
Examining Information Problem-Solving Instruction: Dynamic Relationship Patterns Mediated by Distinct Instructional Methodologies

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Information problem-solving (IPS) is a central focus of information literacy instruction on the K-12 level, and school media specialists are employing various instructional methodologies during the teaching process. The use of different methodologies has the potential to mediate dynamic teaching/learning relationships in distinct ways. The purpose of this study was to examine relationships within two IPS methodologies: problem-based learning (PB) and participatory simulation (PS). Participant observation was employed to record and describe the broad patterns of relationships that were mediated by each methodology. The results of the study give greater insight into the role that methodology plays in mediating interactions between the elements of an instructional system.

Introduction

Information problem-solving (IPS) is a central focus of information literacy instruction on the K-12 level (Eisenberg & Berkowitz, 1990; Moore, 2003; Wisconsin Education Media Association and the American Association of School Librarians [WEMA & AASL], 1993). IPS instruction refers to teaching content and practices related to the creation of information-solutions to problems. Instruction usually has a process orientation and attempts to create a nexus between the information literacy skills needed to access and use information with the skills needed to apply and solve information problems (Wolf, Bush & Saye, 2003).

As library media specialists design learning experiences to teach IPS, they must select and employ an instructional methodology (e.g., resource-based instruction, problem-based instruction, cognitive apprenticeship, anchored instruction, case-based reasoning, learning communities, participatory simulations and communities of practice) to mediate those learning experiences. Instructional methodologies (also called instructional approaches) are designed to inscribe distinct meanings, activities and

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interactions to the basic elements of learning environments such as: students, teachers, media specialists, computers, books, desks and IPS content.

It is currently considered an instructional best-practice to teach IPS using a course-integrated, cognitive constructivist methodology (AASL & AECT, 1998; Thomas, 2004). Course integration refers to school media specialists (school librarians) collaborating with other content area educators to contextualize IPS content and practices within ongoing classroom activities. Cognitive constructivist methodologies are instructional approaches that emphasize learning through rich mental processes and experiences within an objective world (Carey, 1998; Kirshner & Whitson, 1997). Much of the literature on IPS instruction focuses on instructional design issues (e.g., instructional planning) and manifestations of student achievement after instruction (e.g., test scores). There is less focus on the ways in which different instructional methodologies (e.g., resource-based learning, anchored instruction, project-based learning, case-based reasoning, inquiry learning, situated learning, cognitive apprenticeship, learning communities, communities of practice and immersive learning) mediate dynamic interactions and relationships during instruction.

There are various methodologies that could be used to mediate IPS instruction, and it is imperative that school library media researchers gain empirically-based insights into the role that methodological mediation plays in structuring interactions and relationships between the elements of learning environments. This study examined the dynamic interactions and relationships that were mediated by two distinct IPS instructional methodologies (i.e., problem-based learning within a face-to-face learning environment and participatory simulation within a computer-based environment). Problem-based learning is a more cognitive-based instructional methodology that requires students to learn IPS by engaging real-world, complex problems with uncertain and multiple information-solutions (Blumenfeld et al., 1991). Participatory simulation is a more sociocultural instructional methodology that requires students to develop IPS through simulated experiences, interactions and communities of practices (see Figure 1). Specifically, four classes (two problem-based and two participatory simulation) were viewed as teaching/learning systems, and the study examined how the different instructional methodologies mediated the interactions, activities and relationships between elements within the systems.

Figure 1. Screen shot of the computer-mediated participatory simulation



Background

School library media studies in the United States has a long instructional design history. After the publication of the field's sixth set of national standards (AASL & AECT, 1975), scholars began to develop collaborative instructional design models (e.g., Cleaver & Taylor, 1983; Johnson, 1981; Turner & Naumer, 1983) and instructional methodologies (e.g., Callison, 1986; Kuhlthan, 1987; Sheingold, 1986) to aid library media specialists in teaching the literacies associated with the field. Information problem-solving (IPS) is a primary literacy on the K-12 level, and it is currently a central focus of school media instruction (Eisenberg & Berkowitz, 1990; Moore, 2003; WEMA & AASL, 1993).

Information Problem-Solving (IPS)

IPS refers to a set of information-based practices used to generate and communicate distinctive meanings/solutions within ill-structured problem situations. The most common IPS practices are task identification, search strategy initiation, information location/access, information evaluation, information use, information communication and problem-solving product/process evaluation.

The practice of task identification refers to recognizing the existence of an information-based problem and defining the need(s) associated with that problem (WEMA & AASL, 1993). Various activities are embedded within the practice such as: identifying the context and frame of reference (Marland, 1981; WEMA & AASL, 1993), defining the information requirements of the task (Eisenberg & Berkowitz, 1990), articulating the task in the form of critical questions (Irving, 1985; WEMA & AASL, 1993; Yucht, 1997), situating the task within explicit expectations (Eisenberg & Berkowitz, 2003) and relating the task to prior knowledge (WEMA & AASL, 1993).

The practice of search strategy initiation develops from task definition, and it refers to the development of a plan that will be employed to find information. There are various activities associated with the practices such as: clearly articulating needed information (WEMA & AASL, 1993), identifying salient terms and phrases tied to the task (WEMA & AASL, 1993; Yucht, 1997), acknowledging the multimodal nature of resources (Eisenberg & Berkowitz, 1990; WEMA & AASL, 1993), developing evaluation procedures (WEMA & AASL, 1993) and setting source priorities (Eisenberg & Berkowitz, 2003; Irving, 1985).

The practice of information location refers to finding information within: 1) information landscapes, and 2) particular resources. Various activities are associated with the practices such as: physically locating multimodal resources (Eisenberg & Berkowitz, 2003; Irving, 1985; WEMA & AASL, 1993), physically accessing information within sources using internal organizers (Eisenberg & Berkowitz, 1990; WEMA & AASL, 1993) and intellectually accessing ideas and concepts within sources (Eisenberg & Berkowitz, 2003; Mancall, Aaron & Walker, 1986).

The practice of information evaluation refers to the determination of information accuracy, comprehensiveness, relevance and usefulness. Various activities are associated with the practice such as: determining type of source (WEMA & AASL, 1993), comparing and contrasting sources (WEMA & AASL, 1993), determining the usefulness

of format (WEMA & AASL, 1993), identifying facts and opinions (WEMA & AASL, 1993), determining authority (Stripling & Pitts, 1988), judging significance (Stripling & Pitts, 1988) and judging the completeness of information (WEMA & AASL, 1993).

