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Teacher Knowledge about Technology Integration: An Examination of Inservice and Preservice Teachers' Instructional Decision-making

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ABSTRACT This study compared the abilities of inservice and preservice teachers to demonstrate an understanding of technology integration and to apply such knowledge to instructional decision-making. Using a set of online content-specific multimedia scenarios to resolve complex problems of teaching with technology in a simulated school environment, inservice teachers outperformed preservice teachers on criteria measuring practical and pedagogical content knowledge about technology integration; however, preservice and inservice teachers scored similarly in their ability to make an instructional decision about technology. In addition, both preservice and inservice teachers demonstrated a lack of weighing competing options in the case and a lack of orientation toward reflective and adjustable practices. Overall, inservice teachers demonstrated consideration of a broader range of classroom- and school-level factors in making a technology integration decision. Understanding, capturing, and measuring these differences is essential to advance theory on the dimensions of technological pedagogical content knowledge, and how it develops in different teacher sub-groups to advance the work of teacher educators concerned with designing courses about technology integration appropriate to learners' needs.

KEYWORDS: Teacher education, teacher knowledge, technology,

Technology Integration Factors

Skillful teaching is demanding, and integrating technology into teaching and learning places additional demands on teachers, requiring them to learn how to operate the technology and transfer that technology knowledge into applicable educational uses in their content areas, such as, using software-generated simulations in science to improve students' work by deepening their thinking about complex scientific concepts (Gordin & Pea, 1995; Jonassen, 2000). Past studies of how teachers use technology to enhance students' learning in a subject area suggest the importance of several factors in instructional decision-making about technology integration. Specifically, teachers should (1) consider learning outcomes for students; (2) determine how technology supports or enhances teaching, learning, and assessment; (3) consider access to and availability of technology resources and technical support; (4) participate in ongoing staff development experiences targeting technology integration; and (5) interact with colleagues around technology-related issues (Becker & Ravitz, 1999; Dexter, 2002; Greenhow, 2006; Greenhow, Dexter, & Reidel, 2006; Sandholtz, Ringstaff & Dwyer, 1997; Windshitl & Sahl, 2002). This research suggests that considering these five factors can aid successful technology integration and that teacher educators ought to design experiences that help their students attend to these factors, as they learn to use technology as an instructional support.

Need to Define Technology Integration Knowledge among Teacher Sub-groups

While past research has contributed to our knowledge of what successful technology integration looks like and what factors facilitate technology integration, the field of educational technology and teacher education has recently become interested in understanding the dimensions of teachers' technology integration knowledge, the processes of instructional decision-making about technology integration, and how these develop among various teacher subgroups (Angeli & Valanides, 2005; Hughes, 2005; Koehler & Mishra, 2005).

This focus is important to both emerging policies and practices. For instance, new standards for teachers' and students' educational technology use call for all teachers to be leaders in designing, facilitating, modeling, promoting, and inspiring "digital age learning experiences and assessments," which improve students' learning and engagement (ISTE, 2008; UNESCO, 2008). Developing such competencies requires continual progress in professional knowledge development across the teachers' work-lifespan. Historically, leading teacher education organizations in the United States have lamented the shortcomings in teachers' preparation to use technology as an effective instructional tool (AACTE, 1999; NCATE, 1997). According to the U.S. National Center for Education Statistics (NCES) report, Teachers' Tools for the 21st Century: A Report on Teachers' Use of Technology (2000), almost 70 percent of American teachers reported not feeling well prepared to use computers and the Internet for classroom instruction. Additionally, researchers reported that while preservice teachers may know how to operate technology, and use it for personal and professional activities, they still enter classrooms without experience in designing technology-integrated instruction (NCES, 2000). This paper contributes to the accumulation of evidence about the dimensions of teachers' technology integration knowledge, and instructional decision-making at varying levels of classroom experience to inform educational technology policies and teacher education practices. In the next section, we introduce the theories that informed our study design, before turning to a discussion of our methodology, findings, and implications.

Characterizing Teachers' Knowledge and Instructional Decision-making

While research on the nature of teachers' technology integration knowledge is still emerging, research on teacher knowledge in general has existed since the 1980's and 1990's. Shulman (1987), Putnam and Borko (2000), and others have argued that teaching competency depends on the teachers' ability to flexibly draw upon organized systems of knowledge, such as, knowledge of classroom situations, of school contexts, of subject matter, and of teaching methods.

