# THE USE OF SCAFFOLDING IN INTRODUCTORY TECHNOLOGY SKILLS

# INSTRUCTION FOR PRE-SERVICE TEACHERS

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**ABSTRACT**

Joyce Hwee Ling Koh

THE USE OF SCAFFOLDING IN INTRODUCTORY TECHNOLOGY SKILLS INSTRUCTION FOR PRE-SERVICE TEACHERS

Vygotsky's socio-cultural theory emphasizes that development of intelligence includes learning how to use tools in the context of one's culture. Scaffolded instruction embodies the socio-cultural perspective to learning by characterizing it as a process that occurs through co-participation and social interaction between instructors and students. According to Vygotsky, the ultimate aim of instruction is to help students attain self-directedness and independence in learning.

Scaffolded instruction was investigated in this multiple case study of three sections of a pre-service teacher technology skills course. Instructional sequences were video-taped across a semester, following which self-efficacy surveys and stimulated recall interviews were conducted. Analysis of Patterns in Time was used to identify generic scaffolding strategies. It was found that scaffolded instruction comprised at least half of instructional time in the pre-service technology skills course; and scaffolding strategies were adapted by instructors according to students' entry level of self-efficacy. In these cases, self-efficacy for using specific software programs was positively associated with attainment of general self-efficacy, which in turn was related to increased self-efficacy for technology integration.

Use of scaffolded instruction provides a means for personalizing support to adapt to diverse student needs. Current software training research has focused largely on behavioral modeling methods which offer limited advice about how social interaction between instructors and students contributes to the development of computer self-efficacy. Scaffolded instruction addresses a gap in current literature, and is an important method for technology skills training that should be further explored.

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# TABLE OF CONTENTS

**LIST OF TABLES**

**LIST OF FIGURES**

# CHAPTER I. INTRODUCTION

## Problem definition

Technology skills instruction during pre-service teacher education is an important element of teacher education curriculums. A survey of 53 teacher education programs in research universities found that at least 40% emphasize basic technology skills training for word processing, spreadsheets, and hypermedia software in their instructional technology courses (Hargrave & Hsu, 2000). Research studies also found that pre-service teachers' confidence with using technology tools significantly predicts their ability to integrate technology use in the classroom (Zhao, Pugh, Sheldon & Byers, 2002; Negishi, Elder, Hamil & Mzoughi, 2003; Littrell, Zagumny & Zagumny, 2005). Therefore, an important goal of technology skills training is to raise pre-service teachers' computer self-efficacy i.e. what Compeau and Higgins (1995a) defined as their level of confidence with using a computer.

Research on computer skills training found that vicarious observation of software demonstration (behavioral modeling) is more effective for increasing computer self-efficacy than using lectures (Gist, Schwoerer & Rosen, 1989; Torkzadeh, Pflughoeft & Hall, 1999; Johnson & Marakas, 2000). On the other hand, minimalist approaches propose that software manuals designed to facilitate meaningful task performance and exploration-based learning better supports the acquisition of technology skills (Carroll, 1990; Wiedenbeck, Zavala & Nawyn, 2000; Bannert, 2000; Leutner, 2000). However, a study by Ertmer, Evenbeck, Cennamo and Lehman (1994) found that the quality of classroom experiences through teacher-student interaction is more important for fostering self-efficacy of students in technology skills classes than the time spent with technology. Behavioral modeling research is silent on how the social context affects self-efficacy as most studies were experiments that used training videos as instructional treatments (Marakas, Yi and Johnson, 1998). Research studies on the minimalist approach focused on the design of software manuals for use by individuals and do not offer guidance about the social aspect of technology skills training.

Current gaps in technology skills instruction methods can be addressed with an alternative theoretical lens. Vygotsky's socio-cultural theory emphasizes that the development of intelligence includes learning how to use tools in the context of one's culture (Driscoll, 2000). He proposed that this is mediated through social interactions where experts customize support to help novices to bridge their zones of proximal development (ZPD), i.e. the gaps between their developed and undeveloped capabilities (Vygotsky, 1978). "Scaffolding" was first used by Wood, Bruner, and Ross (1976) in the context of guided practice as a metaphor to describe how adults assist children or novices to solve problems. Its concurrence with the propositions of socio-cultural theory was later made explicit by Cazden (1979). Niederhauser, Salem and Fields (1999) proposed that technology skills training should be structured to help pre-service teachers "develop technical competence as they explore educational issues in teaching, learning, and instructional reform." (p.153). The socio-cultural tenant of scaffolding can therefore be used to understand how technology skills training acculturates pre-service teachers to use technology for teaching and learning.

The basic features of scaffolded instruction are co-participation, social interaction between teachers and students, titration of assistance by instructor, and fading of teacher support to gradually transfer responsibility for learning to students (Meyer, 1993). Reciprocal teaching is an instructional method that typifies scaffolding principles (Palinscar & Brown, 1984). The seminal study by Wood, Bruner and Ross (1976) also derived six functions used in the tutorial process. These studies provide existing frameworks to analyze instructional processes and social interactions that occur during technology skills training.

**Research questions and methodology**

This study uses scaffolding as a theoretical lens to analyze how social interactions between instructors and students in a pre-service teacher technology skills course is related to the development of computer self-efficacy, and self-efficacy for technology integration. The following questions were investigated:

1. How is scaffolded instruction used during technology skills training?
2. What types of scaffolding functions occur during technology skills training; and to what extent is scaffolded instruction co-participatory?
3. How are content resources and equipment used during scaffolded instruction?
4. How do instructors titrate assistance during scaffolded instruction?
5. How is technology skills instruction related to computer self-efficacy and self-efficacy for technology integration?

This study was executed through multiple case-study comparisons of three introductory technology skills classrooms in a pre-service teacher training course. Instructional patterns that emerged during scaffolded instruction and their relationships with computer self-efficacy were determined through both qualitative analysis and Analysis of Patterns in Time (Frick, 1990, APT).

**Contribution to the field**

This study considered scaffolding strategies used in technology skills classrooms through temporal interaction patterns between instructors and students. It informs teaching practices in pre-service teacher technology education as it derived scaffolding patterns that can be replicated in technology skills classrooms. Since there is a dearth of qualitative studies related to scaffolding in technology skills classrooms, this study also provides classroom-based data to inform extant research. Finally, this study investigated the use of APT as a measurement methodology to support qualitative case analysis. It provides a prototype study for developing and using this methodology in classroom research.

# CHAPTER II. LITERATURE REVIEW

## Scaffolding and socio-cultural theory

The term "scaffolding" was used by Wood et al. (1976) as a metaphor to describe the process where adults/experts help children/novices to master specific tasks they cannot perform without assistance. In the same way as scaffolds are used in building construction (Greenfield, 1999), experts "scaffold" the learning process by controlling how they provide support and assistance until novices are able to master and perform the entire task independently (Puntambekar & Hubscher, 2005).

Stone (1998) observed the original intent of the scaffolding metaphor to be "largely pragmatic and atheoretical" (p. 345). Cazden (1979) first established its linkages with the zone of proximal development (ZPD) in socio-cultural theory where Vygotsky (1978) conceived children's skill development as consisting of a gap between developed and undeveloped capabilities. Developed capabilities refers to functions that can be performed without assistance while undeveloped capabilities refers to functions that the child has yet to master. ZPD describes the capabilities that can be developed with expert assistance (Driscoll, 2000).

Vygotsky (1978) viewed learning in the ZPD as a means of "awakening a variety of internal developmental processes" (p. 90) in children. It occurs through social interaction between children and "people in his environment" as "human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them" (p.88). According to Vygotsky, learning plays an important role to help one acculturate and integrate into one's social-cultural environment.

**Features of scaffolding**

The linkage with socio-cultural theory enabled scaffolding to be developed beyond an instructional metaphor. Research on scaffolding in instructional contexts describes it as having four features.

*a) Co-participation*

Scaffolding is characterized by active participation of both teachers and students in directing the learning process (Meyer, 1993), which is co-constructed through social negotiation and not dominated solely by teachers (Driscoll, 2000). There is also intersubjectivity, or a shared understanding of the task to be learned (Rogoff, 1990; Wertsch, 1985) where learners "see the point of the task, beyond simple obedience to the teacher's demands" (Langer & Applebee, 1986, p. 185).

*b) Social Interaction*

A key tenet of socio-cultural theory is that learning, and subsequently development occurs through social interaction (Vygotsky, 1978). While early studies of scaffolding focused on one-to-one interaction between adults (or teachers) and children (or students), Palincsar (1998) proposed that other components in the context such as peers could also support learning.

*c) Transfer of Responsibility*

The aim of scaffolding is for students to achieve independent task performance. Teachers may play a central part in directing learning during its initial stages through explicit modeling and feedback. However, they consciously provide support with an aim of "fading out" gradually so that responsibility for learning and task performance is eventually transferred to students (Meyer, 1993; Puntambekar & Hubscher, 2005). In the same way that scaffolds are removed from buildings once these can stand without them, the scaffolding process is characterized by a gradual removal of support once the task has been internalized by students (Langer & Applebee, 1986; Lepper, Drake and O'Donnell-Johnson, 1997).

*d) Titration of Assistance*

To effectively transfer responsibility to students, adults need to "titrate assistance" (Stone, 1998, p. 349) through "ongoing diagnosis" (Puntambekar & Hubscher, 2005, p. 3) of how well the task requirements have been understood by learners. They also use different scaffolds or support to foster enhanced task mastery (Stone). Vygotsky (1978) described the current competency levels of students as "buds" or "flowers". Scaffolding is the process where teacher identify the "buds"; monitor performance, and nurture these into "fruits" that emerge as students move across their ZPDs.

**Scaffolding versus instructor-centered methods**

Instructor-centered methods are defined as those where the teacher is responsible for dictating the learning process and for communicating content to students (Weston & Cranton, 1986). This is exemplified by lectures and demonstrations. Scaffolding has the greatest contrast to instructor-centered methods as its overarching objective is to "fade out" the teacher and transfer responsibility for learning to students. Instructor-centered methods such as demonstrations can therefore be used as a type of scaffold but may only dominate certain points of the instructional process.

Scaffolding, however, can be used in conjunction with instructor-centered methods. In their review, Rosenshine and Meister (1994) noted that one form of reciprocal teaching to be Explicit Teaching Before Reciprocal Teaching where students are taught the four comprehension strategies before they had guided practice of reciprocal teaching with the teacher. The other type of reciprocal teaching is what they termed Reciprocal Teaching Only, where modeling of the four strategies occurs during guided practice. Even though the end goal of scaffolding is different, it does not mean that instructor-centered methods cannot be used during or in conjunction with scaffolding.

**An example of Reciprocal Teaching**

A foremost example of scaffolding based on the socio-cultural perspective is the reciprocal teaching method, which is anchored upon social interaction between teachers and students (Palincsar & Brown, 1984). It is an instructional method designed to teach children four strategies of reading comprehension. During reciprocal teaching, the teacher and students take turns to read and interpret each paragraph in an assigned passage. In the initial turns, the teacher reads and interprets the paragraph while modeling the strategies during the process. Students then practice the strategies on the next paragraph after which the teacher invites students to comment on each others' interpretation. During subsequent turns, each student takes increasing responsibility for interpretation while the teacher scaffolds this process through active dialogue with students by giving structured feedback, hints or further modeling as needed. The teacher slowly relinquishes the task to students as they gain more competence with using the four strategies (Rosenshine & Meister, 1994).

The reciprocal teaching method exemplifies the four features of scaffolding. Both the teacher and students co-participates in the socially-mediated learning process with students actively involved in interpreting passages right from the beginning. The teacher titrates assistance according to his/her understanding of student competency, and fades support intentionally to transfer responsibility for task performance to students. Rosenshine & Meister (1994) found a median effect size of 0.88 when experimenter-developed comprehension tests were used to assess learning from reciprocal teaching.

**Varying interpretations of what constitutes scaffolding**

Sherin, Reiser and Edelson (2004) found that there are varying interpretations of what constitutes scaffolding. They found that studies conducted by Jackson, Krajcik, and Soloway

(1998); and Brush and Saye (2001) defined scaffolding as the types of support provided by an expert to a novice so that they can perform tasks or achieve goals they cannot without expert assistance.

Going beyond the use of social interaction as a means of scaffolding, the use of learner-centered approaches such as project-based learning also saw the development of software tools for scaffolding (Hannafin, Land and Oliver, 1999; Reiser, 2004; Puntambekar & Hubscher, 2005). Studies by Greene and Land (2000), Rasku-Pottonen, Etelapelto, Hakkinen, and Arvaja (2002), and Quintana, Reiser, Davis, Krajcik, Retz, Duncan, Kyza, Eelson, and Soloway (2004) considered scaffolding more broadly as the different types of instructional supports for students, whether these were through social interaction or through the use of software tools.

On the other hand, other studies (Vygotsky, 1976; Stone, 1998) emphasized fading of instructor support and transfer of responsibility to students as critical components of scaffolding. Puntambekar and Hubscher (2005) especially cautioned against relegating scaffolding to a single tool because not all software tools faded out once task processes have been internalized by students. They emphasized that ongoing diagnosis and fading of support to encourage learner self-regulation are essential features of scaffolding. Even though researchers of scaffolding have not yet resolved this issue conclusively, researchers in the field of instructional design viewed the fading of instructional support as an important aspect in the design of instruction.

Merrill (2002) reviewed various instructional design theories and models and found four common principles which he termed as the "First Principles of Instruction". According to these principles, learning is promoted when learners are given demonstrations, have their prior knowledge activated, and engaged in applying and integrating knowledge in the context of whole tasks. The *Application* principle in particular states that learning is promoted when learners are given opportunities to apply what they learned, coached with corrective feedback on their performance, and when coaching is gradually withdrawn with each learning task.

van Merriënboer, Clark and de Croock (2002) proposed that whole-task learning is a type of complex learning that requires learners to coordinate and integrate the constituent skills of task performance. It is different than learning the constituent skills for performing a task separately. In their exposition of the 4C/ID model, the authors proposed that an instructional design blueprint for complex learning needs to have four components: Authentic *Learning Tasks* or task classes/categories of problems that learners should learn to solve; *Supportive Information* that explains non-recurrent constituent skills, i.e. skills that are performed variably from one problem situation to another; *JIT Information* about recurrent constituent skills, i.e. skills that do not vary according to problem situations; and *Part-task Practice* to help learners attain automaticity with performing recurrent constituent skills. In this model, "scaffolding" is defined as the "process of diminishing support as learners acquire more expertise" (p. 45). The "principle of fading" was especially emphasized in the presentation of *JIT Information* where it was recommended that these should be gradually faded away as learners gain competency with recurrent constituent skills. "Fading" is viewed as a way to optimize the cognitive load for learners during complex learning (van Merriënboer, Kirschner & Kester, 2003). It was argued that excessive and redundant information could lead to split-attention effects as learners need to attend to both *JIT Information* and the task environment simultaneously. The 4C/ID model proposes that effective scaffolding of complex learning requires attention to how performance support is provided and faded, while taking into consideration the cognitive load of what the human mind is capable of processing.

**Scaffolding strategies**

Even though there is varying interpretation of what constitutes scaffolding, several studies have provided insight about how different aspects of scaffolding could be implemented.

*Types of social interactions*

Social interactions support co-participation during scaffolding. In their seminal study of how tutors support 30 children to master a wooden puzzle, Wood et al. (1976) found that the "scaffolding" process consists of six functions:

1. Recruitment – where the tutor generates interest in the task.
2. Reduction in degrees of freedom – where the tutor supports the development of task mastery by controlling the size of the task.
3. Direction maintenance – where the tutor motivates the child to continue focusing on the task.
4. Marking critical features – where the tutor highlights aspects of task performance that are critical for detecting performance discrepancies.
5. Frustration control – where the tutor helps the child to reduce stress and frustration with problem-solving.
6. Demonstration – where the tutor models an "idealized" version of the task solution.

Even though studies in technology skills training research that analyzed scaffolding functions cannot be found, current studies show that the scaffolding function of "Demonstration" as described by Wood et al. (1976) may be relevant when applying the construct of scaffolding to technology skills acquisition. This is most often studied as behavioral modeling and how it impacts computer self-efficacy or "a judgment of one's capability to use a computer" (Compeau & Higgins, 1995a, p. 192). It is derived from the concept of self-efficacy defined by Social Cognitive Theory as people's beliefs about the extent to which they are capable of reaching a desired standard of performance (Bandura, 1977). In the 4C/ID model, demonstration is one way of modeling how *JIT Information* is used within a task context (van Merriënboer et al., 2002).

Johnson and Marakas (2000) found that when the correct steps for performing a computer task were demonstrated and observed by trainees, it resulted in significant differences in their computer self-efficacy. Gist et al. (1989) found behavioral modeling to be more effective than lectures for raising computer self-efficacy. One limitation of these studies is that they were experiments where demonstrations were delivered via videotape, and subjects worked on their tasks individually. This may have precluded the emergence of social interaction that typically occurs in a classroom situation. Interestingly, a study by Ertmer et al. (1994) in an actual computer skills class found that positive feedback and encouragement from instructors were more important for fostering self-efficacy of students in technology skills classes than the time spent with technology. These results imply that the scaffolding function of "Direction Maintenance" as described by Wood et al. (1976) may also be relevant when applying the construct of scaffolding to technology skills learning.

*Planning the scaffolds*

Vygotsky (1978) proposed that learning through the ZPD leads to mastery of one's social-cultural context. He also proposed that the ZPD can be used as a way for teachers to plan and structure the scaffolding process. Research on technology integration has identified several factors to be important for raising pre-service teachers' self-efficacy for technology integration. Firstly, there is a need for faculty modeling. Handler (1993) and Pope, Hare and Howard (2002) found that teachers who frequently saw computers being used in their pre-service methods course felt more confident about using the computer as an instructional tool. Secondly, there is a need for practice activities that allow pre-service teachers to develop teaching artifacts with technology. Pellegrino and Altman (1997) emphasized that the more pre-service teachers are encouraged to think about technology integration, the more they will apply it naturally in actual classrooms.

*Titrating assistance*

In order to transfer responsibility to students during scaffolding, teachers need to effectively execute the titration of assistance to move students across their ZPDs. This requires teachers to understand the current competency level of students, and to monitor how student competencies develop (Vygotsky, 1978). Titrating of assistance allows teachers to identify what is termed as *Supportive Information* in the 4C/ID model (van Merriënboer et al., 2002). As such information is unique to problem situations, teachers are able to determine what is needed to bridge the gap between students' current knowledge and the knowledge required to perform the learning tasks through titration of assistance.

Several factors affect how teachers might scaffold different students. The first factor is the initial computer self-efficacy of students. Gist et al. (1989) found that university administrators with a low level of initial computer self-efficacy reported higher post-observation computer self-efficacy when demonstrations were used. Secondly, Compeau and Higgins (1995b) found that the influence of demonstration on self-efficacy is moderated by the type of software package being learned because it had a positive impact on the self-efficacy of subjects who were learning spreadsheets, but not those who were learning word-processing software. Bolt, Killough and Koh (2001) also found that where task complexity is high, undergraduates' performance on a spreadsheet task was better when they were taught demonstrations than by lectures.

*Using content resources during scaffolding*

Even though social interaction remains the backbone of scaffolding, the proposition of "distributed scaffolding" where there is "careful engineering of the whole environment and the multiple agents therein: teachers, tools, resources, peers, and the curriculum."

(Puntambekar & Hubscher, 2005, p. 10). This necessitates the consideration of how content resources such as software tutorials can be used by teachers while scaffolding technology skills learning.

The 1980s saw the emergence of the minimalist approach to software training which is characterized by individualized learning with software documentation that supports guided explorations, error recognition, prevention and recovery (van der Meij & Carroll, 1998). Research on exploratory learning with software documentation found that it did not adequately scaffold students to form correct problem structures. Charney, Reder and Kusbit (1990) found that undergraduates who were given a goal, and supported with feedback to derive the optimal solution (problem-solving condition) performed better than those who were presented with step-by-step solutions (tutorial condition), or those who were allowed to invent and explore solutions to their own problems (exploration condition). Another study by Wiedenbeck and Zila (1997) found that when learning complex development software such as Hypercard, even undergraduates with extensive computer experience performed better when provided with specific tasks during hands-on practice than when asked to devise tasks for themselves.

While research of minimalist approach did not consider the use of software documentation beyond individualized self-paced learning, the use of software documentation used as part of technology skills training may impact how and what teachers need to scaffold during the process.

**The relevance of scaffolding to pre-service teacher technology education**

The study by Ertmer et al. (1994) found that teacher-student interactions were more important for raising self-efficacy of students than the time they spent with technology. As we look towards research in technology skills instruction, the preponderance of experimental studies on behavioral modeling provides little guidance on the relationship between teacher-student interactions and student self-efficacy. Scaffolding emphasizes learning through social interaction. It can be used as a theoretical lens to address a significant gap in extant research on technology skills instruction.

Introductory technology skills courses are important for pre-service teachers as their technology proficiency and self-efficacy for using computers predict their use of technology during student teaching (Negishi et al., 2003; Littrell et al. 2005; Zhao et al., 2002). Vygotsky (1976) conceptualized learning through social interaction as process of acculturation into one's socio-cultural environment. Not only do pre-service teacher technology courses need to build students' technology proficiency, they also need to acculturate students towards using technology in the context of teaching and learning. Understanding how scaffolding occurs in pre-service teacher technology skills courses can provide insight about how teacher educators influence technology skills acquisition through social interaction. Analyzing these social interactions can also provide insights about how computer self-efficacy and self-efficacy for technology integration can be better developed through the process of technology skills acquisition.

# CHAPTER III. METHOD

This study was executed through a case-study approach defined by Creswell (1998) as the exploration of a "bounded system" that could be a program, event or activity. For this study, the "bounded system" was an introductory technology skills training course for pre-service teachers.

## Operational definitions

As described in the literature review, there are varying interpretations of the definition of scaffolding. Some studies defined scaffolding as the providence of different types of instructional support, while others emphasized the need for attainment of student self-regulation through instructor "fading". This study adopts the latter definition.

Meyer (1993) emphasized that scaffolding is contextually-driven. To understand how scaffolding can be operationalized in technology skills classrooms, preliminary observations were carried out in the three instructors' classrooms a semester before data-collection began. While it is recognized that the motivation of student self-regulation through "fading" could occur in a group-based learning situation; as exemplified by Reciprocal Teaching, these preliminary observations showed that this did not occur for the three instructors. A dichotomy of teaching methods was observed as instructors either directed the learning process entirely through lectures and demonstrations; or they allowed students to self-direct learning through lab sessions while they provided support.

Based on these observations, the following operational definitions were developed for this study:

1. During technology skills training, scaffolded instruction occurs when students are working on a learning task independently while being facilitated by the instructor.
2. During scaffolded instruction:

a. Each student is responsible for directing his/her own learning process whereas the instructor provides support either upon student request, or when they see a need for initiating support.
b. The instructor adjusts support according to their understanding of each student's current competencies and what is needed to bridge the gap between current and desired competencies.
c. Social interaction, content resources or equipment can be used as forms of support.

**Multiple case study approach**

The literature review found a dearth of studies that investigates how scaffolding is being used for technology skills learning. A multiple case-study approach was adopted as it allows for theoretical replication (Yin, 2003). Three out of four sections of an educational technology course conducted during the Spring semester of 2007 at a large Midwestern university were chosen for the study. Each section was considered as a case, and cross-case comparisons allowed for "analytic generalization" (Yin, 2003) of how scaffolding is used in pre-service teacher technology skills courses.

**Participants**

The subjects were undergraduates enrolled in three sections of an educational technology course conducted in a large Midwestern university during the Spring semester of 2007. This is a 16-week, 3-credit course that is mandatory for students majoring in Art Education, Music Education and Early Childhood Education. Non-education majors also enroll in the course to fulfill technology proficiency requirements related to their major. Even though four sections were conducted during the semester, one section was omitted because majority of the students were non-Education majors, and the instructor was already included in the study.

The course covers introductory computer skills such as Microsoft Office applications, graphics design and webpage design. Rather than prescribing a standard curriculum, the program coordinator stipulates the minimum technology proficiency standards that the course should equip students with. Associate Instructors have autonomy to design course content and activities to fulfill these performance objectives.

A total of 43 students were studied in the three sections where there were 18, 5, and 20 students enrolled respectively. Section 1 was taught by an instructor with close to 20 years of experience as a K-12 teacher and teacher educator. Section 2's instructor primarily taught educational technology courses as an Associate Instructor for three years; while Section 3's instructor had about 10 years' experience teaching art history and educational psychology courses as an Associate Instructor in higher education settings.

**Data sources and collection**

Prior to data collection, the purpose of the study was explained to instructors and students; and they were asked to sign Informed Consent forms for participation (see Appendix A). Participation was voluntary. Data was then collected in the following order:

*a) Pre-observation survey*

A pre-observation survey was administered to students in each section to determine their demographics, prior experience with using computers, general and task-specific self-efficacy with using technology (see Appendix B). Participation in the survey was voluntary. A total of 34 surveys were returned, resulting in a response rate of 79%.

*b) Observations*

Observations were carried out during class sessions conducted between late February and April 2007 where data was recorded through video-recordings and ethnographic field notes. All students in Section 1 and 2 gave consent to participate in the video-recording while two students who did not give consent in Section 3 were asked to sit at a designated area outside the range of the camera during observations.

A total of 42.5 hours (34 sessions of 75 minutes duration each) were video-recorded. This comprised lessons for Microsoft Excel, Microsoft PowerPoint, and Web Development. All sessions on Microsoft Word and several on Microsoft Excel could not be observed because the researcher was waiting for Human Subjects approval.

*c) Post-observation survey*

At the end of the observations, students were administered another survey to determine if their self-efficacy has changed as a result of the training (see Appendix C). The questions were similar to the first survey, except that open-ended questions were added to gather responses about the instructional strategies students found to be most and least useful for enhancing their self-efficacy. A total of 36 surveys were returned, resulting in a response rate of 83.7%.

*d) Interviews with instructors and students*

After observations were completed, a stimulated recall interview was conducted with instructors to determine why they used certain scaffolding strategies, and their perceptions of student technology proficiency (See interview questions in Appendix D). This is a form of member check recommended by Creswell (1998) to ensure reliability in qualitative analysis.

In early April 2007, an e-mail was sent to students via their instructors asking for volunteers to be interviewed. One student each from Sections 1 and 2 were interviewed (See questions in Appendix D). The student from Section 1 was interviewed through a one-hour face-to-face interview while the student from Section 2 provided responses through e-mail. One student from Section 3 volunteered to provide information via e-mail, but did not respond when the questions were sent.

Results of these interviews were intended as data for triangulation with other data obtained from video recordings, surveys and ethnographic field notes. However, the low number of interviewees limited the extensiveness of this process.

**Instrument design**

a) *Pre-observation survey*

The first four questions in the pre-observation survey were used to collect basic demographic data such as the name, grade-level, gender, age and major of subjects (see Appendix B). Question 5 is a free response question where subjects are asked to list the number of college courses taken as Karsten and Roth (1998) found significant correlation between computer experience and the number of computer courses. Prior experience with computers also has a positive effect on computer self-efficacy (Marakas et al., 1998; Johnson & Marakas, 2000; Agarwal, Sambamurthy, & Stair, 2000; Bolt, et al., 2001; Cassidy & Eachus, 2002, Hasan & Ali, 2004). Therefore, Question 6 is a free response question that determined subjects' computer experiences from the types of activities they most frequently used the computer to perform. Answers to this question were triangulated against Question 7 which measured subjects' experience with the types of software to be covered in the class.

Questions 8 and 9 measure the subjects' perceived confidence with using computers. Computer self-efficacy is conceptualized to be a multi-level construct consisting of both general self-efficacy (GSE) and task-specific self-efficacy (TSE). GSE is perceived as a summation of the related computing experiences that can be influential in predicting "future levels of general performance within the diverse domain of computer-related tasks" (Marakas et al., 1998; p. 129). This was operationalized in Question 8 through a 5-point Likert-type scale.

TSE allows domain-specific skills to be measured. This was operationalized in Question 9 by using the Technology Proficiency Self-Assessment scale developed by Ropp

(1999) for measuring the computer self-efficacy of pre-service teachers for technology tasks commonly performed by teachers in the classroom. While computer self-efficacy scales developed by Kinzie, Delcourt and Powers (1994) were used by Milbrath and Kinzie (2000) and Albion (2001) to measure the computer self-efficacy of pre-service teachers, many of the items refer to dated technology such as computer diskettes, and CD-ROM databases. Technologies such as the World Wide Web and presentation software have not been included. Therefore, the 6-point Likert-type scale developed by Ropp was adapted for use in this study as it was more relevant for the intended target audience.

*b) Post-observation survey*

In the post-observation survey (See Appendix C), Questions 1-3 were repeated from the pre-observation survey to measure changes in students' computer self-efficacy. Question 4 is a free-response question to determine student perceptions about the aspects of their course experience that were most and least useful for raising their self-efficacy. These were triangulated against observation and student interview data to determine effective scaffolding methods.

*c) Validation of Instruments*

Ropp (1999) obtained a high reliability of 0.95 was obtained for the Technology Proficiency Self-Assessment scale. To ensure that the content representation of this scale was valid for the target audience, the program coordinator of the course was asked to conduct an expert review of the survey instrument. The tasks described on the instrument were found to concur with the types of technology tasks that students attending the course were expected to perform. The item "write an essay to describe how I would use technology in my classroom" was re-worded as "Describe how I would use technology in my classroom" because it was felt that the original item did not differentiate between students' ability to write an essay and their ability to discuss how technology is used in the classroom. Another item - "write a plan with a budget to buy technology for my classroom" was omitted because the program coordinator felt that the course was more focused on how teachers used technology in teaching; and not on technology administration tasks carried out by technology coordinators in schools. It was substituted with the item "Send an Instant Message" to better capture the increasing popularity of this technology with undergraduates.

The items in the scale were also categorized as two sub-scales. Items *a* to *p* were conceptualized as TSE related to performing technology tasks with software or over the internet; while items *q* to *t* were related to TSE for technology integration.

An online version of the instrument (see Appendix E) was then pre-tested on 20 students from a section of the course that the researcher taught during the previous semester. As the questions for both the pre and post observation surveys were largely similar, the open-ended questions in the post-observation survey were combined with the questions from the pre-observation survey. An additional question "Were there any questions that you had problems with in this survey? Please list the question number and the problem you faced." was also included to gather feedback related to question design. Five responses were received and open-ended comments from all respondents indicated that they did not find any problems with any questions in the survey. A Cronbach alpha test for the revised Technology Proficiency Self-Assessment scale could not be performed with these results as there were too few responses for statistical reliability.

The survey was then administered on students in each of the three sections without any revisions. High reliabilities of 0.94 and 0.89 were obtained for the pre and post-observation administration of the revised Technology Proficiency Self-Assessment scale respectively. Table 1 shows that the internal consistency of the sub-scales were also high, being 0.84 or above.

**Table 1 - Internal consistency of sub-scales for the Technology Proficiency Self-Assessment scale**

| Subscale | Pre-observation survey | Post-observation survey |
|---|---|---|
| TSE for performing technology tasks with software or internet (Items *a-p*) | 0.92 | 0.84 |
| TSE for technology integration (Items *q-t*) | 0.89 | 0.89 |

**Data analysis**

a) *Pre-observation profile of subjects*

The demographics, computer experience, and pre-observation ratings for general computer self-efficacy (GSE) and task-specific self-efficacy (TSE) were analyzed by using descriptive statistics such as frequency counts, percentages, means and standard deviations. This provides information about the pre-observation profile of subjects.

b) *Analysis of Patterns in Time (APT)*

APT was used in this study to measure temporal patterns that occurred during scaffolded instruction. APT is described as an alternative approach to linear statistical models such as ANOVA, regression, and path analysis because it models relationships by probability of occurrences rather than by linear equations (Frick, 1983). The frequencies of events are computed over time, and temporal patterns identified by analyzing probabilities of events that precede or follow each other. It provides quantitative data for the generalization of relationships, and can be used for making predictions (Frick, 1990).

APT provides a methodology that allows qualitative analysis to be used together with quantification (Frick, An & Koh, 2006). Classifications or variables that co-exist in time are first established according to the research question, following which qualitative analysis are used to establish the categories underlying each classification (Frick, 1990). APT queries are then used to determine joint probabilities of categories within or between classifications.

From the operational definitions, the following were first pre-determined as APT classifications:

1. Instructional Activity
2. Instructor interactions
3. Student interactions
4. Content resources
5. Equipment

The generic terms “scaffolder” and “scaffoldee” rather than “instructor” and “students” were initially used so that instances of peer scaffolding could be captured. Analysis of results found that these occurrences were rare. As such, these classifications have been re-named as “Instructor interactions” and “Students interactions” for better clarity.

Once the classifications were defined, qualitative analysis was used to determine categories underlying each classification; which were subsequently used to code the sequences of instructor-student interactions as revealed through video recordings. Frequencies of occurrences for each category were counted up, and APT queries were constructed with operators (IF, THEN, IS, ARE, NOT, OR, AND) to study relationships within and between categories underlying each classification.

*c) Sampling of video clips for APT analysis*

To control for variation in content, only video clips for PowerPoint and Web Development sessions were selected for APT analysis as these were software programs taught by all three instructors. About 0.70 hours of non-instructional segments were deleted from selected clips as these were not relevant to the analysis (e.g. instructor handling class registration issues, instructor and students engaging in social talk).

Video clips for lessons on Microsoft Excel were not selected as some sessions could not be recorded, which affected a holistic analysis of how instructors instructed this software program. The unselected clips were either used as anecdotal data for triangulation, or for inter-rater training. A total of 29.9 hours (70% of total video recordings) were sampled for APT analysis (see Table 2).

**Table 2 - Breakdown of video sample by instructor and course content**

| | PowerPoint | Web Development |
|---|---|---|
| Instructor 1 | 5.48 hrs(329 mins) | 7.37 hrs (442 mins) |
| Instructor 2 | 3.35 hrs (201 mins) | 4.97 hrs (298 mins) |
| Instructor 3 | 3.75 hrs(225 mins) | 5 hrs (300 mins) |
| Total | 12.6 hrs (755 mins) | 17.3 hrs (1,040 mins) |

*d) Deriving categories underlying APT classifications*

Categories underlying APT classifications need to be exhaustive and mutually exclusive (Frick, 1983). Stake (1995) identified the establishment of patterns and correspondences as one of the key activities undertaken when analyzing and interpreting qualitative data. In this study, categories 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 that defined each category with typical examples from the video recordings was created (See Appendix F). Inter-rater reliability was then used to ensure the "trustworthiness" (Lincoln & Guba, 1985) of the protocol used to code video data.

*e) Coding instructional sequences*

The instructional sequence of each video recording was coded using the categories derived through qualitative analysis. Table 3 shows an example of how an instructional segment from one video recording was coded using the five classifications and its underlying categories.

**Table 3 - Sample coding segment**

| Instructional Activity | From | To | Student interactions | Instructor interactions | Resources | Equipment |
|---|---|---|---|---|---|---|
| Lab | Instructor | C | null | progress check | Project/ Assignment descriptions | Student computer terminal |
| | | | | Show N Tell | | |
| | C | Instructor | clarify task | null | | |
| | Instructor | C | null | Direction maintenance | | |
| | C | Instructor | tech help | null | | |
| | Instructor | C | null | Show N Tell | | |
| | C | Instructor | Clarify content | null | | |
| | Instructor | C | null | Direction maintenance | | |
| | | | | Frustration Control | | |
| | | | | Direction maintenance | | |
| | M | Instructor | can't hear | null | | |
| | Instructor | M | null | can't hear | | |
| | L | Instructor | tech help | null | | |
| | Instructor | L | null | progress check | | |
| | | | | Show N Tell | | |
| | H | Instructor | Tech help | null | | |
| | Instructor | H | null | progress check | | |
| | H | Instructor | Share content | null | | |
| | Instructor | H | null | Show N Tell | | |
| | L | Instructor | tech help | null | | |
| | Instructor | L | null | Show N Tell | | |

According to the assumptions of APT, an event occurred in a classification when there was a change of state (Frick, 1983). There is only one event for the classifications of "Instructional Activity", "Resources", and "Equipment" as students were having a Lab session, used only one type of resource i.e. Project/Assignment Descriptions, and one type of equipment i.e. Student Computer Terminals. However, there are multiple events occurring in the other two classifications as different categories of "Student Interactions" and "Instructor Interactions" were observed. For example, the instructor used two types of "Instructor Interactions" with student C i.e. *Progress Check*, and *Show and Tell*. Following the convention outlined in Frick (1990), a "Null" was coded under "Student Interactions" to denote that nothing relevant was occurring in this classification at that point in time. When the instructor finished *Show and Tell*, student C followed up by asking the instructor to *Clarify Task*, which was then followed by the instructor providing *Direction Maintenance*. Student C then proceeded to ask the instructor for *Tech Help*. The "From" and "To" columns were added to record information about the initiator and receiver of social interactions. This sample instructional segment shows that the Instructor first interacted with student C, then followed by students M, L, H, and then again with student L.

