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INSTRUCTOR AND STUDENT CLASSROOM INTERACTIONS DURING TECHNOLOGY SKILLS INSTRUCTION FOR FACILITATING PRESERVICE TEACHERS' COMPUTER SELF-EFFICACY

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ABSTRACT

Technology skills instruction is an important component of educational technology courses, which has been shown to raise pre-service teachers' computer self-efficacy. Computer self-efficacy, in turn, is positively related to their self-efficacy for technology integration. Studies of undergraduate technology skills instruction found that classroom interactions between instructors and students can influence students' computer self-efficacy. These relationships are not well understood with respect to technology skills instruction of pre-service teachers as there is a dearth of such studies in teacher education literature. This study addressed the gap by analyzing video recordings of three educational technology classes to derive a taxonomy of classroom interactions that occur during technology skills instruction. Survey and interview data were further used to determine how these interaction categories influenced pre-service teachers' computer self-efficacy. Based on these findings, we offer guidelines for how teacher educators can foster pre-service teachers' computer self-efficacy through the process of technology skills instruction.

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Educational technology courses can raise preservice teachers' computer self-efficacy (Abbitt & Klett, 2007; Albion, 2001; Milbrath & Kinzie, 2000; Milman & Molebash, 2008); or these courses can improve one's level of confidence with using a computer (Compeau & Higgins, 1995). Developing computer self-efficacy of preservice teachers through educational technology courses is important because it has been found to be positively related to teachers' actual technology use in classrooms (Littrell, Zagumny, & Zagumny, 2005; Negishi, Elder, Hamil, & Mzoughi, 2003; Wozney, Venkatesh, & Abrami, 2006; Zhao, Pugh, Sheldon, & Byers, 2002).

Hargrave and Hsu (2000) reported that at least 40% of the educational technology courses taught at 53 research universities included some components of technology skills instruction where the use of software programs such as word processing, spreadsheets, and hypermedia software are being taught. Nonetheless, there is limited understanding about how teacher educators raise preservice teachers' computer self-efficacy through technology skills instruction. This is because extant research on educational technology courses has been focused on strategies used by schools of education to integrate technology into their curriculum, and not on the processes of instruction (Brush, Glazewiski, Rutowiski, Berg, Stromfors, Van-Nest, et al., 2003; Kay, 2006; Ma, Lai, Williams, Prejean, & Ford, 2008; Strudler & Wetzel, 1999).

This gap is addressed in the present study through an analysis of interactions among teacher educators and preservice teachers during the process of technology skills instruction. A taxonomy of instructor and student interaction categories was derived through video analysis of instructional sequences. Strategies for raising preservice teachers' computer self-efficacy through these interaction categories were then developed by triangulating video analysis with results from student surveys and instructor interviews. Finally, the pedagogical implications of the study for instruction in educational technology courses are discussed.

PAST RESEARCH

Computer Self-Efficacy

Bandura (1977) conceptualized self-efficacy as people's beliefs about the extent that they are capable of reaching a desired standard of performance. He postulated that there are four sources of self-efficacy: vicarious experiences (observing successful task performance); enactive mastery (actual success in task performance); verbal persuasion (teacher expressing confidence in students' successful task performance); and emotional arousal (reduction in feelings of tension or agitation during task performance). Computer self-efficacy was a term adapted by Compeau and Higgins (1995) to describe one's perceived ability to accomplish a task with computers. Past studies have found that when preservice teachers' computer self-efficacy is high, those teachers are more confident about integrating technology successfully in their classrooms (Abbitt & Klett, 2007; Anderson & Maninger, 2007; Milman & Molebash, 2008).

Instructional Strategies that Enhance Preservice Teachers' Computer Self-Efficacy

Among the four sources of self-efficacy, the vicarious observation of faculty modeling appears to enhance preservice teachers' confidence in using technology for teaching (Beyerbach, Walsh, & Vannatta, 2001; Brush et al., 2003; Duran, Fossum, & Leura, 2006; Handler, 1993; Strudler & Wetzel, 1999; Pope, Hare, & Howard, 2002).