For instance, a teacher's consideration of the technology integration factors might fall under the type of knowledge Carter (1990) characterizes as *practical knowledge*, which is defined as knowledge "teachers have of classroom situations and the practical dilemmas they face in carrying out purposeful action in these settings" (p. 299). Research on practical knowledge has focused on teachers' personal knowledge, implicit theories, and classroom knowledge. Classroom knowledge emphasizes the effect of the teachers' *environment* or overarching context on their thoughts and actions, and the impact of teachers' *schemata* on their comprehension and actions (Carter, 1990, p. 299). For instance, teachers' recognition of which technologies are available for her students to use, are supported by the school's technical support staff, and are addressed in school-based professional development activities may all constitute practical knowledge upon which she draws in planning to integrate technology.

Furthermore, research on *pedagogical content knowledge* lends insight into teachers' understanding of technology integration. Studies of teachers' pedagogical content knowledge have examined how teachers decide to create curricular events to support content area learning, including drawing on their knowledge of students' interests, abilities, and needs (Carter, 1990). Several research studies (Mishra & Koehler, 2005; Drier, 2001; Dun, Feldman, & Rearick, 2000; Hughes, 2000; Margerum-Leys & Marx, 2002) theorize how teachers use their *general pedagogical knowledge* (knowledge of processes and techniques for teaching including consideration of student learning, classroom management, lesson planning, and student evaluation), *subject matter knowledge* (knowledge of central facts, theories, and procedures to be learned/taught in a given field), and *pedagogical content knowledge* (knowledge of what teaching approaches fit the content, and how the content can be represented for better teaching) to identify promising technologies for student learning in subject area disciplines, or demonstration of *technological pedagogical content knowledge* (Mishra & Koehler, 2005). These studies proposed connections between technology integration and teachers' knowledge base, but more work is needed to document the nature of these connections within and across various teacher sub-groups (e.g., content, grade level, years of teaching experience, etc.).

For instance, the research on practical knowledge and technological pedagogical content knowledge builds upon earlier work concerned with teacher planning, instructional decision-making, and expert-novice studies, which were concerned with how teachers process information (Carter, 1990). Summarizing research in this area, Carter (1990) wrote that, "expert teachers, in contrast with novices, draw on richly elaborated knowledge structures derived from classroom experience to understand teaching tasks and interpret classroom events" (p. 299). Compared to novices, experts' thinking about instruction demonstrates more depth and complexity, and their schemata are well developed and elaborated. This knowledge organization supplies them with a framework for meaningful interpretation of information (Fogarty, Wang, & Creek, 1983; Kagan, 1992). In general, experts "(a) provide coherent explanations based on underlying principles rather than description of superficial features or single statements of fact, (b) generate a plan for a solution that is guided by an adequate representation of the problem situation, and possible procedures and outcomes, (c) implement solution strategies that reflect relevant goals and sub goals, and (d) monitor their actions and flexibly adjust their approach based on performance feedback "(Baxter, Elder, & Glaser, 1996, p. 133).

Research on teacher knowledge, teachers' planning processes, and expert-novice differences informs our investigation of preservice and inservice teachers' decision-making around technology integration by suggesting potential dimensions of difference to investigate. For instance, we wondered what factors would inservice and preservice teachers consider in the process of making instructional decisions about integrating technology? What knowledge (e.g., consideration of students, content, methods, contextual factors, etc.) would skilled teachers organize and draw upon when faced with a novel situation of planning to integrate a new technology, and what would their decision-making process entail? What would the process entail for preservice teachers? Would inservice teachers and preservice teachers demonstrate differences in their thinking about integrating technology into instruction and how we might characterize the differences? We were interested in finding the answers to these questions, not only to help inform our evolving theory of technology integration knowledge and its manifestation among teachers with varying levels of teaching experience, but to also understand how our teacher education programs might be better tailored to the needs of each group. Moreover, if expert consideration, organization, and knowledge retrieval related to technology integration could be taught and improved, we wondered what the best approach to scaffolding novice teachers might be. We hoped this study would provide a step toward such insights.