After the instructional sequences were coded, the frequency and relative percentage of occurrence for categories underlying classifications was then counted up as shown in Table 4.

**Table 4 - Counting interactions**

| **Instructional Activity** | | | **Student Interactions** | | |
|---|---|---|---|---|---|
| Category | Freq | % | Category | Freq | % |
| Lab | 1 | 100 | Clarify Task | 1 | 12.5 |
| **Total** | **1** | **100** | Clarify Content | 1 | 12.5 |
| | | | Tech Help | 4 | 50.0 |
| | | | Share Content | 1 | 12.5 |
| | | | Can't Hear | 1 | 12.5 |
| | | | **Total** | **8** | **100.0** |
| **Resources** | | | **Instructor Interactions** | | |
| Category | Freq | % | Category | Freq | % |
| Project/Assignment descriptions | 1 | 100 | Progress Check | 3 | 23.0 |
| **Total** | **1** | **100** | Show and Tell | 5 | 38.5 |
| | | | Direction maintenance | 3 | 23.0 |
| **Equipment** | | | Frustration Control | 1 | 7.75 |
| Student computer terminal | 1 | 100 | Can't Hear | 1 | 7.75 |
| **Total** | **1** | **100** | **Total** | **13** | **100.0** |

*f) Making APT queries*

The coded instructional sequences were also used to make APT queries about the joint probabilities of categories within and between classifications. For example, to find out how instructors responded to student requests for Tech Help, the following APT query could be set-up:

IF Student Interaction = *Tech Help*, THEN Instructor Interaction = *Show and Tell*

Using the information on Table 3, it can be seen that there were four instances of student requests for *Tech Help*, two of which were followed by *Show and Tell.* Therefore, if students asked for *Tech Help*, the probability of instructors responding by *Show and Tell* is 0.5.

*g) Inter-rater reliability*

Inter-rater analysis was used in this study as Creswell (1998) recommended external audit as one of the methods for verifying the standards of qualitative research. An inter-rater who had experience coaching pre-service teachers in a teaching technology laboratory was selected as she is familiar with the context of pre-service teacher technology skills training.

Inter-rater reliability was computed for classifications by comparing the total frequencies of events coded per category. The researcher first coded all selected clips independently with the format showed in Table 3 using an initial coding protocol. A three-hour training session was then conducted by the researcher to familiarize the second coder with both the coding format and protocol. Typical examples underlying each category were explained and demonstrated using pertinent segments from video clips that were not sampled for analysis. The second coder proceeded to code sample segments that typified different categories listed in the protocol. After each segment was coded, the researcher answered questions and made clarifications about the coding protocol. By the end of the practice, the researcher observed that the second coder was able code independently without asking for clarifications.

Through the questions raised by the second coder, two categories were re-named for better clarity. This revised coding protocol was then used by the second coder to independently code 15% (in duration) of each video clip that was selected for data analysis. The researcher selected segments from each video clip that best captured the predominant teaching strategy used within that clip.

Inter-rater reliability was not measured by duration of interactions because classifications for Instructor and Student Interactions involved social interaction where categories of events changed in rapid succession throughout one dialogue. In trying to determine how instructors provide support, it is the sequence rather than the duration that is critical. Furthermore, some events had short duration of a few seconds (e.g. a student giving a Yes or No answer; an instructor solving a student problem by making a click on his mouse; or an instructor silently monitoring student progress on the monitor for a few seconds before moving on to the next student). It was felt that coding the duration of split-second interactions may introduce undue variation into the inter-rater process.

Inter-rater reliability was computed after the second coder finished coding all the video clips. As some of the categories had low frequencies of occurrences, Flander's modification of π was used to compute inter-rater reliability as follows (Frick & Semmel, 1978):

$$\pi_f = \frac{\text{Pof}-\text{Pef}}{1-\text{Pef}}$$

where

$P_{of} = 1 - \sum_{i=1}^{C} \left| \frac{n_{+i}}{N} - \frac{n_{i+}}{N'} \right|$

$P_{ef} = \frac{1}{C} \left( \sum_{i=1}^{C} \left(\frac{n_{+i}}{N} - \frac{n_{i+}}{N'}\right)^2 \right)$

C = Number of categories (states) within a classification

N & N' = total number of events coded by the researcher and inter-rater respectively

It was found that all classifications exceeded 0.80 except for the categories of student interactions, and instructional activity. Discussion with the second coder resolved interpretational differences, following which these two categories were re-coded with the finalized coding protocol (See Appendix E). After re-coding, the inter-rater reliability was re-computed, and all categories showed reliability as $\pi_f$ ranged from 0.78 – 0.88 (See Table 5).

**Table 5 - Inter-rater figures for each classification**

| Classification | $\pi_f$ | $P_{of}$ | $P_{ef}$ |
|---|---|---|---|
| Instructor interactions | 0.82 | 0.84 | 0.12 |
| Student interactions | 0.78 | 0.82 | 0.20 |
| Instructional Activity | 0.86 | 0.89 | 0.21 |
| Resources | 0.85 | 0.87 | 0.12 |
| Equipment | 0.88 | 0.91 | 0.32 |

**Methods used to analyze research questions**

a) *Question 1 – How is scaffolded instruction used during technology skills instruction?*

Since the use of instructor-centered methods such as demonstrations and lectures are typical in software training research (Gist et al., 1989; Torkzadeh et al., 1999; Johnson & Marakas, 2000), it is necessary to determine the extent to which scaffolded instruction was used against instructor-centered methods in the cases studied. It is also necessary to understand how scaffolding instruction occurred within the entire teaching sequence of a software program so that its contexts of use are considered.

This research question was first analyzed by comparing the instructional time each instructor spent on scaffolded instruction and other kinds of instruction. The operational definition of scaffolding was applied to each category under the classification "Instructional Activity" to determine if it described scaffolded instruction. Following this, the duration of scaffolded instruction was compared to the total instructional time to determine the extent to which it was being used in technology skills instruction.

The lesson sequences for PowerPoint and Web Development were subsequently analyzed by “Instructional Activity” to determine if different software programs affected how instructors used scaffolded instruction versus other instructional methods.

*b) Question 2 – What types of scaffolding functions occur during technology skills training; and to what extent is scaffolded instruction co-participatory? AND Question 3 - How are content resources and equipment used during scaffolded instruction?*

Meyer (1993) commented that scaffolding is context-driven. Therefore, there is a need to determine if technology skills instruction involved the use of unique instructor interactions, content resources, equipment; and also the types of student support requests that occur.

These research questions were answered by first counting the frequencies and relative percentages for different categories of instructor interactions, student interactions, content resources and equipment (See Table 4). APT queries were then used to compare how relative percentages for various categories differed between instructional segments identified as scaffolded instruction, and segments that were not. This allows an understanding of how scaffolded instruction differs from other types of instruction used by instructors. For example:

IF Instructional Activity = “Scaffolded Instruction”, THEN Instructor Interaction =?

IF Instructional Activity = “Scaffolded Instruction”, THEN Resources =?

The relative percentage of interactions initiated by both instructors and students were also compared to obtain insights about the extent of “co-participation” during scaffolded instruction. “Corroborating evidence” (Creswell, p. 202) was derived by triangulating video analysis results against data from the interviews and field-notes.

c) *Question 4 - How do instructors titrate assistance during scaffolding?*

Results of current empirical studies were used as a basis of explanation building (Yin, 2003) to answer this research question. Gist et al. (1989) and Compeau and Higgins (1995b) found that the initial computer self-efficacy of subjects and the type of software package affected the outcomes of computer skills training. To determine if initial computer self-efficacy affected how instructors titrated assistance during scaffolded instruction, students were categorized by their pre-observation GSE (See Appendix B Question 8) as follows:

Rating <3 – Low GSE

Rating =3 – Moderate GSE

Rating>3 – High GSE

These were then entered into the coded video sequences for scaffolded instruction as another APT classification (See Table 6).

**Table 6 - Sample of coded video sequences with pre-observation GSE**

| Instructional Activity | From | To | Student Interactions | Instructor Interactions | Resources | Equipment | Pre-Observation GSE |
|---|---|---|---|---|---|---|---|
| Lab | M | T | Clarify content | Null | Project/ Assignment Descriptions | Student Computer Terminal | Moderate |
| | Instructor | M | Null | Show N Tell | | | Moderate |
| | | Class | | Progress Checking | | | - |
| | | | | Prompt & hint | | | - |
| | C | | Share content | Null | | Null | High |
| | Instructor | | Null | Show N Tell | | | - |
| | | | | Prompt & hint | | | - |
| | C | | Share content | Null | | | High |
| | Instructor | | Null | Show N Tell | | | - |
| | | | | Prompt & hint | | | - |

Titration of assistance was studied by comparing the frequencies of different categories underlying instructor and student interactions by pre-observation GSE through APT queries such as:

IF Pre-Observation GSE= "High", THEN Instructor 1 Interactions =?

IF Pre-Observation GSE= "High", THEN Section 1 Student Interactions =?

Comparisons were also made across cases to identify generic strategies used by instructors, and how these strategies varied during scaffolded instruction for Microsoft PowerPoint and Web Development. These results were then triangulated against the data obtained from the student responses in the post-observation survey about the types of instructor strategies that were most and least useful for raising their self-efficacy for using technology (See Appendix C, Question 4).

*d) Question 5 - How is technology skills instruction related to computer self-efficacy and self-efficacy for technology integration?*

Since computer self-efficacy is a multi-level construct comprising GSE and TSE (Marakas et al., 1998), it is necessary to determine how each was related to technology skills instruction; and if there are any inter-relationships between them. Spearman's correlation was first used to analyze the relationships between post-observation scores for GSE, TSE (overall scale), TSE (technology integration), and TSE (performing technology tasks with computer software or internet). High significant positive correlations were found.

APT analysis was then used to further determine temporal patterns related to the outcomes for the lessons analyzed through video analysis. To do this, differences in pre-post observation survey ratings were used as outcome measures for different aspects of technology skills instruction as follows:

1. Outcome of Microsoft PowerPoint instruction - Measured by the change in TSE for making slide presentations i.e. the differences between student ratings for Question 9*o* in the pre- observation survey, and Question 3*o* in the post-observation survey i.e. I feel confident that I could use the computer to create a slideshow presentation

2. Outcome for Web Development instruction – Measured by change in TSE for making a webpage i.e. differences between student ratings for Question 9*i* in the pre- observation survey, and Question 3*i* in the post-observation survey i.e. I feel confident that I could create my own World Wide Web home page
3. Overall outcome – Measured by change in GSE i.e. differences between student ratings for Question 8 of the pre-observation survey, and Question 2 of the post-observation survey
4. Outcome with respect to technology integration - Measured by the differences between average scores ratings for Question 9*q* to 9*t* in the pre- observation survey, and Question 3*q* to 3*t* in the post-observation survey

APT queries were used to determine the relationship between various aspects of students' pre-observation self-efficacy and the corresponding change after technology skills instruction in each section. For example:

*APT Query: If Class=Section 1, and Pre-observation TSE (making webpage) =”Low”, THEN Change in TSE (making a webpage) = 1.*

The probability of this temporal pattern was computed by:

$$\frac{\text{No. of Section 1 students where TSE (Making a webpage =”Low” AND change in TSE (making a webpage) = 1}}{\text{No. of Section 1 students where Pre-observation TSE (making webpage) = “Low”}}$$

Since pre-service teachers' self-efficacy with using technology was found to impact the extent they integrated technology in the classroom, (Zhao et al.,2002, Negishi et al.,2003, Littrell et al.,2005), APT queries were also used to determine if changes in TSE for using specific software and GSE were related to self-efficacy for technology integration. For example:

*APT Query: If Pre-observation TSE (Making a slide) = “High” AND TSE (Making a slide) increases, THEN TSE (technology integration) increases.*

The probability of this temporal pattern was computed by:

$$\frac{\text{No. of students where Pre-observation TSE (Making a slide) = “High” AND change in TSE (Making a slide) > 0 AND change in self-efficacy(tech integration)>0}}{\text{No. of students where Pre-observation TSE (Making a slide) = “High” AND change in TSE (Making a slide) > 0}}$$

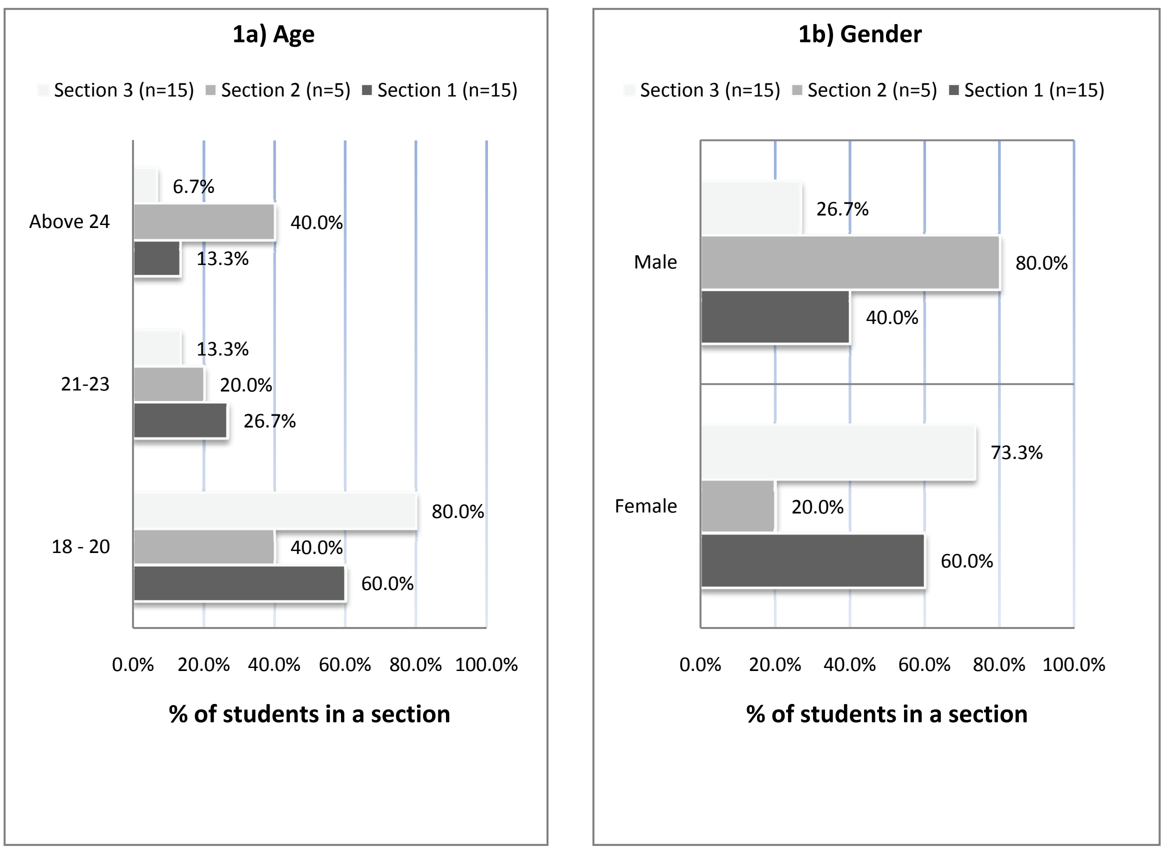
## CHAPTER IV - RESULTS

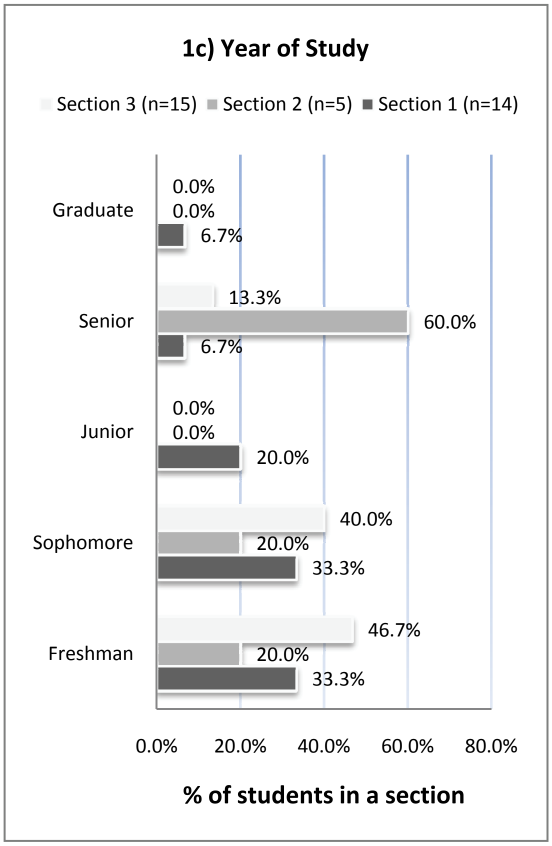
### General student profile

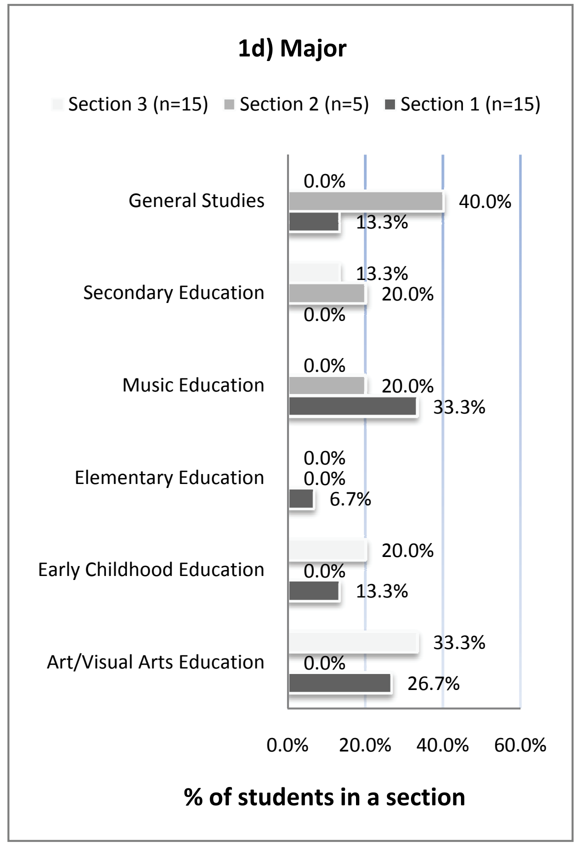
*a) Demographics*

At least 60% of the students in Sections 1 and 3 were females, freshmen or sophomores with age ranging between 18-23 years (M=22.26, SD=7.37) (See Figures 1*a*-1*c*). Section 2 was a small class with only five students. It also had a majority of non-traditional students where 60% of them were seniors, aged above 24, and 80% of the students were male. In terms of major, Section 2 again had 40% of non-education General Studies majors, which was the highest among the three sections (See Figure 1*d*). Refer to Appendix G for the raw data of all figures in this chapter.

**Figure 1 – Student demographics**



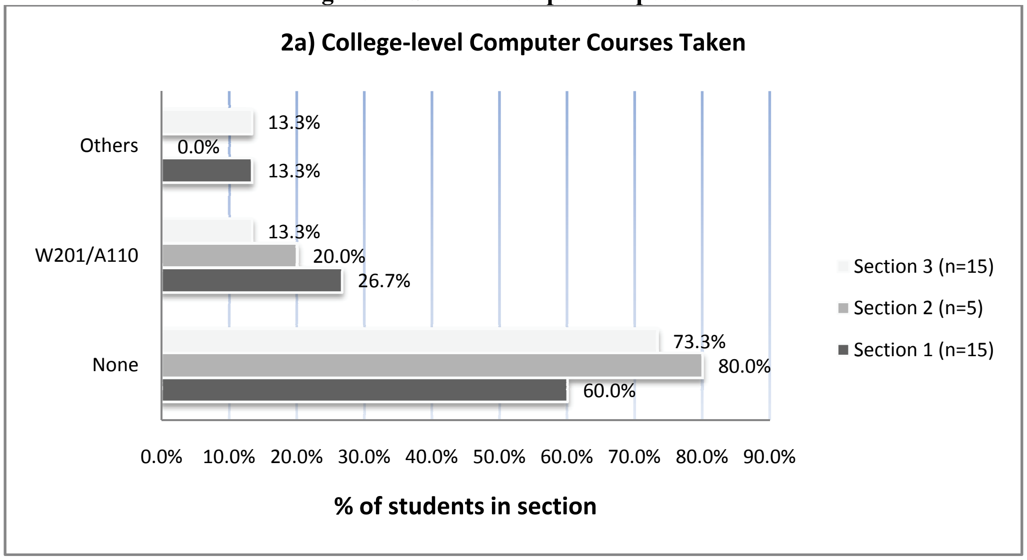


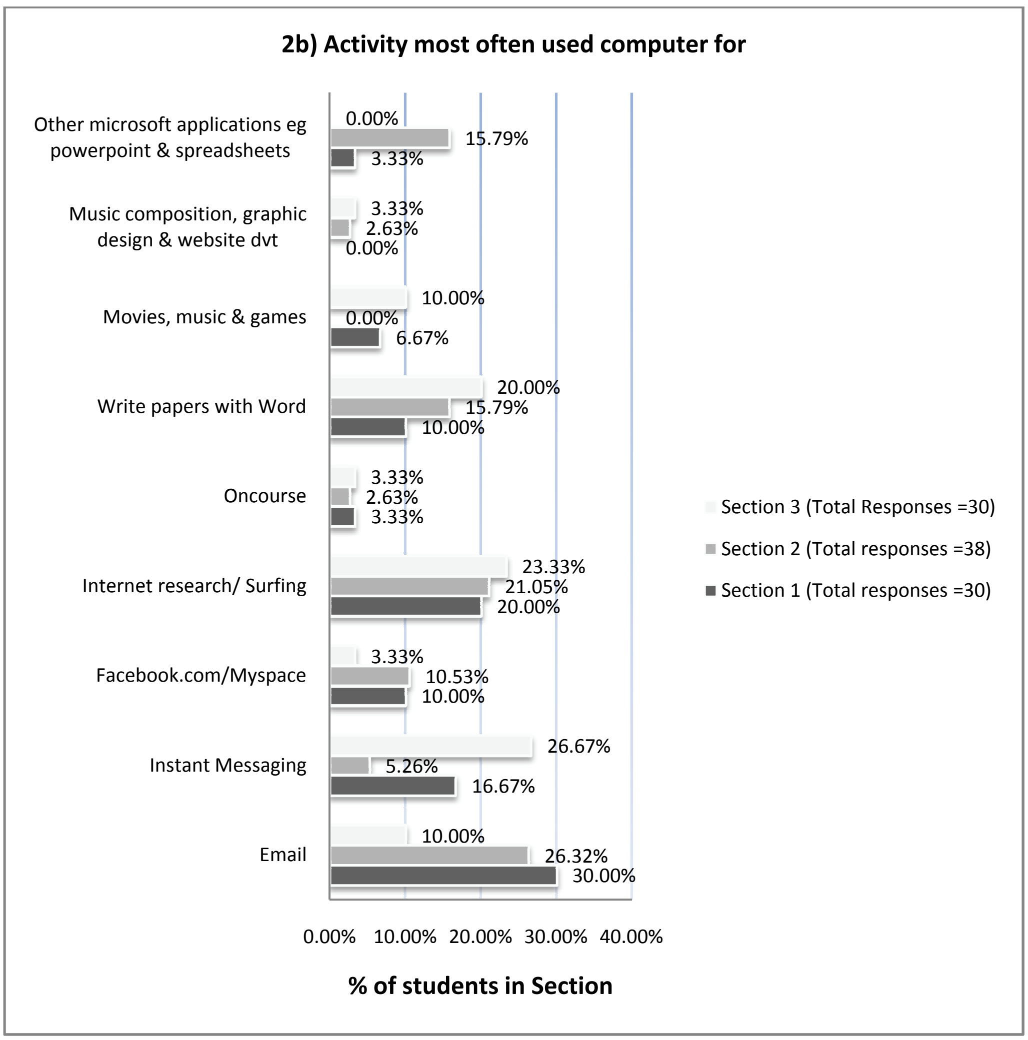




*b) Computer Experience*

At least 60% of subjects each section did not take any college-level computer course before (See Figure 2*a*). In terms of the three activities that they most frequently engaged in when using the computer, E-mail was most often cited by students in sections 1 and 2, while Instant Messaging was most often cited in Section 3 (See Figure 2*b*). Internet surfing was another activity that students most often used the computer for as it was cited by at least 20% of the students in each section.

**Figure 2 - Student computer experience**

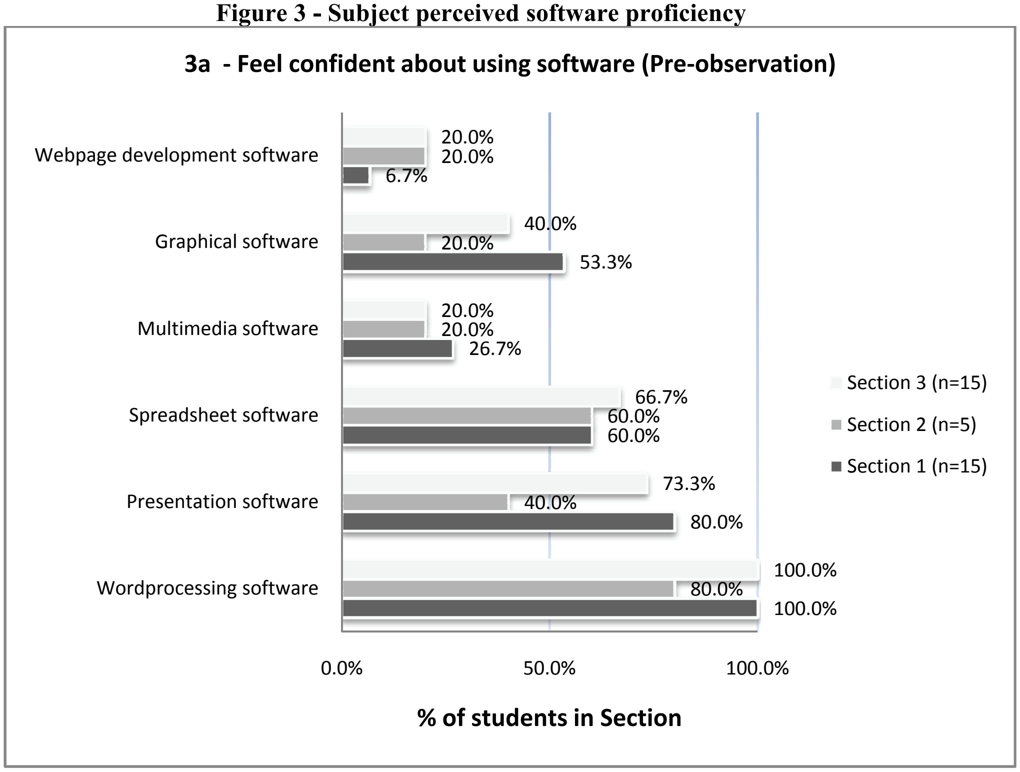


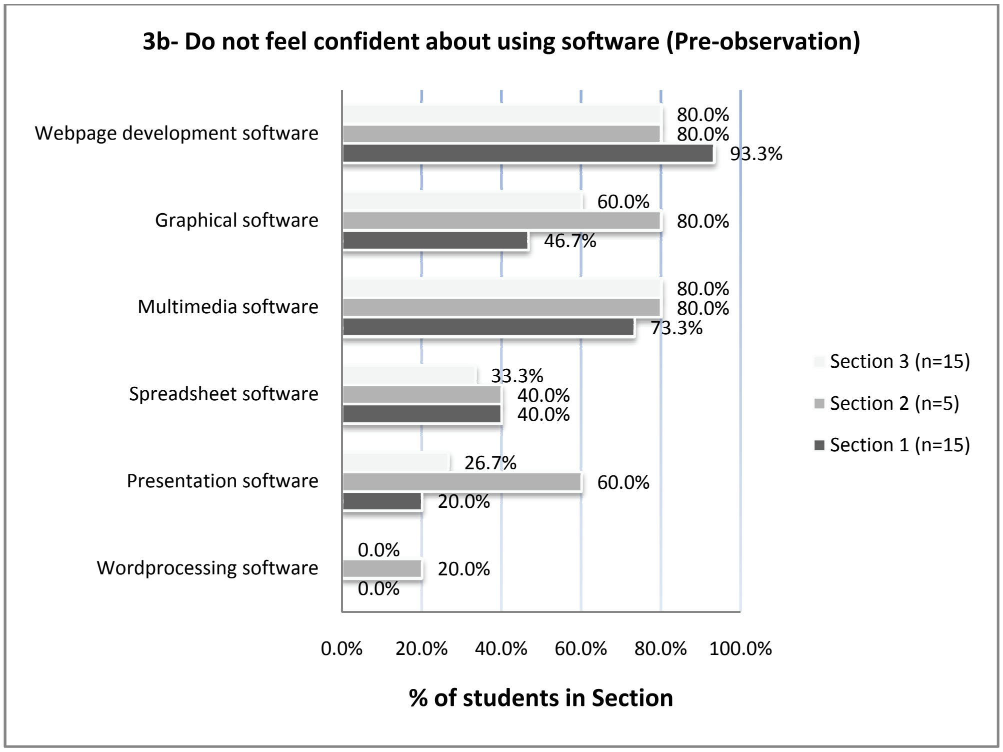



*c) Perceived proficiency by computer package*

The pre-observation survey showed that at least 60% of the students in each section felt confident that they can use word-processing and spreadsheet software (See Figure 3*a*). At least 73.3% of students in Section 1 and 3 felt similarly about using presentation software, but this was only indicated by 40% of Section 2 students. At least 40% of students in Sections 1 and 3 felt confident about using graphical software, but this was only 20% in Section 2. This could be because at least 26% of students in Sections 1 and 3 were Art Education majors who were already exposed to using this type of software while there were no Art Education majors in Section 2 (See Figure 1*d*). Multimedia and webpage development software were packages that at least 70% of students felt they did not have confidence using in the pre-observation survey (See Figure 3*b*).

**Figure 3 - Subject perceived software proficiency**

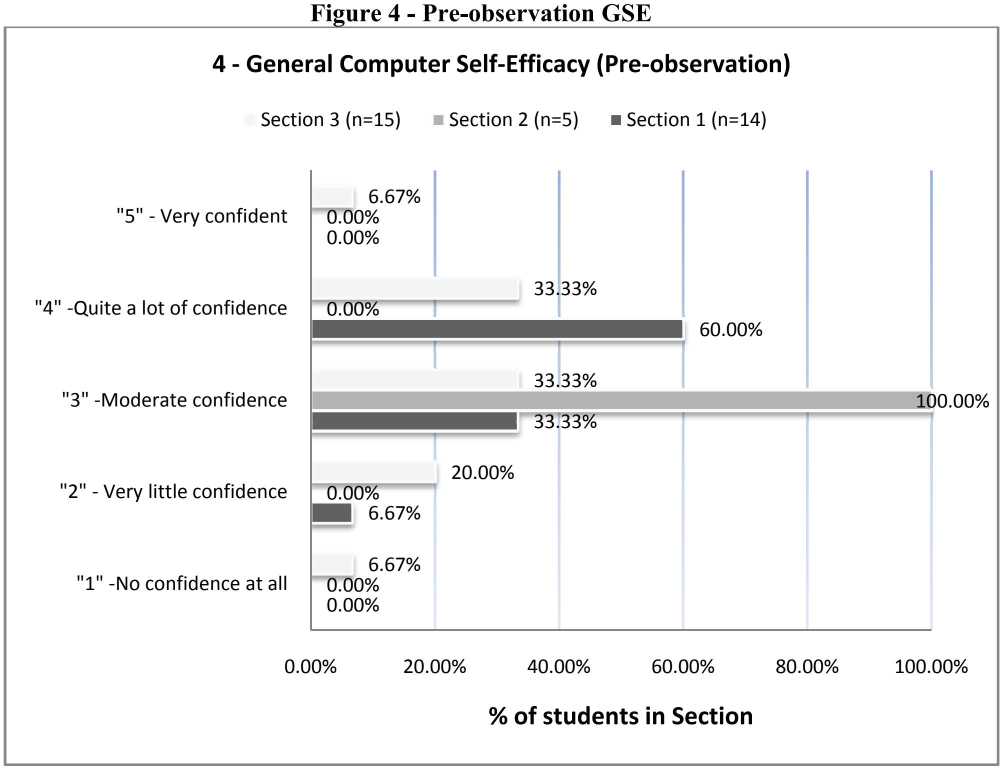





*d) GSE (Pre-observation)*

This was rated on a 5-point Likert scale denoted by 1 (no confidence at all), 2 (very little confidence), 3(moderate confidence), 4(quite a lot of confidence) and 5(very confident). Figure 4 shows that pre-observation GSE of students were high (M=3.29, SD=0.83). At least 60% of students in each section rated themselves as having moderate confidence or higher. Students in Section 2 were unanimous in rating themselves as having moderate confidence with using technology. The lack of variation in their ratings could be because of the small class size. On the other hand, Section 3 had a higher proportion of students with low GSE as compared to Section 1. About 27% felt they had either very little confidence or no confidence with using technology in Section 3 while only 6.67% of students felt similarly in Section 1 with no students rating themselves as having "No confidence at all" with using computers.

