Reaching Adult Learners through the Entry Point Framework and Problem-based Learning in a Croquet-based Virtual Environment

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Abstract

Adult learners with varying needs, backgrounds, skills, experiences, and ways of learning place increasing demands on higher education to provide learning experiences that are accessible, applicable, and relevant to their own individual needs. At the same time, demands of the workplace require the development of competencies and the ability to not only understand but also to communicate, apply, and act on newly acquired knowledge, often through cooperative team work. Though adult learners may approach higher education with apprehension, they are increasingly comfortable with technology. In this paper, we discuss how the Entry Point Framework and Problem-based Learning can be implemented in a Croquet-based virtual environment to support adult learners with varying profiles of intellectual strengths.

1. Introduction

"The mind is not a vessel to be filled but a fire to be kindled." Plutarch

Plutarch understood the challenge educators face today. With the information explosion and the pace of change in the 21st century, graduates cannot rely on merely acquiring knowledge of specific content in a particular field. Higher education must, therefore, extend beyond the focused content learning stressed in most educational settings to develop the processes of understanding, expression in varied media, inquiry, learning, remembering, reasoning, invention, teaching, building models, and deep reading. To be successful, students must learn to generate, communicate, integrate, and act on their knowledge [1]. In addition, the student body has become more diverse, including adult learners with varied backgrounds, needs, skills, knowledge, and ways of learning. Through the integration of learning theories, educational methodologies, and enabling technologies, this paper considers the use of adaptive hypermedia and the emerging technology of a Croquet-based virtual learning environment to implement the Entry Point Framework and Problem-based Learning to reach adults with varying profiles of intellectual strengths.

2. Learning Theories

If we consider the question of what learning is and how it occurs, we can identify three schools of thought on the nature of learning and the properties of knowledge: Behaviorism, Cognitivism, and Constructivism. These theories differ in the way in which learning occurs and in the properties they ascribe to knowledge, whether knowledge is given and absolute or constructed and relativistic. Behaviorist learning theories view knowledge as objective, given, and absolute [2]. Though cognitivist learning theories are based on active mental processing on the part of learners, such theories still maintain the behaviorist perspective on knowledge, considering knowledge to be both given and absolute [3].

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 [4]. According to constructivist theory, information is transmitted, but knowledge cannot be transmitted from teacher to student, or any one individual to another; rather, knowledge is (re)constructed by each individual in his/her own mind and is relative, varying through time and space.

2.1 Social Constructivism

Constructivists believe that learning occurs when students are trying to make sense of their environment, a dynamic process that involves building and shaping meaning and understanding much like a carpenter puts together a piece of furniture [5]. Social constructivism is a version of constructivist theory that locates learning in a dynamic and interactive social context. Confrey [6] describes knowledge as a social product created through the highly interactive processes of negotiation and discussion, while explaining that significant social interaction between learners is the primary source of cognitive growth and knowledge construction. Primary features of social constructivism for adult learners include the important role of knowledge based on previous experience, the critical role of peer interactions

in promoting understanding, and the appreciation for multiple perspectives within a dialogue.

2.2 The Theory of Multiple Intelligences

The cognitive theory that each individual possesses multiple intelligences rather than one single intelligence is presented in Howard Gardner's seminal work, *Frames of Mind: The Theory of Multiple Intelligences* [7]. Gardner explains the need for a theory of cognition that encompasses various distinct human faculties and offers an updated definition of an intelligence as a biopsychological potential for processing information, solving problems, and developing products valued by the culture in which the person resides [8]. Based on evidence from psychology, biology, and anthropology, Gardner defines eight specific human intelligences:

- Linguistic Intelligence – the potential to learn and use spoken and written language to process information and achieve specific goals.
- Logical-Mathematical Intelligence – the capacity to conduct logical analysis of problems as well as scientific investigations and to carry out mathematical operations.
- Musical Intelligence – the ability to perform, compose, and appreciate musical patterns.
- Bodily-Kinesthetic Intelligence – the potential to use one's body for processing information.
- Spatial Intelligence – the capacity to manipulate patterns in both wide spaces and confined areas.
- Interpersonal Intelligence – the ability to understand the intentions, motivations, and desires of others and to relate effectively to them.
- Intrapersonal Intelligence – the ability to understand oneself, construct an effective working model of personal capabilities and difficulties, and employ such knowledge for managing one's own life.
- Naturalist Intelligence – the ability to recognize and classify organisms and objects in the environment.