Methodology

Therefore, using online multimedia problem-solving scenarios, or cases, in a simulated school environment, we elicited inservice and preservice teachers' thinking about the same technology integration problem set. Specifically, we sought to investigate the content and process of their instructional decision-making, including the answers they gave, the case factors they considered, the knowledge they appeared to draw upon (e.g., consideration of students, content, methods, contextual factors, etc.), and their apparent process for reaching their decision.

Three basic questions guided our study:

1. What are preservice and inservice teachers' instructional decisions, when faced with the same technology integration problems in a simulated school environment?
2. What knowledge and knowledge organization do these teachers demonstrate in making their decision?
3. How do inservice and preservice teachers compare in the content and process of their technology integration decision-making?

Because the context-specific nature of expertise is not readily articulated (Leindhardt, 1990), we sought to draw out teacher's explanation of their decision making and used online cases to establish a common context for teachers' consideration in making an integration decision. We also compared the inservice and preservice teachers when analyzing the length, organization, and quality of their written responses to each case. Understanding these differences and perhaps, more importantly, how to capture and measure these differences, are essential to advancing theory on the dimensions of teacher knowledge about technology integration and to advancing the work of teacher educators concerned with designing courses about educational technology and integration methods that are appropriate to learner's needs.

Participants

The participants in this study were 25 elementary education initial licensure students (i.e., preservice) enrolled in an introductory technology and learning course, and 22 students enrolled in one of two master's level instructional technology courses (either a general technology and learning course or a school technology planning course). Of the students in the two master's level courses, 20 had at least two years of classroom teaching experience. Throughout this paper, this group of 22 students will be referred to as inservice teachers. All students were taught by the same instructor (the third author) at a large Midwestern public university. Approximately, two-thirds of the way into each course, students participated in a common class assignment to complete a series of three online case simulations that culminated in the student writing an essay sharing his or her instructional decision about technology integration. Participants were introduced to the online case environment during class time. Subsequently, all students completed the three online case simulations outside of the class meeting. After the first and second case simulations, students posted their decisions to the online case environment, as well as in an online discussion forum that facilitated peer discussion. After the third case simulation, students posted their decision to the online case environment and participated in an in-class discussion of their results.

Instructional Innovation: Online Multimedia Cases on Technology Integration

The online cases, called the Educational Technology Integration Principle (eTIP) Cases (c.f. http://www.etips.info), used in this study were designed to provide students, of varying levels of education and preparation, with practice in planning for technology integration within reality-based school contexts. Since the mid-1990's, researchers have suggested that realistic, complex problem-solving scenarios, or "instructional cases," can help teachers practice how to think professionally about instructional problems, solutions, and alternatives, and demonstrate professional knowledge and decision-making processes (Merseth & Lacey, 1993). Many teacher educators promote instructional cases as unique and helpful tools, which can augment, or in the case of preservice teachers, supplement actual classroom experiences. Cases and case methods have been shown to enhance teachers' understanding of theoretical principles and practice instructional decision-making, but less is known about the influence of case-based instruction on teachers' and students' actual classroom performance. Merseth (1995) calls for more research on learner characteristics, their experiences in using cases, and relationship between case-based instruction and performance (p. 270).

eTIP case design was based upon the idea that providing students with multiple practice opportunities allows them to "shape" (Marzano & Pickering, 1997) their working model of technology integration and implementation in different contexts, and that case-based responses can serve as a clue to the user's assumptions, attitudes, knowledge, and experiences (Miller & Kantrov, 1998).

Instructional cases usually consist of an introduction that sets up a dilemma, and the context in which it occurs; cases describe an experience based on actuality, and require the participant to engage in analysis, reflection, and resolve the case by making a judgment and recommending some course of action (Shulman, 1992). Consequently, each eTIP case begins with an introduction to or framing of the instructional problem. In the series of cases used in these courses, the user is put into the role of a second-grade teacher in an urban school that was discussing how to enhance second graders' reading achievement. After each case, users submitted their recommended decision and justification for using technology to support students' development of reading comprehension skills. Designed to look like an actual school website, the context-rich cases included a description of the classroom and school, in text and/or visual format. Through a menu of hyperlinks, users could explore sixty menu items (e.g., school improvement plan, school mission, teacher retention, teacher characteristics, student achievement, student characteristics, technology resources, technical support, professional development, standards, reading curriculum, etc.) in any sequence to help craft a decision. These menu items, the scenario posed, and the case's content define the "problem space" through which the users navigated. The essays that the students submitted were captured and stored in an online database.