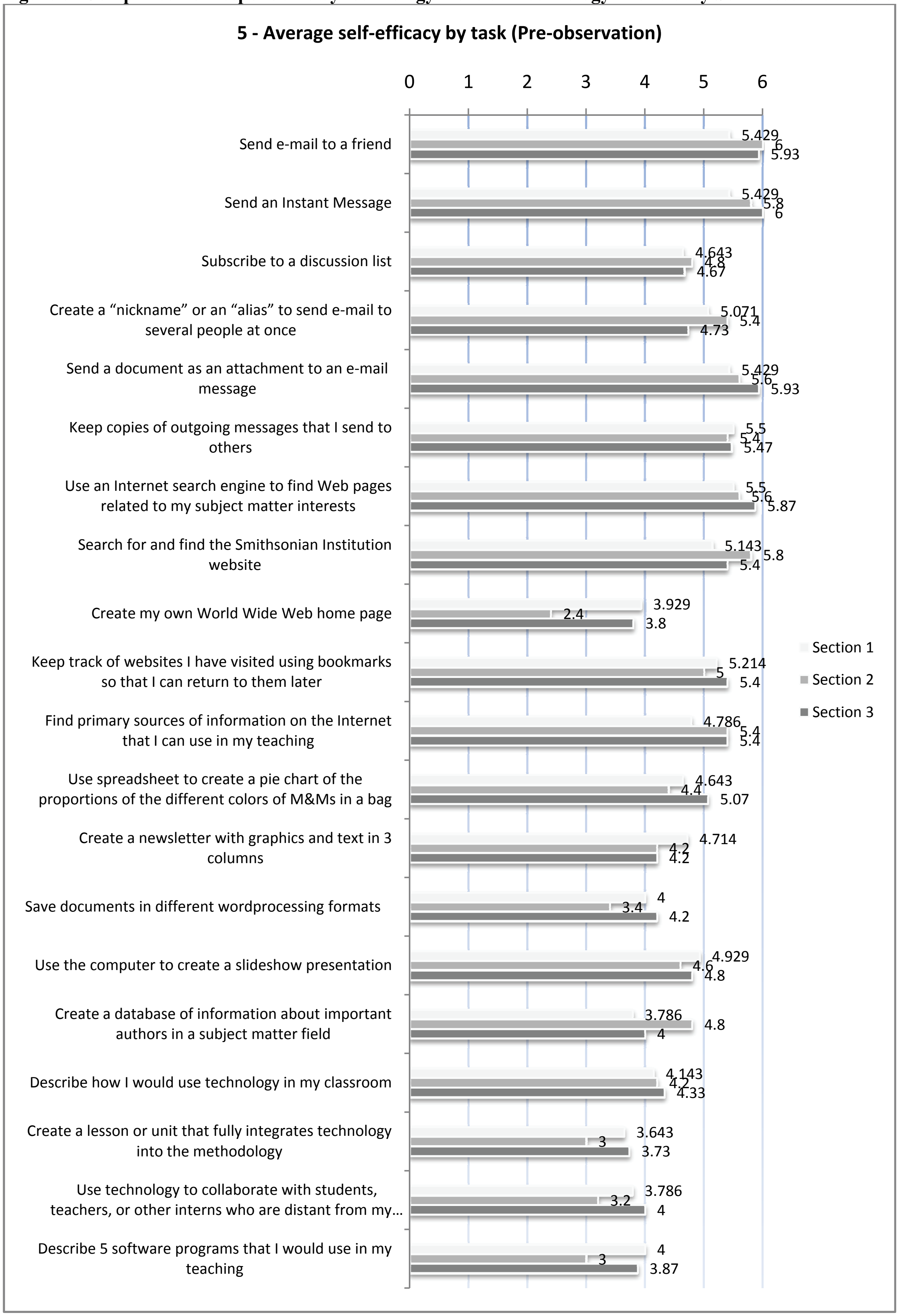
**Figure 4 - Pre-observation GSE**




*e) TSE (Pre-observation)*

This was measured across 20 items of the 6-point scale, where 1(strongly disagree), 2(disagree), 3(mildly disagree), 4(mildly agree), 5(agree), and 6(strongly agree). Figure 5 shows that students generally had high TSE (Overall M=4.75, SD=0.86), especially for tasks that they frequently used the computer to perform. Activities related to e-mail (e.g. sending e-mail, sending e-mail attachments), sending Instant Messages, and Internet surfing (e.g. finding Smithsonian Institute website, using bookmarks) had an average rating of at least five points in all sections (See Figure 5). On the other hand, they had the lowest TSE ratings of 4 points or below for webpage creation and technology integration tasks (e.g. using technology for collaboration, creating a technology integrated lesson, and describing software programs to use for teaching). Notably, students in section 2 had the lowest average rating for these tasks among the three sections except for “Describe how I would use technology in my classroom”.

**Figure 5- Comparison of respondents by technology tasks on Technology Proficiency Self Assessment scale**



**Question 1 – How is scaffolded instruction used during technology skills instruction?**

a) *Scaffolded versus Teacher-Directed teaching methods*

Three types of teaching methods were used during scaffolded instruction – In-class activities, Lab, and Group Discussions (See Table 7). As described by the operational definition of scaffolded instruction, these were activities during which students worked independently on a learning task while being supported by instructors. The qualitative analysis of video data also found instructors using three other types of teacher-directed teaching methods: Lecture, Demonstration, and Instructor-led discussions (See Table 7).

**Table 7 - Classification of teaching methods**

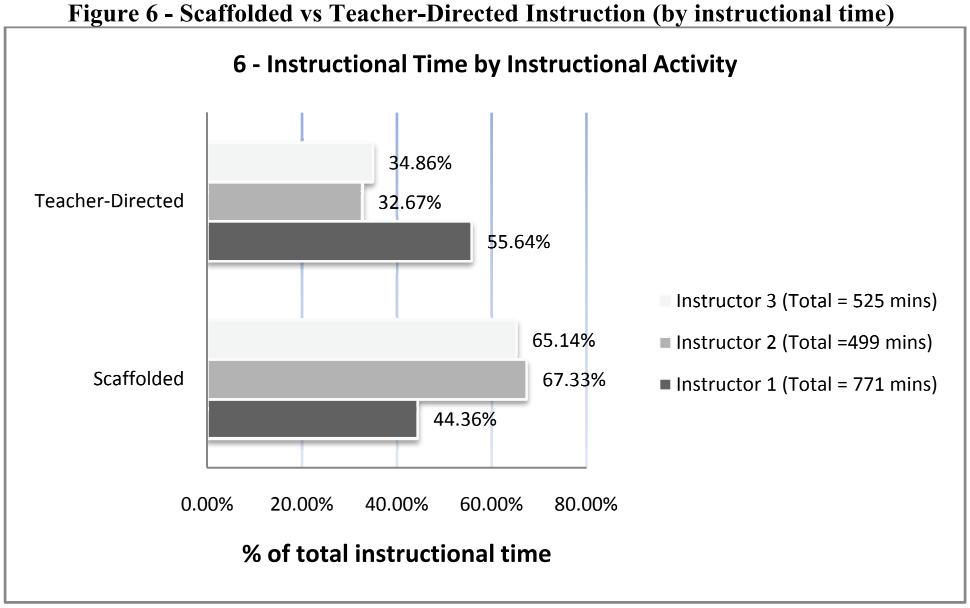
| Scaffolded Instruction | Teacher-Directed Instruction |
|---|---|
| 1. In-class Activities – Students worked individually or in groups on an exercise assigned by the instructor.<br>2. Lab – Students worked independently on their projects.<br>3. Group Discussions – Students got together to discuss assigned in-class activities or their opinions about technology issues. Students were facilitating the discussion themselves. | 1. Lecture – Instructor presents content information to the class either through straight lecture, or through question-and-answer format.<br>2. Demonstration – Instructor shows software procedures to the class using the teacher computer terminal<br>3. Instructor-led Class Discussions – Class-wide discussion of student opinions about technology issues where the instructor is the facilitator. |

Weston and Cranton (1986) classified Lecture and Demonstration as "instructor-centered methods" where teachers have primary responsibility to convey content information to students. The authors also noted that teachers often used the question-and-answer format in conjunction with Lecture and Demonstration. Although Weston and Cranton classified class discussions as an "interactive method" that emphasizes communication in a classroom setting, there is a need in this study to differentiate between Instructor-led Class Discussions, and Group Discussions. Interviews with instructors found that their intention for asking questions during Instructor-led Class Discussions is to, "move them towards what I want them to know". In comparison, students had primary responsibility for facilitating Group

Discussions while instructors provided support only upon request. Therefore, the former was considered as a category of teacher-directed instruction while the latter was considered as a category of scaffolded instruction in this study.

From Figure 6, it can be seen that the use of scaffolded instruction comprised between 44%-68% of total instructional time in the three sections (See Appendix G for raw data of all figures in this chapter).

**Figure 6 - Scaffolded vs Teacher-Directed Instruction (by instructional time)**




Instructor 1 spent more instructional time on teacher-directed instruction as she felt that her role as a teacher educator was to model good teaching practices to her students. She said, "I tell them that even if they know the stuff, they should still watch and see how I present my lesson." Among the three instructors, Instructor 2 used scaffolded instruction the most (67%) because:

> My goal is to try to make them independent in using computers. When there are software changes, I want them to be able to adapt and not feel that they need to go for a training course to learn. My strategy is to have them do most of the things alone by using the IT tutorials and Help feature.

Instructor 3 also had high use of scaffolded instruction (65%). But, she saw it as a means of individualizing support to students. She said:

> When I first taught [the course], I did more demonstrations and required them to turn in the same exercises. I didn't feel that was useful as some were very bored and frustrated because they felt the demonstrations were going too slowly. Some were however extremely confused, which made it necessary for me to go slow. While that is happening, those who already knew the stuff were checking e-mail and Facebook. Now, I try to provide more handouts than demonstrations, and provide time to do one-on-one help.

*b) Sequencing of Scaffolded Instruction*

Figures 7*a* and *b* show the sequencing of instructional activities for class sessions on PowerPoint and Web Development. Instructor 1 taught Microsoft PowerPoint by using first demonstrating how the software could be used to make a teaching artifact, and then giving students lab time to make their own version of the artifact. This sequence was used repeatedly as students progressed from using simple functions of PowerPoint to make a certificate, a seating chart; to using more complex features such as customized templates to design a set of presentation slides for teaching elementary school children how to differentiate between toads and frogs.

**Figure 7 – Instructional Sequences**

*7a - Microsoft Powerpoint (Shaded boxes: Scaffolded Instruction)*

<table>
<tr><th></th><th>Instructor 1</th><th>Instructor 2</th><th>Instructor 3</th></tr>
<tr><td rowspan="4">Session 1</td><td>Demonstration - How to make signs & certificates with PowerPoint (25 mins)</td><td>Demonstration - How to download tutorial from Oncourse (8 mins)</td><td>Instructor-led Discussion - Educational Use of PowerPoint (16 mins)</td></tr>
<tr><td>Instructor-led discussion - What type of seating chart do you want to make?<br>(2 mins)</td><td rowspan="3">In-class assignment - Self-paced tutorial on PowerPoint (47 mins)</td><td>Lecture - Basic functions of PowerPoint (10 mins)</td></tr>
<tr><td>Demonstration - How to make a seating chart with PowerPoint (10 mins)</td><td rowspan="2">Open Lab - Make slide presentation on pros and cons of technology integration (49 mins)</td></tr>
<tr><td>Lab - Make a sign/certificate that you will use when teaching (38 mins)</td></tr>
<tr><td>Session 2</td><td>Demonstration - Making a PowerPoint presentation to teach elementary kids how to differentiate between toads and frogs (29 mins)</td><td>In-class assignment - Self-paced tutorial on PowerPoint (75mins)</td><td>Open Lab - Make slide presentation on pros and cons of technology integration (75 mins)</td></tr>
<tr><td rowspan="4">Session 3</td><td>Demonstration - Making a PowerPoint presentation to teach elementary kids how to differentiate between toads and frogs (47 mins)</td><td rowspan="2">In-class assignment - Make a bad PowerPoint (53 mins)</td><td rowspan="4">Open Lab - Make slide presentation on pros and cons of technology integration (75 mins)</td></tr>
<tr><td>Lecture - Recap the steps for making a PowerPoint (4 mins)</td></tr>
<tr><td>Demonstration - Making a PowerPoint template for your toads and frogs presentation<br>(9 mins)</td><td>Group Discussion - Guidelines for making a good PowerPoint presentation (8 mins)</td></tr>
<tr><td>Lab - Making your toads & frog presentation template (15 mins)</td><td>Lecture - Guidelines for making a good PowerPoint (10 mins)</td></tr>
<tr><td rowspan="3">Session 4</td><td>Lecture - Requirements for project on making lesson plans and supporting PowerPoint, and some samples (25 mins)</td><td rowspan="4">Total instructional time for topic = 201 mins<br>Scaffolded instruction =183 mins (91%)</td><td rowspan="4">Total instructional time for topic = 225 mins<br>Scaffolded instruction =199 mins (88.4%)</td></tr>
<tr><td>Lab - Make your lesson plan and accompanying PowerPoint (18 mins)</td></tr>
<tr><td>Lecture - Making your toads & frogs presentation template - Recap (32 mins)</td></tr>
<tr><td>Session 5</td><td>Lab - Make your lesson plan and accompanying PowerPoint (75 mins)</td></tr>
<tr><td></td><td>Total instructional time for topic = 329 mins<br>Scaffolded instruction = 108 mins (32.8%)</td><td></td><td></td></tr>
</table>

To Instructor 1, “Learning is like making a tapestry… sometimes you start with a new color; sometimes you use an existing color.” Repeated sequences for learning software allow “New things get tied to the old ones.” In their final assignment for Microsoft PowerPoint, students selected a topic of their choice and created a lesson plan, a set of PowerPoint slides, and two different types of practice materials to support the lesson. The lesson plan and practice materials were produced using Microsoft Word, which allowed them to revisit content they learned in earlier class sessions. This lesson format was also used during Web Development where students first learned how to make a class website for a hypothetical teacher Mrs. Smith, followed by a teaching portfolio, and finally created their own website (See Figure 7*b*).

In comparison, Instructor 2 predominantly used scaffolded instruction through labs, in-class assignments, and student-led discussions when teaching Microsoft PowerPoint (See Figure 7*a*). He first conducted an eight-minute demonstration to help students download a self-paced tutorial from the course management system used at the university. Students then learned Microsoft PowerPoint features by working independently on the tutorial that was designed for university-wide IT training. After they completed the tutorial, students were assigned another in-class assignment where they tried to make a bad PowerPoint presentation, following which they critiqued each others’ work through a group discussion to derive guidelines for making a good PowerPoint presentation. The instructor then debriefed the activity with a short 10-mintue lecture.

**Figure 7 - Instructional Sequences**

*7b- Web Development (Shaded boxes: Scaffolded Instruction)*

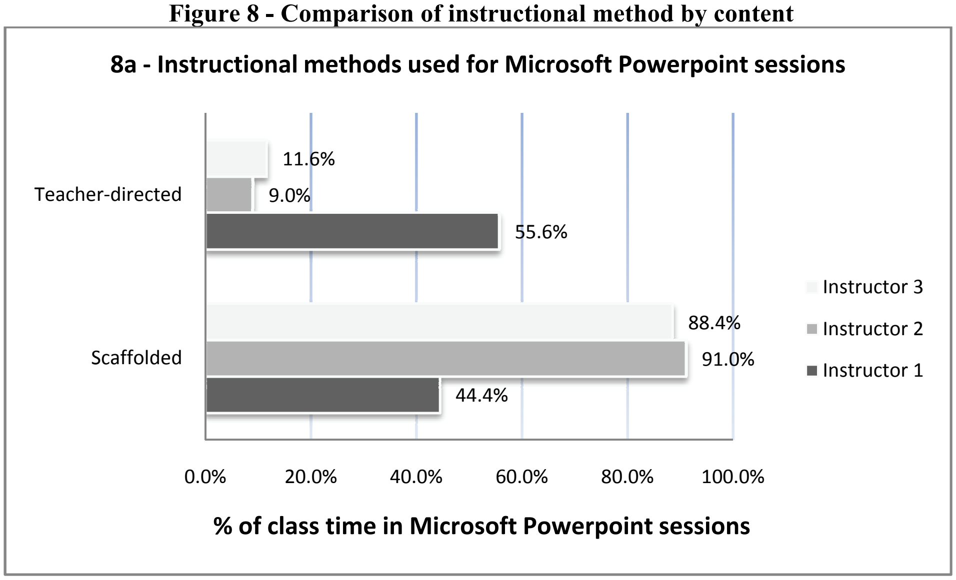
| | Instructor 1 | Instructor 2 | Instructor 3 |
|---|---|---|---|
| Session 1 | Lecture - Anatomy of a website (48 minutes)<br>Demonstration - Using Dreamweaver (8 mins)<br>Lab - First web assignment (19 mins) | Lecture - Image Basics (16 mins)<br>In-class exercise - Image Basics (4 mins)<br>Lecture - Review Image Basics In-class exercise (25 mins)<br>Lecture - What is a site map (8 mins)<br>In-class exercise - Site-Map In-class exercise (12 mins)<br>Lecture - Review Site-Map In-class exercise (10 mins) | Lecture - Design Principles (75 mins) |
| Session 2 | Lecture - Structure of Mrs Smith's class website (15 mins)<br>Demonstration - Making Mrs Smith's class website in Dreamweaver (60 mins) | Lecture - Intro to creating webpages (9 mins)<br>Demonstration - using NVU(52 mins)<br>Lab - Develop your website (12mins) | Demonstration - How to use Dreamweaver (52mins)<br>Open Lab - Develop your website (23 mins) |
| Session 3 | Lecture - Re-cap how to structure files in a website (14 mins)<br>Demonstration - Making a teaching portfolio in Dreamweaver (61 mins) | Lab - Develop your website (30 mins)<br>Lecture: Preparing graphics for the web (25 mins)<br>Lab - Prepare your photos for your website (20 mins) | Demonstration - Set-up Steel account & more on Dreamweaver (30 mins)<br>Open Lab - Develop your website (45 mins) |
| Session 4 | Lecture - Recap how to structure files in a website (5 mins)<br>Demonstration - Preparing your graphics for the website (28 mins)<br>Lecture - Examples of website projects (7 mins)<br>Lab - Making your website (27 mins) | Lab - Develop your website (75 mins) | Open Lab - Develop your website (75 mins) |
| Session 5 | Lab - Making your website (75mins) | **Total instructional time for topic = 298 mins Scaffolded instruction = 153 mins (51.9%)** | **Total instructional time for topic = 300 mins Scaffolded instruction = 143 mins (47.7%)** |
| Session 6 | Lab - Making your website (75mins) | | |

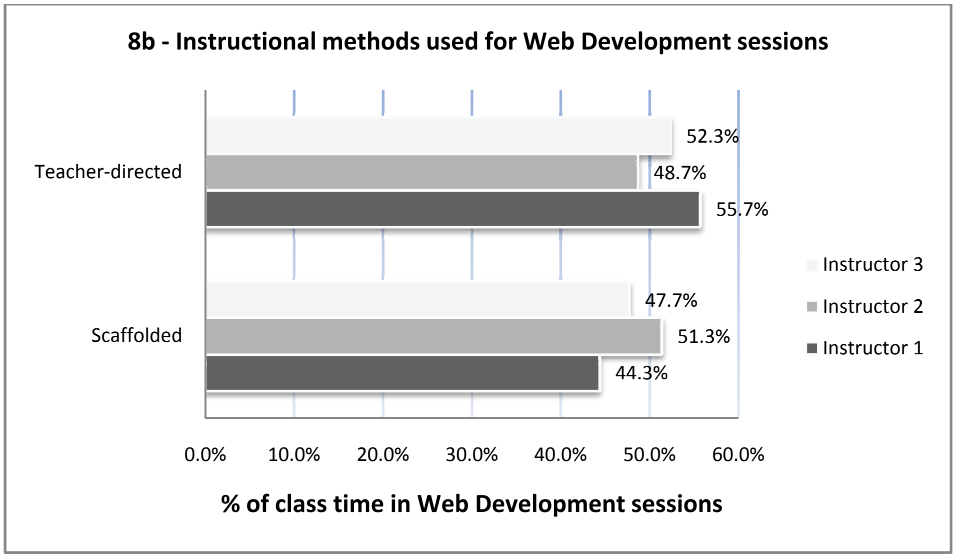
**Total instructional time for topic = 442 mins**
**Scaffolded instruction =196 mins (44.3%)**

A similar sequence was used by Instructor 3 where she first led a discussion on the pros and cons of using Microsoft PowerPoint for teaching followed by a short lecture on the basic features of PowerPoint. Students then proceeded to lab time where they searched for three journal articles and made a slide presentation that summarized what they learned from the articles about the pros and cons of technology integration in education. Instructor 3 recognized that "Students can have different incoming levels and need different types of support to achieve the course goals and their personal goals." The use of scaffolded instruction during lab time allowed her to work one-to-one with students on their projects, to get to know their interests and goals better so as to better customize her teaching to their needs.

Figures 8*a* and *b* show that Instructors 2 and 3 used scaffolded instruction at least 88% of the time during Microsoft Powerpoint sessions, while it was only used between 48 - 51% of the time during Web Development sessions.

**Figure 8 - Comparison of instructional method by content**






Interestingly, both instructors switched to a Lecture/Demonstration followed by In-class assignment/Lab sequence when teaching Web Development (See Figure 7*b*). Even though Instructor 2 commented that, "Students didn't have a problem working on their web assignments independently", the fact that at least 80% of the students in each section did not have confidence using web development software (See Figure 3*b*) could have made instructors feel it was necessary to provide basic content information to students through teacher-directed instruction.

*c) Summary of findings for Question 1*

Therefore, it can be seen that technology skills instruction involved an eclectic use of both scaffolded and teacher-directed instruction where instructors could sometimes use scaffolded instruction almost exclusively if they felt that students' have high computer self-efficacy for a software program. When students' computer self-efficacy for a software program was low, instructors tend to use teacher-directed methods before scaffolded instruction. The process where instructors faded support to transfer responsibility for learning to students was less gradual as compared to reciprocal teaching because instructors either used teacher-directed methods to control learning, or they allowed students to be directing the learning process through scaffolded instruction.

**Question 2 – What types of Scaffolding functions occur during technology skills training; and to what extent is Scaffolded instruction co-participatory?**

*a) Instructor interactions*

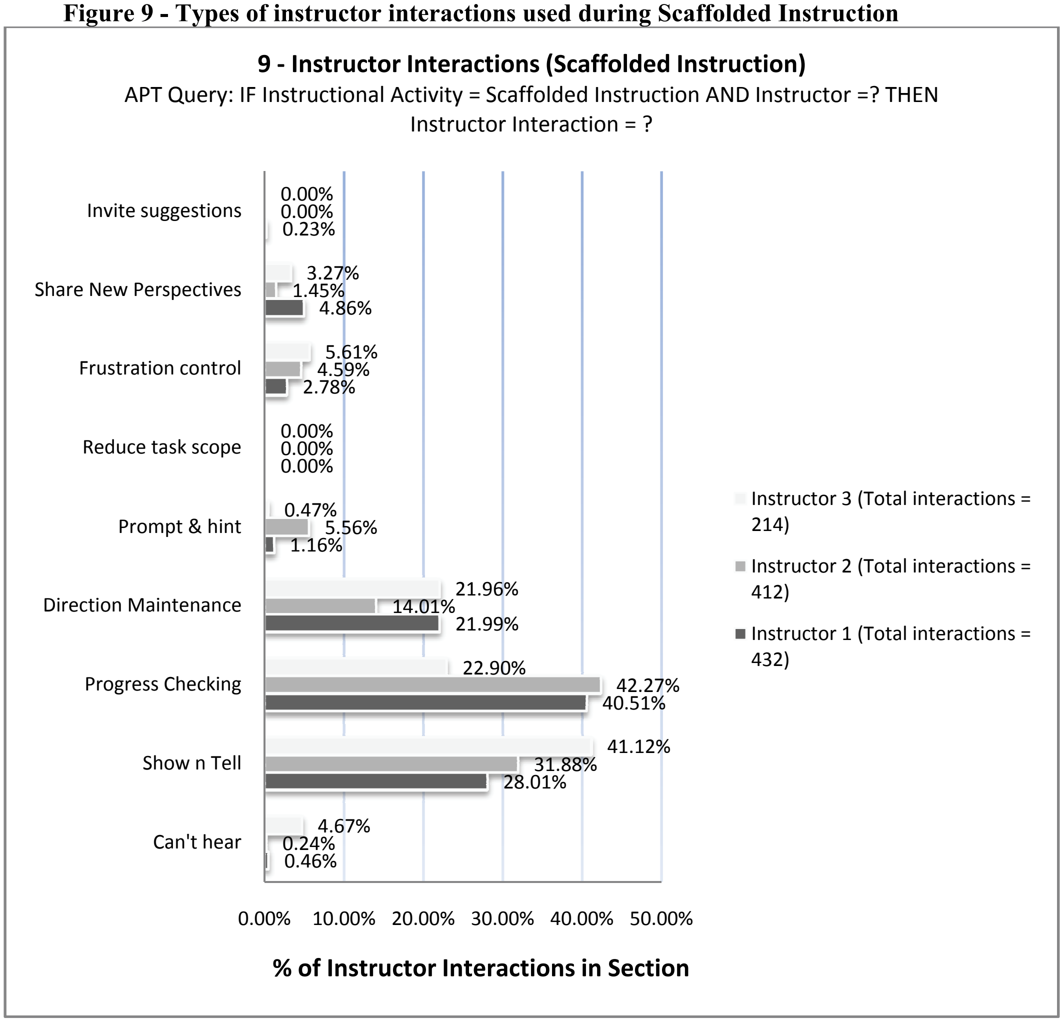
Table 8 shows the eight categories of instructor interactions that emerged from qualitative analysis of video clips.

**Table 8 - Categories of instructor interaction**

1. Show and Tell – Present learning content, task expectations or demonstrate technology procedures
2. Progress Checking – monitor student task performance and identify misconceptions or obstacles that hinder students from successful task performance
3. Direction Maintenance – Motivate students to focus and persist on an instructional task
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
5. Invite Suggestions – Invite students to contribute to specifications for an instructional task
6. Frustration Control – Help students prevent/manage errors before they occur
7. Share New Perspectives – Offer suggestions of new ways to approach an instructional task
8. Can't Hear – when an interaction cannot be clearly heard from the recording

The data in Figure 9 shows that during scaffolded instruction, instructors used mainly three types of interactions: *Progress Checking*, *Show and Tell* and *Direction Maintenance*. For both Instructors 1 and 2, about 40% of their interactions with students involved *Progress Checking* where they monitored if students were keeping on task. One way of *Progress Checking* was passive, where instructors silently observed students' computer terminals, or listened to group discussions and walked away when they concluded that students were not having difficulties. The other way was active, where instructors asked questions (i.e. *Prompt and Hint*) to check student understanding, or probed students to better understand the problems and issues they faced.

**Figure 9 - Types of instructor interactions used during Scaffolded Instruction**




For example, after students worked through a self-paced tutorial in Microsoft PowerPoint, Instructor 2 asked one student a series of questions to determine if he understood how to read the numbers that specified the order of custom animations:

Instructor (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: The order of? [*Prompt & Hint*]

Student: The animation [*Share Content*]

Between 28-41% of instructor interactions during scaffolded instruction also involved the use of *Show and Tell*, which was analogous to the function of "Demonstration" in Wood et al. (1976) where instructors did direct content instruction. This usually occurred as and when students asked for help with technology problems during independent work. An instructor commented that, “there are two types of knowledge being disseminated – technology tasks with mostly procedural skills that have a few concepts tied to it.” Therefore, *Show and Tell* during technology skills training involved a combination of verbal explanation alongside with on-the-spot demonstrations on student computer terminals.

Instructors 1 and 2 tend to be similar in the extent they used *Show and Tell* and *Progress Checking*. In comparison, Instructor 3 showed more emphasis on *Show and Tell* than *Progress Checking* because she mostly used scaffolded instruction during Open Lab sessions where the aim was in-depth personal coaching. During Open Lab, students “could leave if they don’t see a need to be there.” She then worked one-on-one with a smaller number of students who really needed her help, and customized her teaching to their “levels and interest”. When describing how she coached a student to make an animation during one Open Lab session, she said:

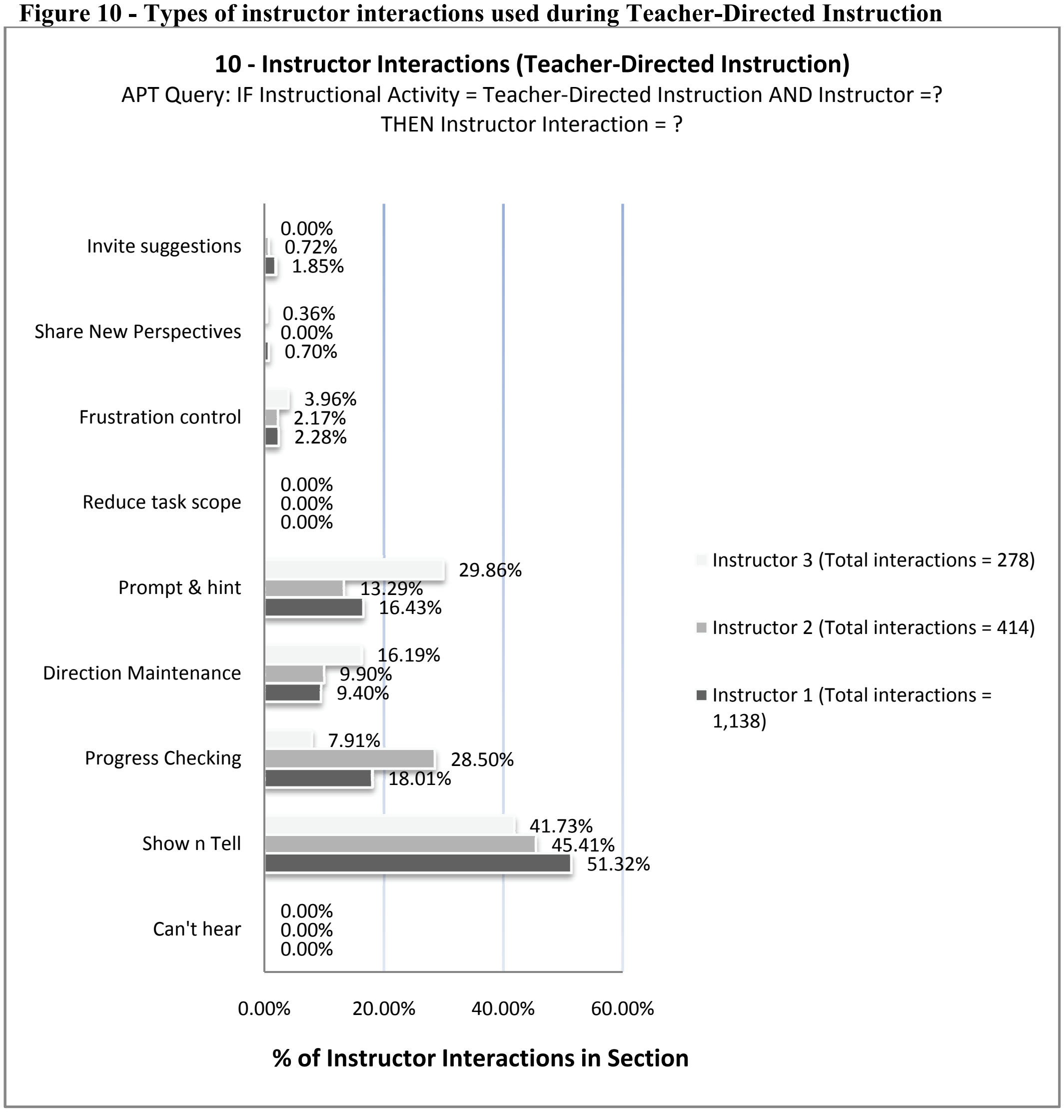
> I started by showing her step-by-step. Then I asked questions to make sure she understood. After I helped the others and made sure there are no more open questions, I walked by again to check and found that she has already done 10 animations on her own.

Besides using *Progress Checking* and *Show and Tell*, *Direction Maintenance* was also a major category that comprised between 14-22% of instructor interactions. Instructors most often used *Direction Maintenance* to praise and validate students’ work-in-progress as they went about *Progress Checking*. They also used *Direction Maintenance* when they provided students with suggestions of how they could maintain good task performance. For example:

Instructor 1: Right now, this looks close to the sample we reviewed in class. On the scale of total creativity, your line is here [Instructor gestures that student was only achieving the halfway mark]. So, find a way to do it differently. You might try putting objects inside the squares. [*Direction Maintenance*]

An analysis of instructor interactions during teacher-directed instruction showed that *Share New Perspectives* had minimal occurrence as almost half of the interactions involved *Show and Tell* through lectures and demonstrations (See Figure 10).

**Figure 10 - Types of instructor interactions used during Teacher-Directed Instruction**




Independent work during scaffolded instruction allowed instructors to use students' work-in-progress to *Share New Perspectives* or technical content that were relevant for improving their task performance. During a lab session for web development for example:

Instructor 1: You 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*]

Instructors engaged in *Frustration Control* both during scaffolded instruction and teacher-directed instruction when they reminded the class to save files, take notes, and check instructions about project requirements to avoid losing points. During scaffolded instruction, instructors also directed *Frustration Control* to individual students when they stopped their independent work and offered instruction to help them prevent technical frustrations even when assistance was not asked for. These interactions resulted in a higher percentage of *Frustration Control* during scaffolded instruction.

On the other hand, scaffolded instruction did not seem to provide occasion for instructors to engage in *Prompt and Hint* with students. This was used more often during teacher-directed instruction as instructors used the question-and-answer format during lectures. For example:

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? It sure takes a little while to find these information. [*Prompt & Hint*]

Student 1: Well, they are all using the same font [*Share Content*]

Instructor: 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 & Hint*]

Student 2: Now the contact information has been shifted to the bottom [*Share Content*]

Instructor: 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*]

*b) Student interactions*

Table 9 shows the eight categories of student interactions that emerged from qualitative analysis of video clips.

**Table 9 - Categories of student interaction**

1. Share content – Respond to instructors' questions or share general opinions
2. Share project – Share ideas or progress of project with instructors or peers
3. Validate task performance – ask instructor to verify if they were performing instructional tasks correctly
4. Tech Help – Ask for help when a software is not working properly
5. Design Help – Ask for help related to the design of a technology artifact
6. Clarify content – Ask for clarification to a technology concept
7. Clarify task – As for clarification to specifications and requirements of instructional task
8. Can't Hear – when an interaction cannot be clearly heard from the recording

Figure 11 shows that during scaffolded instruction, 45% of student interactions in Section 1 were to *Share Project* because Instructor 1 had a deliberate strategy where "I go and see everybody during lab time… I focus on getting around to everyone a few times." This strategy prompted students to focus their interactions on the project, which in turn provided information for the instructor to customize support.

Repeated rounds of *Progress Checking* by the instructor helped students refine their project ideas quickly, and gradually assume increasing responsibility for learning as they started initiating support requests specific to their needs. This is an example of how Instructor 1 scaffolded student M through four rounds of interaction while she was designing a lesson plan for her PowerPoint project.

<u>Round 1 Interaction</u>
Instructor 1: Hi M, any ideas for your lesson? [*Progress Checking*]
Student M: No. [*Share Project*]
Instructor 1: OK.

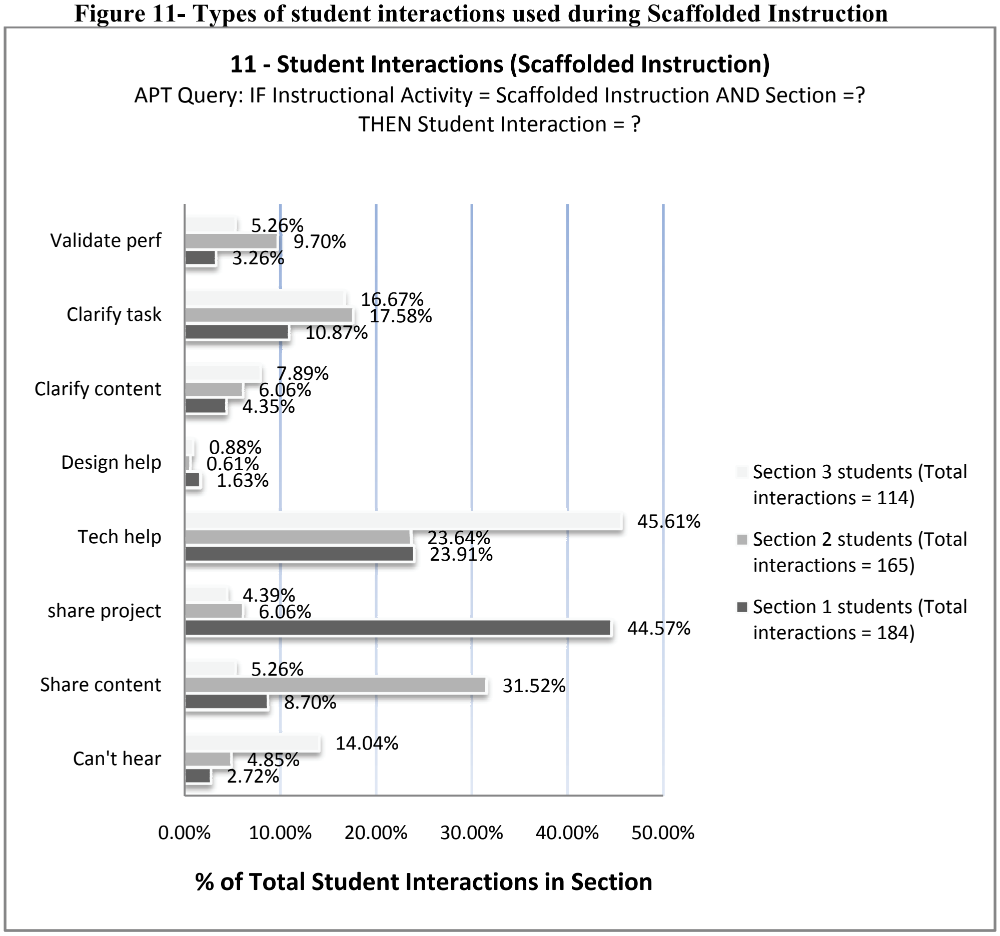
<u>Round 2 Interaction</u>

Instructor 1: So M, what are you doing and where are you at? [*Progress Checking*]
Student M: I'm doing Mixing Paints [*Share Project*]
Instructor 1: So kind of what colors go together to make what colors? [*Progress Checking*]
Student M: Yah. For grades 3 to5. [*Share Project*]
Instructor 1: Cool! [*Direction Maintenance*]

<u>Round 3 Interaction</u>
Student M: What do you mean by "warm up"? [*Clarify Task*]
Instructor 1: Like "Have you seen a butterfly up close?" Just questions to get the lesson started. [*Show & Tell*]

<u>Round 4 Interaction</u>
Student M: Is there a way to save pictures from clipart to a folder? [*Tech Help*]
Instructor 1: Not really [*Show & Tell*]
Student M: I downloaded them and how to do I find it? [*Tech Help*]
Instructor 1: Doubleclick and it sets it up for you. [*Show and Tell*]

**Figure 11- Types of student interactions used during Scaffolded Instruction**




Even though *Share Project* was minimal in the other two sections, Instructor 3's strategy of providing personalized help during Open Lab time was effective for generating conversation with students about the issues they had with the technology, the task, and their understanding of technology concepts. *Tech Help*, *Clarify Task*, and *Clarify Content* accounted for 70% of total student interactions, more than half of which were for *Tech Help*. On the other hand, about 32% of student interactions in Section 2 involved *Share Content* as students had group discussions to derive guidelines for designing a good PowerPoint presentation.