The practice of information use refers to the integration and synthesis of information to solve a defined problem. Various activities are associated with the practice such as: organizing information from multiple sources (Eisenberg & Berkowitz, 2003), integrating ideas and concepts across sources (Eisenberg & Berkowitz, 2003; Stripling & Pitts, 1988; WEMA & AASL, 1993) and using information to create solutions to problems (Eisenberg & Berkowitz, 2003; Stripling & Pitts, 1988; WEMA & AASL, 1993).

The practice of information communication refers to the effective presentation of problem-solving resolutions. Various activities are associated with the practice such as: illuminating salient conclusions and resolutions (WEMA & AASL, 1993), determining appropriate modes of communication (WEMA & AASL, 1993) and generating original presentations within ethical practices (WEMA & AASL, 1993). The practice of problem-solving product/process evaluation refers to a critical assessment of the final resolution and the processes employed in generating it.

The American Association of School Librarians (AASL) promotes the full integration of IPS content and practices within the teaching learning landscape (AASL & AECT, 1998). Although school media literature has illuminated the limited implementation of integration and collaborative instructional planning (e.g., Baumbach, 1991; Pickard, 1993; Putnam, 1996; Small, 1998; van Deusen & Tallman, 1994), it is currently considered an instructional best-practice for school media specialists to engage in collaborative efforts—with other content area educators—to contextualize IPS content/practices within ongoing classroom instruction (AASL & AECT 1998; Thomas, 2004).

General Benefits of Integrated IPS Instruction

School media research literature (e.g., Irving, 1985; Pitt, 1995; Thomas, 2004; Todd, 1995) seem to support the idea of integration. For instance, Todd (1995) examined the use of integrated instruction with middle school, science students and found a positive impact on learning. Bingham (1994) compared an integrated information skills approach with a traditional [non-integrated] approach and reported significantly higher scores for students learning within the integrated approach. Pitts (1995) found integrated instruction necessary because complex information assignments/activities require students to use multiple domains of knowledge, including subject matter and information literacy knowledge. Hara (1996) found integrated information literacy instruction more effective than both (1) no instruction and (2) non-integrated instruction. Although studies have illuminated the general benefits of integrated instruction, school media specialists have to focus on more than the degree of integration when designing IPS learning experiences. Media specialists must also select and use instructional methodologies within integrated approaches, and those methodologies are usually

founded upon cognitive and/or sociocultural constructivist learning theory (Eisenberg, Lowe & Spitzer, 2004; Thomas, 2004).

Cognitive Constructivist Instructional Methodologies

There are many cognition-focused instructional methodologies currently operating within the general K-12 teaching/learning landscape such as: problem-based learning (e.g., Barrows & Kelson, 1993), resource-based learning (Beswick, 1977; Doiron & Davies, 1998; Haycock, 1991), anchored instruction (Cognition and Technology Group 1990, 1993), project-based learning (Blumenfeld et al., 1991), case-based reasoning (Kolodner 1993, 2006) and inquiry learning (e.g., Callison, 1986; Sheingold, 1986). Each methodology has its particular rules and requirements, and a full discussion of each methodology is beyond the scope of this article.

However, instructional methodologies are anchored by specific learning theories (e.g., cognitive and socio-cultural constructivism). Therefore, there is a body of common characteristics that transcend the strict boundaries of specific methodologies (Carey, 1998; Kirshner & Whitson, 1997) and provide insights into the ways that methodologies structure elements within learning environments. For instance, instructional methodologies that are anchored by cognitive constructivism usually situate IPS teaching/learning within the completion of ill-structured, authentic problems (e.g., Barrows & Kelson, 1993). Students within cognitive methodologies are expected to learn from their interactions with a range of resources (e.g., Breivik & Senn, 1998; Sheingold, 1986). Knowledge (both content and procedural knowledge) is developed through dynamic interaction with objects, environments and people (e.g., Jonassen, 2006). Student collaboration (e.g., Barrows & Kelson, 1993; Callison, 1986; Sheingold, 1986) and higher order thinking processes such as analytical, critical thinking and meta-cognitive skills are emphasized (e.g., Eisenberg, Lowe & Spitzer, 2004). Students are also required to make connections between previous knowledge and new knowledge (e.g., Eisenberg, Lowe & Spitzer, 2004), and they are viewed as active learners (e.g., Barrows & Kelson, 1993; Breivik & Senn, 1998; Callison, 1986; Sheingold, 1986), self-directed learners (e.g., Norman & Schmidt, 1992), self-reflective learners (e.g., Sheingold, 1986) and life-long learners (e.g., Schmidt & van der Molen, 2001; Schmidt et al., 2006).

There are also cognitive methodologies (called instructional models in school media literature) designed specifically to teach complex information literacy applications such as: the Inquiry Model (Sheingold, 1986), Free-Inquiry Model (Callison, 1986), Nine Step Model (Irving, 1985) and the Big6 (Eisenberg & Berkowitz, 1990). The Inquiry Model (Sheingold, 1986) is a methodology that is highly influenced by cognitive constructivism. Within the methodology, students learn information literacy—particularly research processes—through inquiry. According to Sheingold (1986), “inquiry is a complex process that includes formulating a [real-world] problem or question, searching through and/or collecting information to address the problem or question, making sense of that information, and developing an understanding of, point of view about, or ‘answer’ to the question” (p. 80). There are three important elements within the methodology: (1) motivation, (2) centrality of questioning, and (3) the meta-

cognitive aspects of inquiry (Sheingold, 1986). The Free Inquiry Learning model (Callison, 1986) is a methodology that views “school libraries as learner-oriented laboratories which support, extend and individualize the school’s curriculum” (ALA, 1984, p. 4). The methodology is founded upon Victor’s (1974) conceptualization of inquiry-based teaching/learning. Free Inquiry Learning has particular elements such as: (1) cycles of planning and strategy revision, (2) personalized student objectives and performance evaluations, (3) process-orientation, (4) question-orientation, (5) flexible scheduling, (6) student collaboration, (7) communication of research results, and (8) life-long learning. The Nine Step Model (Irving, 1985) is a methodology designed primarily for students/teachers in elementary schools. It was developed to guide students through the completion of a range of class-related assignments. The nine steps (or cycles) of the methodology are: defining tasks, considering sources, finding resources, making selections, effective use, making records, presenting work and assessing progress. The Big6 is one of the most influential information-focused methodologies in existence, and it has arguably reached best-practice status within the field. The methodology resembles Ann Irving’s (1985) Nine Step model discussed above; however, it is a little more straightforward. The methodology has six stages, which are task definition, information-seeking strategies, location and access, information use, synthesis and evaluation.