Data Sources and Analysis

Of the 47 teachers who participated in this study, only those 33 teachers (16 preservice and 17 inservice) who completed all three cases (i.e., submitted a decision for each case simulation in the online case environment) were included in our data set. We selected their third response of the three assigned cases for analysis, reasoning that by the time they had reached the third case, the students had explored the simulated school represented in the cases, were familiar with the design and navigation of the online problem space, and, therefore, this third performance would best represent their thinking on this subject. As a complement to their essay response, we also had access to each teachers' search path map, or a map of their trajectory through the case, including which menu items (e.g., student demographics) they clicked on, how long they visited each item, and which items they returned to or did not visit.

In the introduction to the instructional problem for the third case, each group was asked to examine the school (case) context for information to inform his or her recommendations for using technology to support second graders' development of reading comprehension skills. Literacy development within second grade was the content and grade level focus for this third case. Participants submitted their recommended decision and justification for using technology in answer to this challenge as an essay, and these responses were logged by ID number into an online database.

Essays were examined for the process and content of the teacher's instructional decision-making. For instance, each essay was scored with a rubric designed to evaluate the decision-making process. This rubric identified six criteria based on the dimensions of decision-making defined by Marzano and Pickering (1997) (e.g., validation, evidence, decision) and the description of attaining each criterion along a scoring continuum (scores of one, two, and three). All 33 written responses were read by each of the three authors and scored with a rubric, as indicated in Table 1, and we reached consensus on all scores.

Table 1
Scoring Rubric for Teacher Decision about eTIP Case

Criteria:	**Level 1**	**Level 2**	**Level 3**
1. **Validation**: Explains the central classroom challenge in the case	Does not present an understanding of learners' unmet needs in relation to curriculum goals or standards	Presents a vague or inaccurate understanding of the relation between learners' unmet needs and stated curriculum goals or standards	Clearly articulates an understanding of learners' unmet needs in relation to stated curriculum goals or standards
2. **Evidence**: Identifies factors in the case that contribute to the students' learning challenge	Does not identify key factors or aspects of technology selection, use, and context in the sequence of teaching and learning activities that contribute to learners' needs being unmet	Identifies only one aspect of technology selection and uses in the sequence of teaching and learning activities that contribute to learners' needs being unmet	Identifies several aspects of technology selection and uses in the sequence of teaching and learning activities that contribute to learners' needs being unmet
3. **Evidence**: Analyzes a range of classroom options within the case for addressing this challenge, noting their advantages and disadvantages.	Does not analyze any advantages and disadvantages of selecting various technologies to address learners' needs	Presents an incomplete analysis of advantages and/or disadvantages for selecting various technologies to address learners' needs	Analyzes advantages and disadvantages of selecting various technologies to address learners' needs
4. **Decision**: States a decision or recommendation for implementing a viable classroom option to address the challenge	Does not state a decision or recommendation for using a particular technology	Presents a weak or unclear decision or recommendation for using a particular technology	Clearly presents a decision or recommendation for using a particular technology
5. **Decision**: Explains a justifiable rationale for the decision or recommendation	Does not explain a rationale for the decision or recommendation	Presents weak rationale for the decision or recommendation, lacking consideration of case-based information	Presents rationale for the decision or recommendation, with clear justification from case-based information
6. **Decision**: Describes anticipated results of implementing the decision or recommendation on students' needs in the case	Does not describe anticipated ways in which the selected technology will enable all students to meet curriculum goals	Ambiguously or illogically describes anticipated ways in which the selected technology will enable all students to meet curriculum goals	Describes plausible or reasonable ways in which the selected technology will enable all students to meet curriculum goals

In addition, each response was scored with a second rubric designed to examine the content of the decision in terms of teachers' knowledge and knowledge organization. Specifically, of the various dimensions of teachers' knowledge, we focused our analysis on whether teachers drew upon content knowledge and general pedagogical knowledge in making a technology integration decision. Moreover, drawing on the instructional decision-making and expert-novice literature, we focused on capturing teachers' knowledge organization and potential dimensions of difference between inservice and preservice teachers, including the absence or presence of an organizing schema or underlying principles guiding decision-making, and indication of self-monitoring or reflective practice in anticipation of performance feedback (Baxter, et. al., 1996). Again, all 33 essays were read by each of the three authors and scored with a second rubric, as indicated in Table 2), and we reached consensus on all scores.