These intelligences are both innate and learned, and individuals differ in terms of which of their intelligences are more developed than others [9]. Since it is possible to strengthen less-developed intelligences, learning experiences can be designed to help adults develop and build their less-developed intelligences, often by coupling their less-developed intelligences with their better-developed intelligences.

2.3 Adult Learning Theory

Malcolm Knowles began the specialized study of adult learning with his theory of Andragogy [10]. Most adult learning theorists cite the following characteristics of adult learners: dedication to life long 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.

2.4 Situated Cognition

According to situated cognition, "knowing and learning can only be understood within the social world or context in which they occur." [11, p.2] The situated cognition view suggests that students learn best when they are involved in practical learning situations in which modeling and coaching facilitate their learning process rather than in lectures where students are expected to acquire knowledge purely by listening. Adult education has traditionally located learning in experience, whereby the learning experience is naturally tied to the tools, social activities, and practical applications of the knowledge that is gained [11].

3. Educational Methodologies

Based on variations in intellectual profiles across a range of individual learners, Gardner encourages the personalization of education. In his paper, *Reflections on Multiple Intelligences*, Gardner states that "one of the reasons that MI [Multiple Intelligence] 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" [12, p. 208]. In order for adult students to master educational materials, demonstrate their understanding to themselves and others, and succeed in an educational setting, it is important that:

- Differences among adult learners are taken seriously
- Knowledge of differences is shared with learners
- Students are given responsibility for their own learning
- Concepts are presented via multiple approaches [12].

3.1 The Entry Point Framework

The Entry Point Framework describes the various approaches and pathways through which the construction of meaning and subsequent learning can occur [13].

While the Theory of Multiple Intelligences applies to the learners themselves, describing the skills and faculties of those who are engaged in the learning process, the Entry Point Framework considers the aspects and presentation of the subject matter the students are learning. The Theory of Multiple Intelligences and the Entry Point Approach "coincide at the juncture at which the learner intersects with what is being learned" [13, p. 128].

Based on Multiple Intelligence Theory, the Entry Point Framework accommodates individuals by introducing a topic in multiple ways. While certain entry points activate particular intelligences, entry points and intelligences are not in one-to-one correspondence. "The decision about how to introduce students to a rich generative topic or a provocative question proves pivotal" [9, p. 191]. Due to what psychologists refer to as the primacy effect, students are particularly apt to remember the starting point in a learning experience. With multiple demands on their time and concerns about learning new material, an engaging entry point piques the interest of adults, inviting them into a learning experience to delve more deeply into the subject matter.

The Entry Point Framework offers seven points of entry into any new topic. These seven entry points make use of a combination of the eight different intelligences. While initial accounts [13] described five entry points, later versions subdivided the Quantitative and Logical into separate entry points and added an Interpersonal/Collaborative entry point [9]. The seven entry points are described by Gardner [9] as follows:

- The Narrative Entry Point invites students into the learning experience through relating a story. The story can activate Linguistic, Intrapersonal, and Interpersonal Intelligences through verbal storytelling. Using symbolic narrative forms, such as mime or movies, Bodily-Kinesthetic and Spatial Intelligences can also be engaged.
- The Quantitative Entry Point provides an introduction to a new topic through measuring, counting, listing, or determining the statistical attributes of the subject matter, allowing the learner to use numerical relations, thereby engaging his/her Logical-Mathematical Intelligence.
- The Logical Entry Point offers students the opportunity to learn by deducing the cause and effect of specific occurrences and to understand relationships among different factors involved in the study of a particular topic by applying deductive reasoning. This process engages the Logical-Mathematical Intelligence and may also engage the learner's Linguistic Intelligence if written material is provided for the student to read.
- The Aesthetic Entry point engages the senses through an examination and discussion of the visual and aesthetic properties of concepts.