The use of self-paced tutorials however resulted in about 28% of total student interactions in Section 2 being attributed to *Validate Performance* and *Clarify Task* as students sought to clarify tutorial instructions. For example:

> Student 1: What's the "GIF icon"? [*Clarify Task*]
> Instructor 2 (Points to the student's computer screen): It's this one. [*Show & Tell*]
> Student 1 (points to instructions in the tutorial): Do we need to package a CD? [*Clarify Task*]
> Instructor 2: No. Just understand how to do it. [*Show & Tell*]

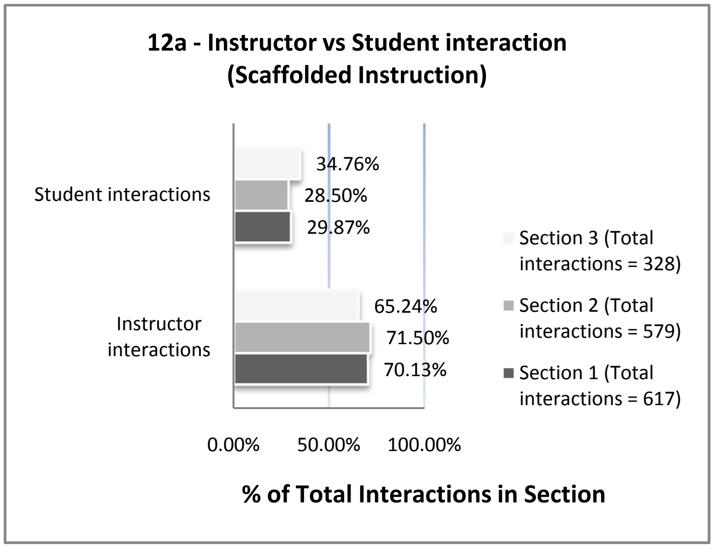
Instructor 2 commented that one drawback of using self-paced tutorials was that students, "need to be attentive when working on the tutorials as the instructions may not be clear." These tutorials could sometimes side-track students' focus from learning technology procedures to them wanting to make their artifacts appear exactly like those in the tutorial. *Validate Performance* may not necessarily be used for issues that were critical to software mastery; for example:

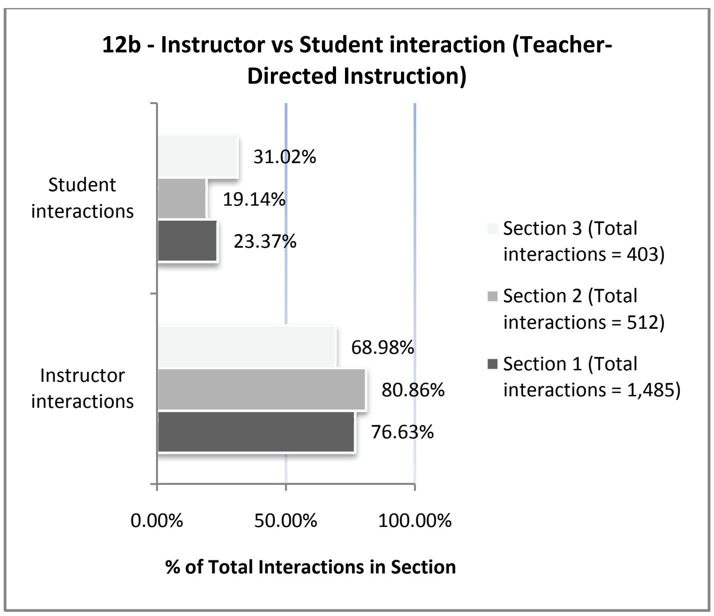
> Student: I did not capitalize all the text [*Validate Performance*]
> Instructor 2: Don't worry about that. It is more important for you to make sure the formulas are correct. [*Show and Tell*]

*c) Co-Participation During Scaffolded Instruction*

Figures 12 *a* to *b* show that instructors tend to dominate social interaction regardless of the type of instructional methods used, as they accounted for at least 70% of total social interactions in each section. But, the percentage of student interaction was higher during scaffolded instruction, especially for Sections 1 and 2.

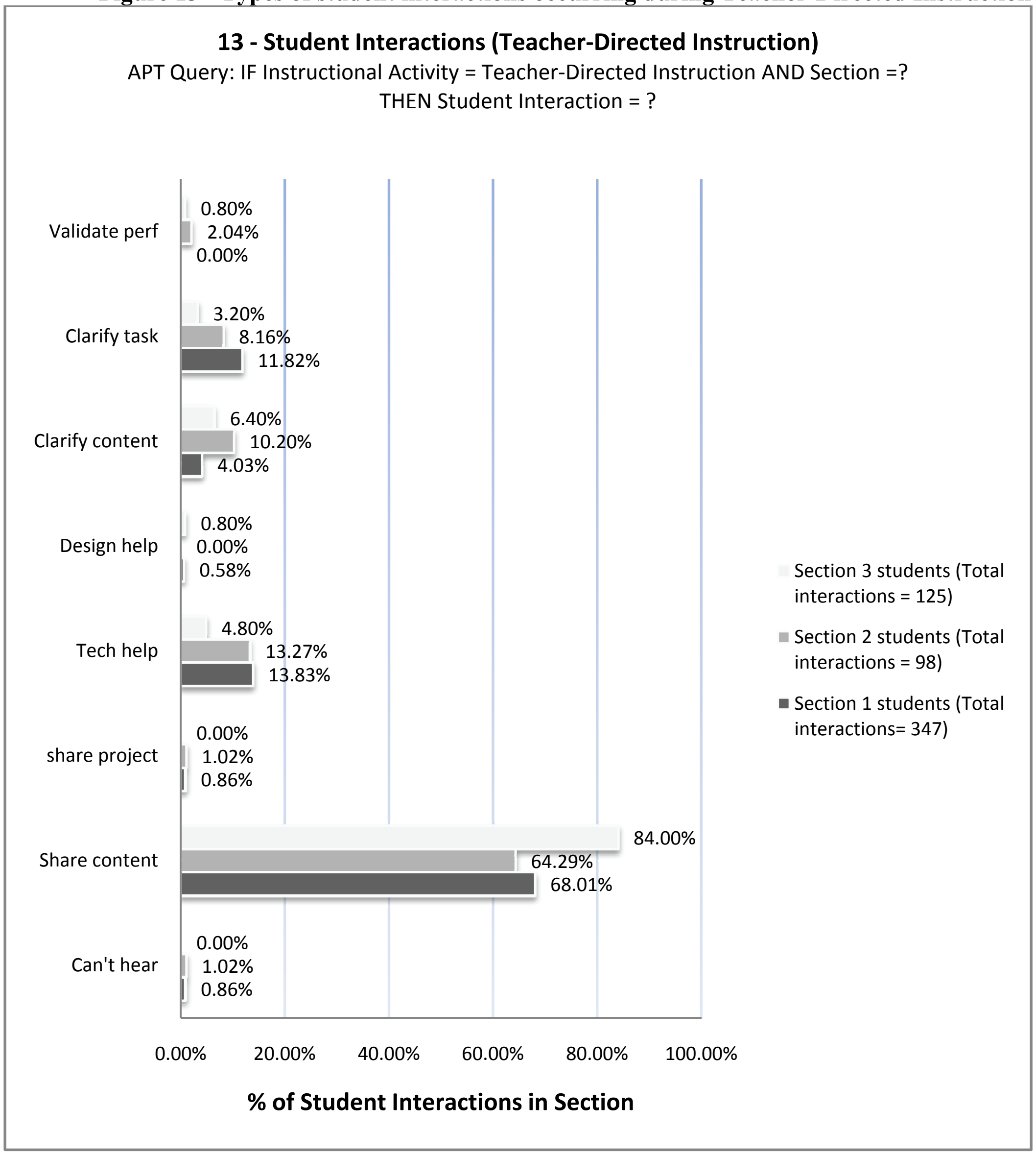
**Figure 12 - Comparison of instructor and student interaction by instructional method**




An analysis of student interactions occurring during teacher-directed instruction found that students typically engaged in *Share Content* by answering instructor-directed questions (See Figure 13).

**Figure 13 - Types of student interactions occurring during Teacher-Directed Instruction**




*d) Summary of findings for Question 2*

When instructors used scaffolded instruction, they interacted with individual students through *Progress Checking* of their project work, encouragement through *Direction Maintenance*, and *Show and Tell*. During teacher-directed instruction however, they tend to focus on *Show and Tell* and *Prompt and Hint* through interactive lectures. Correspondingly, *Share Content* was the predominant student interaction during teacher-directed instruction where students answered questions posed by instructors during lectures. In comparison, scaffolded instruction provided opportunities for students to co-participate in directing the learning process as they had opportunities to initiate *Tech Help*, *Design Help*, *Clarify Task*, *Clarify Content*, and *Validate Performance*. It also enabled instructors to personalize support for titration of assistance if they engaged students to *Share Project*.

**Question 3 – How are content resources and equipment used during Scaffolded instruction?**

*a) Use of resources*

Qualitative analysis of video clips found that instructors used seven types of content resources during technology skills instruction (See Table 10). There were also instances where they used no resources at all.

**Table 10- Categories of content resources used**

1. Project/Assignment descriptions
2. Course Schedule
3. Project Samples
4. Supplementary Notes and Resources (e.g. practice files)
5. Students' Own Class Notes
6. Self-paced Tutorials
7. Presentation Slides
8. Used No Resources

From Figure 14*a*, it can be seen that Instructor 1 either used no resources, or *Supplementary Notes and Resources* that were notes and handouts detailing step-by-step instructions for complex technology procedures such as graphic touch-up and web development (See Appendix G for raw data of all figures in this chapter). A unique feature of the supplementary notes given out by Instructor 1 was the deliberate insertion of blank spaces for students to make their own notes about key technology procedures, thus doubling up as *Students' Own Class Notes* at times. When asked questions about content that were already covered, she referred students to their notes, which replaced her as a scaffold.

Instructor 2 used a mixture of *Self-paced Tutorials* to support independent learning, and also *Project Samples* from his previous classes as exercises for students to learn how to design a site-map for their web project. Like Instructor 1, content resources were used as a substitute for direct content instruction from the instructor. In comparison, Instructor 3 did not use content resources but focused on social interaction during scaffolded instruction.

**Figure 14 - Types of resources used by instructors**

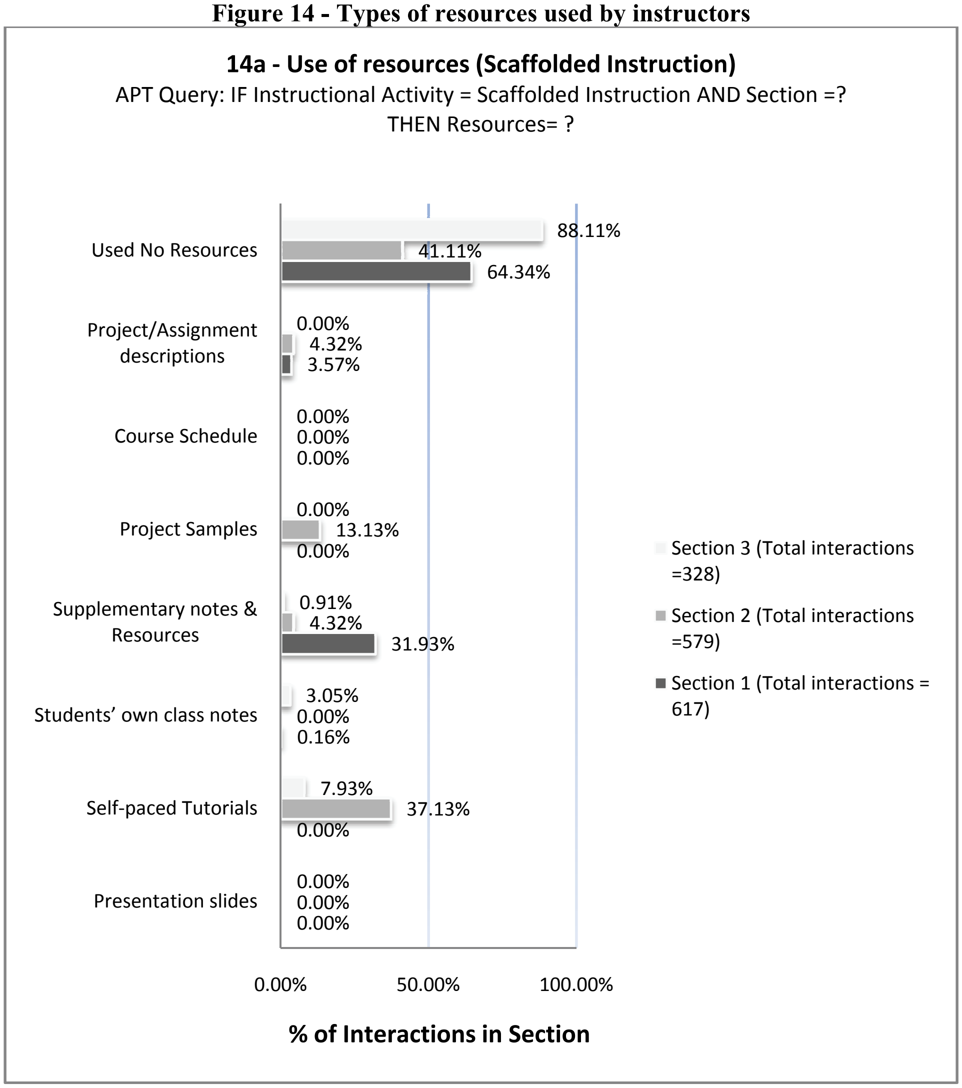
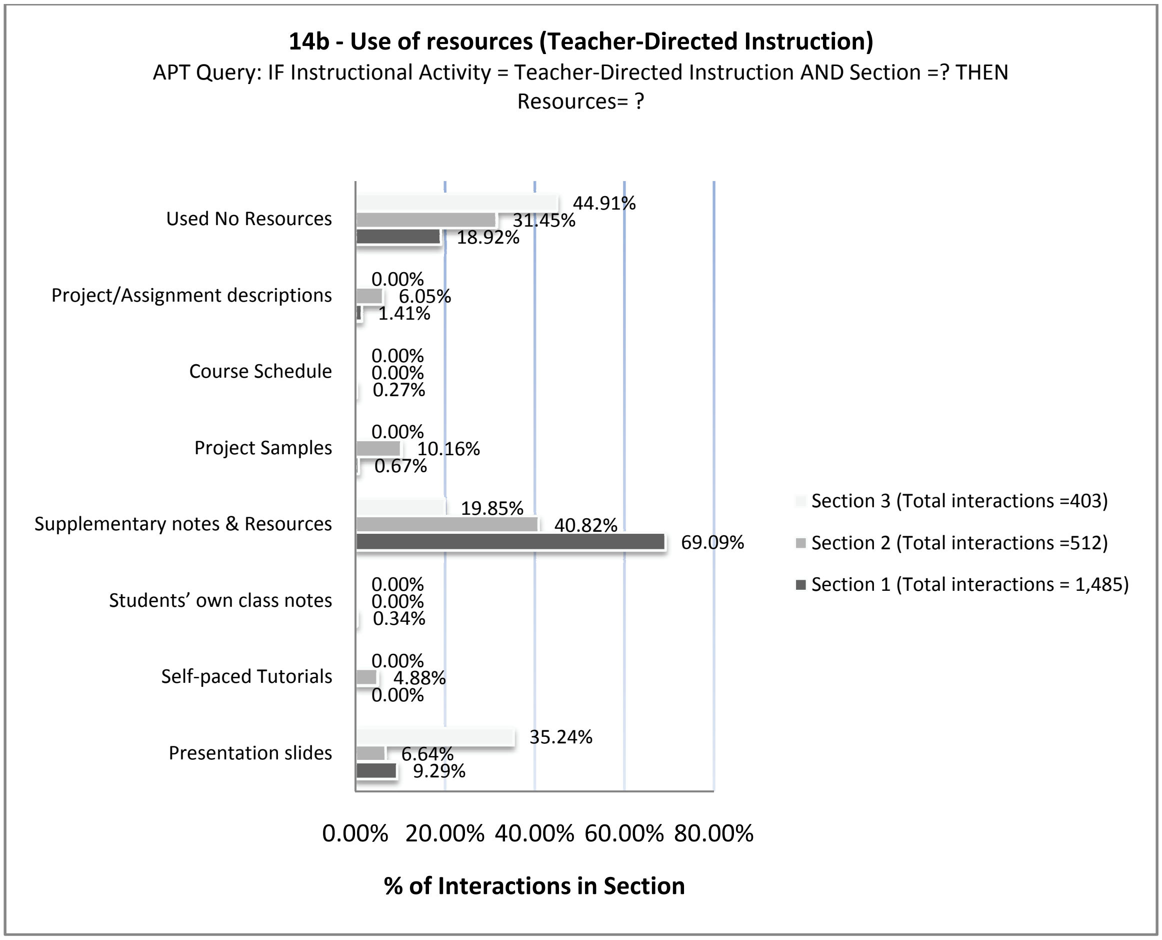


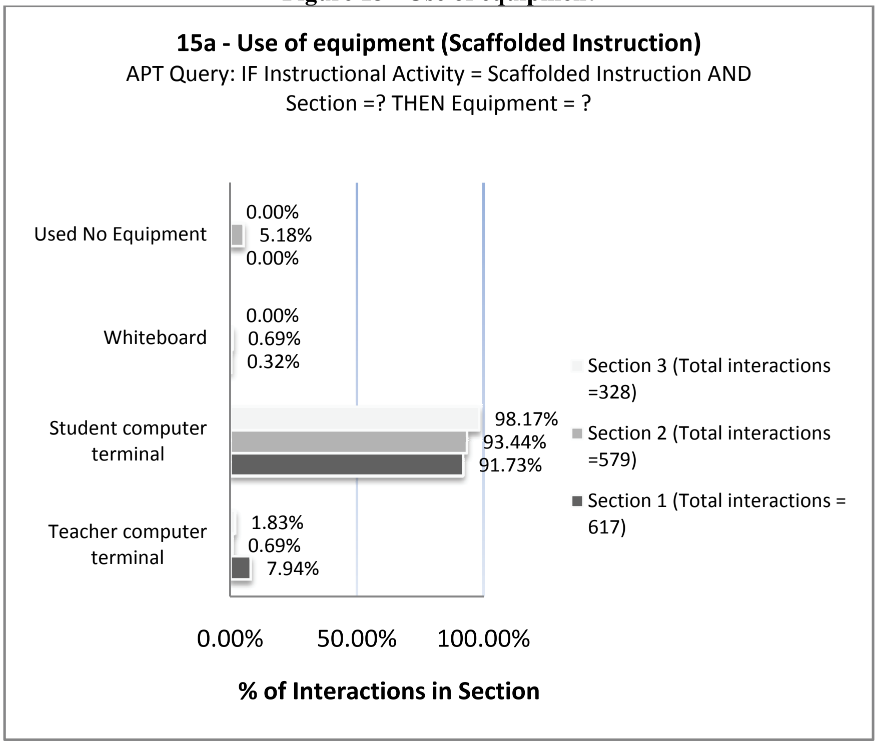

Figure 14*b* shows that instructors tend to use more resources during teacher-directed instruction. *Supplementary Notes and Resources* were used heavily and comprised between 40-69% of interactions for Sections 1 and 2. *Presentation Slides* were also used as part of lectures and demonstrations. Instructor 3 increased her use of resources during teacher-directed instruction where 35% of interactions involved the use of *Presentation Slides* and about 20% with *Supplementary Notes and Resources*.

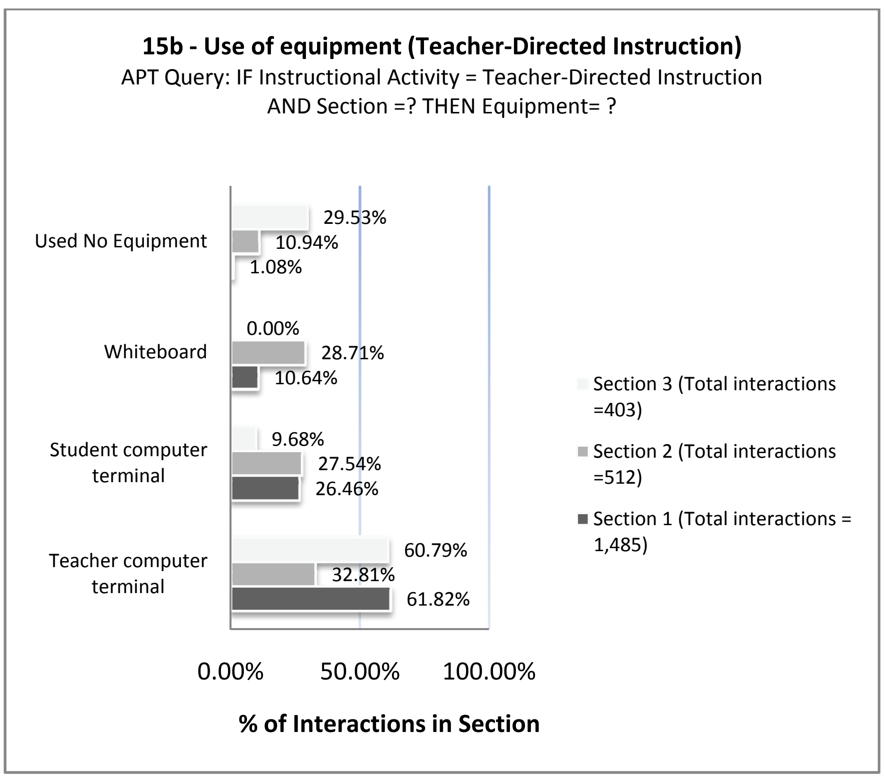



*b) Use of equipment*

Scaffolded instruction was characterized by almost exclusive use of the student computer terminals, while the teacher computer terminal was used only when instructors needed to do impromptu lectures to address issues that majority of the class had problems with (See Figure 15*a*). In comparison, teacher-directed instruction saw the teacher computer terminal being used predominantly to support lecture and demonstrations (See Figure 15*b*).

**Figure 15 - Use of equipment**



*c) Summary of findings for Question 3*

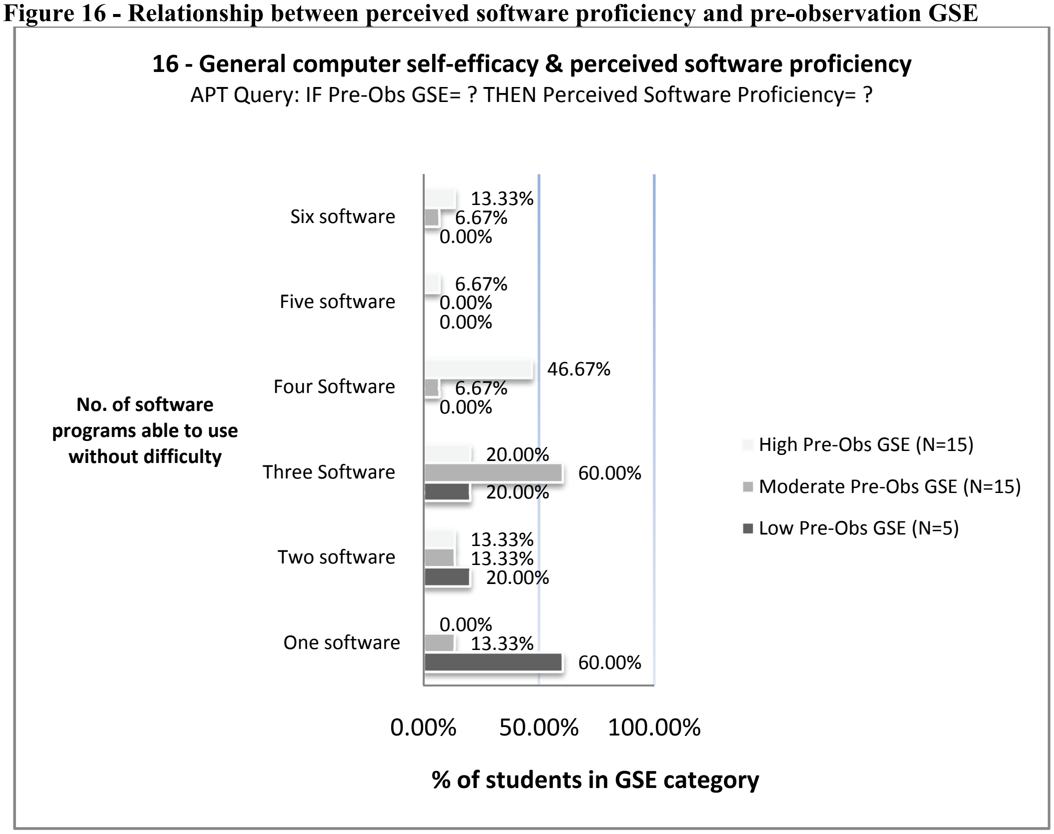
Therefore, it can be seen that scaffolded instruction was characterized by instructor-student social interaction that supported independent student work on the student computer terminal. Content resources were used by instructors as additional scaffolds to provide content information to students, thereby transferring responsibility for content instruction away from instructors. However, these resources did not necessarily fade away. Therefore, this study found support for the caution raised by Puntambekar and Hubscher (2005) for the need to carefully distinguish between "scaffolds" and "resources" as the latter is always needed to support task performance.

**Question 4 - How do instructors titrate assistance during Scaffolded instruction?**

*a) Computer Experience and GSE*

All three instructors emphasized the need to "be prepared for the whole range of students" as students had varying levels of "prior knowledge" about the software applications that were being taught. In fact, Instructor 3 commented that, "It would be easier if I had all experts one time and all novices another, but that won't happen." Figure 16 shows that the more software experience students had, the higher their reported level of pre-observation GSE. Sixty per-cent of student who reported low pre-observation GSE also reported being able to use only one of the software programs listed in Question 7 of the pre-observation survey (See Appendix B for survey question, and Appendix G for raw data). In comparison, 87% of high GSE students felt they could use at least three of the software programs without difficulty.

**Figure 16 - Relationship between perceived software proficiency and pre-observation GSE**



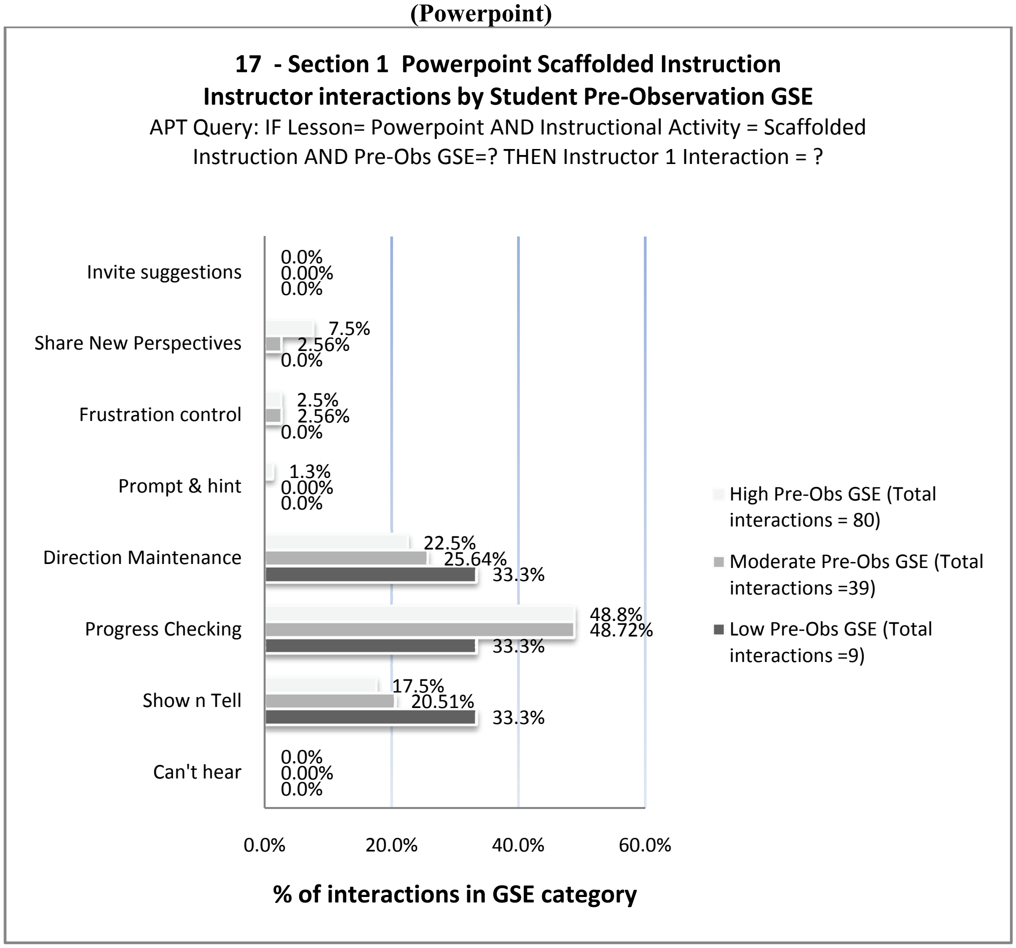
According to his prior teaching experiences, Instructor 2 revealed that these differences tend to be associated with "the kinds of questions they [students] ask and how they do their work." Instructor 3 also commented that scaffolding meant "To understand that students can have different incoming levels and need different types of support to achieve the course goals and their personal goals."

*b) Scaffolding during Microsoft PowerPoint sessions*

Figure 17 shows the interactions used by Instructor 1 to support students of different GSE levels when scaffolded instruction was used during Microsoft PowerPoint sessions. She primarily used *Progress Checking* as a means to engage students in conversation about their projects which comprised 33% of interactions for low GSE students, and about 48% of interactions for the other two groups.

Her interactions with low GSE students showed an equal emphasis for *Progress Checking*, *Show and Tell*, and *Direction Maintenance*. Students' concerns were addressed through *Show and Tell*, while *Direction Maintenance* was used to provide encouragement and motivation. For example, a low GSE student shared her concerns about having too much information in the lesson she was designing to teach the topic of Cubism. The instructor provided suggestions for her, and encouraged her through *Direction Maintenance* by stressing that, "You're definitely moving in the right direction, and I agree with your instinct that it's too much info". In particular, *Direction Maintenance* occurred in 33.3% of interactions with low GSE students, as compared to 25.6% and 22.5% with moderate GSE and high GSE students respectively.

**Figure 17 - Section 1 instructor interactions by pre-observation GSE during Scaffolded Instruction (Powerpoint)**



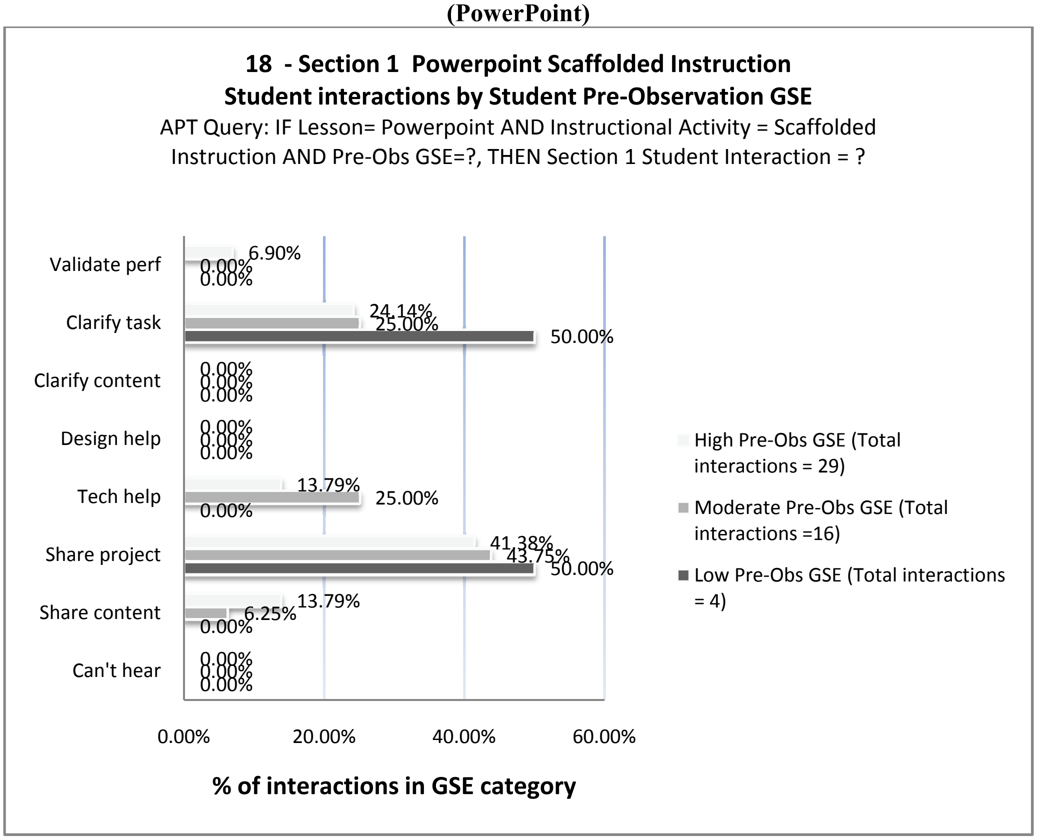

For students with higher GSE, more *Progress Checking* interactions occurred as interactions with these students tend to be shorter and more frequent. This was an example of how the instructor interacted with two students of moderate GSE who sat next to each other:

Instructor 1: J, are your juices going yet? [*Progress Checking*]
J: No. [*Share Project*]
Instructor 1: Don't forget to move your pictures after you put in your new background template. They are in a weird part of the screen now. [*Frustration Control*]
[moves on to next student, and silently observes her computer screen for a few sections] [*Progress Checking*]
Instructor 1: You might want to lasso around those pictures and now go to format picture. [*New Perspective*]That's a cute one [referring to her PowerPoint animation] [*Direction Maintenance*]
[moves on to next student]

As the instructor moved through these students, she also took the opportunity to provide quick comments, new ideas for them to think about, or simply to praise and validate their work-in-progress; thereby resulting in the use of scaffolding functions such as *Frustration Control*, *Direction Maintenance*, and *New Perspective*.

Figure 18 shows the corresponding distribution of student interactions for Section 1. The instructor's deliberate strategy of systematic *Progress Checking* during each lab session resulted in students of each GSE level engaging in *Share Project* for at least 41% of the interactions. Half of the interactions for low GSE students involved them seeking to *Clarify Task* while this was only observed in only a quarter of interactions with the other two groups. In addition to *Clarify Task*, moderate and high GSE students both sought *Tech Help* while only high GSE students sought to *Validate Performance*.