A review by Kay (2006) found that, in addition to faculty modeling, preservice teachers' attitudes and skills for computer use can also be improved through support structures such as development workshops for faculty, enhanced student technology access, and field-based practicums. While these approaches may inform schools of education about successful models for technology integration, they have not addressed specific pedagogical concerns for technology skills instruction at the classroom level. A gap exists in extant research. There is a lack of pedagogical models to help teacher educators plan and structure the process of technology skills instruction. Extant research is limited in informing teacher educators about the types of instructional transactions that help to develop preservice teachers' computer self-efficacy through technology skills instruction.

Need to Study Instructor and Student Interactions

In his exposition of socio-cultural theory, Vygotsky (1978) theorized that learning is a process of acculturation that is mediated through social interactions. Experts customize support to help novices to bridge their zones of proximal development (ZPD)—i.e., the gaps between their developed and undeveloped capabilities. In their seminal study, Wood, Bruner, and Ross (1976) found that six types of social interaction occurred when adult tutors helped children master a wooden puzzle. These interactions included recruiting children's interest in the task, controlling the task scope, motivating children, marking critical features for task success, controlling frustration, and providing demonstration.

The dearth of studies of technology skills instruction processes used in teacher education makes it difficult to ascertain if the categories of Wood et al. (1976) are applicable to the training of preservice teachers. However, some studies of undergraduate technology skills instruction show that two types of instructor interaction could be related to student computer self-efficacy. The first category is motivation through positive feedback. During technology skills instruction, this was found to be more important for fostering students' computer self-efficacy than the time they spent using computers (Ertmer, Evenbeck, Cennamo, & Lehman, 1994). The second category is demonstration.

Software demonstration by instructors was found to be more effective for raising computer self-efficacy than lectures (Johnson & Marakas, 2000; Torkzadeh, Pflughoeft, & Hall, 1999). Studies of interaction between teacher educators and preservice teachers during technology skills training are needed to determine if these results can be applied to teacher education. It also opens a window for understanding the interactions that can acculturate preservice teachers toward technology integration and teaching as they learn technology skills.

RESEARCH QUESTIONS

With respect to the preceding discussion, the following research questions were investigated with respect to technology skills instruction:

1. What types of classroom interaction foster preservice teachers' computer self-efficacy?
2. How can instructors facilitate preservice teachers' computer self-efficacy through classroom interaction?

METHODS

Subjects

Subjects of this study were 43 preservice teachers, who were enrolled in three sections of an educational technology course taught by different associate instructors. Neither of the present authors were the instructors we observed. This was a mandatory 16-week, 3-credit course for students majoring in Art Education, Music Education, and Early Childhood Education at a large Mid-western university. The course is designed to teach preservice teachers technology skills in Microsoft Office applications, graphics design, and webpage design. Students are assessed through projects where they design teaching-related technology artifacts such as presentation slides, grade books, and class websites using various software programs. Technology skills are typically taught through a combination of lectures, software demonstrations, self-paced tutorials, and in-class practice exercises.

Even though four sections of the course were taught during the semester where data collection occurred, one section was dropped from the study because a majority of the students were non-Education majors and the instructor was already included in our study. Using a multiple case study approach, each section was considered as a case, and cross-case comparisons were used to provide "analytic generalization" of the categories of instructor and student interactions that occurred during technology skills instruction (cf. Yin, 2003).

Data Sources and Collection

Prior to data collection, instructors and students signed Informed Consent forms for voluntary participation. Data were then collected through the following sources:

Observations and Video-Recording

Observations were carried out during class sessions conducted between late February and April 2007. Instructor-student interactions were captured through video-recordings and ethnographic field notes. Two students who did not give consent for video-recording were asked to sit at a designated area outside the range of the camera during observations. A total of 42 instructional hours were recorded, comprising lessons in Microsoft Excel, Microsoft Word, Microsoft PowerPoint, and Web Development.