- The Experiential ("Hands-On") Entry Point allows learners to construct their own experiments with physical materials or through computer simulations. Other experiential approaches invite learners to build or manipulate a physical manifestation of some aspect of the subject matter.
- The Existential/Foundational Entry Point allows individuals to consider a subject based on its fundamental characteristics and underlying principles. Through this entry point, learners are invited to consider philosophical issues and to engage on a deep level, which piques and holds their interest in exploring a particular topic.
- The Interpersonal/Collaborative Entry Point engages learners in interactive, cooperative, and collaborative projects with others, or alternately in situations in which they can debate or argue with each other. In these group settings, students learn from each other, with each student contributing to the overall effort [9].

Used singly or in combination, entry points allow instructors to customize learning experiences and reach a wide range of adult learners.

3.2 Problem-based learning

Problem-based learning (PBL) is an effective instructional strategy deeply rooted in social constructivism and adhering to a situated cognition view of learning. More than individual student decision making or problem solving, PBL exploits the social and contextual dimensions of knowledge construction and emphasizes interaction among students and instructors by ongoing discussion of ideas, sharing of learning responsibility, and seeking out different perspectives to develop multiple alternative problem endings. Problems to be studied can be simple to complex, static or dynamic, simulated or real. Students work in small groups with a faculty tutor to recognize useful previous knowledge, identify new knowledge needs, generate questions, select resources, exchange ideas and ultimately construct meaning while developing potential approaches to the issue [14]. PBL applies the tenet of situated cognition by "locating learning in experience" [11, p. 79] and is an especially effective methodology for adult learners with their well-developed meta-cognitive skills and professed affinity for community or group-based learning activities.

4. Reaching Adult Learners

Many adult learners are entering higher education for the first time or after a considerable absence. Returning students have often had a negative experience with college as a "traditional aged" student and approach higher education with apprehension. Most adult learners

have job and family responsibilities which significantly limit the time they have for study and homework. These students often need the academic degree validation for continued employment or job advancement, but hold profound ambivalence due to a threat of societal and economic marginalization if they do not succeed in completing their education. They are increasingly technology savvy and demand relevant, easily applicable information that is accessible when they have time for study, often late at night or early in the morning.

Most importantly, they must develop a set of strategies and defenses that can protect their self-confidence by creating a psychological distance from their educational activities while at the same time allowing them to absorb some of the new skills and forms of behavior.

According to the Commission for a Nation of Lifelong Learners: "most current higher ed practices are ill adapted to the needs of employers and adult learners" [15, p. 4].

The Theory of Multiple Intelligences and the Entry Point Framework can assist instructors in designing effective learning experiences for adult learners. Appropriate technology can increase the educational impact of instruction and meet the specific needs of adult learners. Using a PBL strategy, we will consider ways in which we can implement the Entry Point Framework to reach adult learners. First, let us take a brief look at two enabling technologies that can be used to implement the Entry Point Framework: adaptive hypermedia technology and a Croquet-based virtual environment.

5. Enabling Technologies

5.1 Adaptive Hypermedia

Adaptive hypermedia (AH) combines the technologies of hypermedia and of user-adaptive systems. Adaptive hypermedia systems (AHS) offer both adaptive navigation support and adaptive content so that hypermedia systems can be personalized, thereby increasing their usability and functionality. In adaptive hypermedia systems, a model is built that represents the goals, preferences, and knowledge of a user of the system. This model is used to adapt interactions to the needs of each individual user [16].