**Figure 18 - Section 1 student interactions by pre-observation GSE during Scaffolded Instruction (PowerPoint)**

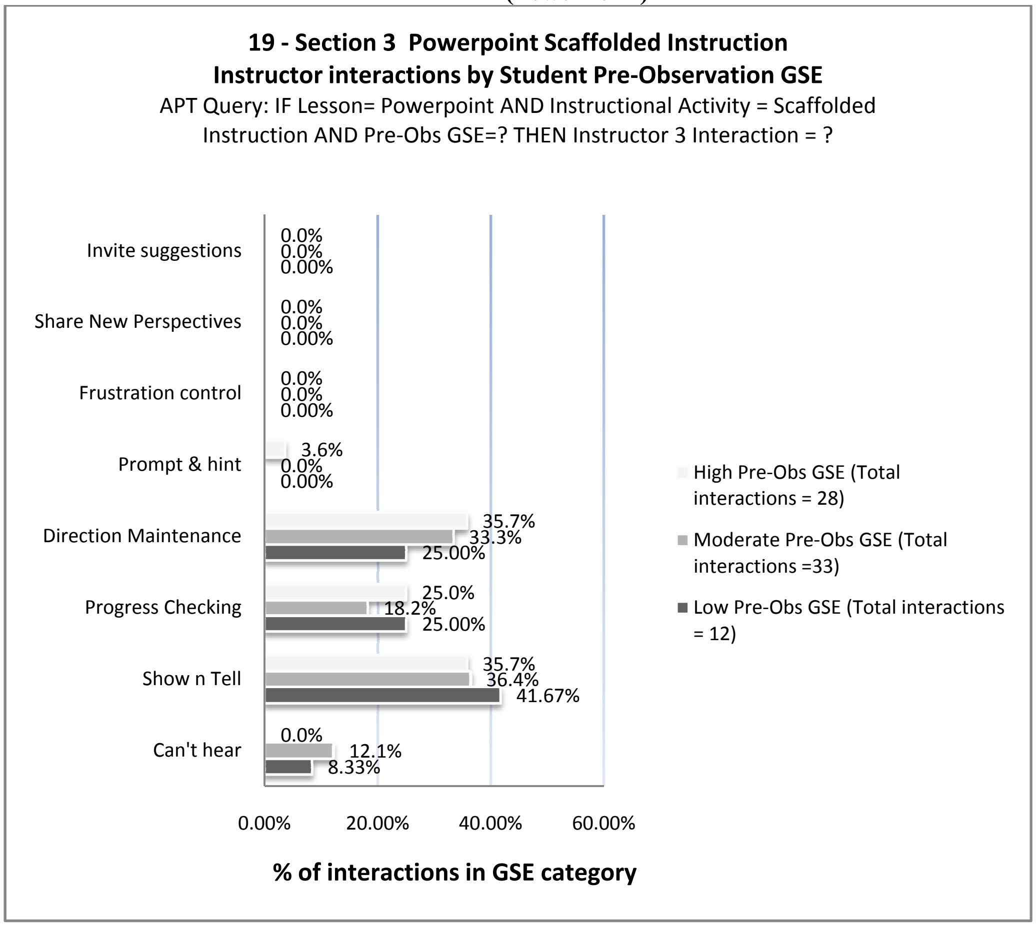


Instructor 1 commented that, “Weaker students don’t ask for help as much as they should”. Even though students generally focused their attention on clarifying what the instructor required of them in the assigned learning task, low GSE students did not ask questions beyond seeking to *Clarify Task*. However, the few number of interactions attributed to low GSE students might have also limited the extent of variation in the data.

A comparison by GSE could not be carried out with Section 2 as all students rated themselves as having moderate GSE. While the small class size may have limited the variation of data, personal observations of Instructor 2 found that students with more software experience tend to ask for more *Tech Help* than those with less. He shared that, “Those with more experience ask questions about things they want to know to do their own work that is beyond what’s covered” while those with less experience “are not thinking about doing other things.” This could explain why between 14-25% of interactions for moderate and high GSE students in Section 1 were for *Tech Help*. Unlike their peers, high GSE students in Section 1 also had the highest percentage of interactions for *Share Content* where they shared their opinions and experiences about software programs with the instructor while asking for *Tech Help*. They were also the only group in Section 1 who sought to *Validate Performance* by asking for feedback such as, “How’s my project?”

Unlike Instructor 1, Instructor 3 used primarily *Show and Tell*, *Progress Checking*, and *Direction Maintenance* (See Figure 19). She did not have students *Share Project* but used *Progress Checking* and *Direction Maintenance* consistently when she paced down each student’s computer terminals, observed their work-in-progress, and validated performance with comments like “This looks good!” She also provided help through *Show and Tell* when students initiated requests for support.

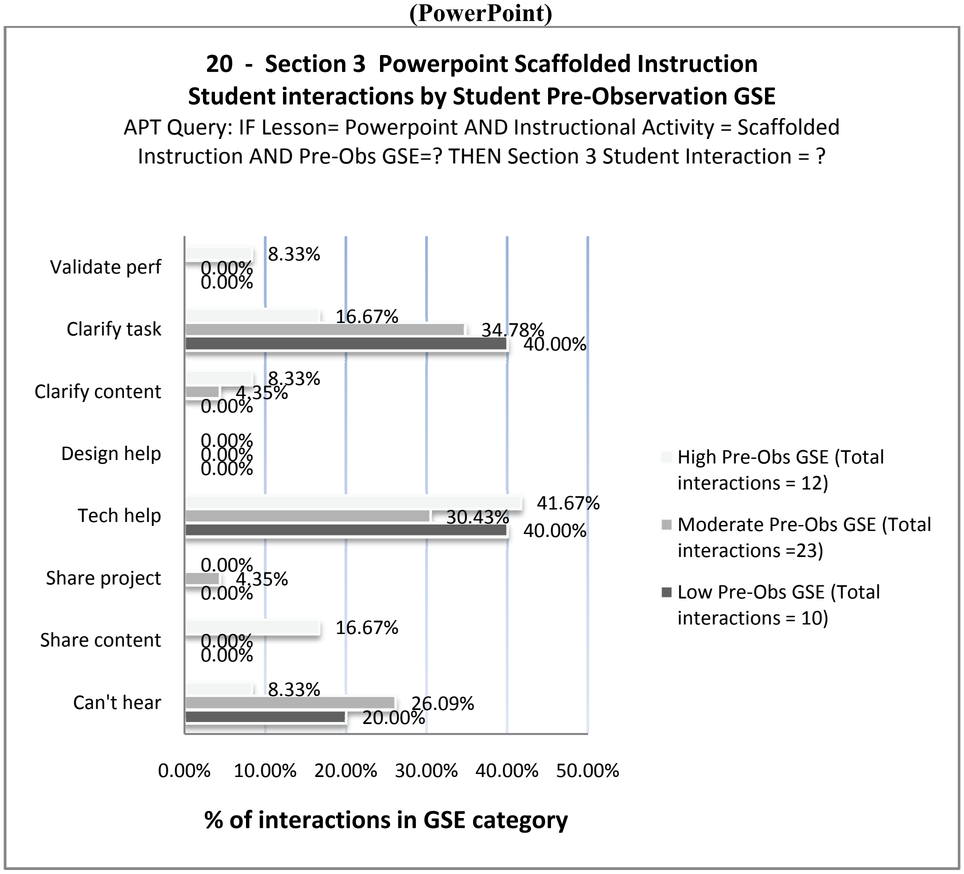
**Figure 19 - Section 3 instructor interactions by pre-observation GSE during Scaffolded Instruction (PowerPoint)**




Since Instructor 3 focused on personal coaching during Open Lab, high emphasis for *Show and Tell* and *Direction Maintenance* was observed regardless of GSE. While Instructor 1 saw lab sessions as a means to" keep them [students] on track and monitor their progress"; Instructor 2 emphasized the use of one-to-one interaction to "give me better opportunities to customize to their levels and interest". *Direction Maintenance* provided a means to "make the students feel comfortable that the things they "send" to me don't get lost, and I care about the quality of learning they are getting." Therefore, it accounted for 25% - 36% of interactions with each group, as compared to *Progress Checking* which comprised at most 25% of interactions with each group. She also had more emphasis on *Show and Tell* for low GSE students.

Figure 20 shows the corresponding student interactions in Section 3. These students emphasized *Clarify Task,* with the relative percentage being highest for low GSE students. A difference between student interactions of Sections 1 and 3 was the preponderance of *Tech Help* requests regardless of GSE in the latter. This could be because students who chose to attend Open Lab sessions tend to be those who needed technical consultation with the instructor. *Validate Performance* also occurred with only high GSE students in Section 3. In addition, only these students engaged in *Share Content* with the class or instructor by offering suggestions such as websites that were good for researching articles needed to do their PowerPoint project.

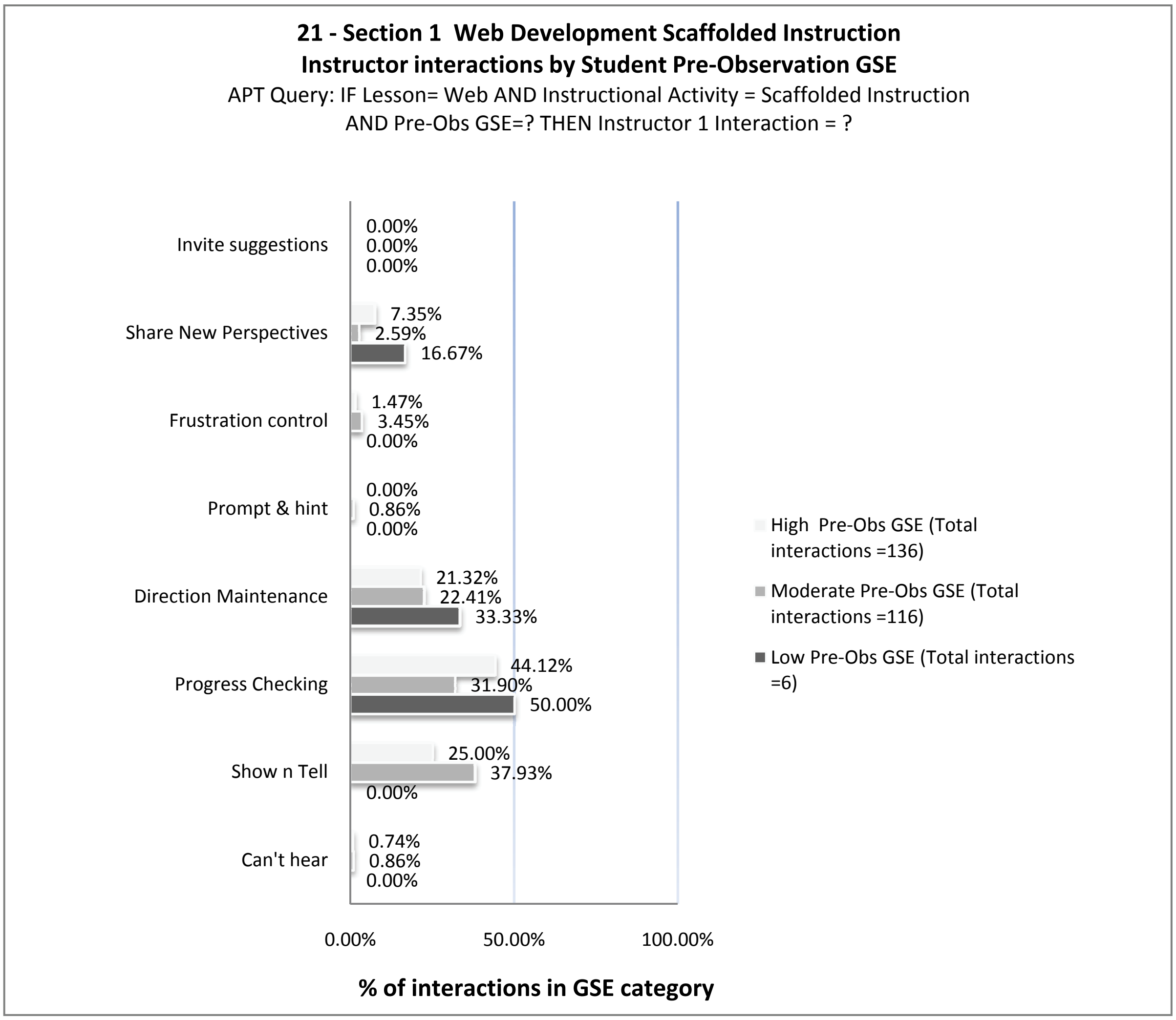
**Figure 20 - Section 3 student interactions by pre-observation GSE during Scaffolded Instruction (PowerPoint)**



*c) Scaffolding during Web Development sessions*

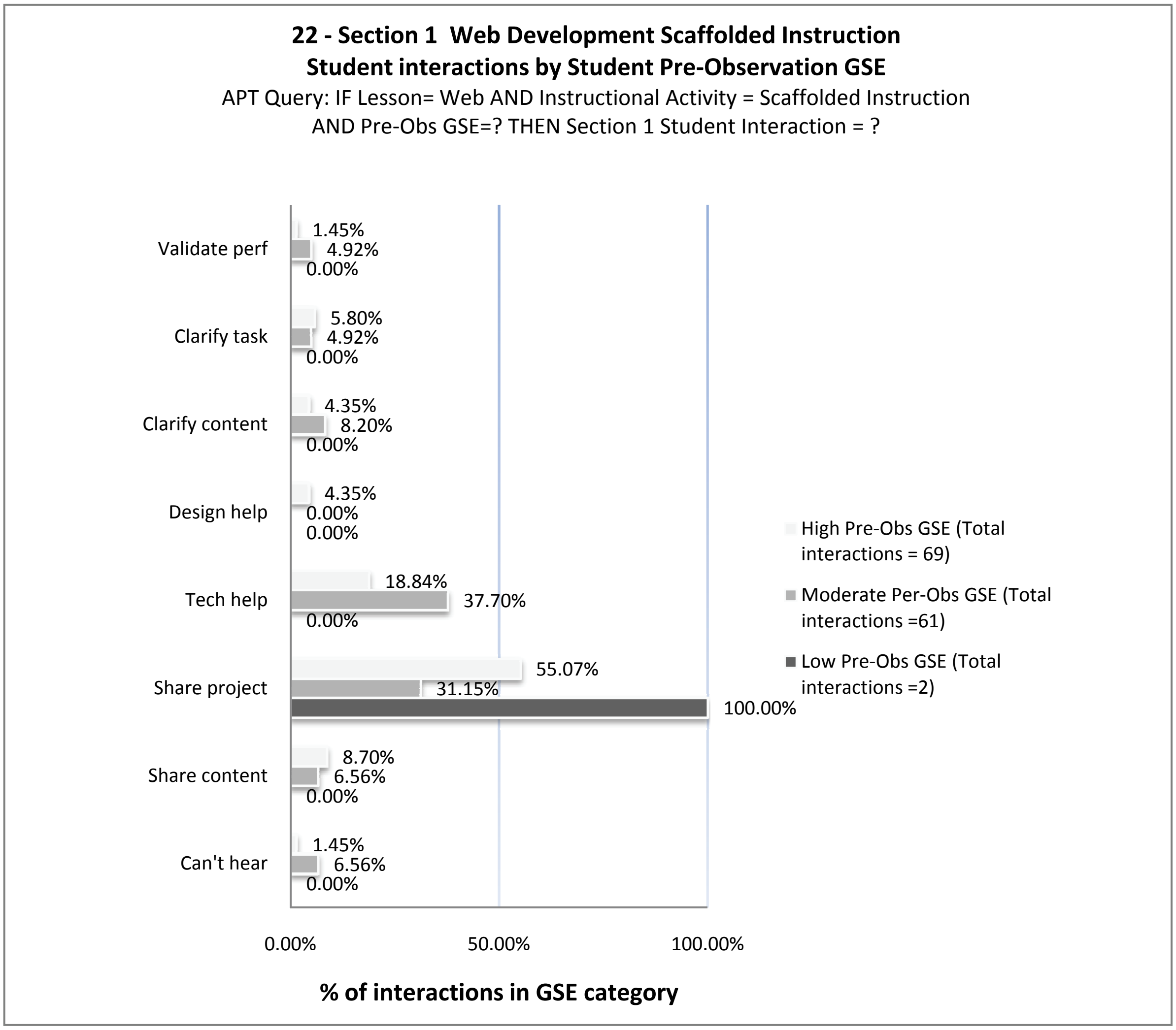
Figure 21 shows the instructor interactions for Section 1 when scaffolded instruction was used to teach Web Development. Even when a different software program was being taught, Instructor 1 had similar focus on *Progress Checking*. She also emphasized *Direction Maintenance* for the low GSE students.

**Figure 21 - Section 1 instructor interactions by pre-observation GSE during Scaffolded Instruction (Web Development)**




A comparison of Figure 18 and Figure 22 show that the percentage of *Tech Help* increased from 25% to 37.7% for moderate GSE students; and from 13.8% to 18.9% for high GSE students. Corresponding, Instructor 1 also increased the proportion of *Show and Tell* interactions with these students. One reason for this observation could be because majority of the students did not feel confident using web development software (See Figure 3*b*).

**Figure 22 - Section 1 student interactions by pre-observation GSE during Scaffolded Instruction (Web Development)**

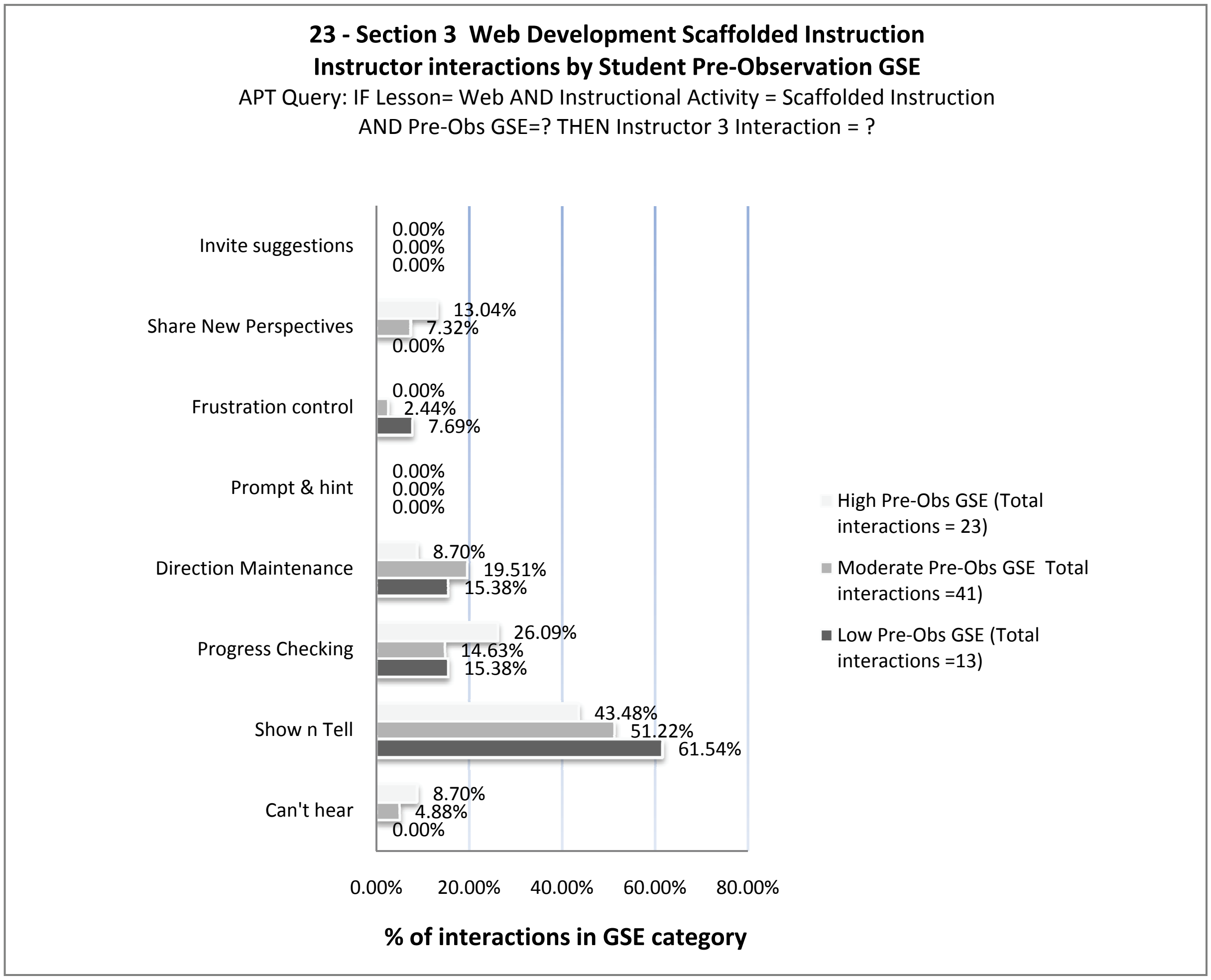



Making a webpage was more complex than making a presentation slide as it required students to design backgrounds, buttons, links, and manipulate graphics. A comparison of Figure 18 and 22 found that the percentage of interactions for *Share Project* increased for both high and low GSE students as there were more aspects about a project to talk to the instructor about. Although the numbers also saw a huge jump for low GSE students, it needs to be interpreted with caution as the low number of interactions may have affected the variation of data. For moderate GSE students, the dip in their *Share Project* interactions was replaced by them asking for more *Tech Help* and also seeking other types of support such as to *Clarify Content*, and *Validate Performance*.

Moderate and high GSE students also had a smaller percentage of interactions for *Clarify Task* during web development. It decreased sharply from about 25% to 5% (See Figure 18 and Figure 22). This could be because students watched demonstrations and completed three mini webpage projects before they started making their own during the lab sessions. There was sufficient modeling in terms of task expectations to the extent that a student commented during the interview that, “we could have done one or two instead of three… and jumped straight into doing our own thing.” Therefore, the extensive use of teacher-directed instruction prior to scaffolding may have reduced the need for students to *Clarify Task* during scaffolded instruction.

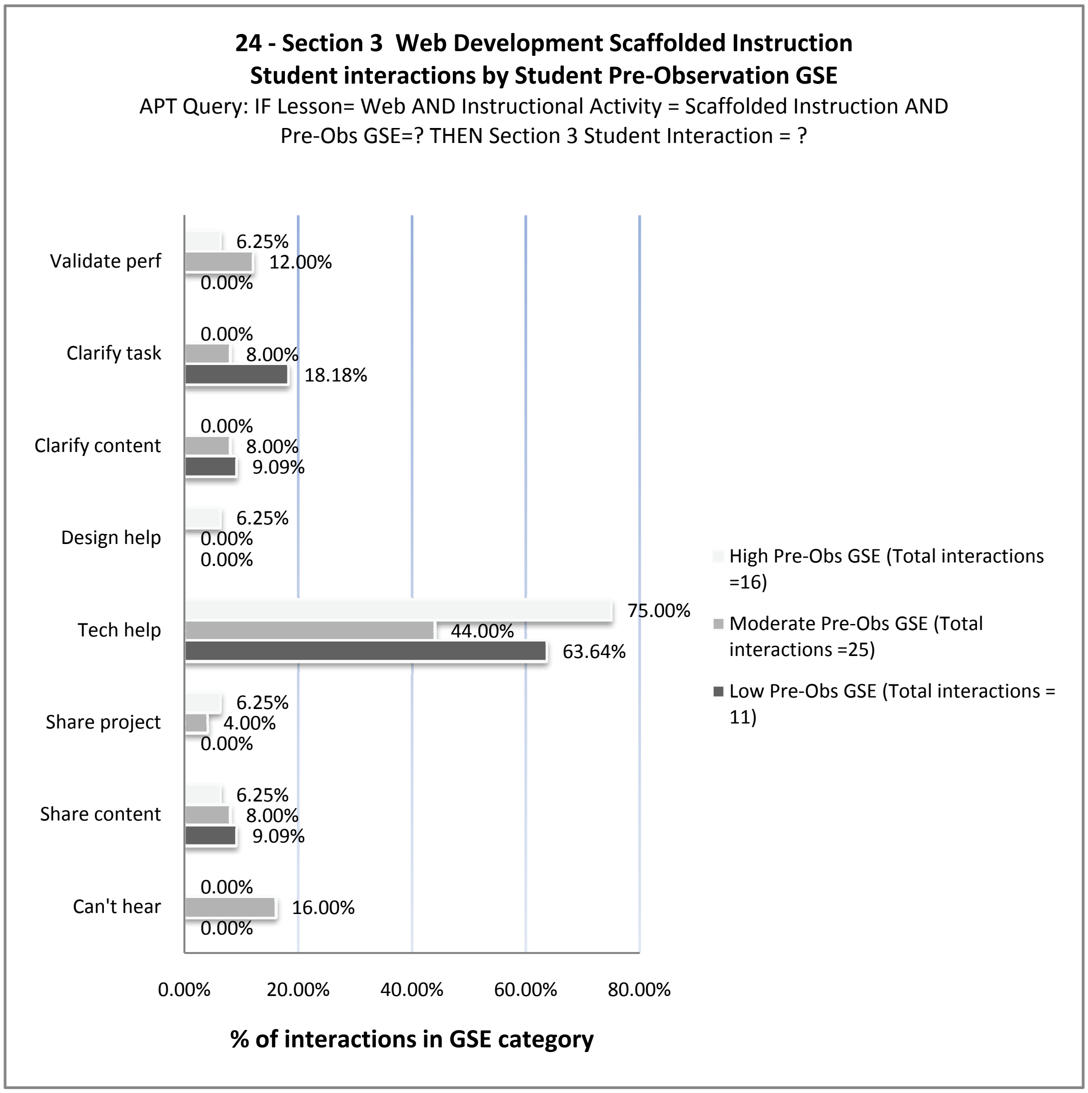
Instructor 3 had a greater emphasis on *Show and Tell* during web development sessions. Comparisons of Figures 19 and 23 showed that it increased from 42% to 62% for low GSE students, 36% to 51% for moderate GSE students, and 36% to 43% for high GSE students. Correspondingly, *Direction Maintenance* interactions decreased from an average of 31% to 15% for all students. She also used functions such as *Frustration Control* and *Sharing New Perspectives* with moderate and high GSE students. On the other hand, *Progress Checking* interactions were maintained at between 15-26% across the three groups.

**Figure 23 - Section 3 instructor interactions by pre-observation GSE during Scaffolded Instruction (Web Development)**




Student interactions during Web Development for Section 3 showed that the increased use of *Show and Tell* by the instructor corresponded with the sharp increase in the proportion of *Tech Help* requests from all three groups (See Figure 24). A comparison of Figure 20 and 24 showed that the high GSE group showed the sharpest increase from 42% to 75%. Students also had less need to *Clarify Task* during web development because Instructor 3 provided lectures and demonstrations for web development before students had Open Lab. They also made webpages by HTML coding in an earlier part of the course that could not be recorded for video analysis. However, the pre-observation survey administered after students completed the HTML lessons showed that 80 % of them still reported being unfamiliar with using web development software (See Figure 3*b*). Therefore, their prior training in HTML might have familiarized them with the task of web development but not with executing the task using web development software. This could also explain why students were highly focused on *Tech Help* during web development lessons.

**Figure 24 - Section 3 student interactions by pre-observation GSE during Scaffolded Instruction (Web Development)**




While it was not possible to compare Section 2's data by self-efficacy level, Figure 25 shows that Instructor 2 was similar to Instructor 1 in his emphasis on *Progress Checking* which comprised between 37% -44% of instructor interactions between sessions for the two software programs. Unlike the other two instructors, he also used *Prompt and Hint* and *Frustration Control* with *Direction Maintenance* in different ways to support independent learning with students whom he perceived to have "different levels of computer experience." For those whom he felt had less computer experience he typically used *Show and Tell* because "If I haven't done it before, I'll do it for him and explain." On the other hand, he used *Prompt and Hint* to challenge students whom he felt had more computer experience. He explained, "I won't give an answer but try to ask questions and get her to figure it out. I try to take her to the next step." Therefore, as compared to the other two instructors, *Prompt and Hint* had more prominence in Instructor 2's interactions with students.

**Figure 25 - Comparison of Section 2 instructor interactions by lesson**

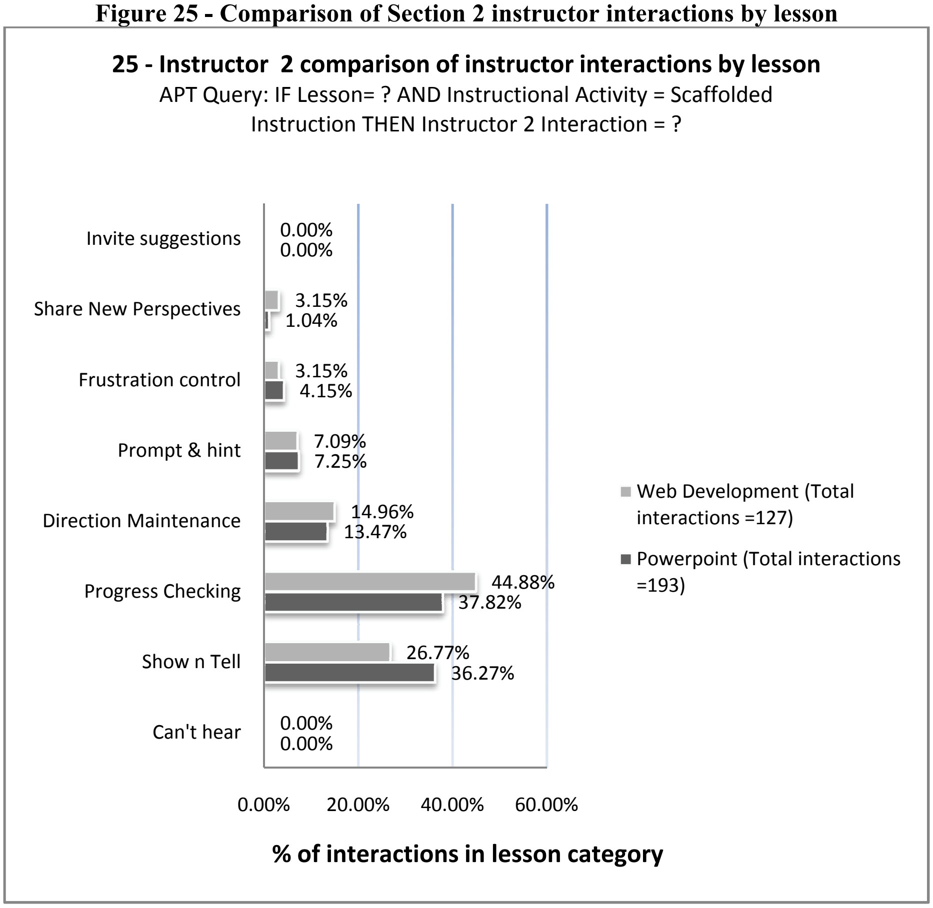
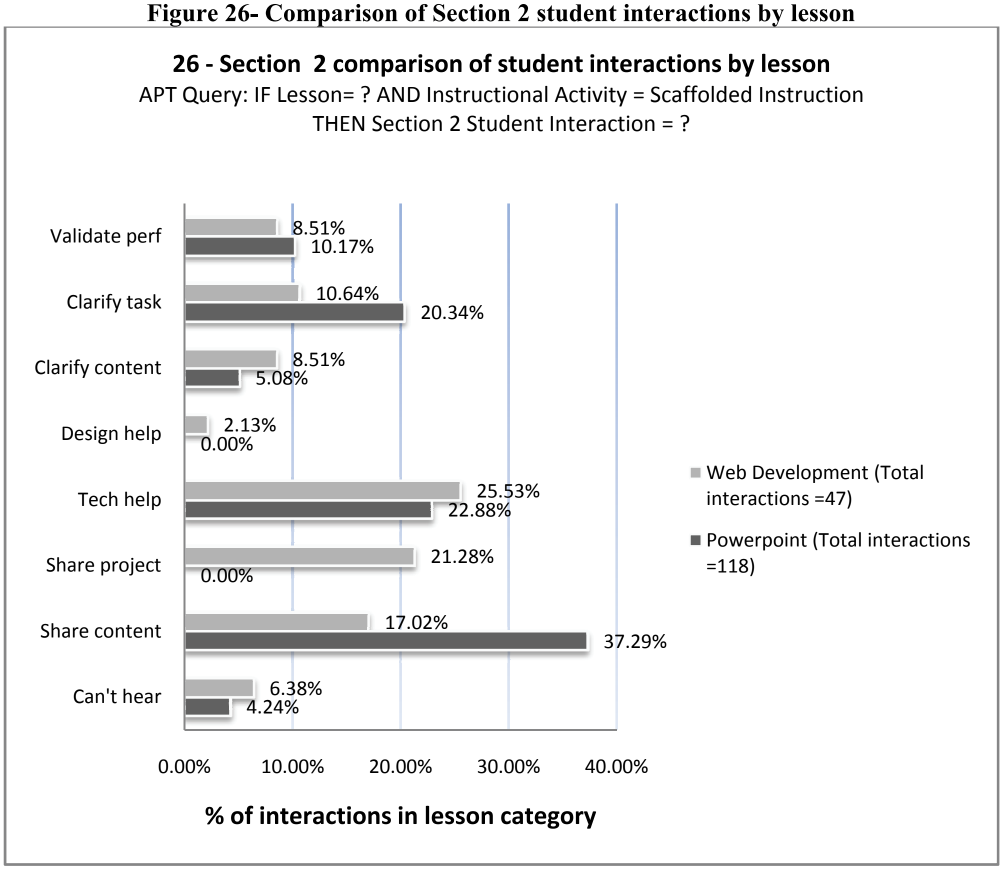



Figure 25 also showed that there were fewer *Show and Tell* interactions during scaffolded instruction sessions for Web Development despite a slight increase in the percentage of *Tech Help* requests (See Figure 26). This could be because it was taught with a mixture of teacher-directed instruction and scaffolded instruction while PowerPoint was taught almost exclusively through scaffolded instruction by using self-paced tutorials.

Instructor 2 also had to support a higher percentage of *Clarify Task* and *Validate Performance* requests during Microsoft PowerPoint sessions; which may have corresponded with a higher usage of *Show and Tell* (See Figure 25). As discussed earlier, the use of self-paced tutorials may have been associated with students seeking requests to clarify unclear instructions from the tutorial, rather than for content-based help. On the other hand, the use of student-led discussions during Microsoft PowerPoint was associated with a high percentage of *Share Content* interactions between students. Figure 26 shows that the relative complexity of the web development task created occasions for students to *Share Project*, and to seek *Design Help* which did not emerge during sessions for Microsoft PowerPoint.

**Figure 26- Comparison of Section 2 student interactions by lesson**



*d) Student perceptions of instructor strategies*

Question 4 in the post-observation survey (See Appendix C) asked students about the types of instructor strategies that were most and least useful for raising their self-efficacy for using technology. Table 11 shows that responses differed by pre-observation GSE.

For students with low pre-observation GSE, personal help and encouragement was important. This comprised 100% of low GSE student comments from Section 1, and 33.3% in Section 3. Personalized coaching that occurred during scaffolded instruction was important to this group, as evidenced by comments such as, "She taught me well at my own pace. She gave individual help, and actually cared. She was patient, and knew what she was talking about" and "Extra help, patience while teaching" (See Appendix H). This corresponded with instructors emphasizing *Direction Maintenance*, especially Instructor 1, who used more of this interaction with low GSE students.

In addition to personal help and encouragement, 66.7% of comments from low GSE students in Section 3 also listed successful experiences with mastering software as a factor that increased their confidence for using technology. These referred to mastery of specific software such as "Microsoft Word" or simply learning more about software programs as "I did not know most of the programs used."

Comments from students who had moderate pre-observation GSE in Sections 1 and 3 showed that 42.9% listed successful software/task mastery as a factor that raised their confidence for using technology. Besides stating particular software programs like "Excel" or "Web Development", students also emphasized how their instructor taught useful knowledge that enhanced their competencies as future teachers because she "Taught programs that we will now know how to use to our advantage. She applied the programs well to the way we will be using them in the classroom." and that "Learning Excel, particularly learning to chart grades, seemed very helpful and applicable to my future as a teacher."