Interviews with Instructors and Students

After classroom observations were completed, a semi-structured stimulated recall interview was conducted with instructors to determine why they engaged in certain interactions. This is a form of member checking recommended by Creswell (1998) to ensure reliability in qualitative analysis. Student volunteers for a post-observation interview were sought via e-mail requests. Semi-structured interviews could only be completed with two students. Results of these interviews were intended as data for triangulation with video recordings. However, the extensiveness of this process was limited by the low number of interviewees.

Student Surveys

At the start of data collection, students completed a survey that gathered demographic data (name, grade-level, gender, age, and major), information about their computer experiences (number of college courses taken, three activities they most frequently used the computer to perform, and the computer packages they could use without difficulty), and their computer self-efficacy. Computer self-efficacy is a multi-level construct that should be measured at both general and application-specific levels (Marakas, Yi, & Johnson, 1998). Students rated their *general* computer self-efficacy on a 5-point Likert-type scale where 1 = no confidence at all, 2 = very little confidence, 3 = moderate confidence, 4 = quite a lot of confidence, and 5 = very confident. Their *application-specific* computer self-efficacy was assessed with a 20-item scale adapted from Ropp (1999). They indicated the extent to which they agreed or disagreed that they were confident about performing technology tasks such as sending e-mail, word-processing, making slideshow presentations, conducting web searches, and technology integration on a 6-point Likert-type scale where 1 = strongly disagree, 2 = disagree, 3 = mildly disagree, 4 = mildly agree, 5 = agree, and 6 = strongly agree. A total of 34 pre-observation surveys were returned, resulting in a response rate of 79%.

At the end of the semester, a post-observation survey asked students to rate their general and application-specific computer self-efficacy again. They also were asked, "What did the instructor do, or have you do that was most and least useful for raising your confidence for using technology?" Answers from this free-response question were used as an alternative to student interview data. Thirty-six post-observation surveys were returned, yielding a response rate of 83.7%. High Cronbach alphas of 0.94 and 0.89 were obtained, respectively, for the pre- and post-observation administrations of the 20-item *application-specific*, computer self-efficacy scale.

Data Analysis

In this study, categories of instructor and student interactions were derived using the constant comparative method (Glaser & Strauss, 1967). Categorization began after each video recording was made, and was refined with subsequent video recordings. Ethnographic field notes and interviews were also used to confirm or "saturate" a category. At the end of this process, a coding protocol was created that defined each category with typical examples from the video recordings. Inter-rater reliability was then used to ensure the "trustworthiness" (Lincoln & Guba, 1985) of the protocol by having a second coder independently code 15% (in duration) of each video clip. Comparisons of the total frequencies of events coded using Flander's modification of ð (Frick & Semmel, 1978) resulted in inter-rater reliabilities, when corrected for chance agreement, to be 0.82 and 0.78 for the categories of instructor interactions and student interactions, respectively.

The protocol was then used to code the instructional sequence of each sampled video recording, following which the frequency and relative percentage of occurrence for each category were tallied. Stake (1995) identified the establishment of patterns and correspondences as one of the key activities undertaken when analyzing and interpreting qualitative data. Patterns in student responses to the open-ended questions in the post-observation survey were determined through qualitative analysis. This provided "corroborating evidence" (Creswell, 1998, p. 202) for triangulation of the video analysis, and data from interviews and field-notes.

RESULTS

Student Profiles

Sixty percent of the students were females and 71% were freshmen or sophomores. The majority (85.7%) were between 18 and 23 years of age ($M = 22.26$, $SD = 7.37$). Sixty percent of them had not taken any college-level computer course before, but they generally felt confident about using word-processing and spreadsheet software. This corresponded with their reported computer use. E-mail, instant messaging, Internet surfing, word-processing, making spreadsheets, making presentation slides, gaming, entertainment, and accessing the school's learning management system were listed as activities they most often performed with a computer. Correspondingly, at least 77% of them felt they did not have confidence using multimedia and webpage development software as these were not activities they frequently performed with the computer. Pre-observation means of general ($M = 3.29$, $SD = 0.83$) and application-specific (overall $M = 4.75$, $SD = 0.86$) computer self-efficacy showed that they were confident with using technology. Post-observation means of general ($M = 3.75$, $SD = 0.91$) and application-specific (overall $M = 5.35$, $SD = 0.56$) computer self-efficacy were also high.