Sociocultural Constructivist Instructional Methodologies

Although school media specialists have traditionally used more cognitive-focused instructional methodologies within integrated approaches (Eisenberg, Lowe & Spitzer, 2004; Thomas, 2004), sociocultural methodologies are gaining ground in many K-12 areas of study (e.g., American Association for the Advancement of Science, 1993; Millar & Osborne, 1999; National Council of Teachers of Mathematics, 2000; National Research Council, 1996), and they offer great opportunity for IPS instruction. There are various sociocultural instructional methodologies that could be used within integrated approaches to IPS teaching/learning such as situated learning (Brown, Collins & Duguid, 1989; Lave & Wenger, 1991), cognitive apprenticeship (Collins et al., 1989), legitimate peripheral participation (Lave & Wenger, 1991), learning communities (Brown, 1992; Brown et al., 1994) and communities of practice (Lave & Wenger, 1991).

As for cognitive methodologies, there is a body of common characteristics that transcend specific sociocultural instructional methodologies. Across sociocultural methodologies, learning emerges from: (1) processes of active meaning making within a student’s mind, and (2) processes of enculturation into the disciplinary practices of literate people within a particular domain of study (Cobb, 1996). These methodologies also assert the idea that students should engage the social, material and procedural activities of professionals tied to K-12 disciplines (e.g., historians and information specialists) rather than learning the outcomes of those activities. Furthermore, students learn through their participation in authentic tasks, communities and contexts (Lave & Wenger, 1991). Tacit processes are made visible for learners for the purposes of observation, practice and reflection (Collins et al., 1989). Teaching strategies such as scaffolding, guiding participation, self-reflection and hypotheses testing are employed

(Collins et al., 1989), and educators guide student participation within their zone of proximal development (Vygotsky, 1978), which refers to a sphere of knowledge and skills that are just beyond the student's current ability level.

There are not many socio-cultural information literacy (IL) instructional methodologies that are designed particularly for school media settings. However, a few methodologies (e.g., Kuhlthau's Information Search Process) have very strong socio-cultural orientations. The Information Search Process (Kuhlthau, 1987; 1993) is an instructional methodology that emerged from a series of empirical studies which examined the information search process from the student's point-of-view (Thomas, 2004). The first study (Kuhlthau, 1983) attempted to: (1) illuminate the problems that high school students encountered during the search process, and (2) compare the findings to Kelly's (1963) theory of personal construction. The study used observation instruments, journals, interviews, flowcharts, student writings, timelines, search logs, and questionnaires to collect data on twenty-four seniors completing two separate research projects. Results indicated that students' information search processes resembled Kelly's (1963) process of construction, and the study generated a six-stage model of the information search process which illuminated the thoughts, actions and feelings commonly experienced by students. The model was verified through additional surveys (e.g., Kuhlthau, 1989) and longitudinal studies (e.g., Kuhlthau, 1988). The stages of the model are: task initiation, topic selection topic exploration, focus formulation, resource collection and presentation. In 1993, Kuhlthau embedded Vygotsky's (1978) concept of zones of proximal development (ZPD) into her methodology which shifted it more along the socio-cultural end of the constructivist continuum.

Summary

A collaborative effort—between media specialists and other disciplinary educators—to integrate IPS content and practices within ongoing classroom instruction is currently considered a best-practice. When designing IPS learning experiences media specialist must select and employ instructional methodologies to mediate teaching/learning. Instructional methodologies that are suitable for IPS instruction are usually founded upon cognitive and sociocultural learning theory, and there are many methodologies currently operating within the general K-12 instructional landscape. Each methodology has particular rules and requirements that structure elements within learning environments. The surface level similarities between the methodologies assign similar labels to elements within learning environments such as teachers and students; however, different methodologies inscribe distinct meanings within labels that could engender distinct interactions, activities and relationships during the teaching/learning experience. Furthermore, the type of information literate student that emerges from particular methodologies is shaped, in part, by those distinct activities, interactions and relationships. Much of the literature on IPS instruction focuses on instructional design issues (e.g., instructional planning) and manifestations of student achievement after instruction (e.g., test scores). There is less focus on the ways in which different

instructional methodologies mediate dynamic interactions and relationships during instruction.

Research Design

This study examined dynamic teaching/learning relationships within two IPS instructional methodologies: problem-based learning within a face-to-face learning environment and participatory simulation within a computer-based environment. Specifically, four classes (two problem-based and two participatory simulation) were viewed as teaching/learning systems, and the study examined how the different instructional methodologies mediated the interactions, activities and relationships between elements within the systems. Participant observation—coupled with the central tenets of activity theory—was employed to record and describe the broad patterns of dynamic interactions and relationships that were mediated by each instructional methodology. Portfolio analysis was employed to corroborate or eliminate patterns identified from observations.

Participants

This research study was conducted within a middle school setting. The study was the second phase of a previous rapid design ethnography (i.e., Newell, 2004); therefore, the research site (middle school) was already predetermined. For this phase of the study, a school media specialist and technology teacher was recruited using purposeful sampling. Recruiting the technology teacher and her classes were of great importance because 1) the school envisioned the computer classes as primary sites for information literacy instruction, and 2) computers were needed for the computer simulation.

Students enrolled in the technology classes were also recruited for the study. The technology teacher had four classes. The classes were randomly assigned to the instructional methodologies (problem-based instruction and participatory simulation). The problem-based group was composed of 27 students (twelve 7th grade and fifteen 8th grade students), and the participatory simulation group was also composed of 27 students (eleven 7th grade and sixteen 8th grade students).

Observation Protocol

An activity theory framework was used to structure observations during the research study. Activity theory (AT) views interactions and learning as dynamically interrelated and embedded within a socio-cultural context (Jonassen & Rohrer-Murphy, 1999; Leont'ev, 1972). Therefore, within this theoretical perspective, information problem-solving learning emerges from rich interactions, activities and relationships. AT focuses upon the object-oriented, artifact-mediated, collective activity system as its unit of analysis, and it (AT) allows for the collective elements within learning environments to be viewed as an activity system (Engestrom, 1999).

The minimum elements of any system consists of objects, subjects, mediating artifacts (signs and tools), rules, communities and divisions of labor (Engestrom, 1999). *Objects* refer to the socially distributed and collective purposes of activity within a

system. Following the logic of Kutti (1996), an object can be a material thing, but it can also be less tangible (such as a curricular goal) or totally intangible (such as a common idea) as long as it can be shared for manipulation and transformation by the participants of the activity. All activity systems—including learning environments for information problem-solving—attempt to transform their object(s) into outcomes, which refer to the materializations of object-oriented activity. Subjects are agents that participate in the transformation of the object(s), and they combine to form a community of agents in collective activities. The idea of artifact mediation is central to activity theory. According to the theory, artifacts (such as instructional methodologies) mediate the subject/community's transformation of the object into desired outcomes. Artifacts can range from physical tools (e.g., technological instruments) to nonphysical tools (e.g., language, procedures and methods). System elements do not exist and operate in isolation; instead, any activity system—including learning environments for information problem-solving—is defined by the dynamic and continuous interactions/relationships within, between and among its elements (e.g., subjects, communities, objects, mediating tools, rules and so on).