**Table 11 - Distribution of student responses for factors most useful and least useful for raising confidence with using technology**

| Pre-observation GSE | Section 1 | Section 2 | Section 3 |
|---|---|---|---|
| Low | **Most useful (n=1)**<br>Personal help & encouragement (1, 100%) | NA | **Most useful (n=3)**<br>1. Personal help & encouragement (1, 33.3%)<br>2. Software/Task Mastery (2, 66.7%) |
| Moderate | **Most useful (n=7)**<br>1. Software/Task Mastery (3, 42.9%)<br>2. Structured Teaching (2, 28.6%)<br>3. Resources (1, 14.25%)<br>4. Social interaction (1, 14.25%)<br>**Least useful (n=2)**<br>1. Software/Task Mastery (2, 100%) | **Most useful (n=5)**<br>1. Structured Teaching (2, 40%)<br>2. Resources (1, 20%)<br>3. Personal help & encouragement (2, 40%)<br>**Least useful (n=1)**<br>1. Resources (1, 100%) | **Most useful (n=7)**<br>1. Software/Task Mastery (3, 42.9%)<br>2. Structured Teaching (3, 42.9%)<br>3. Personal help & encouragement (1, 14.2%)<br>**Least useful (3)**<br>1. Resources (2, 66.7%)<br>2. Software/Task Mastery (1, 33.3%) |
| High | **Most useful (n=11)**<br>1. Personal help & encouragement (2, 18.2%)<br>2. Software/Task Mastery (6, 54.6%)<br>3. Structured Teaching (2, 18.2%)<br>4. Resources (1, 9%)<br>**Least useful (n=6)**<br>1. Slow pace (2, 33.3%)<br>2. Too much work (2, 33.3%)<br>3. Resources (1, 16.7%)<br>4. Software/Task Mastery (1, 16.7%) | NA | **Most useful (n=7)**<br>1. Personal help & encouragement (1, 14.2%)<br>2. Software/Task Mastery (3, 42.9%)<br>3. Structured teaching (2, 28.4%)<br>4. Resources (1, 14.2%)<br>**Least useful (n=3)**<br>1. Resources (1, 33.3%)<br>2. Software/Task Mastery (2, 66.7%) |

An interesting observation is that unlike low GSE students who felt that learning new software programs alone increased their self-efficacy, moderate GSE students also appreciated instructors, "giving info about programs I already know of, but going into detail about it", and that "Having notes to pen and follow helped so much" These students also showed a preference for teacher-directed methods as about 40% of their comments in Sections 2 and 3, and 28.6% of their comments in Section 1 mentioned factors such as "Step by step walk through of each specific piece of material.", and being given clear instructions.

However, this did not mean that personalized help through scaffolded instruction was not important to this group as 40% of their comments in Section 2 and 14.2% of their comments in Section 3 were about personal help and encouragement from the instructor such as, “He was willing to give personal attention to me until I understand. He was very patient and helpful and willing to work with me.” In Section 1, social interaction with peers through class discussions about the use of technology in schools was also mentioned because “The discussions made me really understand”.

Successful software/task mastery was very important to the high GSE group as this was listed in 54.6% of the comments in Section 1 and 42.9% of the comments in Section 3. However, this group emphasized that task mastery was “Doing instead of just saying”, and appreciated that the instructor, “Showed us how to perfect things”, which may be an explanation for why only high GSE students sought to *Validate Performance* during scaffolded instruction. They also enjoyed challenges such as, “Websites although hard”, and that the instructor did not allow them to “use short cuts or cheats when completing a task”. In comparison to moderate GSE students, this group had more comments about desiring to learn advanced software skills because, “Starting out with email seemed too easy. I wish we could’ve spent more time on more difficult things”, and “Wordprocessing is so common that we didn’t really learn anything but more likely improve our skills.”

This group also valued personal help and encouragement during scaffolded instruction where, “My instructor helped with so many things during the class including Dreamweaver and Word”. This was the same as the other two groups. They also listed structured teaching in 18-28% of their comments where the instructor was “Reviewing over and over on how to use the different programs”. However, the extensive use of teacher-directed methods in Section 1 could have been negatively perceived by some high GSE students as they listed “slow instruction” and “too many practice exercise” as being least useful for raising their confidence for using technology. They also became "bored and disinterested". In comparison, Instructor 3 chose to limit demonstrations to "in-class introductory demonstrations on things they struggle with." This seemed to be perceived more positively by high GSE students in her section as their reaction to structured teaching was that "She would do demonstrations in class for us to better understand the assignment."

*e) Summary of findings for Question 4*

Analysis of the video recordings shows that Instructor 1 and 3 executed scaffolded instruction differently. Instructor 1 used a strategy of *Progress Checking* with each student where she systematically probed them to *Share Project*. On the other hand, Instructor 3 had Open Labs where attendance was not compulsory if students did not need one-to-one help. She would then focus on providing *Tech Help* through *Show and Tell*.

The open-ended comments of the survey show that students with different pre-observation GSEs had different perceptions of the strategies used by instructors. While all students cited the attainment of software/task mastery as a factor that was most useful for raising their confidence with using technology regardless of their pre-observation GSE levels. However, this factor was most important for high GSE students, especially if they could learn advanced features of software programs. APT analysis of student interactions found that this corresponded with them having the highest percentage of interactions for *Validate Performance* among the three GSE groups. Instructors also responded to this need as they had the highest percentage of *Share New Perspectives* with high GSE students. In addition to software/task mastery, 40% of comments from moderate GSE students also listed structured teaching as a factor useful for raising their confidence with using technology. On the other hand, low GSE students valued personal help and encouragement from teachers. While this corresponded with Instructor 1 using the highest percentage of *Direction Maintenance* with low GSE students, this needs to be interpreted with caution as the number of interactions attributed to low GSE students tend to be low, which may have limited the variation of data.

Another common trend found across the three sections was that *Clarify Task* was lower during instruction for Web Development than for PowerPoint. This was because all instructors spent 50% of class time on teacher-directed instruction for Web Development. As students had extensive modeling of the web development process, it reduced the need for them to *Clarify Task* during lab sessions.

**Question 5 – How is technology skills instruction related to computer self-efficacy and self-efficacy for technology integration?**

*a) General relationships*

Table 12 shows that strong positive correlations were found between post-observation GSE, and TSE (overall scale), and TSE (technology tasks performed with computer software and Internet). The correlation between GSE and TSE (technology integration) was positive but moderate. However, there was a strong positive correlation between the TSE (technology tasks performed with computer software and Internet) and TSE (technology integration) scales.

**Table 12 - Correlations between GSE and TSE as measured in the post-observation survey (*n* = 36)**

| Spearman's rho | Task-Specific Self-Efficacy (Overall Scale) | General Self-Efficacy | Task-Specific Self-Efficacy (Technology Tasks) | Task-Specific self-Efficacy (Technology Integration) |
|---|---|---|---|---|
| Task-Specific Self-Efficacy (Overall Scale) | 1.000 | .752(**) | .976(**) | .830(**) |
| General Self-Efficacy | .752(**) | 1.000 | .768(**) | .535(**) |
| Task-Specific Self-Efficacy (Technology Tasks) | .976(**) | .768(**) | 1.000 | .720(**) |
| Task-Specific self-Efficacy (Technology Integration) | .830(**) | .535(**) | .720(**) | 1.000 |

** Correlation is significant at the 0.01 level (2-tailed).

*b) Outcomes on TSEs for making slideshow presentations and making a webpage*

This section analyzes how technology skills instruction was associated with students' confidence level for performing the two software tasks that were analyzed through video recordings. The change in TSE for making presentation slides i.e. TSE (Slides) was computed by differences in rating reported by students for "I feel confident that I could use the computer to create a slideshow presentation" in the pre-observation and post-observation survey (See Question 9*o* of Appendix B, and Question 2*o* of Appendix C).

Each student was classified as having low, moderate or high pre-observation TSE (Slides) as follows:

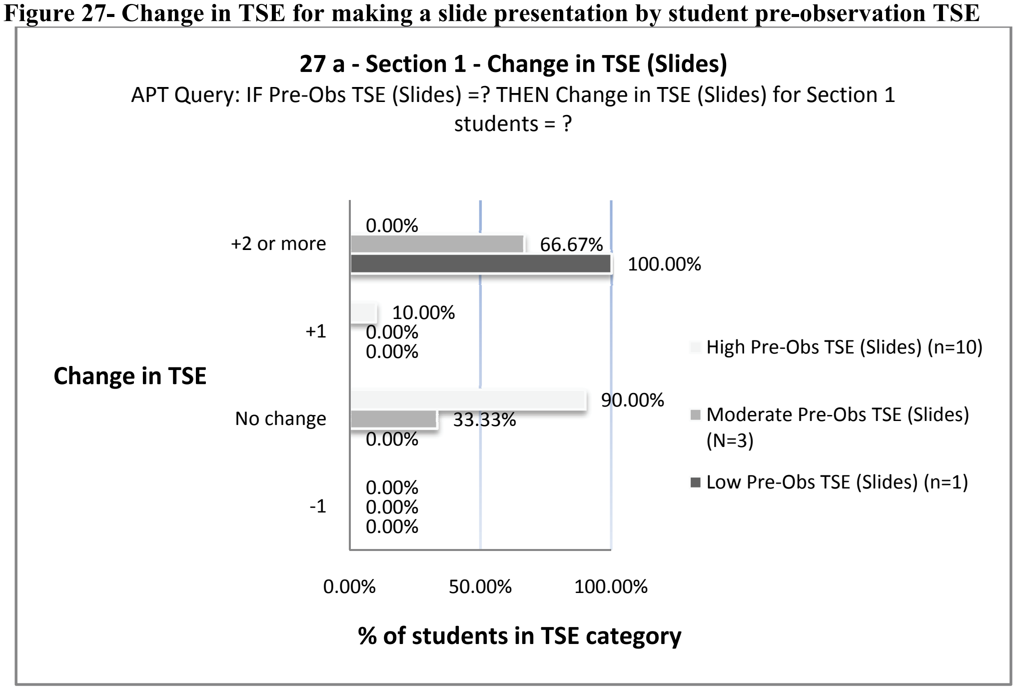
Rating 1 or 2 – Low TSE (Slides)

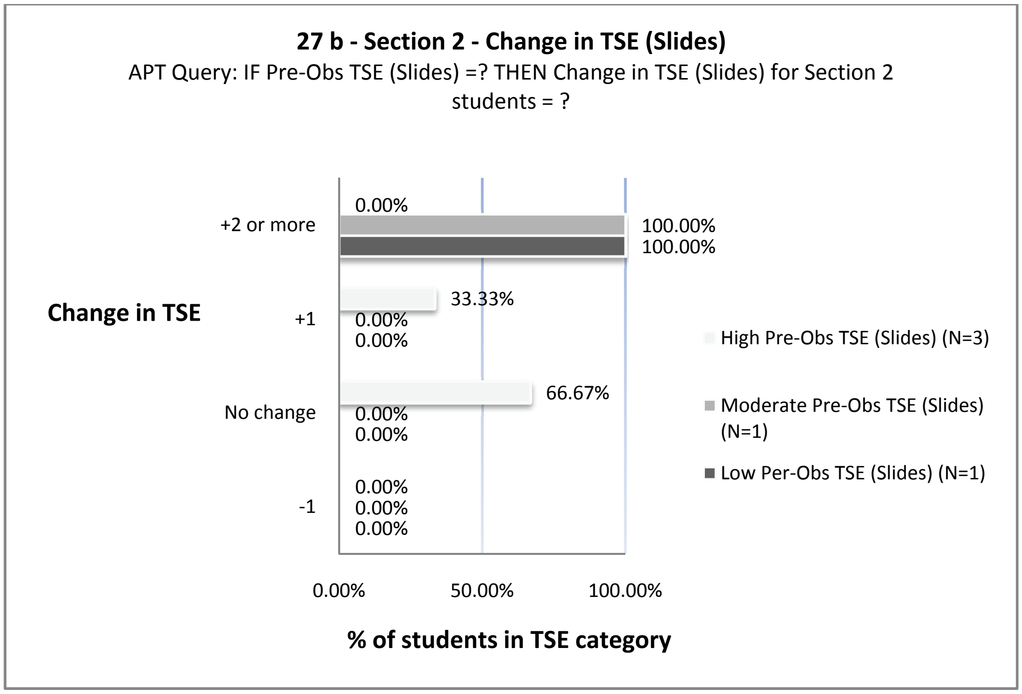
Rating 3 or 4 – Moderate TSE (Slides)

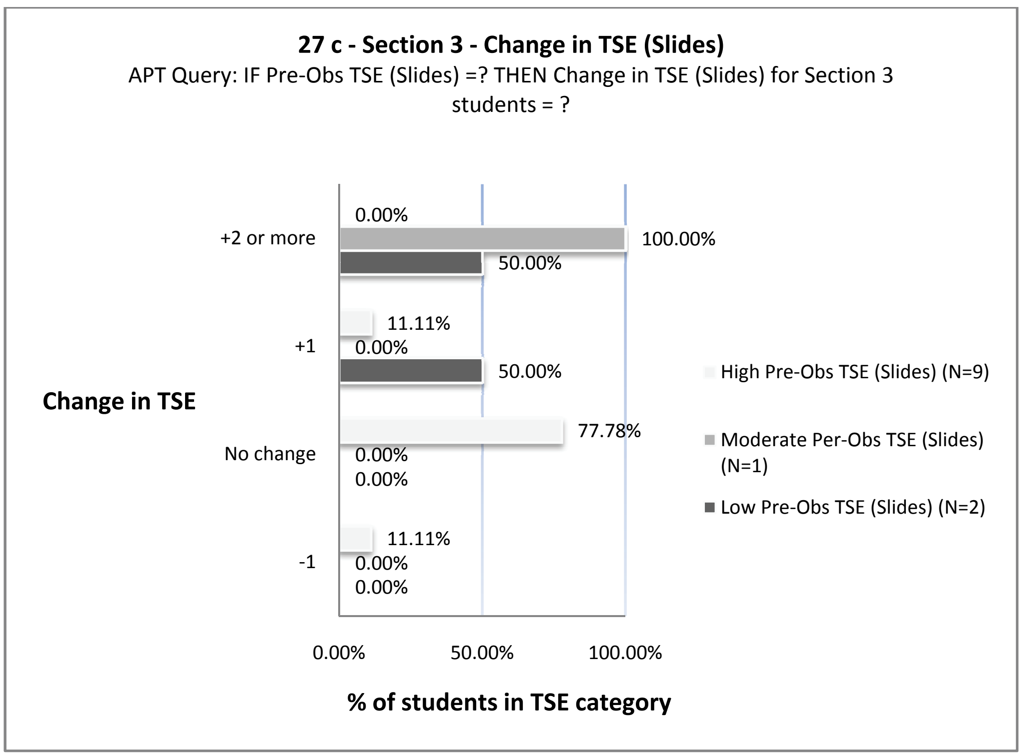
Rating 5 or 6 – High TSE (Slides)

Figures 27 *a* to *c* show that technology skills instruction in Microsoft PowerPoint could be associated with increases in TSE (Slides) for students with low or moderate pre-observation TSE (Slides) as all students in these categories reported at least a one-point increase in their post-observation TSE (Slides) rating. In comparison, majority of students with high pre-observation TSE (Slides) did not report any changes. However, these results need to be interpreted with caution as the small numbers of low and moderate TSE (Slides) students may have restricted the variation of data.

**Figure 27- Change in TSE for making a slide presentation by student pre-observation TSE**






Section 1 experienced a mixture of teacher-directed and scaffolded instruction during Microsoft PowerPoint, while the other two sections used scaffolded instruction exclusively. But, Sections 2 and 3 had a higher percentage of students who reported increases in TSE

(Slides). An interview with a student in Section 2 found that his perceptions of scaffolded instruction were positive because, “I prefer a combination of methods. But, if forced to choose one I would pick the self-paced tutorials because I can go slowly and redo things until I have them mastered. I feel that in most cases I learn better by doing.” While he recognized that he still had a need to familiarize himself with Microsoft PowerPoint, the use of self-paced tutorials gave him confidence that “The Help feature will be my best friend” if he had to use it in future.

The change in TSE for making a web page, i.e. TSE (Web) was computed by differences in rating reported by students for “I feel confident that I could use the computer to create my own World Wide Web homepage” in the pre-observation and post-observation survey (See Question 9*i* of Appendix B, and Question 2*i* of Appendix C). Each student was classified as having low, moderate or high pre-observation TSE (Web) as follows:

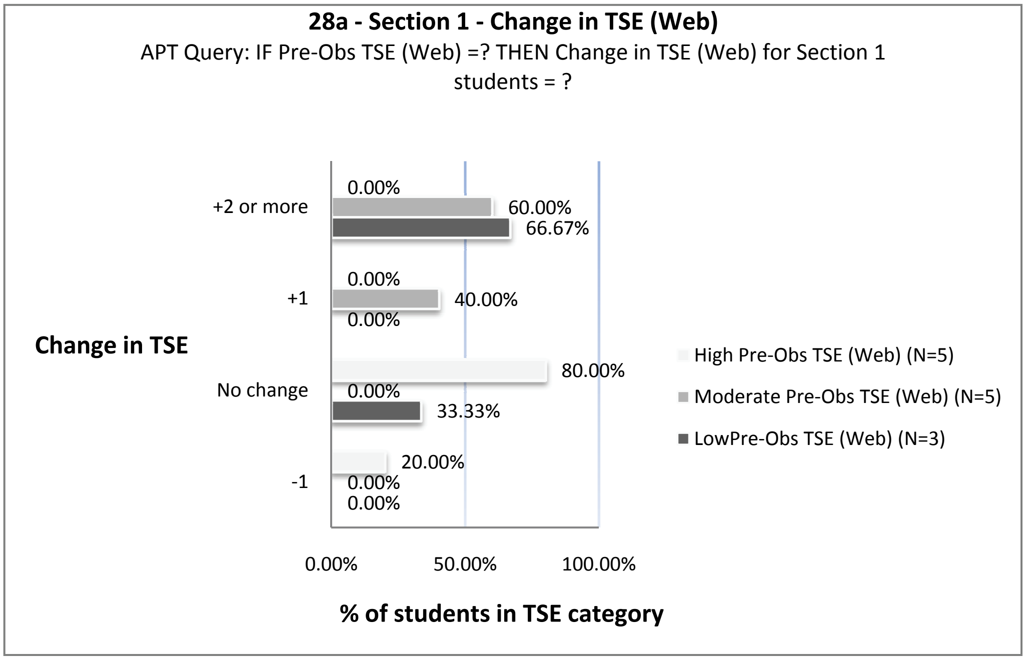
Rating 1 or 2 – Low TSE (Web)

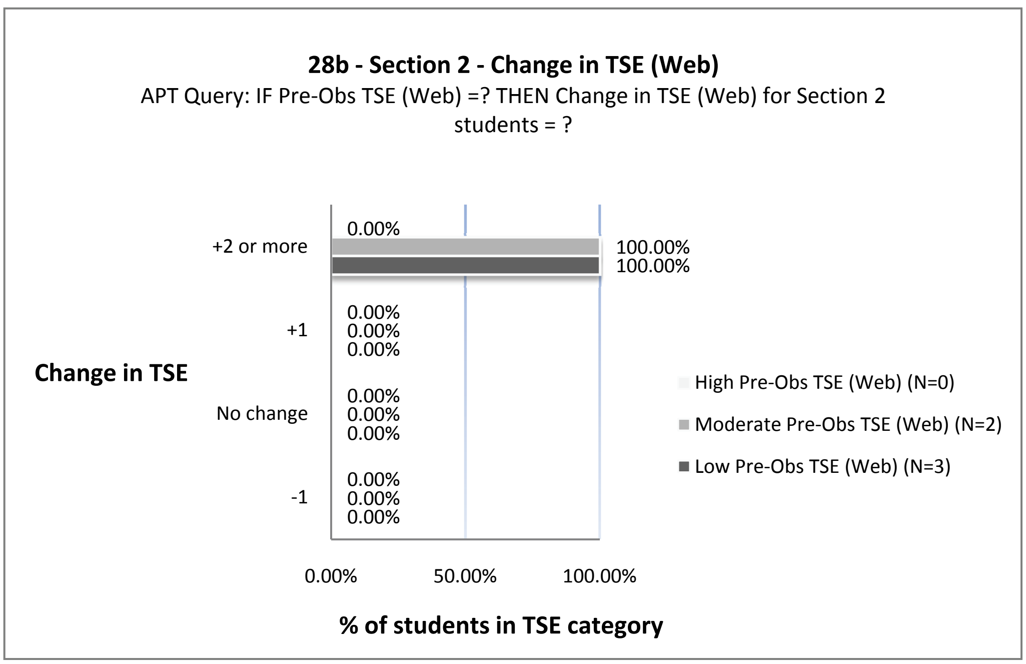
Rating 3 or 4 – Moderate TSE (Web)

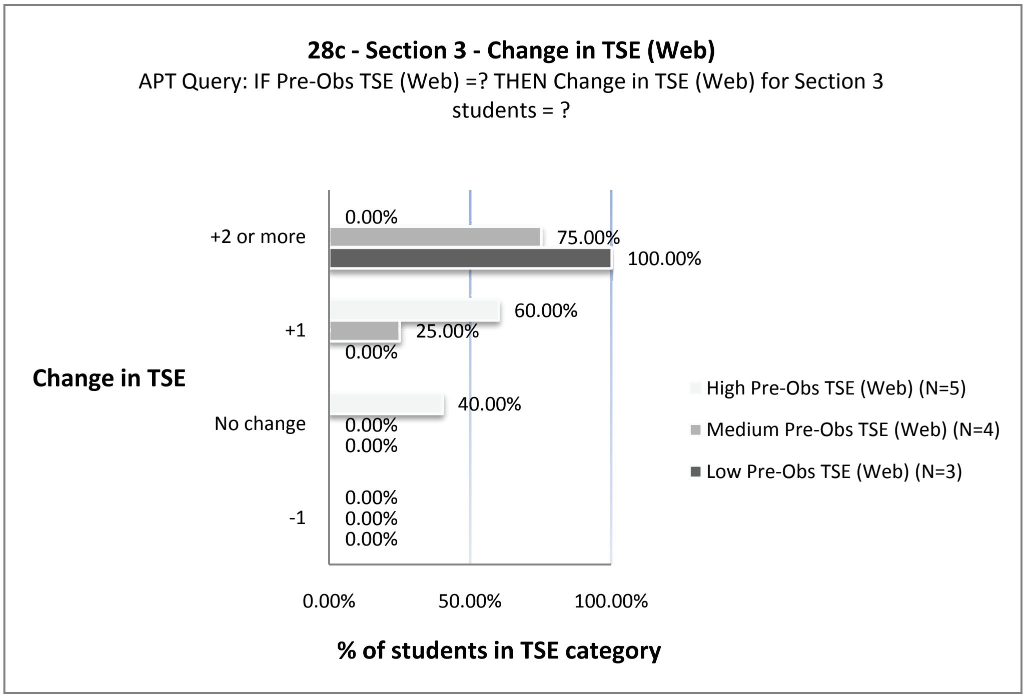
Rating 5 or 6 – High TSE (Web)

Figures 28 *a* to *c* show that technology skills training could also be associated with increases in TSE (Web) for students with low or moderate pre-observation TSE (Web). Almost all these students reported at least a one-point increase on their post-observation TSE (Web).

**Figure 28 - Change in TSE for making a webpage by student pre-observation TSE**





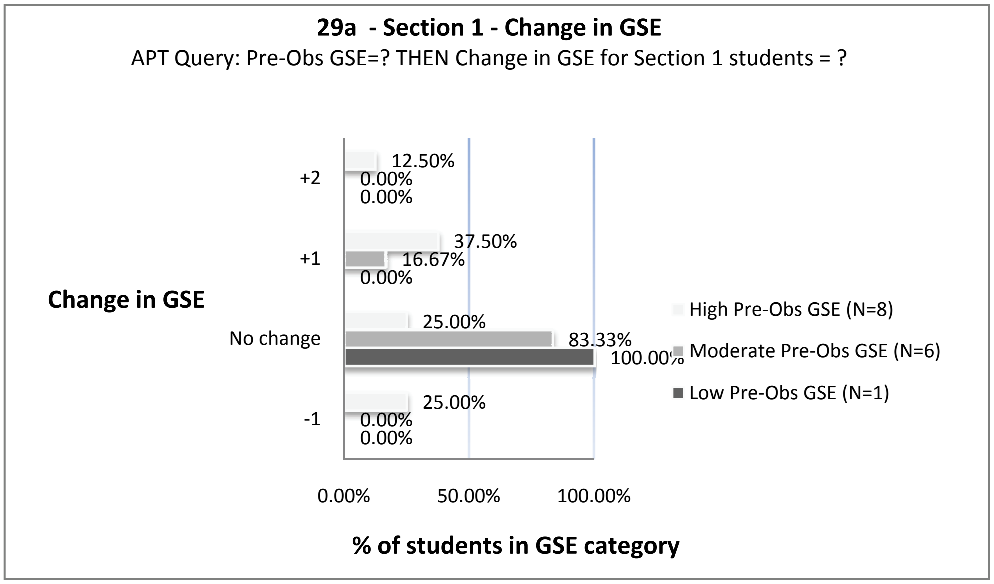

All Section 2 students reported an increase of two-points or more with respect to their TSE (Web). However, the small class size may have limited the variation of data. Comparisons of Sections 1 and 3 showed that 60% of high TSE (Web) students in Section 3 reported a one-point increase in post-observation TSE (Web), while there was either no change or a decrease in post-observation TSE (Web) for high TSE (Web) students in Section 1. Analysis of survey data found that 80% of high TSE (Web) students in Section 1 rated their pre-observation TSE (Web) as "6" on a 6-point scale, as compared to 40% in Section 2. Therefore, even though majority of high TSE (Web) students in Section 1 did not raise their TSE (Web), neither was it lowered.

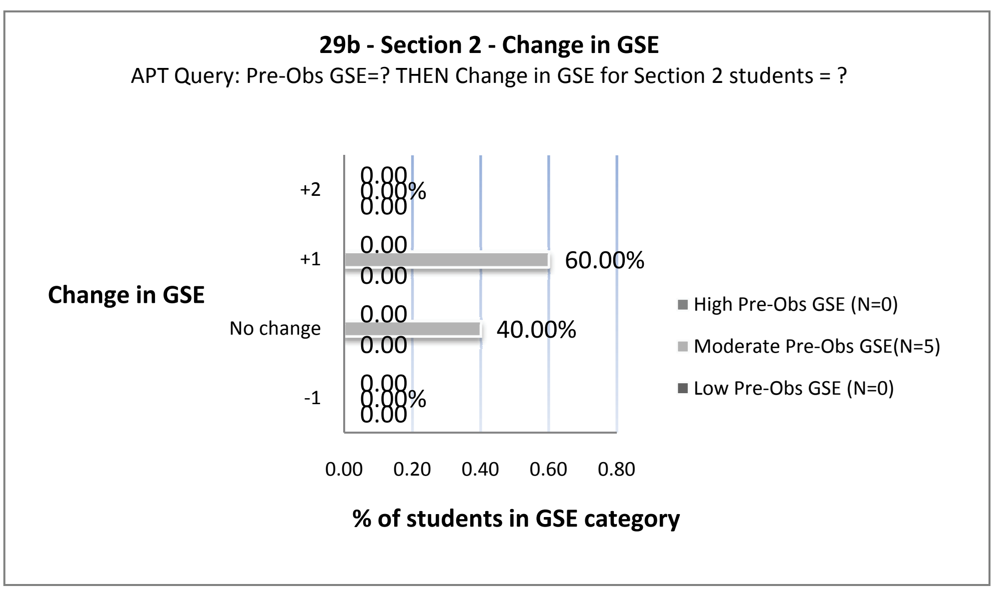
Figure 8*b* shows that for web development sessions, all three instructions used a combination of scaffolded and teacher-directed instruction, with 44%-51% of instructional time being devoted to scaffolded instruction. Therefore, it was not possible to analyze how scaffolded instruction may be associated with increases in TSE (Web).

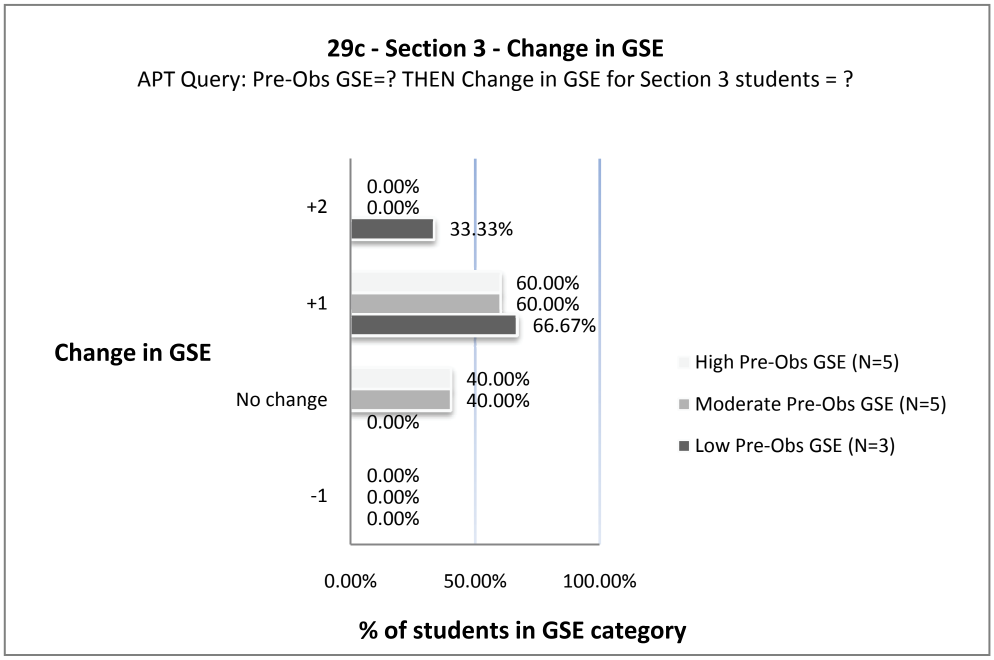
*c) Outcomes on GSE*

Figures 29 *a* to *c* show the change in GSE reported by students with different levels of pre-observation GSE. Forty per-cent of students with moderate per-observation GSE in Sections 2 and 3; and 83.3% of students in Section 1 did not report an increase in post-observation GSE. In comparison, all low GSE students in Section 3 reported an increase. While the only low GSE student in Section 1 reported no change in post-observation GSE, this needs to be interpreted with caution as there is too little variation.

**Figure 29 - Change in GSE by student pre-observation GSE**






Interestingly, at least 50% of high GSE students in both Sections 1 and 3 showed an increase in GSE. There is insufficient data to analyze if scaffolded instruction was related to this observation as no high GSE students were available for interview. One possible explanation could be that scaffolded instruction provided opportunities for high GSE students to *Validate Performance*, thereby allowing them to confirm their level of task mastery. It could have also addressed their need for personal help and encouragement through opportunities for instructors to provide *Direction Maintenance* during personalized coaching. In Section 1 especially, scaffolded instruction was used as an avenue for students to *Share Project*. Notably, *Share New Perspectives* was used exclusively with high GSE students where new ways of approaching a project, and advanced software features were shared. This may have provided students with the challenges they desired, which may explain why 12.5% of high GSE students in Section 1 to report a two-point or higher increase in post-observation GSE.

*d) Outcomes on TSE for technology integration*

The change of TSE for technology integration, i.e. TSE (Tech Int.) was computed by the difference in average rating reported by students Questions 9*q* to *t* of Appendix B, and Question 2*q* to *t* of Appendix C).

Each student was classified as having low, moderate or high pre-observation TSE (Tech Int.) as follows:

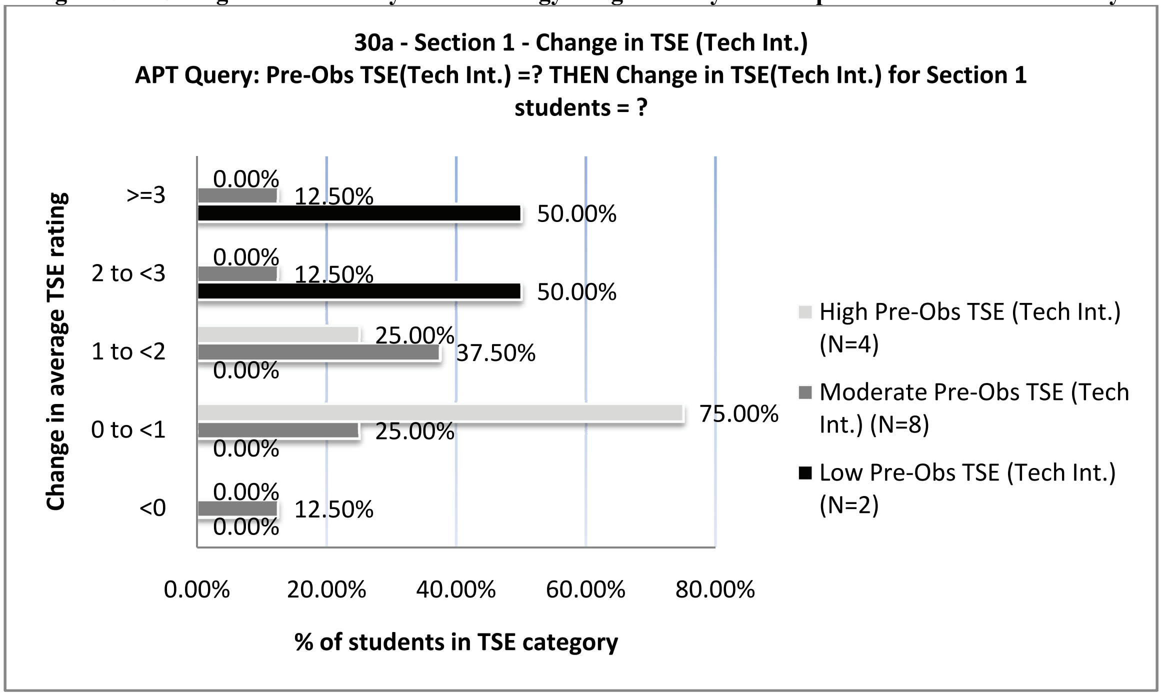
Rating $<3$ – Low TSE (Tech Int.)

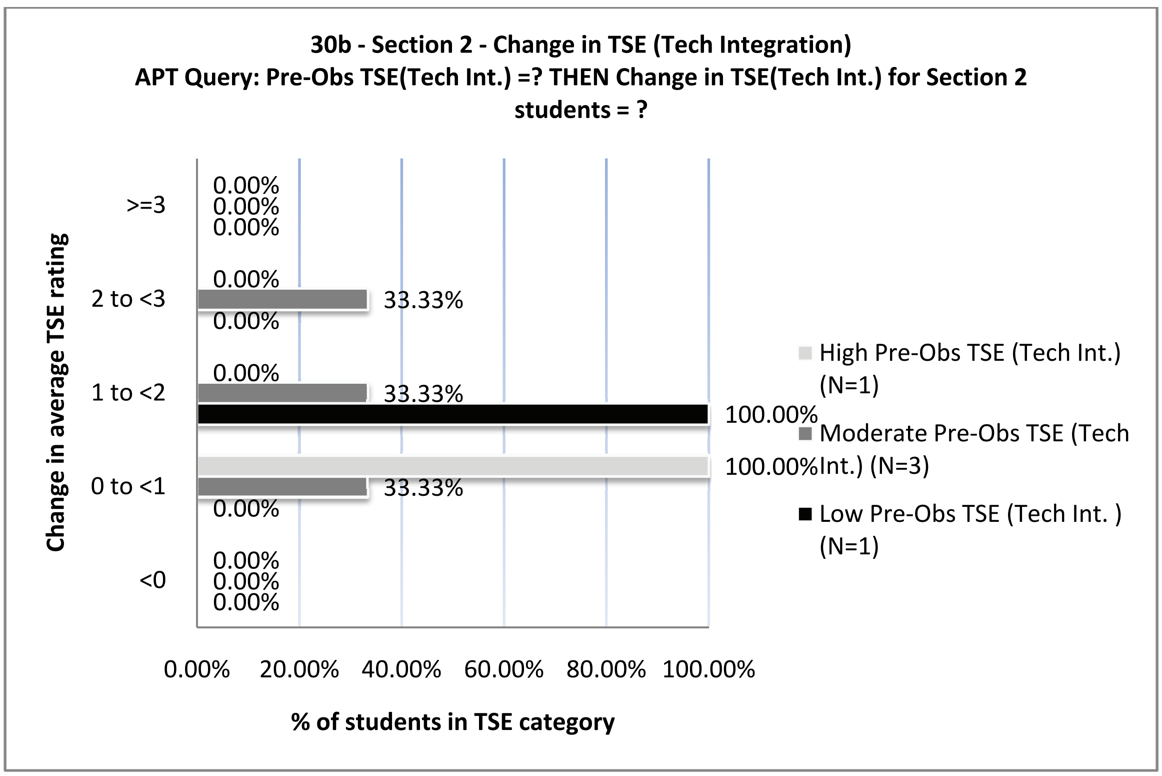
Rating 3 to $< 5$ – Moderate TSE (Tech Int.)