Classroom Experiences Associated with Students' Computer Self-Efficacy

Technology skills instruction conducted by the instructors appeared to have a positive impact on the computer self-efficacy of students. Paired samples *t*-tests showed significant differences in pre- and post-observation ratings of students for both general ($t(30) = 3.97$, $p < 0.0005$ (two-tailed), $d = 0.52$) and application-specific ($t(31) = 4.90$, $p < 0.014$ (two-tailed), $d = 0.69$) computer self-efficacy. Table 1 shows the types of classroom experiences that were perceived by students as being most and least useful for raising their computer self-efficacy.

About 34% of the comments cited opportunities for enactive mastery of software programs as a factor most useful for raising students' computer self-efficacy. These were obtained through successful mastery of technology tasks such as "Excel, making a chart." About a quarter of the survey comments mentioned that students' computer self-efficacy can be raised through instructor demonstrations where there was "step by step walk through of each specific piece of material," whereas another quarter of the comments mentioned the need for positive emotional arousal where instructors created a stress-free learning environment by being "very patient," "helpful," "went slow and made sure everyone stayed together," and "taught me well at my own pace."

Of the four sources of self-efficacy postulated by Bandura (1977), no comments related to verbal persuasion were made. However, students cited two other factors that were useful for raising their computer self-efficacy. They felt it was important that they be given clear learning goals where, "everyone understood what was to be done." About 11% of the comments were also related to having appropriate resources such as handouts, notes, and practice sites to support their learning.

For factors deemed least useful for raising students' computer self-efficacy, more than half of these comments mentioned that learning technology such as

Table 1. Student Perceptions of Classroom Experiences

	Most useful for raising computer self-efficacy		Least useful for raising computer self-efficacy	
	No. of comments	%	No. of comments	%
Software mastery	15	34.09	8	53.33
Instructor demonstrations	11	25.00	2	13.33
Emotional arousal	11	25.00	—	—
Having appropriate learning resources	5	11.36	5	33.33
Clear learning goals	2	4.55	—	—
Total	44	100.00	15	100.00

"Word" or "e-mail" was not useful for raising their computer self-efficacy because, "I wish we could've spent more time on more difficult things." They felt, "bored and disinterested" when they were given "too many practice exercises." About 13% of these comments said that the "slow" pace of instructor demonstrations did not help to raise their computer self-efficacy because they tended to lose focus and concentration. The development of students' computer self-efficacy could also be hindered when they perceived resources assigned to them as "confusing" or "not useful."

Instructor and Student Interactions

Table 2 describes the taxonomy of instructor and student interactions that emerged from qualitative analysis of video clips.

Instructor Interactions

Figure 1 shows the relative percentages of interaction categories by instructor. When subjects were speaking too softly, or have moved outside the range of the microphones for the recording to be audible, these interactions were coded as *Can't Hear*. It can be seen that the majority of instructor interactions occurred in four categories: *Show and Tell, Progress Checking, Direction Maintenance,* and *Prompt and Hint.*

Table 2. Taxonomy of Instructor and Student Interactions

Instructor interaction categories	Student interaction categories
1. *Show and Tell*—Preset learning content, task expectations, or demonstrate technology procedures.	1. *Share content*—Respond to instructors' questions or share general opinions.
2. *Progress Checking*—Monitor student task performance and identify misconceptions or obstacles that hinder students from successful task performance.	2. *Share project*—Share ideas or progress of project with instructors or peers.
3. *Direction Maintenance*—Motivate students to focus and persist on an instructional task.	3. *Validate task performance*—Ask instructor to verify if they were performing instructional tasks correctly.
4. *Prompt and Hint*—Ask questions to prompt attention on information needed to identify performance discrepancies, improve performance, or check correct understanding of a concept.	4. *Tech Help*—Ask for help when software is not working properly.
5. *Invite Suggestions*—Invite students to contribute to specifications for an instructional task.	5. *Design Help*—Ask for help related to the design of a technology artifact.
6. *Frustration Control*—Help students prevent/manage errors before they occur.	6. *Clarify content*—Ask for clarification of a technology concept.
7. *Share New Perspectives*—Offer suggestions of new ways to approach an instructional task.	7. *Clarify task*—Ask for clarification of specifications and requirements of instructional task.