Table 2
Scoring Rubric for Teacher Demonstration of Pedagogical Content Knowledge in Response to eTIP Case

Criteria	Score 0	Score 1
1. **Pedagogical knowledge - students**: Considers student data in making an instructional decision	Does not describe how student's interests or motivation or abilities or prior knowledge influences what the teacher should do.	Describes how student's interests, motivation, abilities, or prior knowledge influences what the teacher should do.
2. **Content knowledge - curriculum**: Considers curriculum content (central theories and procedures) and design in making an instructional decision	Does not put new curriculum ideas in the context of prior or following curriculum; does not discuss how curriculum content elements fit together; lacks interpretive attitude toward curriculum.	Puts new curriculum ideas in the context of prior or following curriculum; does not discuss how curriculum content elements fit together; demonstrates an interpretive attitude toward curriculum.
3. **Organizing Schema**: Describes the situation in more general terms, indicating it is an instance of a situation teachers or schools face	Does not make a generalization about the situation, describing it as an instance of a situation teachers or schools face or evince ideas/principles as organizing the search for information and elaborate on how that influences what else they want to know or how they organize their answer	Makes a generalization about the situation, describing it as an instance of a situation teachers or schools face or evinces ideas/ principles as organizing the search for information and elaborates on how that influences what else they want to know or how they organize their answer; (*generalization seems to organize answer around a theme or strand rather than diverge into disconnected, single statements of fact*)
4. **Reflective implementation**: Considers adjusting planned approach to solving the situation based on self-monitoring and performance feedback	Demonstrates awareness of maintaining flexibility in implementing planned approach to solving the situation. Does not discuss the implications of peer feedback or administrative feedback or students' performance feedback on one's planned approach to solving the situation.	Demonstrates awareness of maintaining flexibility in implementing planned approach to solving the situation. Discusses the implications of peer feedback or administrative feedback or students' performance feedback on one's planned approach to solving the situation. peer or admin feedback

Findings and Discussion

Educational Technology Integration Decisions

We sought to understand: What were teachers' instructional decisions, when faced with the same technology integration problems in a simulated school environment? What factors did inservice and preservice teachers consider in the process of making instructional decisions about integrating technology?

Interestingly, inservice and preservice teachers performed remarkably similarly in (a) demonstrating their ability to make a decision around technology integration, and (b) taking factors relevant to technology integration into account (e.g., student learning outcomes, technology access, and availability of technical support, technology as curricular/instructional support, staff development opportunities, and collegial supports), as indicated in Table 3.

For all six decision-making criteria, the median scores for the two groups were not significantly different according to a Mann-Whitney U-test. Average scores for both groups were highest for Criteria 1 and 4. Most teachers in both groups were able to identify the central challenge posed in the case, and make a decision that addressed the challenge, alluding to factors they felt were relevant to their decision and giving a recommendation about how to use technology in the particular school context to improve their students' reading comprehension. Average scores were weakest for Criterion 3 that assessed teachers' ability to weigh advantages and disadvantages of the range of options considered in making the decision, and Criterion 6 that assessed teachers' description of anticipated results of their decision/recommendation.

Table 3
Summary of Results in Comparing Teachers' Decision-making

Criteria (Scale 1 to 3):	Average Score		Mode		Median	
	Inservice	*Pre-service*	*Inservice*	*Pre-service*	*Inservice*	*Pre-service*
1. Validation: Explains the central classroom challenge in the case	2.22	2.24	2	2	2	2
2. Evidence: Identifies factors in the case that contribute to the students' learning challenge	1.89	1.82	1	1	2	2
3. Evidence: Analyzes a range of classroom options within the case for addressing this challenge, noting their advantages and disadvantages.	1.33	1.18	1	1	1	1
4. Decision: States a decision or recommendation for implem enting a viable classroom option to address the challenge	2.61	2.71	3	3	3	3
5. Decision: Explains a justifiable rationale for the decision or recommendation	2.22	1.76	2	1	2	2
6. Decision: Describes anticipated results of implementing the decision or recommendation on students' needs in the case	1.17	1.06	1	1	1	1

Low scores on Criterion 3 and 6 might suggest that making predictions about implementation and, likewise, making "back-up" plans related to technology integration may be difficult for both beginning and experienced teachers.