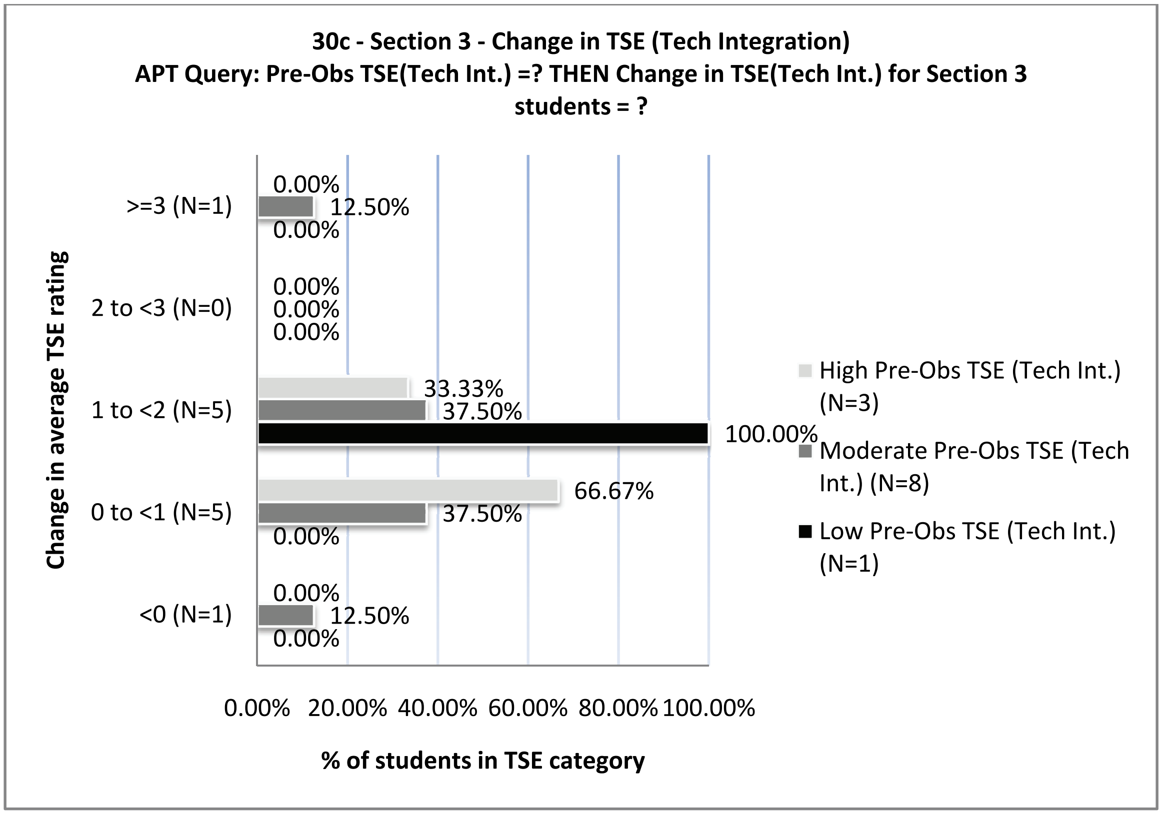
Rating $\geq 5$ – High TSE (Tech Int.)

Figures 30 *a* to *c* show that all students with low pre-observation TSE (Tech Int.) in Sections 1 and 3 reported an increase in post-observation self-efficacy for technology integration. Twenty-five percent of high efficacy students in Section 1 reported at least a one-point increase while the rest reported marginal or no change. On the other hand, all high efficacy students in Section 3 reported an increase. However, this needs to be interpreted with caution as there was only one high efficacy student in Section 3.

**Figure 30 - Change in self-efficacy for technology integration by student pre-observation self-efficacy**






All the low TSE students and 25% of moderate TSE (Tech Int.) students in Section 1 reported at least a 2-point increase, which was the highest among the three sections. An analysis of assessment requirements of instructors for lessons in Microsoft Excel, Microsoft PowerPoint and Web Development showed that students in Section 1 had more hands-on experience with making educational artifacts as they made educational boardgames, awards and signs, lesson plans, and teaching slides (See Appendix I). In comparison, the other two instructors assigned only one project for each software program that was framed within a general educational context e.g. "Design a PowerPoint presentation that you can use to support your teaching" or "Review 3 articles on technology integration in K-12 settings. Create a PowerPoint which summarizes arguments for and against integration and then take a personal position". In addition, their focus was primarily on assessing technical skills which comprised 60-80% of overall score in each assignment. Instructor 1 however had a mixture of smaller projects such as making awards and signs where 60% of the overall grade was for technical competency. She also had integrative projects such as making boardgames and lesson plans where about 60% of the overall score was based on instructional feasibility, content and design. These projects might have provided deeper and more authentic experiences for students with respect to technology integration.

*e) Relationship between TSE (Slides), TSE (Web) and GSE*

APT queries were used to determine how changes in TSE (Slides) and TSE (Web) were related to changes in GSE. Table 13 shows that PowerPoint is a software program that students were confident of using because about 70% of the students reported high TSE (Slides) and majority of them also reported no change in TSE (Slides). Despite this, the probability of them reporting an increase in GSE is 0.50. For high TSE (Slides) students who reported an increase in TSE (Slides), the probability of them reporting an increase in GSE is 0.67. Therefore, for high TSE (Slides) students, technology skills instruction in software they were familiar with could still be useful for enhancing their GSE even if it did not raise their TSE (Slides). For students with moderate and low TSE (Slides), almost all students reported an increase in TSE (Slides); and there was a 0.50 probability that these students also reported a corresponding increase in GSE. For these students, it can be seen that if technology skills instruction raised their TSE (Slides), it was also related to increases in GSE about half the time.

Table 13 also shows that majority of the students reported an increase in TSE (Web) after undergoing technology skills instruction as webpage development is a task that majority of students were not familiar with. The relationship between increases in TSE (Web) and increases in GSE is strongest among students with moderate TSE (Web) (probability = 0.72). This occurred with probability of 0.50 or the low TSE (Web) group, and probability of 0.40 for the high TSE (Web) group.

**Table 13 - Relationships of TSE (Making Slides), TSE (Making a Webpage), and GSE**

| If TSE (Making a Slide) is | And TSE (Making a Slide) | Then GSE Increases | Est. Probability |
|---|---|---|---|
| High (22 cases) | Increases (3 cases) | 2 cases | 0.67 |
| | Remains unchanged (18 cases) | 9 cases | 0.50 |
| | Decreases (1 case) | 1 case | 1.00 |
| Moderate (5 cases) | Increases (4 cases) | 2 cases | 0.50 |
| | Remains unchanged (1 case) | 0 cases | 0.00 |
| | Decreases (0 cases) | 0 cases | NA |
| Low (4 cases) | Increases (4 cases) | 2 cases | 0.50 |
| | Remains unchanged (0 cases) | 0 cases | NA |
| | Decreases (0 cases) | 0 cases | NA |
| **If TSE (Making a Webpage) is** | **And TSE (Making a Webpage)** | **Then GSE Increases** | **Est. Probability** |
| High (10 cases) | Increases (10 cases) | 4 cases | 0.40 |
| | Remains unchanged (0 cases) | NA | NA |
| | Decreases (0 cases) | NA | NA |
| Moderate (12 cases) | Increases (11 cases) | 8 cases | 0.72 |
| | Remains unchanged (1 case) | 0 cases | 0.00 |
| | Decreases (0 cases) | NA | NA |
| Low (9 cases) | Increases (8 cases) | 4 cases | 0.50 |
| | Remains unchanged (1 case) | 0 cases | 0.00 |
| | Decreases (0 cases) | NA | NA |

*f) Relationship between TSE (Slide), TSE (Web) and TSE (Tech Int.)*

From Table 14, it can be seen that regardless of their pre-observation TSE (Slides), students report an increase in TSE (Tech Int.) whenever they report an increase in TSE (Slides). The same relationship was found with a probability of 0.83 for high TSE (Slides) students who did not report any change in TSE (Slides). The same relationship was also observed between TSE (Web) and TSE (Tech Int.). Across the three groups by TSE (Web), the probability of students reporting an increase in TSE (Tech Int.) when TSE (Web) increases ranged from 0.80 to 1.00. Therefore, there is a strong positive relationship between raising student TSE for performing technology tasks and raising their TSE for technology integration.

**Table 14 - Relationships of TSE (Making a Slide), TSE (Making a Webpage) and TSE (Technology Integration)**

| If TSE (Making a Slide) is | And TSE (Making a Slide) | Then TSE (Technology Integration increases | Est. Probability |
|---|---|---|---|
| High (22 cases) | Increases (3 cases) | 3 cases | 1.00 |
| | Remains unchanged (18 cases) | 15 cases | 0.83 |
| | Decreases (1 case) | 1 cases | 1.00 |
| Moderate (5 cases) | Increases (4 cases) | 4 cases | 1.00 |
| | Remains unchanged (1 case) | 1 case | 1.00 |
| | Decreases (0 cases) | NA | NA |
| Low (4 cases) | Increases (4 cases) | 4 cases | 1.00 |
| | Remains unchanged (0 cases) | NA | NA |
| | Decreases (0 cases) | NA | NA |
| **If TSE (Making a Webpage) is** | **And TSE (Making a Webpage)** | **Then TSE (Technology Integration increases** | **Est. Probability** |
| High (10 cases) | Increases (10 cases) | 8 cases | 0.80 |
| | Remains unchanged (0 cases) | NA | NA |
| | Decreases (0 cases) | NA | NA |
| Moderate (12 cases) | Increases (11 cases) | 11 cases | 1.00 |
| | Remains unchanged (1 case) | 1 case | 1.00 |
| | Decreases (0 cases) | NA | NA |
| Low (9 cases) | Increases (8 cases) | 8 cases | 1.00 |
| | Remains unchanged (1 case) | 0 cases | 0.00 |
| | Decreases (0 cases) | NA | NA |

*g) Relationship between GSE and TSE (Tech Int.)*

Table 15 shows that at about half of the high and moderate GSE students reported an increase in GSE after technology skills instruction, while 75% of low GSE students reported similarly. Across the three groups, increases in GSE were strongly related to increases in TSE (Tech Int.). While a similar relationship was observed for students who reported no change in GSE, this needs to be interpreted with caution as the low number of cases may have restricted the variation of data.

**Table 15 - Relationship between GSE and TSE (technology integration)**

| If GSE is | And GSE | Then TSE (Technology Integration) increases | Est. Probability |
|---|---|---|---|
| High (12 cases) | Increases (6 cases) | 6 cases | 1.00 |
| | No change (4 cases) | 3 cases | 0.75 |
| | Decreases (2 cases) | 1 case | 0.50 |
| Moderate (15 cases) | Increases (7 cases) | 6 cases | 0.86 |
| | No change (8 cases) | 8 cases | 1.00 |
| | Decreases (0 cases) | NA | NA |
| Low (4 cases) | Increases (3 cases) | 3 cases | 1.00 |
| | No change (1 case) | 1 case | 1.00 |
| | Decreases (0 case) | NA | NA |

*h) Summary of findings for Question 5*

From these results, it can be seen that technology skills instruction tends to be more strongly associated with increases in TSE (Slides) and TSE (Web) for students with low and moderate pre-observation TSE. For these groups, increases in GSE were associated only with increases in TSE. Table 13 shows that when low and moderate TSE students report no change in TSE, they also do not report any increases in GSE.

Table 13 also shows some unique characteristics of high TSE students. When they were familiar with technology tasks such as making a slide, majority of them did not report changes in TSE after technology skills training. However, about half of them still reported increases in GSE. When it was for technology tasks they were less familiar with such as web development, increases in GSE were only observed when TSE increases.

In comparison, the relationships between TSE (Slides), TSE (Web) and TSE (Tech Int.) were much clearer. Regardless of their pre-observation TSE, strong positive relationships were reported between increases in TSE (Slides), TSE (Web), and TSE (Tech Int.). Therefore, it can be seen that enhancing students' technology proficiency can be one way of raising their TSE for technology integration. This finding is also consistent with the high positive correlation of $r = 0.72$ between TSE (Technology Tasks) and TSE (Tech Int.)

(see Table 12). Frick (1990) states that results from correlation analysis and APT should be consistent when there is a linear relationship between variables.

This study also shows that technology skills instruction could be associated with increases in GSE as about half of the high and moderate GSE students reported an increase in GSE after technology skills instruction, while about 75% of low GSE students reported similarly. It also found strong positive relationships between increases in GSE and TSE (Tech Int.).

# CHAPTER V – DISCUSSION

Since its initial conception by Wood et al. (1976), the construct of "scaffolding" has been enlarged from a process of social-cultural exchange between experts and novices to an interactive system of people, methods, and tools used to support student learning (Puntambekar & Kolodner, 1998). Its theoretical connections with Vygotsky's socio-cultural theory emphasized scaffolding to be mediated through social interactions between teachers/experts and students/novices where experts help the novices move across their "zones of proximal development" or the gap between their current and potential competencies. Researchers characterized this process by co-participation between teachers and students to direct the learning process (Meyer, 1993), and titration of assistance by teachers (Puntambekar & Hubscher, 2005) where they continually diagnose student needs to vary support accordingly. Some researchers also stressed the need for scaffolding to encompass "fading", or a conscious intent of teachers to "fade out", so that students can become increasingly self-regulated in learning (Puntambekar & Hubscher, van Merriënboer et al., 2002; van Merriënboer et al., 2003). Especially when scaffolding complex learning, van Merriënboer et al. (2003) stressed that appropriate "fading" of performance support helps students focus on task performance by preventing cognitive overload. Other researchers however, adopted a broader definition of scaffolding as a process of providing instructional supports to students, whether through social interaction and the use of software tools (Greene & Land, 2000; Rasku-Pottonen et al., 2002, Quintana et al., 2004). This study defined scaffolding as occurring when instructors adjust support to individual students when they are directing their own learning process.

This study attempted to understand how "scaffolding" occurred in technology skills instruction for pre-service teachers through cross-case comparisons of three educational technology classes conducted in a large Midwestern university, each conducted by a different instructor. Computer self-efficacy predicted teacher use of technology (Negishi et al., 2003; Littrell et al. 2005; Zhao et al., 2002). Ertmer et al. (1994) found that teacher-student interactions were more important for raising self-efficacy of students than the time they spent with technology. There is a gap in extant research of computer skills training as extant research has mostly focused on behavior modeling. The relationship between teacher-student interactions and computer self-efficacy has been rarely studied. The construct of scaffolding therefore provided an alternative theoretical lens to address this gap. Vygotsky (1976) stressed that learning through social interaction was a means for acculturating into one's socio-cultural environment. This theoretical construct was also used to provide insight about how acculturation of pre-service teachers to integrate technology in the context of teaching and learning could occur through technology skills acquisition.

In the present study, surveys were administered to 43 pre-service teachers in three sections of an educational technology course to collect data on student demographics, prior experience with using computers, and computer self-efficacy. Video recordings and observations were then carried out during class sessions across a class semester, following which post-observation surveys were administered to measure the differences in student computer self-efficacy. Interviews with instructors and student volunteers were subsequently conducted as a means for triangulation.

Analysis of lessons for PowerPoint and Web Development found that Instructor 1 consistently used half of her class-time in teacher-directed instruction through teaching methods such as lectures and demonstrations as she believed this to be a way of modeling good teaching techniques to pre-service teachers. The other two instructors used scaffolded instruction almost exclusively during PowerPoint lessons when they had students learn through self-paced tutorials or Open Lab sessions. Scaffolded instruction was viewed as a means of encouraging independent mastery of technology, and provided the structure for them to personalize support to the needs of each student. However, when teaching Web Development, a topic where majority of the students had low familiarity, both Instructors 2 and 3 spent half their class-time on lectures and demonstrations of key contents through teacher-directed instruction.

When video recordings of instructor-student social interaction was analyzed with APT (Analysis of Patterns in Time), it was found that scaffolded instruction allowed for more variation in different types of student interaction (i.e., requesting for help with technology, requesting for help with artifact design, clarifying content information, clarifying task information, and validating interim performance). On the other hand, students primarily answered questions posed by instructors during teacher-directed instruction. Scaffolded instruction also allowed instructors more opportunities to motivate students, demonstrate task performance, and share new ideas and perspectives on a one-to-one basis. This study also found that instructors scaffolded mainly through social interaction with students, as a large percentage of interactions occurring during scaffolded instruction did not involve the use of content resources. If they did, these were used as additional scaffolds for content information so that responsibility for content instruction could be gradually transferred away from instructors.

During scaffolded instruction, instructors in this study reported that they used their personal assessments of student GSE to determine how they should titrate assistance. Analysis of survey results also found that students with different levels of pre-observation GSE varied in terms of the factors they felt was most useful for raising their self-efficacy for using technology. Students with low pre-observation self-efficacy appreciated personal help and encouragement from instructors; moderate self-efficacy students appreciated the use of teacher-directed methods such as lectures and demonstrations; whereas high self-efficacy students stressed the need for challenge and attainment of task mastery. Some correspondence was found in APT analysis of video recordings. Instructors 1 and 3 were found to have the highest percentage of *Validate Performance*, and *Share New Perspectives* interactions with high efficacy students. This spoke to their need for attainment of task mastery, and to be challenged with learning advanced software features. Instructor 1 was also found to have the highest percentage of *Direction Maintenance* interactions with low GSE students, which spoke to their need for encouragement and motivation.

This study also found that technology skills instruction was related to changes in TSE and GSE. The majority of moderate and low TSE students reported increases in TSE (Slide) and TSE (Web) following technology skills instruction. About half of them also reported corresponding increases in GSE. An increase in TSE (Slide) and TSE (Making a Webpage) was associated with corresponding increases in TSE (Tech Int.) with a probability of at least 0.80. Therefore, it can be seen that in this study, the acquisition of software proficiency was a means of enhancing pre-service teachers' confidence for technology integration.

**Implications for practice**

a) *What is Scaffolding?*

One difficulty associated with the application of scaffolding as an instructional strategy for technology skills courses is the lack of agreement on its definition. While there is general agreement that it involves experts providing support to novices in tasks that novices would not be able to perform without expert assistance; there is less agreement as to whether it needs to involve "fading out" of teachers so that students are encouraged to be self-regulated. Proponents of a broader view of scaffolding define it as a means for providing instructional support through "scaffolds" which may be different types of social interaction, or resources and tools. As it can be seen, instructors' definitions for scaffolding could affect the instructional goals, and types of social interaction that they engaged students in. As technology skills instructors attempt to implement scaffolded instruction, it is important for them to be clear about which definition they want to adopt. A clear choice of definition for scaffolding can help instructors evaluate appropriate scaffolding examples from extant research, and plan their instructional activities more effectively.

*b) Scaffolding functions and the instructional context*

This study found that instructors expected pre-service teachers to attain technology skills proficiency by producing technology artifacts. During this process, pre-service teachers were expected to interpret project guidelines, and make design decisions about how the artifact could be used in an educational context. As a result, scaffolding interactions used by technology skills instructors in the current study differed from those found by Wood et al, (1976) where children were mastering the steps for solving a wooden puzzle. The learners in Wood et al.'s study were of a younger age, and they also had a less complex task as compared to the pre-service teachers in this study. The profile of learners, the open-endedness of task performance, and instructional approach used in this study led to the emergence of new scaffolding categories, and the merging of categories from Wood et al. (1976). This supports the proposition by Meyer (1993) that scaffolding is contextualized. Several implications are derived to guide how technology skills instructors should approach scaffolding.

Firstly, *Show and Tell* during technology skills instruction should entail the demonstration of technology procedures, explanation of technology concepts, and explication of the corresponding strategies for navigating an assigned project successfully. As compared to Wood et al. (1976), it is more difficult to isolate "Marking Critical Features" as a separate category from "Demonstration" because technology procedures, project instructions and fatal flaws students should avoid were found to be interwoven as *Show and Tell* during technology skills training.

Secondly, technology skills instruction involved the use of new scaffolding functions that did not emerge in the study by Wood et al. (1976). While scaffolding independent work by students, it is necessary for technology skills instructors to engage in *Progress Checking* by monitoring student work silently, or asking students questions about the progress of their projects. Even though this mode of scaffolding may seem rather passive, it is nonetheless essential as a form of "ongoing diagnosis" (Puntambekar & Hubscher, 2005) of student learning. This could then be followed by instructors using other scaffolds according to student needs. Examples of scaffolding functions that were unique to technology skills instruction were the sharing of content information through *Show and Tell*, prevention of error through *Frustration Control*, interactive questioning through *Prompt and Hint*, praise and encouragement through *Direction Maintenance,* and helping students visualize new ways of approaching a technology problem through *Share New Perspectives*

c) *Scaffolded Instruction and Teacher-Directed Instruction*

This study found that teacher-directed and scaffolded instruction served different purposes during technology skills instruction. Scaffolded instruction could be used to support instances where instructors desired to foster students' ability to learn technology skills independently, and also when instructors needed to engage in personalized coaching. One advantage of scaffolded instruction was that it allowed for a higher extent of co-participation between instructors and students as students had more opportunities to initiate a variety of support requests such as *Clarify Task*, *Clarify Content*, *Validate Performance*, and *Tech Help*. On the other hand, teacher-directed instruction could be used when instructors need to convey content information or to demonstrate technology procedures. The advantage of using teacher-directed instruction is that when combined with active strategies to *Prompt and Hint*, it could be used to engage dialogue and participation from students through *Share Content*. This study found that instructors often used interactive lectures when teaching conceptual knowledge about technology. When deciding on the types of teaching methods to use, technology skills instructors should exploit the relative advantages of each method to best support their teaching objectives.

This study also found that instructors should consider students' level of familiarity with technology tasks when deciding how much class time to allocate for each type of teaching method. Where familiarity with a technology task was high (e.g. during PowerPoint lessons), the exclusive use of scaffolded instruction could be more effective for raising TSE. This can be seen in Section 3, where there was a higher percentage of moderate TSE (Slide) students who reported increases in TSE (Slide) as compared to Section 1 whose students experienced a mixture of both teacher-directed and scaffolded instruction. Where familiarity with a technology task was low (e.g. during web development lessons), students tend to have a high intrinsic cognitive load i.e. cognitive load associated with the properties of the task (Sweller, 1994). It is recommended that teacher-directed instruction should precede scaffolded instruction as teacher modeling and direct instruction could reduce the intrinsic cognitive load of students. This study found that when task requirements were first modeled through teacher-directed instruction, it improved student familiarity with it. During scaffolded instruction that followed, there were a lower proportion of student requests to *Clarify Task* which then allowed instructors to focus on giving personalized *Tech Help*. This approach is similar to what Rosenshine and Meister (1994) described as Explicit Teaching Before Reciprocal Teaching, which was one variation of reciprocal teaching.

*d) Strategies for titrating assistance during Scaffolded Instruction*

Titration of assistance during scaffolding embodies the application of scaffolds according to the specific needs of students. It can be seen that students in this study were engaging in what van Merriënboer et al. (2002) termed as complex learning as they had to integrate their knowledge of software skills to produce various technology artifacts. When scaffolding complex learning, it is necessary to adjust the types of performance support to avoid cognitive overload on students (Merriënboer et al., 2003).

In this study, it was found that instructors applied different scaffolding strategies based on student GSE (See Table 16). As compared to high GSE students, those with low and moderate GSE were less familiar with both the software programs being taught, and had less experience with the technology tasks they had to perform, and therefore had higher intrinsic cognitive load (Sweller, 1994). When the instructors of this study scaffolded them by clarifying task instructions and demonstrating software procedures (See Table 16), it reduced their intrinsic cognitive load, thereby enhancing their confidence for learning technology. On the other hand, high GSE students had a lower intrinsic cognitive load than low and moderate GSE students as they were more familiar with the software programs and technology tasks they had to learn. Therefore, they were able to absorb new technical information and perspectives from instructors without facing cognitive overload. As such when instructors of this study focused on *Share New Perspectives* with high GSE students (see Table 16), it motivated and enhanced their confidence for learning technology.

**Table 16 - Generic Scaffolding Strategies for Titrating Assistance**

| Pre-Observation GSE | Predominant Student Need derived from comments in post-observation survey | Scaffolding Strategy |
|---|---|---|
| Low | • Personal Help Encouragement<br>• *Clarify Task* | • Provide encouragement with *Direction Maintenance*<br>• Clarify task requirements with *Show and Tell* |
| Moderate | • Structured Teaching<br>• Software/Task Mastery | • *Show and Tell* with Lectures and Demonstrations<br>• Provide details about software features and functions |
| High | • Software/Task Mastery<br>• Validate Performance | • Provide knowledge of advanced features with *Share New Perspectives*<br>• *Validate Performance* and stimulate challenge |

The strategies listed in Table 16 can therefore be used as a reference for technology skills instructors who are interested in using scaffolded instruction in a similar context.

*e) Strategies for "fading out" during Scaffolded Instruction*

Another aspect of scaffolding was the gradual "fading out" of the instructor as students gained increasing self-regulation for learning. In this study, it was found that instructors used two strategies to achieve "fading".

The first strategy was the use of content resources such as supplementary notes and self-paced tutorials as substitutes for content instruction of technology procedures. In the 4C/ID model, these technology procedures would be considered as *JIT Information*, or constituent skills that did not vary across tasks (van Merriënboer et al., 2002). van Merriënboer et al. (2003) recommended that such procedural information should be presented just when learners need to use it, and be integrated with the task environment to avoid extraneous cognitive load on learners. Instructors in this study helped students recognize these resources as legitimate content scaffolds by referring students back to them whenever students asked instructors repetitive questions during lab time. Across time, students learned to look beyond the instructor as the main source of content knowledge during task execution, thereby establishing a system of "distributed scaffolding" as described by Puntambekar and Kolodner (1998). It also enabled the instructor to gradually fade out as a content provider by helping students self-direct their learning with the support of resources.

The second way of "fading out" was by sustaining *Progress Checking* through repeated turns. The analysis of student-instructor interactions in Section 1 demonstrated how systematic *Progress Checking* targeted at having students *Share Project* could help them concretize project ideas and develop responsibility for initiating support requests. However, this strategy was associated with more student initiation when it was sustained across repeated turns. This is similar to the process used during Reciprocal Teaching where students learned reading comprehension skills across repeated scaffolding cycles. In technology skills training, repeated turns of *Progress Checking* followed by *Share Project* served as catalysts to fuel the development and maturation of project ideas. As their ideas became more concrete, students also took more responsibility for directing their project and initiating support requests. Repeated and targeted *Progress Checking* was therefore another strategy that instructors used to "fade out" and encourage student responsibility for directing the learning.

Through *Progress Checking* and *Share Project*, instructors in this study also helped students obtain what is termed in the 4C/ID model as *Supportive Information*, or constituent skills that varied with different task classes (van Merriënboer et al., 2002). The authors recommend that *Supportive Information* is best acquired through instructor modeling of cognitive strategies and heuristics for task performance, and providing feedback on the quality of students' problem-solving process. The repeated turns of *Progress Checking* enabled instructors in this study to provide feedback to students according to their requirements in each stage of the problem-solving process.  van Merriënboer et al. (2003) emphasized that presenting *Supportive Information* as "embellishments" as learners progress through each task class was a strategy that prevented extraneous cognitive load on learners.

*f) Using self-paced technology skills materials with classes with high GSE*

This study found that students entered introductory technology skills course with relatively high levels of GSE. They were conversant with using computers for e-mail, on-line chatting, and information search, and almost all of them felt they could use word-processing software proficiently while at least 60% felt similarly about spreadsheet and slide-presentation software.  If technology skills instructors encounter a similar profile of students, it is recommended that they consider the use self-paced tutorials, especially during instruction of software programs that students were already familiar with. This strategy was used by both Sections 2 and 3 during instruction for PowerPoint. However, they should note several issues involved with using self-paced materials. Carroll, Mack, Lewis, Gischkowsky, and Robertson (1985) and Charney et al. (1990) found that self-paced tutorials used for exploratory learning did not adequately scaffold the formation of problem structures. This study showed that when self-paced tutorials are used as part of scaffolded instruction, instructors should use scaffolding functions such as *Show and Tell* to model problem structures, and also use *Prompt and Hint* to engage students in dialogue about the problem-solving process. Another caution about using self-paced materials is that if materials are not designed well, instructors could incur instructional time clarifying task instructions, rather than focusing on scaffolding content learning. Therefore, when using self-paced tutorials during technology skills instruction, care must be taken to review and select well-designed materials with clear task instructions.

*g) Going beyond behavioral modeling*

Extant research for software training is primarily based on Social Cognitive theory which found that vicarious experiences obtained through behavioral modeling was more effective for raising computer self-efficacy than lectures (Gist et al., 1989; Compeau & Higgins, 1995b; Johnson & Marakas, 2000; Bolt et al., 2001). However, the predominant use of experiments in current research may not have allowed for the emergence of social interaction that is typical of actual classroom situations. This study fills a gap in current research as the post-observation survey showed that besides behavioral modeling (i.e. structured teaching) students also cited personal help and encouragement, and software mastery as factors that enhanced their computer self-efficacy. These corresponded to verbal persuasion and mastery experiences that were the two of the four sources of self-efficacy postulated by Bandura (1977).

As technology skills instructors in pre-service teacher technology courses attempt to raise student computer self-efficacy through scaffolded instruction, reference should be made to match the types of scaffolding functions derived in this study to the sources of self-efficacy as explicated by Social Cognitive Theory. While extant research has explored these four sources of self-efficacy in a large-group classroom context, scaffolded instruction allows technology skills instructors the opportunity to vary the use of these sources according to student needs. This study found that even though all students valued mastery experiences, the relative importance of each self-efficacy source varied by their GSEs. During scaffolded instruction, the instructor should attempt to help students obtain mastery experiences. On top of that, they should stress the use of verbal persuasion through personal encouragement with low GSE students, behavioral modeling or one-to-one structured demonstrations with moderate GSE students, and focus on creating challenges for high GSE students, Instructors should also note that some high efficacy students could be negatively motivated when they perceive behavioral modeling to be excessive, especially when they were already familiar with a software program. Therefore, the use of structured demonstrations with high GSE students should be carefully considered, and focused on providing knowledge that is new to them.

*h) Technology skills and technology integration skills*

An identity crisis often faced by pre-service teacher programs that had only one educational technology course was whether it should provide technology competency or competency for technology integration. The results of this study show that TSE (Slides) and TSE (Web) had a strong positive relationship with TSE (Tech Int.). Therefore, strategies used by technology skills instructors to help pre-service teachers gain confidence with performing specific technology tasks will also help them gain confidence about their ability to integrate technology in the classroom. This relationship can also be further strengthened by assigning pre-service teachers with authentic tasks designed to acculturate them towards the practice of technology integration.

The projects assigned by Instructor 1 were good examples of authentic tasks. Some examples were the production of lesson plans with Microsoft Word, teaching slides with Microsoft PowerPoint, and educational board games with Microsoft Excel. These projects were tightly framed in the context of actual tasks performed by teachers. As pre-service teachers produced these artifacts, they also gained experience with using technology in the way a teacher would. In fact, Section 1 had a higher percentage of students reporting at least a 2-point increase in self-efficacy for technology integration as compared to the other two sections where technology projects were loosely framed within an educational context and focused on technology skills acquisition. Pellegrino and Altman (1997), Bayerbach, Walsh, and Vannatta (2001), and Snider (2003) also found that when pre-service teachers have hands-on practice in developing technology integrated lesson plans, it encourages them to integrate technology.

**Limitations of study**

This is a case study of three technology skills classes. Since it is not a random sample and small, "statistical generalization" (Yin, 2003) to all technology skills courses cannot be claimed. Another limitation of this study was the numbers of students with low GSE and TSE for Microsoft PowerPoint in each section. These factors may have limited the variation of data, and related trends need to be interpreted with caution.

The researcher was unable to obtain identifiers for student course performance data as instructors were protective of the confidentiality of students. It is therefore not possible to compare student-instructor interactions by learning achievement, or relate student projects to their course grade. Therefore, the study is not able to draw conclusions about relationships between scaffolding strategies and learning achievement.

Another limitation of the study is the poor response from student interviewees. Only one student each volunteered from Sections 1 and 2. In addition, both were mature students whose comments may not be typical of younger pre-service teachers. Therefore, student comments from the post-observation survey were used as a main source of anecdotal data to determine the relationship between scaffolding strategies and self-efficacy. It is not possible to further triangulate these results with interviews of students with varying GSE levels. Logistical difficulties prevented the administration of surveys on student self-efficacy after instructors finished teaching each software program. Therefore, it is not possible to analyze how self-efficacy gained in earlier parts of the course was translated to the later parts of the course.

The final limitation of the study is that lessons on word-processing software could not be observed because of schedule conflicts. The pre-observation survey found this to be a software program that students reported the highest level of familiarity and self-efficacy. Not being able to observe sessions related to word-processing may have limited the breadth with which technology skills courses are described.

**Suggestions for future research**

As the target audience of this study was pre-service teachers, it is not possible to determine if the categories of student-instructor interactions are applicable to undergraduates in other majors. This study could be replicated in introductory technology skills courses in different undergraduate majors, which will provide a validated framework to guide the planning of scaffolded instruction in these courses.

Due to the design of the curriculum, this is the only educational technology course undertaken by pre-service teachers majoring in Art Education, Music Education, and Early Childhood Education at the university. Pre-service teachers in other majors such as Elementary Education and Secondary Education at the university undergo a different curriculum where basic technology skills courses are followed up with other courses focused on technology integration. One area of further research would be to replicate the study in pre-service teacher courses focused on technology integration to determine if scaffolding strategies differ. This will contribute towards an understanding of how scaffold instruction is used in methods courses.

A third area of study would be test the applicability of the coding protocol for interactions in an on-line instructional environment, and also for higher level technology courses related to multi-media production. It could serve as a basic framework upon which new scaffolding functions might emerge. This will contribute towards a comprehensive understanding of how scaffolding occurs in different contexts, and enhance the development of scaffolding as a theoretical construct.

**Conclusion**

Scaffolded instruction is the process whereby instructors support students with an aim of helping them achieve independence and self-directedness in learning. It could be an important aspect of technology skills training as it was found to comprise half, if not more of instructional time in the three technology skills classes that were studied. This study also found that technology skills courses play a critical role in pre-service teacher education as strategies used to raise student self-efficacy for using computers also raised student self-efficacy for technology integration. In this study, socio-cultural theory provided a theoretical lens to understand how social interaction in technology skills courses contributed to the acculturation of pre-service teachers for the practice of technology integration. It also found that behavioral modeling alone may not be adequate for raising self-efficacy as the entry-level self-efficacy of students significantly differentiated the types of support they required. The use of scaffolded instruction provides a means for personalizing support to cater to these differences. It is an important method for technology skills training that should be further explored.

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# APPENDICES

## Appendix A - Instructor and Student Consent Forms

Study # 07-11679

INDIANA UNIVERSITY – BLOOMINGTON
INFORMED CONSENT STATEMENT - INSTRUCTORS

Scaffolding Models in Preservice Teacher Technology Courses

You are invited to participate in a research study. The purpose of this study is to compare the models of instructional support (or scaffolding) that instructors in pre-service teacher technology courses use, and to determine how different scaffolding models impact pre-service teachers' self-efficacy or confidence in learning technology skills, performance in technology courses, and confidence for integrating technology.