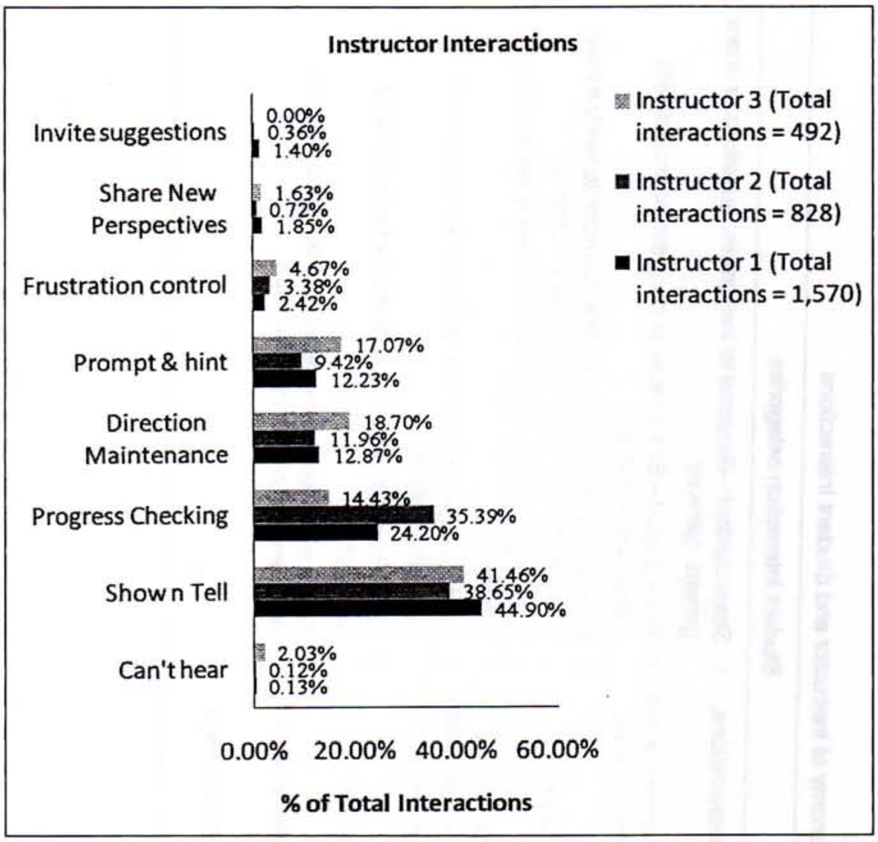

Figure 1. Instructor interaction categories.

Show and Tell is an interaction used to provide content information to students. It comprised approximately 40% of instructor interactions in each section. It was used during lectures, demonstrations, and when instructors provided one-on-one help during lab-time. At times, *Show and Tell* was interjected with *Prompt and Hint,* where instructors asked students questions to stimulate recall about technology procedures they have learned previously. Going beyond technology procedures, Instructor 1 felt that technology skills instruction also involved teaching the "concepts tied to it." Instructors were observed to use *Prompt and Hint* when teaching conceptual knowledge. They asked students leading questions during class discussion to "move them toward what I want them to know." Instructor 3 felt that *Prompt and Hint* helps to promote "deeper thought" because "they would learn better when developing answers or applying what they already know." Besides *Prompt and Hint,* instructors also used *Direction Maintenance* during these discussions to provide students with positive emotional arousal by praising and validating their responses. The use of *Show and Tell, Prompt and Hint,* and *Direction Maintenance* is exemplified by how Instructor 3 explained the use of a webpage design principle.