Adaptive hypermedia systems can be classified in terms of what can be adapted as well as in terms of which features may vary according to the needs of different users [16]. The two major categories of hypermedia adaptation are: content adaptation and link adaptation, categories which can be further subdivided into specific technologies that can be used to implement such adaptation. Content adaptation is also referred to as adaptive presentation and includes techniques that adapt the content of a page based on the user model [16]. Content adaptation methods include:

- Additional explanations
- Prerequisite explanations
- Comparative explanations
- Explanation variants
- Sorting

Techniques to implement these content adaptation methods include:
- Fragment variants
- Page variants
- Frame based techniques

5.2 Networked Virtual Environments

Virtual environments are designed to support real-time interaction among geographically-dispersed users as well as to provide a sense of realism and an immersive experience through various rich media modalities, including 3D graphics and sound [17]. Access to a networked virtual environment is gained through the user interface on each user's individual computer.

According to Singhal and Zyda [17], a networked virtual environment is characterized by the following five features:
- Shared sense of space among users
- Shared sense of presence among users
- Shared sense of time among users
- Method whereby users can communicate
- Method whereby users can share

5.3 Croquet-based Virtual Environment

Designed to support collaboration between users through a peer-to-peer architecture, Croquet provides a complete development and delivery platform, offering the features of a standard networked virtual environment along with the potential for a much deeper level of collaboration and a much richer form of interaction than is possible in current virtual environments [18]. With powerful 3D graphics and support for collaboration and interaction, a Croquet-based virtual environment can provide a social, interactive, and immersive Virtual Learning Environment (VLE) [19].

6. Technology-enabled Entry Points

As a first step in testing the use of technology-enabled entry points for adult learners, the author constructed an adaptive hypermedia system and two prototype online learning modules. The two prototype online learning modules focused on: Legacy Systems Integration with the Web (for technical learners) and an Overview of Web and Internet Technology (for non-technical learners). The prototype online learning module on Legacy Systems Integration with the Web was based on a course in E-

Commerce and Web Business Management taught by the author in a face-to-face format to industry professionals pursuing continuing education through the Stanford University Western Institute of Computer Science (WICS) and to students pursuing their Master of Science degrees in Engineering at the University of Hong Kong in the fledging E-Commerce and Internet Computing program. Face-to-face courses taught at Stanford were videotaped and later offered to other industry professionals for continuing education via Stanford Online. Prototype online learning modules were developed to explain a particular topic in Legacy Systems Integration with the Web, which was presented in the E-Commerce and Web Business Management course.

The adaptive hypermedia system contained a user model, expressing user preferences in terms of the technical background of the learner (to determine which learning module to present) and in terms of each adult learner's profile of three most-developed intelligences (to determine appropriate entry points and content presentations). Each learner's profile of most-developed intelligences was based on self-report from a series of questionnaires [20]. The adaptive hypermedia online learning modules employed content adaptation, which was implemented through page variants in order to present explanation variants of the subject matter [20]. In this section, we will see how three different entry points were implemented through an adaptive hypermedia approach.

In a quest to find more effective technology to support the Entry Point Framework, the author located Squeak, which led to the author's participation in the first SqueakFest conference in 2003, where the author saw a demonstration of Croquet. Viewing the Croquet demonstration, the author determined that Croquet would offer the type of virtual environment in which the Entry Point Framework could be fully realized. Since downloading the developer's release, the author has been experimenting with Croquet, trying out various features, using a Croquet tutorial offered by a user through the Croquet developers list [21], and considering ways in which content can be developed with multiple entry points in a Croquet-based virtual environment. The following screen shots are intended to illustrate the concepts the author is presenting and by no means, represent the full capabilities of a Croquet-based virtual environment.

