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Examining Information Problem-Solving, Knowledge, and Application Gains within Two Instructional Methods: Problem-Based and Computer-Mediated Participatory Simulation

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This study compared the effectiveness of two instructional methods—problem-based instruction within a face-to-face context and computer-mediated participatory simulation—in increasing students' content knowledge and application gains in the area of information problem-solving. The instructional methods were implemented over a four-week period. A two-group, pretest–posttest, randomized control design coupled with an independent sample t-test on learning group gains was used to examine effectiveness. The results of this study show that the simulation group experienced significant overall (which refers to combined knowledge and application abilities) gains from pre–implementation to post–implementation (T = 1.852, p = .04); however, as we divide overall development into its constitutive parts, the results su6(s)1a2(he)41(s).angJ 0.6(e)4(l)-h2(ts)t41(*

subject matter and IL knowledge. Hara (1996) found integrated IL instruction more effective than both no instruction and noncontextualized instruction.

It is currently best practice to use process frameworks in conjunction with integration and instructional methods (Thomas 2004). Process frameworks are user-centered, cognitive frameworks that focus on strategies for thinking during research and problem-solving activities (Thomas 2004). Examples of process frameworks include the Inquiry Model (Sheingold 1986), Information Search Process (Kuhlthau 1988), Big6 (Eisenberg and B*   BT4(onj)-2(0002 T3 s 0.33 0 Td   [ni)-1/
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practices. The researchers also found that twenty-seven of the sixty-seven studies concluded instruction-as-gaming to be more effective then instruction within traditional practices. Other empirical research studies show that gaming approaches are just a effective as traditional teaching approaches in teaching basic math and reading comprehension skills (Rosas et al. 2003; Laffey et al. 2003), mathematical problem-solving skills (Van Eck and Dempsey 2002), basic logic (Costabile et al. 2003), geographical content knowledge (Wiebe and Martin 1994; Virvou, Katsionis, and Manos 2005), and vocabulary skills (Malouf 1988). The gaming and learning literature has also illuminated particular affordances associated with these learning environments such as the development of critical thinking skills (Rieber 1996), problem-solving skills (Rieb-4(()3(W)ca 0 T

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

Within the participatory simulation, students learned information problem-solving practices through simulated experiences, interactions, and communities of practices. Moreover, students learned problem-solving practices by actively participating as IL apprentices within a computer-t ntsnommsnosnommt| wough s(2T1ji)-2(on pr)3(ofD)lf 94(om)e4(om)e4(om)4(p1(i)-a(on pr)3(ofD)lf 94-TJ used in the construction of tasks. However, the SLMS and the technology teacher, within the research site, reviewed and augmented all tasks a month before the study was conducted. Tasks were also added by the educators during this period.

Problem-Based Instruction within a Face-to-Face Context

As stated above, it is currently best practice to teach information problem-solving using an integrated instructional approach coupled with an instructional method and process framework (Thomas 2004; AASL and AECT 1998). Staying true to the integrated approach, the technology teacher and information specialist decided to design a technology-focused unit of study that embedded information problem-solving 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 participatory simulation tasks to determine the primary technological applications and problem-solving processes used. For example, many simulation tasks required students to search for websites and watch and listen to online videos and search catalogs; therefore the educators designed the unit with daily lessons focusing on those technologies and processes. Second, the educators took the 3D simulation tasks and restructured them into problem-based learning situations to be used as integrated classroom activities that supported the daily lesson. The educators decided to use the simulation tasks to ensure that students within both learning environments experienced the same content and similar activities.