> Instructor 3: This is an example of a poster about a chamber concert. Do you know how many concerts there are, where are they held, who's the sponsor, and how to get more information? [*Prompt and Hint*] It sure takes a little while to find these [sic] information.
>
> Student 1: Well, they are all using the same font. [*Share Content*]
>
> Instructor 3: Yes. The principle of Proximity is not used as the contents are all running together. There is no differentiation and they all look the same. [*Show and Tell*] Here is an after example. Student 2, what do you say? [*Prompt and Hint*]
>
> Student 2: Now the contact information has been shifted to the bottom. [*Share Content*]
>
> Instructor 3: Good. [*Direction Maintenance*] So they used the principle of Proximity by clustering contact information together and adding extra white space between clusters. [*Show and Tell*] This makes sense? [*Progress Checking*] You can apply the same principle when doing web design. [*Show and Tell*]

Besides doing whole group instruction through lectures and demonstrations, all three instructors provided lab-time for individual project work and consultation. Analysis of video data found that several instructor interactions were used to support software mastery during lab-time. *Progress Checking* occurred when instructors silently observed students' computer terminals; or actively asked questions to check their understanding. Of the three instructors, Instructor 2 showed the highest use of *Progress Checking* as he believes that a critical aspect of technology skills instruction is to help students become "independent in using computers." His strategy is therefore to focus less on direct *Show and Tell,* but to monitor performance through *Progress Checking,* and provide remediation when the need arises. For example he asked one student a series of questions to determine if he understood how to read the numbers that specified the order of custom animations in the PowerPoint software:

> Instructor 2: (Points to the custom animation section on students' computer terminal) Do you know what are these numbers? [*Progress Checking*]
>
> Student: It's like the order. [*Share Content*]
>
> Instructor 2: The order of? [*Prompt and Hint*]
>
> Student: The animation. [*Share Content*]

Two other types of instructor interactions were also used during lab-time to support software mastery, though they accounted for less than 5% of total interactions. *Frustration Control* occurred when instructors pointed out potential errors to students so that they avoided task frustration and failure. Examples were reminders to save files regularly, take notes, and to check their work. *Share*

New Perspectives occurred when instructors made suggestions of alternative approaches that students could consider to improve their performance. During a lab session for web development for example:

Instructor 1: Your banner looks interesting. [*Direction Maintenance*] Did you make those stars yourself?
Student: No. I just clicked here (points with his mouse on the student computer terminal) to change the color and opacity.
Instructor 1: Well, if you group them, you can change all their colors easily. [*Share New Perspectives*]

Instructor 1 also used *Invite Suggestions* to obtain student "buy-in" when they participated in making decisions for assigned tasks. While demonstrating how Microsoft PowerPoint can be used to make a class seating chart for example:

Instructor 1: What grade-level should this class be? [*Invite Suggestions*]
Student 1: 4th. [*Share Content*]
Instructor 1: OK—4th. Should we have tables or desks? [*Invite Suggestions*]
Student 2: Tables. [*Share Content*]

Like *Direction Maintenance, Invite Suggestions* was also used as a means for developing positive emotional arousal.

Student Interactions

Figure 2 shows the categories of student interaction for each section. Close to half of the student interactions were to *Share Content*, usually in response to instructors' questions through *Prompt and Hint*. This is an example of how Instructor 1 used these interactions to stimulate mental rehearsal of technology procedures:

Instructor 1: How do I select more than one object? [*Prompt and Hint*]
Class: Use CTRL. [*Share Content*]
Instructor 1: CTRL or? [*Prompt and Hint*]
Class: SHIFT. [*Share Content*]

Instructors also supported mastery experiences during lab-time when they initiated conversation with students about their project ideas and progress through *Share Project*. This accounted for 16% of student interactions in Section 1 because the instructor proactively sought to "go and see everybody" and "focus on getting around to everyone a few times." Through *Share Project*, instructors probe for opportunities to *Share New Perspectives* and remediate technology procedures through *Show and Tell*.