AT provides a powerful gaze for interrogating how subjects and communities interact with/within mediating artifacts (i.e., instructional methodologies) to transform objects into outcomes (i.e., literate students in the domain of information problem-solving). It also provides a framework for generating rich descriptions of activities and transformations that occur and gives greater insight into the type(s) of learners that emerge from particular mediated learning environments.

The framework was used to generate rich descriptions of activities, interactions, relationships and transformations that occur within the different learning environments. I spent four weeks observing the complex interactions within the two different learning environments/activity systems. The school operated on an A/B schedule, which means that classes meet every other day. Therefore, over the 4-week period, both groups met 10 times with each class lasting an hour. I was able to make observations and collect data about the dynamic relationships among students, educators, tools, objects, contexts and information learning that were mediated by the instructional methodologies. Field notes were continuously recorded as activity units because the AT observational form guided the classifying and grouping of notes in the field. As notes were generated, they were read and reread to identify dynamic patterns of interactions and activity, and in most cases, students' work samples were used to corroborate or eliminate the identified patterns.

Student Portfolios

Guided portfolios were used to capture students' actions/activities during the information problem-solving process. The term "guided" refers to the fact that these portfolios were not simply folders filled with work samples after the four-week implementation period. Instead, the portfolios facilitated the collection of student IPS actions/activities within seven areas: task identification, search strategy initiation, information location/access, information evaluation, information use, information

communication and problem-solving product/process evaluation. The portfolio document was printed out for students before the instructional periods began. The documents had twenty different sections, which represented the 20 required tasks for the four-week period (at least one task per day), and each sections had seven sub-sections that were designated spaces for recording IPS actions/activities. When possible, student portfolios were used to corroborate or eliminate patterns identified from observations. For example, if field notes suggested that students were not fully engaging the practice of task identification, then portfolios could be used to corroborate that data.

Instructional Methodology A: Participatory Simulation

Instructional methodology A was a computer-based participatory simulation (see Figure 1), and it was the result of a rapid design ethnography, which attempted to extend instructional role possibilities for school media specialists (Newell, 2004). Participatory simulations (PS) attempt to educate students through goal-oriented, student-professional interactions within authentic contexts, and there are various models of participatory simulation that are based on slightly different social learning theories (e.g., Donahue et al., 1998; Rock & Lauten, 1996; Rock & Lawless, 1997). The design of this particular PS methodology was largely influenced by cognitive apprenticeship theories. Moreover, the PS methodology used in this study situated students within a computer-based, virtual reality environment and students learned information problem-solving knowledge/practices by engaging authentic information-oriented tasks as apprentices to information professionals. The PS methodology had the following characteristics:

Goal. The instructional goal was to develop students' IPS knowledge/practices using simulated experiences, interactions and communities of practices.

Teaching/Learning Context. All teaching and learning actions/activities occurred within a 3D computer-generated context, which consisted of a middle school library (see Figure 2), high school library (see Figure 3), informal information environments such as homes (see Figure 4) and electronic environments (see Figure 5). The various contexts were designed to represent a small community/town; in other words, students could virtually walk from the middle school library to the high school library within the 3D simulation. Furthermore, the 3D simulation technology enabled the construction of personalized student/instructor avatars (virtual representations of students and instructors within the simulation), which provided learners with a virtual presence and added an extra dimension to the simulated experience. The technology also enabled the construction of simulated information objects and resources such as books, computers, televisions and people. Both the simulated objects and environments were interactive and responded to the participant's actions (e.g., the computers worked and student avatars could use many of the books within the space). Within the 3D simulation environment, students could 1) move and interact freely and collaboratively using avatars, 2) communicate using chat features and gestures and 3) use a variety of information objects, artifacts and resources.

Figure 2. Screen shot of the middle school library with the computer simulation

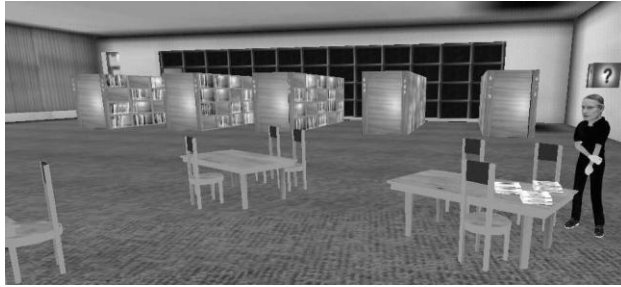


Figure 3. Screen shot of the high school library with the computer simulation



Figure 4. Screen shot of an informal information environment with the computer simulation



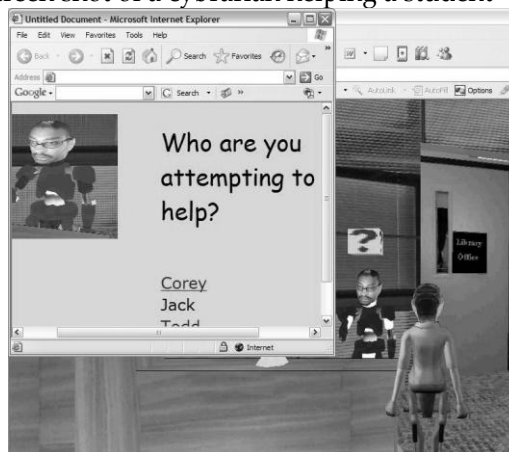
Figure 5. Screen shot of a student accessing an electronic resource within the computer simulation



Learning Process. Within the methodology, students learned IPS practices as they engaged simulated, information-oriented problems as burgeoning members of the information profession (Lave & Wenger, 1991). That is, students learned practices by actively participating as information literacy (IL) apprentices within a computer-generated community of practice (CoP) composed of the school media specialist, technology teacher and cybrarians—computer-generated librarians placed within the simulation to share knowledge, practices and to answer questions (see Figure 6).

