for students and faculty members to use to provide feedback on their experiences with the hybrid model. The questionnaire consists of a combination of multiple choice and open-ended questions. Feedback from students and faculty has been positive so far. Responses to feedback questionnaires have indicated that students would like to see more use of the online problems and case studies. Students have found the Web-based system easy to use. Students report that they have benefited from receiving feedback from other students on the cases that are based on real-life problems they have encountered in their jobs. Feedback from questionnaires is being used to improve the features and design of the online modules.

The major limitation in implementing the hybrid model has come from adjunct faculty members who are hesitant to adopt online approaches. These faculty members are comfortable with the face-to-face model they have already developed and do not necessarily want to invest time in learning a new model or modifying their syllabus or lesson plans. While some faculty members have readily embraced the hybrid model, others make little use of the online components. Students have much more readily accepted the online components than some faculty members have.

Furthermore, the current Web-based system, adopted by the university, is organized in a linear fashion that best supports the use of Linguistic and Logical-Mathematical Intelligences. The predetermined logical/sequential categories make it difficult to present content through experiential, existential/foundational, or aesthetic entry points. Multiple representations of content are only possible once a category has been selected. Within a category, it is possible to link to a graphical presentation, discussion forum, or interactive exercises, but this two-step approach detracts from viewing the content through an entry point window. Other tools are also needed to support multiple exit points, with students performing their understanding using different intelligences. Within the logical structure of the Web-based environment, a student can attach a graphical presentation or link to a multi-modal presentation with sound effects, metaphors, or interactivity, but again, additional effort and software tools are necessary to support the use of intelligences other than Linguistic or Logical-Mathematical. Since these two intelligences are the most used in direct instruction, this reduces the benefit of the Web-based environment to augment the use of intelligences employed in the face-to-face environment.

Research is underway to develop a Web-based environment that supports authoring content with multiple entry and exit points as well as multiple representations. Software tools, including the Squeak

object-oriented programming language, are currently being investigated to determine how best to provide a Web-based environment that truly supports the use of different windows through which adult learners with varying profiles of intelligences can view and learn new content.

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