While inservice teachers scored higher than the preservice teachers scored on Criterion 5, which assessed teachers' rationales underlying their proposed decision, the difference was not statistically significant, but it is illustrative of the qualitative differences we noticed between the two groups. For instance, the inservice teachers' responses were longer, provided more detail to share the reasoning behind their answer, and illustrated a more critical view of the school context presented in the cases. In contrast, the preservice teachers' responses were not only shorter, but they also lacked the detail present in the inservice teachers' responses. Preservice teachers wrote shorter answers (193 words on average or about half what inservice teachers wrote) and were more likely to restate facts from the case as if the facts "speak for themselves" than were the inservice teachers. As an illustration of the qualitative differences that we found between preservice and inservice teachers' responses, we provide the following excerpt from a preservice teacher's response to the case assignment to give recommendations for using technology to support second graders' development of reading comprehension skills. In this example, the preservice teacher stated facts from the case, such as, the software available in the school, the school's problem area on which the staff is focusing, and the professional development and consultation opportunities available to the school's teachers:

> *Software has to be carefully selected to meet the needs of students and teachers. Mention was made of the use of Reading Adventures. No other mention is made of software used to enhance the reading learning of students. There also seems to be a focus on writing as opposed to reading. Reading is the stated problem area, yet standards for reading are underdeveloped. Professional development around the area of reading and language arts primarily occurs in April. This could be made a priority earlier in the year. Media experts are available for consultation. Teachers should take advantage of this resource. First, they must carefully define their reading objectives and then they should consult with the experts to select the most effective reading software available. (Preservice Teacher Submission; Underline emphasis added)*

In the excerpt, the writer made recommendations related to the facts with little elaboration or justification. For instance, in the underlined excerpt the respondent stated a fact from the case and recommended a course of action, but did not rationalize it in terms of how it might help students reach the desired learning outcome of improved reading skills, which was the central focus for the case exercise. The respondent also did not indicate how these issues might be interrelated.

In contrast, inservice teachers not only wrote longer responses (averaging 360 words), but also were more likely to use case information in support of their rationale or interpretation. In the following example, an inservice teacher provided many details from the school about the standards for students' learning, how teachers should work together on understanding these standards, and how technology could be a part of the teachers' plans to get their students working up to the standard in reading comprehension:

> *My recommendations for using technology to support students' development of reading comprehension skills and to justify selection of technology are as follows. There are some beginning steps that ought to be taken in this technology endeavor. Examining the national technology and English standards, examining our school's scope and sequence and aligning the two are crucial actions that must be completed. It is important that every primary elementary teacher take part in this process, if not the entire school staff. It has been stated in various ways that our teachers aren't fluent in the standards, are more comfortable referring to a scope and sequence, and don't feel they have been trained to be proficient in the current school technologies. From this point, grade level teams should meet and discuss how they are covering the standards. What are all of them accomplishing with their students? Which standards are being overlooked? Which technologies are the teachers comfortable using, and which applications are they less proficient in using. Once the areas have been identified that are lacking training and/or coverage, training should be planned to get all of the teachers on board. If a weakness is found in using technology in reading context expression, then the teams should be given release time to meet with the administrator, media specialist, and curriculum coordinator to decide how this weakness will be strengthened. It is stated clearly in the School Improvement Plan that "effective powerful instruction is key to early reading achievement." If this is true, provide appropriate training for what you are expecting your teachers to do. In the technology survey, teachers were anxious to have more money spent on technology, particularly training. Districts may spend all the money they would like on the newest technologies, but if the teachers don't know how to use it, more and newer technology won't help. Since members of the second grade team seem to be on different levels of proficiency, a technology leader in the grade level could be identified and chosen to help get the rest of the team on the path... (Inservice Teacher Submission; Underline emphasis added)*

As the underlined portion indicates, this inservice teacher organized his or her response around two issues, that is, standards alignment and teacher training. The teacher suggested how standards alignment and teacher training are central to the problem to which he or she was to respond in this case, and how the two issues are interrelated.