The educators employed the use of a problem-based instructional method and a generic process framework. Within the problem-based method the educators designed instructional opportunities that required students to learn information problem-solving by engaging real-world, complex problems with uncertain and multiple information solutions (Blumenfeld et al. 1991). These instructional opportunities emphasized student-driven question formulation, multimodal information searching, use of information artifacts (e.g., books and computers), sense-making, and multimodal information use (Sheingold 1986; Blumenfeld et al. 1991; Callison 1986). Furthermore, all instructional opportunities culminated in concrete demonstrations of problem-solving practices (Blumenfeld et al. 1991; Callison 1986). During instruction, the technology teacher and information specialist structured, supported, and guided student-constructed understandings and products (Blumenfeld et al 1991; Callison 1086), and as students engaged tasks, students used a generic process-oriented framework that guided them through the stages of information problem-solving and thinking strategies related to the different stages. The method also infused aspects of inquiry-learning. For example, students were viewed as self-reflective learners in a meta-cognitive sense, which refers to "knowing about [himself or herself] and other people as knowers, knowing about the task to be undertaken, knowing what strategies to apply to the task, and how to monitor one's own performance with respect to the task" (Sheingold, 1986, 84). The students are also viewed as active learners that are motivated by the real-world nature of problems and multimodal information contexts and learners that actively use prior knowledge in the personal construction of information solutions to problems (Sheingold 1986). Within the instructional method, students were also required to work in teams of two during the completions of tasks (Callison 1986; Bransford and Stein 1993). The face-to-face teaching and learning context consisted of a computer lab, middle school library, and all of the information objects and 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 or her own during the learning periods.

was then graded and removed to ensure a blind review. The researcher also graded the problem-solving activity portion of the tests, and the SLMS and technology educator were asked to review all assigned problem-solving grades for rater reliability purposes. The goal was to achieve 100 percent agreement on grade assignment; therefore all rating discrepancies were discussed and agreement was achieved through rating clarifications or grade modifications. (See appendix B for the scoring guide.)

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Analysis

Each of the three hypotheses was tested using independent sample t-test comparing student gains from pretest to posttest.

- *Hypothesis 1*. The first hypothesis stated that the PS learners would have significantly higher overall mean gain scores from pretest to posttest. Hypothesis 1 was supported. There was a significant difference (T = 1.852, p = .04*) between the overall PB and PS gains after the 4-week implementation period (see table 1).
- *Hypothesis 2*. The second hypothesis stated that the PS learners would have significantly higher mean gains scores on the knowledge section from pretest to posttest. Hypothesis 2 was not supported. There was a significant difference but not in the direction anticipated. The PB learners experienced significantly larger knowledge gains (T = -3.664, p = .00*) after the 4-week implementation period. Furthermore, data suggests that the PS students made no knowledge gains during the 4-week period (see table 2).
- *Hypothesis 3*. The third hypothesis stated that the PS learners would have significantly higher mean gains scores on the application section from pretest to posttest. Hypothesis 3 was supported. There was a significant difference (T = 3.873, p = .00*) between the PB and PS application gains after the implementation period (see table 3).

Table 1. Results for Hypothesis 1

Entire Information Literacy Test	**Problem-Based Group (N=27)**		**Simulation Group (N=27)**		**T**	**Significance**
	M	**SD**	**M**	**SD**		
Gain Score	2.1482	8.498	16.963	10.505	1.852	.04*

Table 2. Results for Hypothesis 2

Knowledge Section of Test	**Problem-Based**

Conclusion

We should not take an either/or approach to IL instruction; instead, we must expand our range of instructional approaches on the basis of effectiveness and affordances. The PB method coupled with a high level of direct and dynamic instruction seems to be very effective in presenting content knowledge, and the PS method coupled with scaffolding, CoP, and process frameworks seems to be very effective in teaching the application of IL practices. Both approaches should be used to develop the type of information-literate students that our field desires. However, we must attempt (via research studies, learning theory, and instruction systems technology) to decrease the affordance gap between the two approaches. For example, the findings of this study suggests that learning within the two approaches is distinct and that the two approaches have the potential to construct distinct types of information-literate learners (i.e., learners skilled in content knowledge and learners skilled in the application of information practices). Research studies that attempt to illuminate dynamic activity patterns within IL learning approaches are needed to give greater insight into student learning and instructional affordances and to generate design recommendations that could decrease the distance between affordances tied to particular instructional approaches.

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