This CoP represented a group of expert practitioners bound by: (1) a common task of educating students, (2) a shared set of IL standards, and (3) a common understanding of IPS best-practices. The purpose of the CoP was to share knowledge and practices with students during the instructional process. As IL apprentices, students consulted the librarians (both live and preprogrammed) and assisted them in meeting the information needs of other computer-generated characters within the simulation using novice problem-solving knowledge and practices (Wenger, 1998). All information-oriented problems emerged from computer-generated characters needing help, and through participation, students' IPS practices could develop (from novice to master). As students learned through active participation, the CoP aided student development using instructional scaffolding, which existed in the form of tutorials (Gee, 2007), information on-demand (Gee, 2007), just-in-time pop-ups (Gee, 2007), coaching (Collins et al., 1989), modeling (Collins et al., 1989), exploration (Collins et al., 1989), questioning (Gallimore & Tharp, 1990) and cognitive structuring (Gallimore & Tharp, 1990). Cognitive structuring refers to process frameworks that help students structure: (1) the stages of information problem-solving, and (2) thinking strategies related to the different stages. The stages were task identification, search strategy initiation, information location/access, information evaluation, information use, information communication and problem-solving product/process evaluation.

Figure 6. Screen shot of a cybrarian helping a student



Tasks Context. All information-oriented problems emerged from computer-generated characters needing help with authentic information problems. The tasks are embedded with: (a) subject matter ranging from daily life (e.g., using the Internet to find

the fastest route to work by train) to academic work (e.g., helping community members with homework and research projects); (b) multiple information domain areas of focus such as access, evaluation and use; and (c) task structures ranging from well-structured problems (e.g., location and differentiation) to less-structured problems where problem identification, collection, organization, integration, evaluation and use of information are emphasized. The initial development of all instructional/learning tasks was preformed by the researcher using a variety of information literacy and information problem-solving textbooks/articles. The school media specialist and technology teacher reviewed and augmented all tasks before the study was conducted. They also added tasks during the augmentation period.

Student Portfolios. As students engaged each task, their actions/activities were recorded using guided portfolios. Using designated spaces in the portfolios for each information-oriented problem, students were required to detail their actions/activities in seven IPS areas: task identification, search strategy initiation, information location/access, information evaluation, information use, information communication and problem-solving product/process evaluation.

Instructional Methodology B: Problem-Based Instruction

Instructional Methodology B was a problem-based approach conducted within a face-to-face context. Problem-based instruction (PB) is a methodology that enhances students' content and procedural development within the context of solving authentic, ill-structured problems (e.g., Barrow, 2000; Dochy et al., 2003; Hmelo et al., 2000; Torp & Sage, 2002), and it has been employed within a number of different disciplines such as: information studies (e.g., Newell, 2008), law (e.g., Segers, 2001), curriculum and instruction (e.g., Oberlander & Talbert-Johnson, 2004), biology (e.g., Szeberenyi, 2005) and chemistry (e.g., Barak & Dori, 2005). Problem-based learning is based on constructivist learning theories; therefore, it is assumed the knowledge is constructed (individually and socially) and tied to specific, real-world contexts/tasks. The PB methodology had the following characteristics:

Goal. The instructional goal was twofold. The first goal of was to teach students about the many ways that technology can be used in everyday life. The second goal was to teach IPS through authentic, ill-structured classroom activities. This dual goal was illuminated during educator planning sessions that focused on representing both domains of knowledge—technology and information.

Teaching/Learning Context. All teaching and learning actions/activities occurred within a real-world, formal educational context. The real-world context consisted of a computer lab, middle school library and all of the information objects/tools within them (e.g., library catalogs, books, computers, websites and search engines). The middle school, library media center and computer lab were connected,

and the computer lab housed enough computers for each student to have his/her own during the learning periods.

Learning Process. Within the methodology, the educators designed instructional opportunities that required students to enhance IPS development by engaging authentic, complex problems with uncertain and multiple information-solutions (Blumenfeld et al., 1991). These instructional opportunities were designed to emphasize student driven question formulation, multimodal information searching, use of information artifacts (e.g., books and computers), sense-making and information use (Blumenfeld et al., 1991; Callison, 1986; Sheingold, 1986). All instructional opportunities had to culminate in concrete demonstrations of problem-solving practices (Blumenfeld et al., 1991; Callison, 1986). During instruction, the technology teacher and school library media specialist were inscribed the role of learning directors, which means that the educators structured, supported and guided student-constructed understandings and products (Blumenfeld et al., 1991; Callison, 1986). The methodology was also highly influenced by the concept of inquiry-learning, which constructs students as self-reflective learners in a meta-cognitive sense (Sheingold, 1986). Furthermore, students were viewed as active learners who are motivated by the real-world nature of problems and multimodal information contexts (Sheingold, 1986) and who use prior knowledge in the personal construction of information-solutions to problems. Within the instructional methodology, learning had a collaborative nature, and students are required to form micro-communities (teams of two) during the completions of tasks (Bransford & Stein, 1993; Callison, 1986). As students engaged in tasks, they used the same cognitive structuring framework employed within the PS methodology to guide them through the stages of information problem-solving and the thinking strategies related to the different stages.

Task Context. The technology teacher and school media specialist decided to design a technology focused unit of study that embedded IPS lessons into the class activities. The title of the unit was *Applied Computer Skills*, and the general purpose was to overview how technology can be used in everyday life. The educators, surprisingly, began the construction of this unit by examining the 3D simulation tasks to determine the primary technological applications and problem-solving processes used. For example, many simulation tasks required students to search for websites, watch/listen to online videos and search catalogs; therefore, the educators designed the unit with daily lessons focusing on those technologies and processes. Next, the educators took the 3D simulation tasks and restructured them into problem-based learning problems to be used as integrated classroom activities that supported the daily lesson. The educators decided to use the 3D simulation tasks to ensure that students within both learning methodologies experienced the same content and similar activities.

Student Portfolios. As students engaged in each task, their actions/activities were recorded using guided portfolios. Using designated spaces in the portfolios for

each problem, students were required to detail their actions/activities in seven IPS areas: task identification, search strategy initiation, information location/access, information evaluation, information use, information communication and problem-solving product/process evaluation.

Results

This section (1) illuminates the major interaction and relationship patterns observed during the first two weeks of instruction, and (2) provides a narrative of typical student activity as the learning environments stabilized during Week 4.

PB Instruction: Relationships, Interactions and Transformations during Weeks 1&2

During the first two weeks of problem-based learning (PB), five major relationship patterns were identified (see Table 1). First, a conflict relationship between 93% of students and the ill-structured delivery of problem scenarios was identified. Second, a high level of direct instruction and IPS modeling emerged in response to the students' conflict with the structure of problems scenarios. Third, a positive relationship between 100% of students and many aspects of the PB methodology emerged. Fourth, 100% of students experienced a conflict with the classroom context. Fifth, 78% of students began to deviate from the process framework for IPS, and the deviation caused a transformation in both student activity and the object of the learning system.