Students were found to ask for five types of assistance. *Technology Help* involved students asking for assistance when they could not get a software program to work as they had envisioned, or had problems accessing and downloading files from the university's course management system. *Clarify Content*

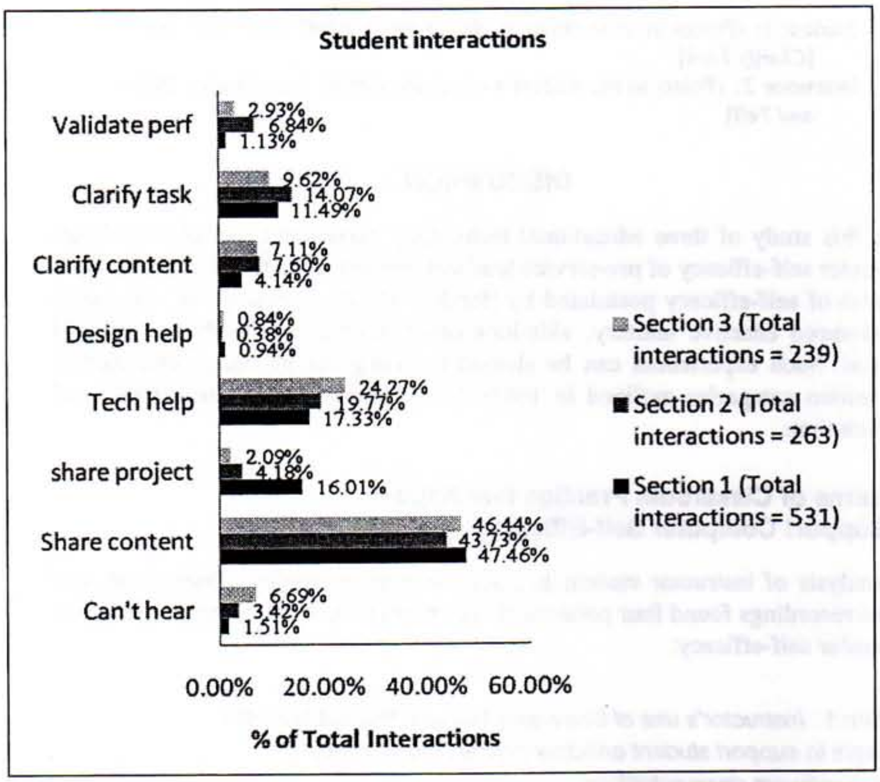

Figure 2. Student interaction categories.

refers to student requests for instructors to explain or repeat conceptual content they are to learn, while students also asked for *Design Help* to support decision-making during artifact design. When these requests were supported appropriately with *Show and Tell*, it helped to ensure successful task performance, thereby contributing to student perceptions of mastery experiences.

Figure 2 shows that, of the types of assistance sought, students were most concerned with *Clarify Task* where they asked questions about project specifications. They also asked instructors to *Validate Performance* by verifying if they were performing an assigned task correctly. These student interactions provided instructors with opportunities to clarify learning goals, which can contribute to the enhancement of students' computer self-efficacy. In Section 2 especially, *Clarify Task* and *Validate Task Performance* provided the instructor with opportunities to clarify confusing instructions from resources such as self-paced IT tutorials. For example:

Student 1: (Points to instructions in the tutorial) What's the "GIF icon"? [*Clarify Task*]

Instructor 2: (Points to the student's computer screen) It's this one. [*Show and Tell*]

DISCUSSION

In this study of three educational technology classrooms, we observed that computer self-efficacy of pre-service teachers appears to be fostered through the sources of self-efficacy postulated by Bandura (1977)—particularly when they experienced enactive mastery, vicarious observations, and positive emotional arousal. Such experiences can be shaped by using the instructor and student interaction categories outlined in Table 2 to support lectures, demonstrations, and lab-time.

Patterns of Classroom Practice that Appear to Support Computer Self-Efficacy

Analysis of instructor student interactions through survey, observation, and video recordings found four patterns of classroom practice that appear to support computer self-efficacy:

Pattern 1. Instructor's use of Show and Tell *with* Prompt and Hint *appears to support student enactive mastery experiences during software demonstrations.*

Previous researchers provided evidence that instructor modeling and demonstration of technology use permit vicarious observation that helps raise pre-service teachers' computer self-efficacy. Classroom videos in the present study showed that instructor modeling was used to facilitate mastery experiences when instructors combined *Show and Tell* with *Prompt and Hint.* When demonstrations are interjected with questions that stimulate mental rehearsal of technology procedures, it engages students in enactive learning (Bruning, Schraw, Norby, & Ronning, 2004). These are mental forms of enactive mastery that develop the preliminary levels of computer self-efficacy for successful task performance.