6.1 Narrative Entry Point

Schank [22] recommends a Story-based Curriculum as an effective learning strategy, particularly for adult learners in Master's degree programs. A Story-based Curriculum can be developed through a Problem-based learning strategy with a Narrative Entry Point, using real-world scenarios that adult learners can apply directly to

their own work situations. One way to implement a PBL strategy with a Narrative Entry Point to introduce the story is to implement an adaptive hypermedia page-based explanation variant, which presents a case study based on a real-life situation. Fig. 1 shows an example of a Narrative Entry Point into a case study involving integration of a vacation scheduler application with the Web. This example engages the Linguistic Intelligence by telling a story in words and engages the Intrapersonal and Interpersonal Intelligences by asking the learner to reflect on the case study and respond to the instructor.
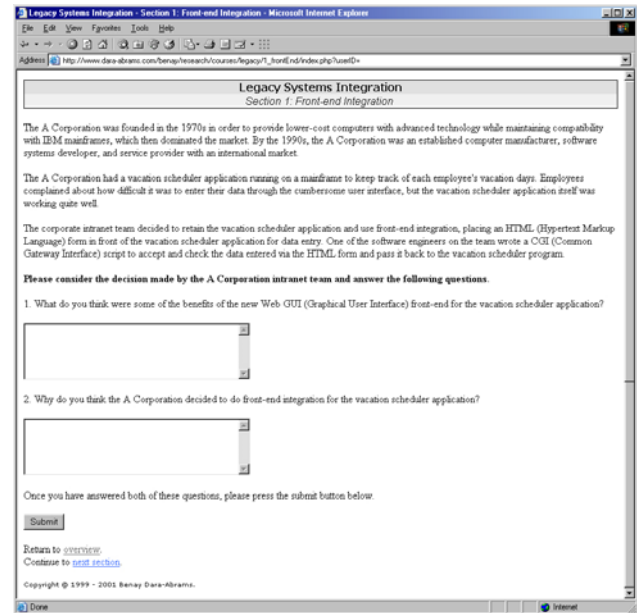

Fig. 1. Explanation Variant with Narrative Entry Point

Now, let's consider how we can provide a deeper level of engagement in the story by presenting the learner with a Croquet window relating the story of the vacation scheduler application and its integration with the Web, as illustrated in Fig. 2.

Croquet provides rich media capabilities to support the presentation of the story of the development of the Web interface. The story is related through a combination of text, graphics, audio, animation, and video. The Croquet elements used to convey the narrative are arranged in Croquet's 3-dimensional space in a way that provides a spatial context for the story.
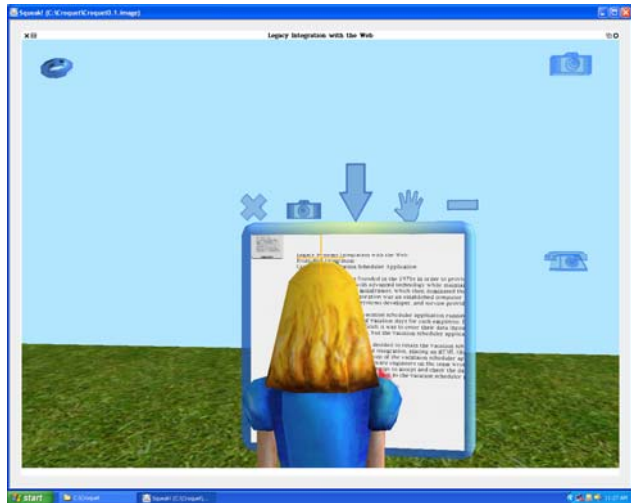
Fig. 2. Croquet Window with Narrative Entry Point

With Croquet's 3D graphics and communication capabilities, the Narrative Entry Point offers learners an immersive way to enter and engage in the story of designing a front-end integration strategy for a legacy vacation scheduler application. Not only can the learner read the story displayed in the Croquet window, but also he/she can pick up the phone and talk to another learner or the instructor about the case or engage in a discussion about the front-end integration strategy that was chosen for the vacation scheduler application.