Table 1. PB Instruction: Relationships, Interactions and Transformations during Weeks 1&2

Themes
1. Initial conflict relationship between students and problem structure
2. High level of educator facilitation in the form of teaching and modeling
3. Positive relationship between students and instructional methodology
4. Conflict relationship between students and real-world context
5. Transformation of the information object and student activities from process-oriented work to product-oriented work

PS Instruction: Relationships, Interactions and Transformations during Weeks 1&2

During the first two weeks of participatory simulation learning (PS), seven major relationship patterns were identified (see Table 2). First, 100% of students experienced the same initial conflict relationship with the ill-structured problems that were observed in the PB learning environment. Second, a very high-level of student-cybrarian interaction emerged in response to the students' conflict with the structure of problem scenarios. Third, 98% of students did not initially interact positively with the 3D simulation context that recreated a seemingly infinite information space. Fourth, a

conflict relationship between 98% of students and the PS approach to learning emerged. Fifth, a positive relationship between 100% of students and the problem-solving script (IPS process framework) was observed. Sixth, 67% of students began to deviate from the IPS script, which caused a transformation in cognitive mediation and activity. Seventh, unintended patterns of student collaboration developed outside of the simulation environment.

Table 2. PS Instruction: Relationships, Interactions and Transformations during Weeks 1&2

Themes

1. Initial conflict relationship between students and problem structure
 2. High level of student-cybrarian interaction for the purpose of equipping students with needed cognitive tools
 3. Initial conflict relationship between students and the computer-generated context, which recreated a seemingly infinite information space
 4. A conflict relationship between students and the socio-cultural approach to learning by doing
 5. Positive initial relationship between students and the problem-solving script (process framework)
 6. Student deviation from the information script, which caused a transformation in cognitive mediation and activity
 7. Unintended patterns of student collaboration developed *around* the simulation environment
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Discussion

It is important to note that the first two weeks of both mediated learning environments were illuminated as periods of instability because during that period: (1) students experienced conflict interactions with other learning system elements, (2) system elements (e.g., educators) responded to negative interactions, (3) positive interactions were strengthened through time and experience, and (4) the learning environments experienced transformations.

PB Instruction

As stated above, five major relationship patterns and system responses were identified during the first two weeks of PB instruction. First, a conflict relationship between students and the ill-structured delivery of problem scenarios was identified. Moreover, students displayed a violent reaction to the problem structure which did not specifically state—in a step by step and linear sequence—what the problem was and how to solve it. The phrase *violent reaction*, of course, does not refer to any physical or verbal threats made by the students; instead, it refers to a very immediate and negative reaction

engendered by encountering an unfamiliar, information problem-based structure. Although the problems were stated in very clear and age appropriate language, students frequently stated, "I don't know what I am being asked to do."

It seems that the constructivist rule of structuring problems in an ill-structured format (e.g., Carey, 1998) conflicted with the school's unstated rule—which was implicitly stated and largely practiced as a norm—of providing very clear, straightforward and concise delivery of tasks to students. Therefore, students had a severe conflict—at the level of mediation—as constructivist rules inscribed a new and confusing structure to information problems.

Second, a high level of direct instruction and information problem-solving modeling emerged in response to the students' conflict with the structure of problems scenarios. The educators initially planned to aid students in the development of information problem-solving literacy using a coaching and guiding role, which is promoted as best-practice in the K-12 information literature (Thomas, 2004). However, due to the students' conflict with the problem structure, the educators were forced to employ a very high level of facilitation during the first week of learning. This level of facilitation is not entirely foreign within K-12 information literature. For example, many scholars encourage direct instruction when necessary (e.g., Kuhlthau, 1987; Means & Olson, 1994) and when teaching the overall process of information problem-solving and/or research (Eisenberg & Berkowitz, 1990). Direct instruction seemed to be a necessity in getting students to the point where they could be coached, and it appeared to be very effective in illuminating the knowledge structure of information problem-solving to students.

Third, a positive relationship between students and many aspects of the problem-based instructional methodology emerged. Students became very familiar with aspects such as working in teams of two and teachers' initiating activities after brief lessons.

Fourth, students experienced a conflict with the classroom context. During the initial planning process, the technology teacher and the school media specialist did not fully realize how many of the simulation tasks—which had been converted into integrated problem-based activities—required information from various information landscapes such as a high school library. After the educators made that realization, they had to borrow the materials from the high school library, and they were also required to allow students to frequently go to the middle school library. However, rules were in place that only allowed one team to enter the middle school library at a time. Although those rules were being implemented to better monitor students and to reduce foot traffic, they also frustrated teams who were waiting for their opportunity to enter the middle school library. If one team was using an extended resource that another team needed at the same time, they were forced to wait on the first team to finish, which made one team feel rushed and the other idle. This context surrounded all scenarios that required extended resources, and it constrained—and in some cases redefined—problems by restricting the physical context of the problem and subjecting students to access restricting/delaying rules.

Fifth, students began to deviate from the process framework for information problem-solving—which is a chain of information practices—and the deviation caused a transformation in both student activity and the object of the learning system. For example, during the first few days of problem-based mediated instruction, students actively engaged in a string of problem-solving practices (or framework)—task definition, information identification, skills identification, multimodal resource identification, information evaluation/section, information organization/communication and information application—as they attempted to solve information-oriented problems. By the end of the first week, students began to deviate from the information problem-solving process, and the deviation caused a transformation in both student activity and the object of the learning system.

In activity theory, *activity* refers to the conscious performance of a chain of actions/practices used to accomplish objects. In the beginning of Week 1, students consciously employ an information problem-solving chain of practices (i.e., task definition, information identification, information skills identification, multimodal resource identification, evaluation, selection, organization, using information and process reflection) to accomplish the object of problem-solving literacy development. Toward the end of Week 1, students prematurely attempted to collapse problem-solving practices into problem-solving operations; however, according to activity theory this collapse can only occur over time with experience and internalization of practices. The problem-solving practices had not reached a point where they became operations, which is the point where they become automatic and less conscious. Instead, many practices were being cut from the information problem-solving equation, and this transformation in activity also affected the object of the problem-based learning system. Moreover, by not engaging all information problem-solving practices, students seemed to focus less on the process of information problem-solving and more on the generation of products. In other words, they became more product-oriented and less process-oriented. According to the initial/planned object, students were to work toward higher levels of information problem-solving literacy while developing processes and generating products. The students' move toward higher levels of literacy was to be accomplished through highly collaborative teams, real-world problems, information tools, information processes and information practices. However, students began to focus more upon a quick solution (product) generated outside of the problem-solving framework and its practices, which transformed the object of activity within the mediated learning environment. The new object from the students' point of view became the use of technology to generate a quick product for the scenario.

Student collaborations—between the middle of the 1st and 2nd week—were also transformed by the PB students. However, collaborative interactions did not reflect the collaboration patterns noticed during the first few days of implementation. During the first few days of problem-based learning, labor was shared, which meant that information problem-solving practices were joint ventures, and both students within the teams of two worked toward the completion of each practice together (e.g., brainstorming about problem definition and the identification of needed information).