Differences between the preservice and inservice teachers' responses suggest several possibilities. First, inservice teachers likely possess a better understanding of the school terms and structure presented in these authentic problem-solving cases. Drawing on their experience working in schools, inservice teachers may have better comprehension of case vocabulary (i.e., "professional development," "school improvement plan," "mission statement," "instructional sequence") than do preservice teachers, allowing them to move beyond mere restatement of facts from the case. Inservice teachers may also be more adept at seeing and organizing the problem situation within a case. While inservice teachers are probably more accustomed to the process of reasoning through instructional designs, given that daily lesson planning involves some degree of option weighing, rehearsal, error correction and modification, the difference between the responses suggests that preservice teachers may need more practice and scaffolding in explaining and justifying their instructional designs, if they are to be better prepared for implementing technology.

Teacher Knowledge in Technology Integration Decisions

We also sought to understand, what knowledge and knowledge organization did these teachers demonstrate in making their decision? We found that overall, inservice teachers' average scores were higher for the two dimensions of teacher knowledge (content and pedagogical knowledge) and the two dimensions of knowledge organization (schema and reflective implementation) that we included in the second rubric for scoring respondents' essays (see Table 2). However, the Mann Whitney U test showed that the difference between scores for the two groups was significant only for Criterion 3 (organizing schema), as indicated in Table 4.

Table 4
Summary of Results in Comparing Teachers' Pedagogical Content Knowledge

Criteria (Scale 0 to 1):	Average Score		Mode		Median	
	Inservice	*Pre-service*	*Inservice*	*Pre-service*	*Inservice*	*Pre-service*
1. Pedagogical knowledge - students: Considers student data in making an instructional decision	.56	.53	1	1	1	1
2. Content knowledge - curriculum: Considers curriculum content and design in making an instructional decision	.50	.29	0	0	.5	0
3. Organizing Schema: Describes the situation in more general terms, indicating it is an instance of a situation teachers or schools face	.61*	.12*	1	0	1	0
4. Reflective implementation: Considers adjusting planned approach to solving the situation based on performance feedback	.11	.00	0	0	0	0

The significant differences on the two groups' Criterion 3 scores, which assessed teachers' ability to conceptualize the situation in general terms, suggests that inservice teachers indeed approached the educational cases more hypothetically, and were able to move between context-specific facts and broader principles of teaching methods, school culture, and technology integration, than were their preservice teacher counterparts.

We found that inservice and preservice teachers performed similarly with respect to Criterion 1, drawing on general pedagogical knowledge, in this case, consideration of students' abilities, backgrounds, and needs in planning for technology integration. The preservice teachers' scores were highest on Criterion 1; however, the inservice teachers not only scored slightly higher, but they also discussed a *wider range* of classroom and school-level factors from the case in making their decision. For example, while preservice essays focused primarily on case information pertaining to their classroom, such as, student demographics, student performance data, instructional sequence, and content area standards, inservice teachers' responses considered both classroom-related information, such as, content area standards and students' achievement scores, as well as factors outside the classroom, such as, technology support staff, technology plan and budget, and family involvement.

Preservice teachers may need more prompting to consider how factors particular to a school environment, such as, school administration, school policy, technology infrastructure, professional development opportunities, and school-community culture can influence a teacher's technology integration decision. What is clear from their essays, but not reflected in their scores, is that preservice teachers maintained an awareness that such factors weighed in on their decisions, even if they were unable to articulate how and why as well as the inservice teachers did. Such awareness could form a starting point for further case-based experiences and discussion in teacher preparation courses.

In addition, both groups scored lowest on Criterion 4, perhaps demonstrating a lack of orientation toward maintaining flexibility in implementing a planned approach to technology integration. Neither inservice or preservice teachers seemed to organize their stated approach to technology integration as adjustable and improvable with feedback over time. This might suggest that both new and experienced teachers do not conceptualize clear relationships between feedback and instructional planning for technology integration, which may not be surprising given the reality that most teachers in schools work independently without ongoing evaluation from peers or administrators, and both groups had only limited practical knowledge of the technology on which to draw.