6.2 Interpersonal Entry Point

In the adaptive hypermedia prototype, a threaded discussion forum was offered as an entry point into the Front-End Integration part of the learning module as illustrated in Fig. 3. The Interpersonal Entry Point was an effective way of engaging a number of adult learners, including one adult learner who was successful in his career as a sales engineer though he suffered from dyslexia and had difficulty learning about new technologies from written documentation and manuals. The sales engineer stated that learning about Front-End Integration through a case study presented and discussed in a discussion forum was the most effective way he had learned new material since becoming a sales engineer. He reported feeling engaged by being invited into the learning experience through an Interpersonal Entry Point.
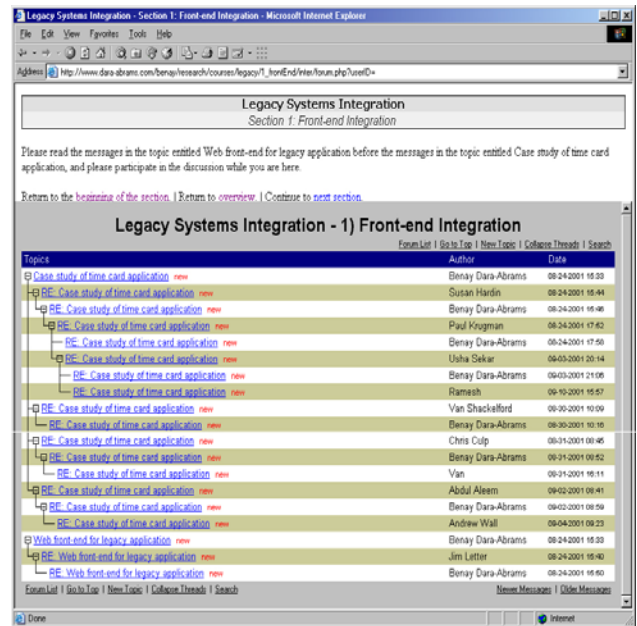

Fig. 3. Explanation Variant with Interpersonal Entry Point

With Croquet, we can implement an Interpersonal/Collaborative entry point into the topic of Front-End Integration by creating a 3D portal through which the learner can move to interact and collaborate with other learners, as illustrated in Fig. 4. The avatar that can be seen in the portal has a photo of the author's face instead of the face of the avatar, provided by A.F. Damasceno Jr., in his Croquet tutorial lessons [21].

Fig. 4. Croquet Portal with Interpersonal Entry Point

The act of moving through the portal creates a feeling of walking into a room to engage in a discussion with others about Front-End Integration. Graphical representations of the room and the learners could provide a more realistic look and feel of the environment.

By creating a portal to implement an Interpersonal/Collaborative Entry Point, we can literally and figuratively invite the learner into a classroom where he/she can learn more about Front-End Integration through discussion with other members of the "class."

Once in the classroom, the learner can pick up the phone in the space and talk to other learners using voice over IP. Other learners are portrayed as figures in the room to simulate a classroom environment. In the peer-to-peer environment, learners interact with each other and move about in the space, knowing where other learners are in the lesson by seeing where their figures are currently located. Educational materials for the lesson are embodied in the Croquet 3-D environment, and learners can find others with whom to interact on a particular topic represented by a specific educational element.

6.3 Experiential Entry Point

Using the Experiential Entry Point, learners can be invited into the learning experience through their Bodily-Kinesthetic Intelligence. This is a difficult entry point to implement in current systems, with most learning environments offering simulations, such as the Flash-based approach to demonstrating Business Services Integration illustrated in Fig. 5. The Flash-based simulation engages the Spatial and Musical Intelligences but does not fully engage the Bodily-Kinesthetic Intelligence in an interactive learning experience. A Flash-based simulation does not provide a situated learning experience as is possible in a Croquet-based virtual environment.
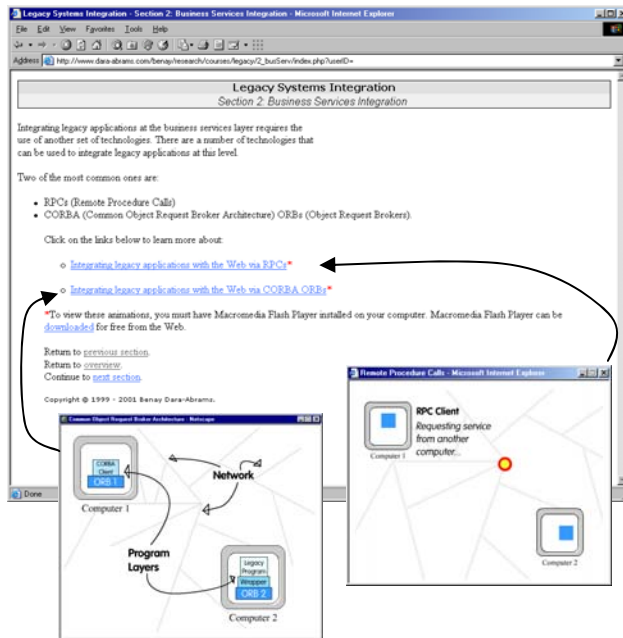