However, by midweek, labor began to be increasing distributed according to students' strengths. Within groups, students did not engage in practices (e.g., task identification) that they were not comfortable with.

The end of Week 2 brought a reinforcement of the initial focus. In a problem-based planning meeting, during the middle of Week 2, the technology teacher stated, "Our groups can perform information problem-solving without thinking about it," and the researcher had to explain that it was not possible for the information practices to have been so quickly internalized and that field data did not indicate that the functional level of information problem-solving—which is the level of conscious performance of practices/actions—had become automatic and routine. After the meeting, it was agreed that the initial object must be re-centered and reinforced. Therefore, during the end of the second week, it was required that students either: (1) employ the provided information problem-solving practices, (2) find a different version of information problem-solving practices to use, or (3) develop and use practices/actions of a similar structure. Teams were also required to alternate roles if they decided to divide labor; however, the problem of context and access restricting rules could not be avoided because of supervision issues.

It was evident that the object was beginning to be re-centered by Week 3. However, an examination of the student reflections at the end of each problem activity revealed that they were still heavily product-oriented. Moreover, groups were observed *quickly* employing the practices, but during their required period of reflecting and documenting how they addressed the information problems, they started at the point when information was found and immediately moved to a point when information was packaged.

PB Instruction: Narrative of Typical Student Activity during Week 4

By Week 4, definite interaction and activity patterns emerged within the PB learning environment. For example, after the lecture—which was generally an overview of a technology application or problem-solving action—students would relocate into their teams of two. One student would walk to the activities table to retrieve a problem activity, which served as a mediating tool that was used by the team of two (micro-community) to work towards the object of literacy development. Upon returning to the team of two, one student would read the problem aloud, and at that point, three interactions would occur. First, the student reading the text was interacting directly with the mediating artifact (information problem) in a printed mode of delivery. Second, the other student was interacting with the mediating artifact in a verbal form, while also viewing the IPS practices to be performed. Third, both students were interacting with system rules stating that students must alternate the completion of IPS practices if they were dividing labor. Typically, students would then verbally articulate the division of labor—each taking two of the beginning four practices—and they would begin to quickly perform their assigned practices of task definition, information identification, information skills identification, and/or multimodal resource identification on separate pieces of paper. However, some groups verbally discussed and quickly answered each

practice together. The typical groups—the ones that divided labor—entered into a very brief review and communication period, after both students were finished, to share the conclusions of their IPS practices.

Next, students used their computers in one of two ways: (1) students would use one computer together, or (2) students would use individual computers. The use of one or two computers transformed the type of talk that emerged around computer use. For example, students using two computers talked more about what they found, and students sharing a computer negotiated on how and where to find the information. Also, if students were working on two separate computers, they would typically print out located information and shift all activity towards quickly making joint decisions concerning the best pieces of information to address the problem because many scenarios required students to link or weave together multiple pieces of information to solve a problem. However, if students were working together using the same computer, then linking/weaving was done continuously as new pieces of information were encountered. Students would use the information to address the problem, which usually took the form of a quick product (e.g., report, slides show, homework assignment, etc.), and they reflected upon the process used to solve the problem. The classroom was undoubtedly the context for learning. Students were asked to imagine that they were in a particular scenario or, better said, in a particular information need situation; however, no matter the problem activity, the classroom was the stage/backdrop/context/semiotic informational landscape for information problem-solving within the imagined situation.

PS Instruction

As stated above, six major relationship patterns and system responses were identified during the first two weeks of PS instruction. First, students experienced the same initial conflict relationship with the ill-structured problems that were observed in the problem-based learning system. However, in the simulation learning environment, a major relationship pattern among students, educators and cybrarians resulted from the students' conflicts with the structure of problems. Educators in this environment redirected the vast majority of student concerns to environmental cybrarians. These cybrarians served as mediating tools, which helped students understand the information problem-solving process and its practices. Unlike the problem-based learning environment, instructional mediation took the form of an apprenticeship instead of direct instruction, which is a very different type of instruction that embeds learning within activity and through enculturation (Brown, Collins & Duguid, 1989).

Second, students did not initially have a positive relationship with the simulation method of learning. The simulation learning environment was designed to decrease the distance between learning about information problem-solving and engaging in information problem-solving. The PS learning methodology was based on the view that information problem-solving can only be fully understood through use and that using information problem-solving processes will change learners' views of the world and engender his/her adoption of the social practices of the culture in which the processes are used (Brown, Collins & Duguid, 1989). However, students could not readily

understand how they could implement processes and practices without first acquiring the knowledge and skills during teaching sessions. During the first week of simulation instruction, it was very common for students to ask, "How are we supposed to do this if we don't know how?"

Third, students did not initially interact positively with the 3D simulation context which recreated a seemingly infinite information space. Students were confronted with what seemed to be too many options in respect to information environments and information objects. They frequently yelled, "I don't know what to do or where to go." They also frequently stood in the middle of a virtual information environment and said, "I am frustrated" and "This is hard." The school media specialist explained to students that, in reality, they are very small within very large information environments, and that they must explore and learn the environments. She also encouraged them to ask the cybrarians for processes that would help them navigate environments. The student reactions were consistent with the K-12 information literature on information overload (e.g., Akin, 1998) which illuminates how students respond when they encounter too many information resources and too much information. Akin found that middle school students reacted to information overload through vulgar expressions and expressions of stress, tension and panic, and they responded to overload by filtering and linking information. In the simulation learning environment, students initially reacted and responded in similar ways. They initially responded with verbal expressions of frustration, stress, tension and panic; however, they reacted by: (1) surveying information landscapes (e.g., libraries and homes) for the types of information and resources present and absent in each space, (2) obtaining and employing information seeking processes, (3) routinely using an expanded version of Akin's notion of filtering—meaning that students applied the practice of filtering to entire sections of information environments based on the task at hand—and (4) linking information.

In the simulation learning system, transformations also occurred in the areas of student activity and student collaboration. For example, during the first week, a positive and stable relationship was observed between students and information problem-solving practices. The complexity of the information universe within the 3D simulation and the tasks that required students to employ knowledge/practices that they did not possess, caused students to heavily rely upon the cybrarians for problem-solving processes and practices. However, the stable relationship between students and the problem-solving process quickly changed. During the middle of the second week, students began to deviate from the provided macro information problem-solving process, which caused a transformation in activity and practice. The noticeable transformation pattern began to emerge in the portfolio reflections and class session observations. Students began to augment the initial 7-stage process (i.e., task definition, information identification, information skills identification, multimodal resource identification, evaluation/selection, organization, and application of information) with an additional conscious chain of practices. The additional practices were: (1) defining the problem through a multimodal and keyword generating process, (2) questioning the

current information environment for needed information, (3) searching for different versions of information skills, and (4) thinking about resources that were not in their current environment. The typical course of events within activity systems is for actions—through experience and internalization—to collapse into operations, which is the automatic and almost unconscious performance of actions; however, within the simulation environment, the movement from conscious information practices to automatic (almost unconscious) operations was disrupted because of perceived limitations in the information problem-solving process/script and its chain of practices.