Comparison of Inservice and Preservice Teachers

Overall, how do inservice and preservice teachers compare in their technology integration decision-making? While both teacher groups could make a decision about technology integration and consider factors identified in their technology integration courses as important, the process and content of their decisions varied. For instance, the rationales upon which preservice teachers based their instructional decisions were more superficial, uncritical, and relied largely on consideration of students and classroom-related facts of the case compared to inservice teachers' responses, which were more detailed, better elaborated, more interpretive, and critical of the school context. The rationales upon which inservice teachers based their decisions also mentioned a wider range of classroom, school, and district-level factors as influential. However, the decision-making processes of both groups demonstrated a lack of weighing the relative advantages and disadvantages of the range of options posed in the case.

Moreover, preservice and inservice teachers similarly drew upon pedagogical and content knowledge in making their decisions. Not surprisingly, inservice teachers were also able to situate the case within their more extensive experience-based knowledge of teaching and schools; however, both groups of teachers demonstrated a lack of reflection and flexible orientation toward their planned approach, and scored low for their indication of adjusting technology integration strategies based on students' performance feedback.

Implications and Conclusion

Our findings suggest implications for research methods concerned with investigating the dimensions of teachers' knowledge of technology integration, as well as for teacher education about technology integration. First, better methods and data collection instruments for capturing and assessing teacher knowledge need to be developed. As suggested here, technology can aid us in developing research methods that tease out the elaboration of teachers' decision-making process. The use of online cases with built-in archival and assessment capabilities could be used to compare groups of teachers, at varying levels of expertise, around a common case experience, and to tap teacher's various knowledge sources and ways of thinking about learning to teach with technology.

Further research is needed to determine whether there is a viable method for investigating how teachers develop their pedagogical content knowledge with respect to technology integration. Can we develop a more comprehensive map of how various teacher sub-groups decide to create instructional events with technology to support content area learning? Do preservice and inservice teachers grow more alike or continue in their dimensions of difference in their decision-making over a series of case performances? And if so, how do we measure their trajectories and growth? What tools might we develop to help teachers themselves assess their technological pedagogical content knowledge development along a continuum?

Second, our findings have implications for the design of preservice and inservice technology course instruction. We found that more experienced inservice teachers were able to base their decisions regarding technology integration on a wider range of contextual considerations. This suggests a need for more field experiences in preservice technology courses. Adding a field experience component to technology preparation courses, or considering a shift in the timing of the technology course to later in the preservice teacher's program, after or during their field placement, might help them to better understand the influence of varying contexts upon integration and make decisions based on context that are ultimately, and flexibly implemented. A follow-up to this study, where preservice teachers navigate the Internet-based simulations during or immediately after their immersion in the field, would help to illuminate this issue.

Our findings from this study also suggest a need for teacher educators to teach planning and decision-making, especially emphasizing the importance of identifying and weighing options and articulating a well-justified instructional plan to students, parents, and administrators who may be wary of innovation. Our findings suggest the importance of providing formative feedback on students' decision-making performances, so that they can develop a more nuanced understanding of the complexities of planning for, and using technology in ways that enhance teaching and learning. For example, resources, such as these Internet-based simulations to teach technology integration planning, ought to provide feedback to students both during their performance and between successive performances. Moreover, providing such ongoing feedback would model for students what it means to be a reflective practitioner and, hopefully, encourage both preservice and inservice teachers to bring a more reflective and inquiry-oriented approach to technology integration into their actual classrooms.

Beginning and experienced teachers are increasingly challenged to utilize new technologies in ways that improve teaching and student achievement. Such effective use of technology requires sustained learning on several levels. Further research is needed to explore how the development of knowledge structures for solving instructional design problems related to technology integration influence the actual use of technology in the classroom. This study begins to sketch out the additional research necessary for teacher educators to develop the pedagogy, and assessment materials necessary to scaffold new and experienced teachers' knowledge development about effective technology integration. This research agenda is important and timely, as new technology standards for teachers and students (ISTE, 2007, 2008; UNESCO, 2008) require them to develop sophisticated technology-supported practices and assessment.

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