Pattern 2. Instructor's use of Progress Checking, Frustration Control, *and* Share New Perspectives *can support successful enactive mastery during lab-time.*

Bandura (1977) found that efficacy expectations from actual successful performances tend to be more influential than those developed by vicarious observation alone. Hands-on projects are an important aspect of educational technology curricula (Collier, Weinburgh, & Rivera, 2004; Pellegrino & Altman, 1997; Snider, 2003) that provide preservice teachers with experiences of using technology in the context of teaching and learning.

In this study, instructors used lab-time as a means to personalize students' enactive mastery experiences as they worked on their projects. This occurred when instructors engaged in *Progress Checking* of individual students' progress during lab-time. In doing so, they reduced barriers for students to initiate requests for *Tech Help, Design Help, Clarify Content, Clarify Task,* and *Validate Task Performance*. This in turn provided instructors with opportunities for *Show and Tell* to remediate students' content knowledge, *Frustration Control* to prevent errors, and *Share New Perspectives* help students improve their projects. These interactions are synonymous with the various types of scaffolding functions (Wood et al., 1977) that instructors can use to diagnose problems, sustain successful task performance, and to share professional knowledge regarding the use of technology in the context of teaching and learning.

Pattern 3. During lab-time, instructors who Invite Suggestions *from students facilitate conversations and allow students to* Share Content *and* Share Projects. *Instructors who use* Direction Maintenance *support positive emotional arousal.*

Lab-time can develop positive emotional arousal, when students perceive their instructors to be attentive and accommodating to their learning needs. When instructors and students engage in conversation—through *Invite Suggestions, Share Content,* and *Share Project*—students could be understood at a personal level; then instructors are able to motivate them through *Direction Maintenance*. We found that patience and encouragement were important for fostering students' computer self-efficacy, and for building relationships among instructors and their students. Making connections with people in one's social context not only helps to promote student motivation for learning (Stipek, 2002), but these connections can also contribute to positive emotional arousal.

Pattern 4. When students were able to Clarify Task *and* Validate Task Performance, *they were able to be clear about the learning goals.*

In this study, establishing clear learning goals appeared to be associated with students' computer self-efficacy. This was explained by Schunk (1991) who found that learning goals provide students with "an initial sense of self-efficacy" (p. 213), and therefore motivate them toward goal performance. Instructors who encourage students to *Clarify Task* and *Validate Task Performance* during project-based technology skills instruction help them to conceive project ideas, design, and produce technology artifacts. Planned opportunities for students to engage in these interactions during lab-time can ensure that they maintain a clear sense of instructor expectations throughout the project process.

SUGGESTIONS FOR FUTURE RESEARCH

This was a case study of three educational technology classes for preservice teachers. Since it is a small, non-random sample, "statistical generalization" to educational technology courses and technology skills instruction cannot be claimed (Yin, 2003). For future research, we recommend that this study be replicated in other educational technology courses for preservice teachers. Such studies will help to further validate the taxonomy, uncover optimal combinations of interaction categories, and develop pedagogical models for preservice teacher education.

The limitations of this study could be addressed in two ways. To enhance the taxonomy's predictive validity, interaction categories could be developed into survey items or experimental treatments, and be correlated with variables such as students' project grades. Incentives could be used to motivate participation of student interviewees so that the sources of corroborating evidence are enhanced.

CONCLUSION

For educational technology courses to produce technology integration practices, teacher educators need to develop preservice teachers' computer self-efficacy. In this study we derived an instructor and student interaction taxonomy that can guide the process of preservice teacher technology skills instruction. Based on the findings of this study, we have described pedagogical patterns that can help teacher educators plan and initiate classroom interaction. Such interactions are expected to contribute to the enhancement of preservice teachers' computer self-efficacy. Increased teacher computer self-efficacy, in turn, is expected to increase the likelihood that these teachers will integrate technology in their classroom instruction.

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