Fig. 5. Explanation Variant with Experiential Entry Point

In Fig. 6, Alice is looking at a window with a package browser and tools to program in the Squeak programming language, illustrating the availability of Squeak-based programming tools. With such tools, an adult student can engage in some real "hands-on" learning by working with code to provide a front-end Web interface to the legacy vacation scheduler. Squeak classes can be provided so that the learner can construct a solution through the Experiential Entry Point, thereby engaging the Bodily-Kinesthetic Intelligence as well as the Logical-Mathematical Intelligence.
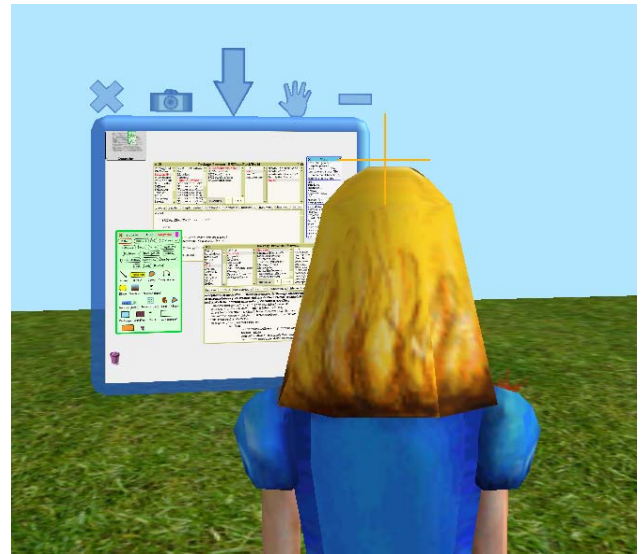

Fig. 6. Croquet Window with Experiential Entry Point

The first level of experiential activity is provided through interaction with an instructional simulation, which runs inside the Croquet environment. At the other end of the spectrum, learners use the tools of the Squeak-Croquet programming environment along with an instructor-provided library of domain-specific classes to construct their own solutions to specific problems. Experiential activities take place within the Croquet 3-dimensional environment, designed to depict the elements of the environment in which these experiential activities are actually occurring.

7. Summary and Further Work

Understanding how adults learn based on constructivist learning theory, the Theory of Multiple Intelligences, adult learning theory, and situated cognition, online learning experiences can be designed using classroom-tested educational methodologies such as the Entry Point Framework and Problem-based Learning. Based on the results of a formative evaluation of adaptive hypermedia-based prototype learning modules with multiple entry

points, there is reason to believe that the Entry Point Framework can be used to support online learning experiences in a way that reaches adult learners [20]. While an adaptive hypermedia system provided a useful platform to prototype multi-intelligent online learning modules, a Croquet-based virtual environment has the potential to provide a much richer virtual environment for adult learners [19]. Therefore, the author hopes to continue work on ways in which multiple entry points can be implemented for online learning modules in a Croquet-based virtual environment, in which all eight intelligences can be utilized and all seven entry points can be offered, reaching out to adult learners of varying profiles of intelligences and inviting them into the learning experience.

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