An unintended transformation of student collaboration also emerged during the second week. Shortly before implementation, I was asked to disable student-to-student collaboration in the simulation until students achieved a particular information literacy level/rating. The educators were afraid that initial collaborative capabilities within the 3D space would keep student off-task. The capabilities were disabled; however, unintended and very interesting patterns of student collaboration developed *around* the simulation environment. Students began to typically collaborate in groups of two, three or four, but in some cases—such as a student emailing his webpage evaluation process to everyone—the collaborative group consisted of the entire class. These collaborative groups did not divide labor; instead, they existed to share knowledge/practices and experiences. For example, it was common during the second week to observe groups of students planning to solve the same problem at the same time—notice that I did not say *together*. While solving the problem, students went through their own processes; however, they often shared practices and asked if anyone in the group had better approaches. They would also momentarily lean over to watch a member of the group perform a new/different practice. This pattern was also noticed in student portfolios. For example, it was common to see groups using the same new processes (e.g., new book, webpage, commercial and advertisement evaluation processes) and generating different answers, and the groups frequently asked that the new processes be programmed into the cybrarians.

By the middle of Week 2, it was evident that the simulation learning environment had stabilized. Students began to adjust to the structure of problems, the idea of learning by doing, and the many information environments within the 3D simulation. Adjustments primarily occurred through student exploration and experience, through the cybrarian's cognitive tools, and through the emerging patterns of collaborations. Furthermore, students' increased comfort levels were evident through the observations of the period. As one student stated, "It is still hard, but I am getting it."

PS Instruction: Narrative of Typical Student Activity during Week 4

By Week 4, definite interaction and activity patterns had emerged. For example, students were using their individual computers to enter the 3D simulation. Groups of two, three or four would then decide which computer-generated character they were going to help—in other words, they would decide which problem to complete. The group would then approach the character and click on the question mark above his/her

head. Students would then perform one of two actions. They would read (text) and listen (audio only) to the person's problem, or they would read (text) and watch (audio and animation) the community member as s/he communicated the problem. After the multimodal interaction, students would typically perform the problem-solving practice of defining. It was also very common for students to repeat the action of listening or viewing while they attempted to define the problem. The student groups did not often share their problem definition statements; instead, each student proceeded to the problem-solving practice of identifying the information needed. However, instead of simply identifying needed information, students also surveyed the virtual information landscape for access to the needed information. At this point, students within the groups began to talk, and the student talk revolved around the strengths and weaknesses of various landscapes in providing needed information. For example, it was very common to see students turn to each other and say, "I don't see any way that we could do that in here—you?"

Next, students completed the problem-solving practice of multimodal resources identification. As for the previous practice, immersive students usually augmented the action with an examination of resources not found in their current virtual environments. Moreover, students during the multimodal resources identification practice would discuss, identify, and target potential information formats across information environments. At this point, students would typically go to the cybrarian in groups to view tips, to do tutorials and to retrieve cognitive tools such as evaluation forms. However, a definite culture emerged—without prompting—within which student groups would actively seek and share different cognitive tools. The researcher asked a student why he used an alternative commercial critique process, and he responded, "This one was better and easier to follow." After securing—and, in most cases, sharing—the appropriate cognitive tools, students began to search resources to find the needed information, and they often shared strategies for searching types of resource (e.g., books, search engines, and electronic encyclopedias). Students then would analyze/select pieces of information and link the pieces together. Then, they would use the information to address the problem, which usually took the form of a product.

Conclusion

On the surface there is an apparent continuity between the implementation of an information literacy learning approach and the development of students that can: (1) identify an information need; (2) access, evaluate, analyze, synthesize and apply information; and (3) solve real-world problems in a variety of contexts using information literate processes. However, as we look past the superficial numerical nexus between learning approach implementation and student growth, it is clear that learning mediated by different instructional methodologies is distinct, and that these distinct methodologies have the potential of constructing particular types of information literate learners.

While there are surface level similarities between different types of instructional methodologies that have similar system elements (e.g., information literacy object,

student, educators and so on), the distinctions in respect to inscribed interactions between/among elements may be profound. The data from this study suggest that the type of information literate student that emerges is shaped, in part, by the distinct interactions, relationships, transformations and stabilizations within mediated learning environments.

Due to distinct interactions and relationship patterns, the PB environment stabilized as a product-oriented environment. Groups of students were observed employing—quickly employing—the IPS practices, but during their required period of reflecting and documenting how they addressed the problem, they started at the point when information was found and immediately moved to a point where information was packaged. PB students seemed to approach the practices as something that they were forced to do—which they were—not as needed processes to successfully address the scenario. Similar to students in other studies (e.g., McGregor 1994; Pitts 1995), the PB students seemed to view the IPS processes as meaningless hurdles to be rushed through. This attitude seemed to be caused, in part, by the PB learning context because no matter the problem activity, the classroom computers constituted the primary stage/backdrop/context/semiotic informational landscape for information problem-solving within the imagined situation. It was very hard to get PB students to focus on the process when the answers were *seemingly* at their fingertips. Instead, the PB students focused on the completion of as many scenarios as possible within the class period.

Due to distinct interactions and relationship patterns, the PS learning environment stabilized as a more process-oriented system. The process orientation is believed to be the result of: (1) the conflict relationship between students and the ill-structured task format, which required students to heavily rely upon cybrarians to explain IPS processes; (2) the conflict relationship between students and the 3D simulation context that recreated a seemingly infinite information space and forced students to rely upon information processes to understand, navigate and use the many information environments and artifacts within the space; and (3) the culture of sharing knowledge, practices, processes and experiences that emerged among simulation students.

This study has many implications for the field. It will undoubtedly extend current discussions on information literacy learning and engender many future research studies. The results from this study suggests that it is no longer possible to think about IL learning/teaching in isolation from the dynamic interactions and relationships within, between and among the elements of mediated learning systems. The findings of this study suggest the need to illuminate the mediated interaction and relationship patterns within IL learning environments that employ different instructional methodologies. The field must also reexamine learning environments to determine if/how they stabilize and if the learning opportunities really allow enough time for students to learn practices and develop identities.

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