**INFORMATION**

This study will be conducted with the instructor and students in three to five introductory technology classes for pre-service teachers. These activities will be carried out:

1. The researcher will provide you with Consent Forms to be signed and returned to the researcher for your agreement to participate in video-taping during classroom observations, and for the video-tape to be used by the researcher for future research.
2. The researcher will ask for your permission to give out Consent Forms and explain the purpose of study to students during the last 10 minutes of a class session. Surveys will also be administered to students at the beginning and end of the observations. Your assistance is sought to allow the researcher to give out the survey forms at the end of a class session, and to collect them back from students during the next session.
3. Selected class sessions in the computer lab will be video-recorded. Focus will be on the instructor's teaching methods, and how instructional support is being provided. Your help is sought to have students who choose not to be video-taped to sit at computer terminals on one side of the classroom that is outside the range of the video camera. The researcher will make hand-written notes during classroom observations, and will not participate nor interrupt your normal class activities.
4. At the end of the observations, the researcher will request your help to forward an e-mail to students asking for volunteers to participate in an interview about their perceptions of instructor scaffolding strategies.
5. The researcher will also contact and schedule an interview with you at a time and place at your convenience. During the interview, selected video-clips from classroom observations will be used as stimulated recall materials. The interview should take at most an hour. A transcript of the interview will be sent to you via e-mail for verification after the interview. No audio recording, video recording or film will be used during the interviews.
6. Samples of class projects and assignments related to the sessions observed will be collected from you for analysis. Only aggregate data about the instructors' grading rubrics and class-wide performance distribution will be analyzed to determine the effectiveness of the instructors' support strategies. No individual grades or names will be reported.

**RISKS**

No foreseeable risks or discomforts are expected for participants of the study.

Subject's initials ____

Page 1 of 2

**BENEFITS**

Your participation in this study may benefit the development of effective scaffolding strategies for pre-service teacher technology courses.

**CONFIDENTIALITY**

Your identity will be kept confidential in the report. Quotations will be made using your responses to the interview questions, but these will be reported using codes assigned to interview subjects. Names will be recorded with the data but will not be used in the report. However, confidentiality of data received via e-mail is not guaranteed. Identifiable data collected will be destroyed by December 2008.

**CONTACT**

If you have questions at any time about the study or the procedures, you may contact the researcher, Joyce Koh, at 1750 N. Range Road, K302, Bloomington, IN 47408, 812-339-4439, and joykoh@indiana.edu.

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the office for the Indiana University Bloomington Human Subjects Committee, Carmichael Center L03, 530 E. Kirkwood Ave., Bloomington, IN 47408, 812/855-3067, or by e-mail at iub_hsc@indiana.edu.

**PARTICIPATION**

Your participation in this study is voluntary; you may refuse to participate without penalty. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed your data will be returned to you or destroyed.

**CONSENT**

I have read this form and received a copy of it. I have had all my questions answered to my satisfaction. I agree to be video-recorded during classroom observations, and for the video-recording to be used as part of the instructor's portfolio or for further research after this study is completed.

Subject's printed name: ______________________________

Subject's signature__________________________________

Date _______________

Consent form date: 12 February 2007

IRB Approved
Approval Date: FEB 1 2 2007
Expires: DEC 3 1 2008

Page 2 of 2

Study # 07-11679

INDIANA UNIVERSITY – BLOOMINGTON
INFORMED CONSENT STATEMENT - STUDENTS
Scaffolding Models in Preservice Teacher Technology Courses

You are invited to participate in a research study. The purpose of this study is to compare models of instructional support (or scaffolding) that instructors use in pre-service teacher technology courses, and to determine how different scaffolding models affect pre-service teachers' self-efficacy or confidence in learning technology skills, performance in technology courses, and confidence for integrating technology.

**INFORMATION**

This study will be conducted with the instructor and students in three to five introductory technology classes for pre-service teachers. These activities will be carried out:

1. The researcher will provide you with Consent Forms to be signed and returned to the researcher for your agreement to participate in video-taping during classroom observations, and for the video-tape to be used by your instructor as part of his/her teaching portfolio and for future research. Only students with a signed consent form will be video-recorded.
2. The researcher will ask you to complete and return a survey to provide information about your perceived self-efficacy for using technology software and technology integration. This is expected to take about 15 minutes. The survey will be given out at the end of the class session, and collected at the end of the next class session. Participation is voluntary.
3. Selected sessions conducted in the computer lab will be video-recorded. Focus will be on the instructor's teaching methods, and how instructional support is being provided. Students who choose not to participate in the video-taping will be requested to sit at computer terminals on one side of the classroom that is outside the range of the video camera. The researcher will also make hand-written notes during classroom observations, and will not participate nor interrupt your normal class activities.
4. Another survey will be administered at the end of the classroom observations. This will be administered in the same way as the first survey, as outlined in (2).
5. The researcher will ask your instructor to assist in sending out an e-mail asking for 3-5 volunteers to participate in an interview. If you express willingness to participate, the researcher will contact and schedule interviews with you. The interview will take at most an hour, and will be scheduled with you at a time and place at your convenience. If you are unable to meet face-to-face for the interview, written responses can be provided via e-mail, or the researcher will call you on the phone for the interview. A transcript of the interview will be sent to you via e-mail for verification after the interview. No audio tapes, videotapes or film will be used during the interviews.
6. Samples of class projects and assignments related to the sessions observed will be collected from the instructor for analysis. Only aggregate data about the instructors' grading rubrics and class-wide performance distribution will be analyzed to determine the effectiveness of the instructors' support strategies. No individual grades or names will be reported.

**RISKS**

No foreseeable risks or discomforts are expected for participants of the study.

Subject's initials _______

**BENEFITS**

Your participation in this study may benefit the development of effective scaffolding strategies for pre-service teacher technology courses.

**CONFIDENTIALITY**

Your identity will be kept confidential in the report. Quotations may be made using your responses to the interview questions, but these will be reported using codes assigned to interview subjects. Names will be recorded with the data but will not be used in the report. However, confidentiality of data received via e-mail is not guaranteed. In terms of survey information, only aggregate data will be reported. No individual names or information will be used. Identifiable data collected will be destroyed by December 2008.

**CONTACT**

If you have questions at any time about the study or the procedures, you may contact the researcher, Joyce Koh, at 1750 N. Range Road, K302, Bloomington, IN 47408, 812-339-4439, and joykoh@indiana.edu.

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the office for the Indiana University Bloomington Human Subjects Committee, Carmichael Center L03, 530 E. Kirkwood Ave., Bloomington, IN 47408, 812/855-3067, or by e-mail at iub_hsc@indiana.edu.

**PARTICIPATION**

Your participation in this study is voluntary; you may refuse to participate without penalty. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed your data will be returned to you or destroyed.

**CONSENT**

I have read this form and received a copy of it. I have had all my questions answered to my satisfaction. I agree to be video-recorded during classroom observations, and for the video-recording to be used as part of the instructor's portfolio or for further research after this study is completed.

Subject's printed name: ________________________________

Subject's signature____________________________________ Date ________________

Consent form date: 12 February 2007



IRB Approved
Approval Date: FEB 1 2 2007
Expires: DEC 3 1 2008

## Appendix B - Survey of Student Technology Profile (Pre-Observation)

Your Name: ______________________________

*Circle the appropriate answer or fill in the blank for the following questions:*

1. Year in School : Freshman Sophomore Junior Senior
2. Gender: Female Male
3. Age:___________________________
4. Major: __________________________
5. List the college-level computer-related courses have you completed
6. What are the three activities that you most frequently engage in when using the computer?
7. Which of the following computer packages can you use without much difficulty? Check all that apply:

    1. Wordprocessing packages (e.g. Word)
    2. Spreadsheets (e.g. Excel)
    3. Presentation software (e.g. Powerpoint)
    4. Graphical software (e.g. Adobe Photoshop)
    5. Multimedia software (e.g. Flash)
    6. Webpage development software (e.g. Dreamweaver)

8. How would you describe your general level of confidence with using computers?

| | | | | |
|---|---|---|---|---|
| No confidence at all | Very little confidence | Moderate confidence | Quite a lot of confidence | Very confident |

| 9. **I feel confident that I could…** **(check the rating that applies)** | **Strongly disagree** | **Disagree** | **Mildly disagree** | **Mildly agree** | **Agree** | **Strongly agree** |
|---|---|---|---|---|---|---|
| a. Send e-mail to a friend. | | | | | | |
| b. Send an Instant Message. | | | | | | |
| c. Subscribe to a discussion list. | | | | | | |
| d. Create a "nickname" or an "alias" to send e-mail to several people at once. | | | | | | |
| e. Send a document as an attachment to an e-mail message. | | | | | | |
| f. Keep copies of outgoing messages that I send to others. | | | | | | |
| g. Use an Internet search engine to find Web pages related to my subject matter interests. | | | | | | |
| h. Search for and find the Smithsonian Institution website. | | | | | | |
| i. Create my own World Wide Web home page. | | | | | | |
| j. Keep track of websites I have visited using bookmarks so that I can return to them later. | | | | | | |
| k. Find primary sources of information on the Internet that I can use in my teaching. | | | | | | |
| l. Use spreadsheet to create a pie chart of the proportions of the different colors of M&Ms in a bag. | | | | | | |
| m. Create a newsletter with graphics and text in 3 columns. | | | | | | |
| n. Save documents in formats so that others can read them if they have different word processing programs | | | | | | |
| o. Use the computer to create a slideshow presentation | | | | | | |
| p. Create a database of information about important authors in a subject matter field | | | | | | |
| q. Describe how I would use technology in my classroom | | | | | | |
| r. Create a lesson or unit that fully integrates technology into the methodology. | | | | | | |

| 9. **I feel confident that I could…** **(check the rating that applies)** | **Strongly disagree** | **Disagree** | **Mildly disagree** | **Mildly agree** | **Agree** | **Strongly agree** |
|---|---|---|---|---|---|---|
| s. Use technology to collaborate with students, teachers, or other interns who are distant from my classroom. | | | | | | |
| t. Describe 5 software programs that I would use in my teaching | | | | | | |

~ end of survey~

**Appendix C - Survey of Student Technology Profile (Post-Observation)**

Your Name: ______________________________

*Circle the appropriate answer or fill in the blank for the following questions:*

1. Which of the following computer packages or tasks do you consider yourself to be proficient with? Check all that apply:
   7. Wordprocessing packages (e.g. Word)
   8. Spreadsheets (e.g. Excel)
   9. Presentation software (e.g. Powerpoint)
   10. Graphical software (e.g. Adobe Photoshop)
   11. Multimedia software (e.g. Flash)
   12. Webpage development software (e.g. Dreamweaver)

2. How would you describe your general level of confidence with using computers?

| No confidence at all | Very little confidence | Moderate confidence | Quite a lot of confidence | Very confident |
|---|---|---|---|---|

| 3. **I feel confident that I could… (check the rating that applies)** | **Strongly disagree** | **Disagree** | **Mildly disagree** | **Mildly agree** | **Agree** | **Strongly agree** |
|---|---|---|---|---|---|---|
| a. Send e-mail to a friend. | | | | | | |
| b. Send an Instant Message. | | | | | | |
| c. Subscribe to a discussion list. | | | | | | |
| d. Create a "nickname" or an "alias" to send e-mail to several people at once. | | | | | | |
| e. Send a document as an attachment to an e-mail message. | | | | | | |
| f. Keep copies of outgoing messages that I send to others. | | | | | | |
| g. Use an Internet search engine to find Web pages related to my subject matter interests. | | | | | | |
| h. Search for and find the Smithsonian Institution website. | | | | | | |
| i. Create my own World Wide Web home page. | | | | | | |
| j. Keep track of websites I have visited using bookmarks so that I can return to them later. | | | | | | |

| 3. **I feel confident that I could…** **(check the rating that applies)** | **Strongly disagree** | **Disagree** | **Mildly disagree** | **Mildly agree** | **Agree** | **Strongly agree** |
|---|---|---|---|---|---|---|
| k. Find primary sources of information on the Internet that I can use in my teaching. | | | | | | |
| l. Use spreadsheet to create a pie chart of the proportions of the different colors of M&Ms in a bag. | | | | | | |
| m. Create a newsletter with graphics and text in 3 columns. | | | | | | |
| n. Save documents in formats so that others can read them if they have different word processing programs | | | | | | |
| o. Use the computer to create a slideshow presentation | | | | | | |
| p. Create a database of information about important authors in a subject matter field | | | | | | |
| q. Describe how I would use technology in my classroom | | | | | | |
| r. Create a lesson or unit that fully integrates technology into the methodology. | | | | | | |
| s. Use technology to collaborate with students, teachers, or other interns who are distant from my classroom. | | | | | | |
| t. Describe 5 software programs that I would use in my teaching | | | | | | |

4. What did the instructor do, or have you do that was most and least useful for raising your confidence for using technology?

   Most useful

   Least useful

~ end of survey~

**Appendix D - Interview Questions**

Interview questions for instructors

1. Briefly describe your teaching experience.
2. What do you understand by the term scaffolding?
3. How would you describe the technology proficiency and performance of the class you are currently teaching?
4. In your experiences as a instructor of the course, what do think are the most effective ways of scaffolding?
5. With respect to this video segment of your teaching, can you describe your scaffolding strategy? What did you think worked or didn't work in this case?
6. What factors might affect how you scaffold?
7. To what extent do students consult you outside class e.g. via e-mail or during help hours? What type of support did they seek?

Interview questions for students

1. How would you describe your confidence and proficiency with using computers before and after you've attended the course?
2. Review your experiences in the Microsoft Word classes. Describe some examples of experiences that raised your confidence for using Word.
3. Review your experiences in the Microsoft Excel classes. Describe some examples of experiences that raised your confidence for using Word.
4. What were some experiences that did not help with improving your confidence or proficiency for using the software?
5. How did you work on the assignments and projects outside class? What type of resources or help did you get?
6. Share some ideas about how you might use technology when you are teaching in the future.

**Appendix E - Web Survey**

**Survey of Student Technology Profile**

*Check the appropriate answer or fill in the blank for the following questions:*

1. Year in School : ☐ Freshman ☐ Sophomore ☐ Junior ☐ Senior

2. Gender: ☐ Female ☐ Male

3. Age: ____________

4. Major: ____________________

5. List the college-level computer-related courses have you completed

6. What are the three activities that you most frequently engage in when using the computer?

7. Which of the following computer packages can you use without much difficulty? Check all that apply:

- [ ] Wordprocessing packages (e.g. Word)
- [ ] Spreadsheets (e.g. Excel)
- [ ] Presentation software (e.g. Powerpoint)
- [ ] Graphical software (e.g. Adobe Photoshop)
- [ ] Multimedia software (e.g. Flash)
- [ ] Webpage development software (e.g. NVU, Dreamweaver)

8. How would you describe your general level of confidence with using computers?

| ○ | ○ | ○ | ○ | ○ |
|---|---|---|---|---|
| No confidence at all | Very little confidence | Moderate confidence | Quite a lot of confidence | Very confident |

| **9. I feel confident that I could ...(check the rating that applies)** | | | | | | |
|---|---|---|---|---|---|---|
| a. Send e-mail to a friend. | Strongly disagree ○ | Disagree ○ | Mildly disagree ○ | Mildly agree ○ | Agree ○ | Strongly agree ○ |
| b. Send an Instant Message. | Strongly disagree ○ | Disagree ○ | Mildly disagree ○ | Mildly agree ○ | Agree ○ | Strongly agree ○ |
| c. Subscribe to a discussion list. | Strongly disagree ○ | Disagree ○ | Mildly disagree ○ | Mildly agree ○ | Agree ○ | Strongly agree ○ |

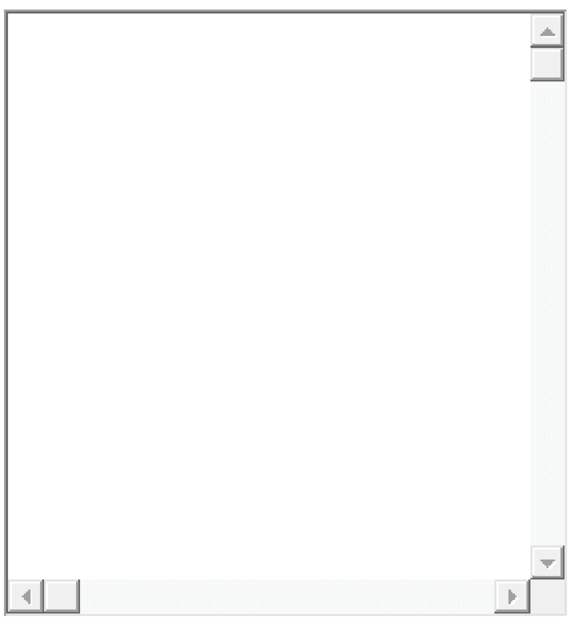
| | | | | | | |
|---|---|---|---|---|---|---|
| d. Create a "nickname" or an "alias" to send e-mail to several people at once. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| e. Send a document as an attachment to an e-mail message. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| f. Keep copies of outgoing messages that I send to others. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| g. Use an Internet search engine to find Web pages related to my subject matter interests. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| h. Search for and find the Smithsonian Institution website. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| i. Create my own World Wide Web home page. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| j. Keep track of websites I have visited using bookmarks so that I can return to them later. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| k. Find primary sources of information on the Internet that I can use in my teaching. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |

| | | | | | |
|---|---|---|---|---|---|
| l. Use spreadsheet to create a pie chart of the proportions of the different colors of M&Ms in a bag. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| m. Create a newsletter with graphics and text in 3 columns. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| n. Save documents in formats so that others can read them if they have different word processing programs | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| o. Use the computer to create a slideshow presentation | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| p. Create a database of information about important authors in a subject matter field | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| q. Describe how I would use technology in my classroom | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| r. Create a lesson or unit that fully integrates technology into the methodology. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |

| | | | | | | |
|---|---|---|---|---|---|---|
| s. Use technology to collaborate with students, teachers, or other interns who are distant from my classroom. | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |
| t. Describe 5 software programs that I would use in my teaching | Strongly disagree | Disagree | Mildly disagree | Mildly agree | Agree | Strongly agree |

10. What did your instructor do, or have you do that was most and least useful for raising your confidence for using technology?

a) Most useful



b) Least useful

11. Were there any questions that you had problems with in this survey? Please list the question number and the problem you faced.

Submit Answers

## Appendix F - Video Coding Protocol

Category 1 - Instructional activity

a) Lecture -Instructor provides content information to the class or uses question-and-answer format to present content information to the class
b) Demonstrations –Instructor shows software procedures to the class using the teacher computer terminal
c) Instructor-led discussions - Class-wide discussion of student opinions about technology issues where the instructor is the facilitator.
d) Group discussions – Students got together to discuss assigned in-class activities or their opinions about technology issues. Students were facilitating the discussion themselves.
e) Lab – Students worked independently on their projects.
f) In-class Activities – Students worked individually or in groups on an exercise assigned by the instructor.

Category 2 - Equipment

a) Teacher computer terminal
b) Student computer terminal
c) Whiteboard

Category 3 - Resources

a) Presentation slides
b) Self-paced tutorials for software programs
c) Students' own class notes
d) Supplementary notes and work materials
e) Project samples
f) Course schedule
g) Project/Assignment descriptions
h) Written assignment feedback

Category 4 – Student/Scaffoldee interactions

a) Can't hear – when you can't hear what the teacher or student is saying.
b) Provide content information – respond to teachers' content questions or share knowledge with peers
c) Share project ideas (eg I want to make a game for 3rd graders that ….)
d) Validate task performance - ask teacher to check if they are doing tasks correctly, check why they lost points
e) Request help with technology –when students are working with a software and they are having problems with some functions eg the file is not showing up – it's not letting me change fonts, I can't download the files.

f) Request help with artifact design –when students do not know a specific software function for making a design they have in mind eg how do I make this arrow bigger? I want to make the arrows look brighter here
g) Clarify content - ask to repeat instructions for a technology procedure or ask questions to clarify a concept during lecture. Can also be used when the teacher is explaining something during 1-1 help and the student asks a question to check if they've understood what the teacher has explained.
h) Clarify task requirements – ask to clarify specifications for task performance e.g. Must we use the same font for this project? Can we use articles that are older than 2001? How different must our website be from what you demonstrated? What does this word mean in the self-paced tutorial?

Category 5 – Instructor/ Scaffolder interactions

a) Can't hear – when you can't hear what the teacher or student is saying.
b) Show and Tell (to present learning content, task expectations , or demonstrate technology procedures)
    i) Lecture and demonstration of correct task performance or present basic content related to a concept
    ii) Explain work instructions or project requirements required for correct task performance eg task specifications, when it is due, how long more students should take on an in-class assignment
    iii) Teacher uses examples/personal experiences to illustrate correct task performance or project requirements during lecture
    iv) Teacher uses advanced organizers, examples or questions to introduce and warm up students to the contents to be covered
    v) When asked a technology problem, teacher tells students the correct steps for solving a technology problem
    vi) Teacher explain the problem students had with the software/concept after troubleshooting – this is not working because you did not click A
    vii) Teacher uses the mouse and demonstrates how a technology problem can be fixed
    viii) Teacher writes key points or work instructions on the whiteboard
    ix) Teacher uses student responses to further explain important content or correct misconceptions during lecture eg defer a question to point to something more critical, or affirm the correctness of the answer and add on to it.
    x) Teacher reiterates important contents/procedures from lecture in response to the problem students faced
    xi) Teacher shares examples of potential problems that could happen and how to prevent them during lecture/demonstration e.g. I want you to look at what happens when I do this
c) Progress Checking (identify misconceptions, or obstacles that hinder students from successful independent task performance)

i) Teacher pauses and invites questions or clarifications from students during lecture/demonstrations eg Do you understand? Any questions at this point?
ii) Teacher asks content questions to check understanding of lecture contents/software functions– eg what key do we use to size pictures proportionally?
iii) Teacher asks questions during one-to-one help to understand problems students are face e.g. did you send the picture to the back? What settings did you do here?
iv) Teacher asks questions to check on students' task progress during one-to-one help e.g. what's the topic of your game? How many players will play this game? Will you roll a dice to take turns?
v) Teacher listens to group discussions or observe students' computer terminal silently

d) Direction maintenance (motivate and advice students to focus and persist on an instructional task)
i) Teacher reminds students to focus attention on their work e.g. We need to focus here, are you chatting or doing your work? Take 5 minutes more for this, Watch me for this
ii) Teacher uses cues to have students stop work and pay attention to him/her when transitioning between tasks e.g. whistle
iii) Teacher praises good performance or successes when students are able to resolve problems independently
iv) Teacher validates correct interim task performance e.g. this looks good so far! Yes- this is the correct way, don't worry, this is not a problem
v) Teacher provides suggestions on what to do if students get stuck on an assignment– e.g raise your hands if you have problems, check the Help menu.
vi) Teacher provides interim feedback on student work to help them decide what they need to do to make it better e.g. this would only get you 5 points creativity. You'll want to add more features
vii) Teacher encourages students to try what they think might be correct when asked a question – Yes, you can try this and see
viii) Teacher asks students to refer to their notes for the correct steps for performing a technology procedure when asked a how to question
ix) After resolving part of the students' problems, teacher gives instructions on how they should proceed

e) Prompt and hint (highlight information needed to identify performance discrepancies, improve performance or ensure correct understanding of a concept)
i) Teacher asks leading questions or uses hints to lead into important aspects of content, or help students determine correct procedures for solving a problem or correct misconceptions
ii) After students contribute answers to a discussion, teacher asks "What else?" to have them think of more points

f) Invite scaffoldee opinions/suggestions

    i) Teacher asks students for suggestions on task specifications e.g. what color is the certificate? What do you want to make? An announcement or a certificate?

g) Frustration Control (help students prevent/manage errors before they occur when students are working on tasks independently)
    i) Teacher stops students' independent work and tells them their mistake even before they ask for help
    ii) Teacher reminds students to save files they are working on
    iii) Teacher reminds students to take notes about important points or procedures during lecture/demonstrations so that they can refer to it when they are working independently
    iv) Teacher reminds students about the schedules and deadlines for the task
    v) Teacher reminds students to check instructions to avoid losing points

h) Share New Perspectives (present new perspectives/methods to enlarge student understanding)
    i) Teacher provides alternative ways to carry out a technology procedure or task that could be more productive
    ii) Teacher provides suggestions on alternative ways for approaching a project or designing an artifact

## Appendix G - Raw Data for Figures

**Figure 1 - Student Demographics**

| 1a) Age | | | |
|---|---|---|---|
| | Section 1 | Section 2 | Section 3 |
| 18 - 20 | 9 | 2 | 12 |
| 21-23 | 4 | 1 | 2 |
| Above 24 | 2 | 2 | 1 |
| **Total** | **15** | **5** | **15** |

| 1b) Gender | | | |
|---|---|---|---|
| | Section 1 | Section 2 | Section 3 |
| Female | 9 | 1 | 11 |
| Male | 6 | 4 | 4 |
| **Total** | **15** | **5** | **15** |

| 1c) Year of Study | | | |
|---|---|---|---|
| | Section 1 | Section 2 | Section 3 |
| Freshman | 5 | 1 | 7 |
| Sophomore | 5 | 1 | 6 |
| Junior | 3 | 0 | 0 |
| Senior | 1 | 3 | 2 |
| Graduate | 1 | 0 | 0 |
| **Total** | **15** | **5** | **15** |

| 1d) Major | | | |
|---|---|---|---|
| | Section 1 | Section 2 | Section 3 |
| Art/Visual Arts Education | 4 | 0 | 5 |
| Early Childhood Education | 2 | 0 | 3 |
| Elementary Education | 1 | 0 | 0 |
| Music Education | 5 | 1 | 0 |
| Secondary Education | 0 | 1 | 2 |
| General Studies | 2 | 2 | 0 |
| **Total** | **14** | **4** | **10** |

**Figure 2 - Subject Computer Experience**

2a) College-level computer courses taken

| | Section 1 | Section 2 | Section 3 |
|---|---|---|---|
| None | 9 | 4 | 11 |
| W201/A110 | 4 | 1 | 2 |
| Others | 2 | 0 | 2 |
| **Total** | **15** | **5** | **15** |

2b) Activity most often used computer for

| | Section 1 | Section 2 | Section 3 |
|---|---|---|---|
| Email | 9 | 10 | 3 |
| Instant Messaging | 5 | 2 | 8 |
| Facebook.com/Myspace | 3 | 4 | 1 |
| Internet research/ Surfing | 6 | 8 | 7 |
| Oncourse | 1 | 1 | 1 |
| Write papers with Word | 3 | 6 | 6 |
| Movies, music & games | 2 | 0 | 3 |
| Music composition, graphic design & website dvt | 0 | 1 | 1 |
| Other microsoft applications eg powerpoint & spreadsheets | 1 | 6 | |
| **Total** | **30** | **38** | **30** |

**Figure 3 - Subject Perceived software proficiency**

3a) Feel confident about using software (Pre-Observation)

| | Section 1 | Section 2 | Section 3 |
|---|---|---|---|
| Wordprocessing software | 15 | 4 | 15 |
| Presentation software | 12 | 2 | 11 |
| Spreadsheet software | 9 | 3 | 10 |
| Multimedia software | 4 | 1 | 3 |
| Graphical software | 8 | 1 | 6 |
| Webpage development software | 1 | 1 | 3 |
| **Total** | **15** | **5** | **15** |

3b) Do not feel confident about using software (Pre-Observation)

| | Section 1 | Section 2 | Section 3 |
|---|---|---|---|
| Wordprocessing software | 0 | 1 | 0 |
| Presentation software | 3 | 3 | 4 |
| Spreadsheet software | 6 | 2 | 5 |
| Multimedia software | 11 | 4 | 12 |
| Graphical software | 7 | 4 | 9 |
| Webpage development software | 14 | 4 | 12 |
| **Total** | **15** | **5** | **15** |

| Figure 4 - Pre-Observation GSE | | | |
|---|---|---|---|
| | Section 1 | Section 2 | Section 3 |
| "1" -No confidence at all | 0 | 0 | 1 |
| "2" - Very little confidence | 1 | 0 | 3 |
| "3" -Moderate confidence | 5 | 5 | 5 |
| "4" -Quite a lot of confidence | 9 | 0 | 5 |
| "5" - Very confident | 0 | 0 | 1 |
| **Total** | **15** | **5** | **15** |

| Figure 6 - Scaffolded vs Teacher-Directed Instruction (by instructional time) | | | |
|---|---|---|---|
| | Section 1 | Section 2 | Section 3 |
| Scaffolded | 342 | 336 | 342 |
| Teacher-Directed | 429 | 163 | 183 |
| **Total minutes** | **771** | **499** | **525** |

**Figure 8 - Comparison of instructional method by content**

| 8a) Instructional methods used for PowerPoint | | | |
|---|---|---|---|
| | Inst 1 | Inst 2 | Inst 3 |
| Scaffolded | 146 | 183 | 199 |
| Teacher-directed | 183 | 18 | 26 |
| **Total minutes** | **329** | **201** | **225** |

| 8b) Instructional methods used for Web Development | | | |
|---|---|---|---|
| | Inst 1 | Inst 2 | Inst 3 |
| Scaffolded | 196 | 153 | 143 |
| Teacher-directed | 246 | 145 | 157 |
| **Total minutes** | **442** | **298** | **300** |

| Figure 9 - Types of Instructor Interactions Used During Scaffolded Instruction | | | |
|---|---|---|---|
| | *IF Instructor = ?* | | |
| *THEN Inst Interaction =?* | Inst 1 | Inst 2 | Inst 3 |
| Can't hear | 2 | 1 | 10 |
| Show n Tell | 121 | 132 | 88 |
| Progress Checking | 175 | 175 | 49 |
| Direction Maintenance | 95 | 58 | 47 |
| Prompt & hint | 5 | 23 | 1 |
| Reduce task scope | 0 | 0 | 0 |
| Frustration control | 12 | 19 | 12 |
| Share New Perspectives | 21 | 6 | 7 |
| Invite suggestions | 1 | 0 | 0 |
| **Total occurrences** | **432** | **414** | **214** |

| Figure 10 - Types of Instructor Interactions Used During Teacher-Directed Instruction | | | |
|---|---|---|---|
| | *IF Instructor = ?* | | |
| *THEN Inst Interaction =?* | Inst 1 | Inst 2 | Inst 3 |
| Can't hear | 0 | 0 | 0 |
| Show n Tell | 584 | 188 | 116 |
| Progress Checking | 205 | 118 | 22 |
| Direction Maintenance | 107 | 41 | 45 |
| Prompt & hint | 187 | 55 | 83 |
| Reduce task scope | 0 | 0 | 0 |
| Frustration control | 26 | 9 | 11 |
| Share New Perspectives | 8 | 0 | 1 |
| Invite suggestions | 21 | 3 | 0 |
| **Total occurrences** | **1,138** | **414** | **278** |

| **Figure 11 - Types of Student Interactions Used During Scaffolded Instruction** | | | |
|---|---|---|---|
| | *IF Instructor = ?* | | |
| *THEN Student Interaction =?* | Inst 1 | Inst 2 | Inst 3 |
| Can't hear | 5 | 8 | 16 |
| Share content | 16 | 52 | 6 |
| share project | 82 | 10 | 5 |
| Tech help | 44 | 39 | 52 |
| Design help | 3 | 1 | 1 |
| Clarify content | 8 | 10 | 9 |
| Clarify task | 20 | 29 | 19 |
| Validate perf | 6 | 16 | 6 |
| **Total occurrences** | **184** | **165** | **114** |

| **Figure 12 - Comparison of Instructor and Student Interaction By Instructional Method** | | | | | | | |
|---|---|---|---|---|---|---|---|
| 12 a) Scaffolded Instruction | | | | 12b) Teacher-Directed Instruction | | | |
| | Sect 1 | Sect 2 | Sect 3 | | Sect 1 | Sect 2 | Sect 3 |
| Instructor interactions | 432 | 414 | 214 | Instructor interactions | 1,138 | 414 | 278 |
| Student interactions | 184 | 165 | 114 | Student interactions | 347 | 98 | 125 |
| **Total occurrences** | **616** | **579** | **328** | **Total occurrences** | **1,485** | **512** | **403** |

| **Figure 13 - Types of Student Interactions Occurring During Teacher-Directed Instruction** | | | |
|---|---|---|---|
| | *IF Section =?* | | |
| *THEN Student Interaction =?* | Sect 1 | Sect 2 | Sect 3 |
| Can't hear | 3 | 1 | 0 |
| Share content | 236 | 63 | 105 |
| share project | 3 | 1 | 0 |
| Tech help | 48 | 13 | 6 |
| Design help | 2 | 0 | 1 |
| Clarify content | 14 | 10 | 8 |
| Clarify task | 41 | 8 | 4 |
| Validate perf | 0 | 2 | 1 |
| **Total occurrences** | **347** | **98** | **125** |

| Figure 14 - Types of Resources Used by Instructors | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14a) Use of Resources (Scaffolded Instruction) | | | | 14b) Use of Resources (Teacher-Directed Instruction) | | | |
| | *IF Section =?* | | | | *IF Section =?* | | |
| *THEN Resources =* | Sect 1 | Sect 2 | Sect 3 | *THEN Resources =* | Sect 1 | Sect 2 | Sect 3 |
| Presentation slides | 0 | 0 | 0 | Presentation slides | 138 | 34 | 142 |
| Self-paced Tutorials | 0 | 215 | 26 | Self-paced Tutorials | 0 | 25 | 0 |
| Students' own class notes | 1 | 0 | 10 | Students' own class notes | 5 | 0 | 0 |
| Supplementary notes & Resources | 197 | 25 | 3 | Supplementary notes & Resources | 1,026 | 209 | 80 |
| Project Samples | 0 | 76 | 0 | Project Samples | 10 | 52 | 0 |
| Course Schedule | 0 | 0 | 0 | Course Schedule | 4 | 0 | 0 |
| Project/Assignment descriptions | 22 | 25 | 0 | Project/Assignment descriptions | 21 | 31 | 0 |
| Used No Resources | 397 | 238 | 289 | Used No Resources | 281 | 161 | 181 |
| **Total occurrences** | **617** | **579** | **328** | **Total occurrences** | **1,485** | **512** | **403** |

| Figure 15 - Use of Equipment | | | | | | | |
|---|---|---|---|---|---|---|---|
| 15a) Use of Equipment (Scaffolded Instruction) | | | | 15b) Use of Equipment (Teacher-Directed Instruction) | | | |
| | *IF Section =?* | | | | *IF Section =?* | | |
| *THEN Equipment =* | Sect 1 | Sect 2 | Sect 3 | *THEN Equipment =* | Sect 1 | Sect 2 | Sect 3 |
| Teacher computer terminal | 49 | 4 | 6 | Teacher computer terminal | 918 | 168 | 245 |
| Student computer terminal | 566 | 541 | 322 | Student computer terminal | 393 | 141 | 39 |
| Whiteboard | 2 | 4 | 0 | Whiteboard | 158 | 147 | 0 |
| Used No Equipment | 0 | 30 | 0 | Used No Equipment | 16 | 56 | 119 |
| **Total occurrences** | **617** | **579** | **328** | **Total occurrences** | **1,485** | **512** | **403** |

| **Figure 16- Relationship Between Perceived Software Proficiency And Pre-Observation GSE** | | | |
|---|---|---|---|
| *THEN Perceived Software Proficiency =* | *IF Pre-Obs GSE = ?* | | |
| | Low GSE | Moderate GSE | High GSE |
| One software | 3 | 2 | 0 |
| Two software | 1 | 2 | 2 |
| Three Software | 1 | 9 | 3 |
| Four Software | 0 | 1 | 7 |
| Five software | 0 | 0 | 1 |
| Six software | 0 | 1 | 2 |
| **Total students** | **5** | **15** | **15** |

| **Figure 17 - Section 1 Instructor Interactions By Pre-Observation GSE During Scaffolded Instruction (Powerpoint)** | | | |
|---|---|---|---|
| | *IF Pre-Obs GSE=* | | |
| *THEN Inst. Interactions =* | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE |
| Can't hear | 0 | 0 | 0 |
| Show n Tell | 3 | 8 | 14 |
| Progress Checking | 3 | 19 | 39 |
| Direction Maintenance | 3 | 10 | 18 |
| Prompt & hint | 0 | 0 | 1 |
| Frustration control | 0 | 1 | 2 |
| Share New Perspectives | 0 | 1 | 6 |
| Invite suggestions | 0 | 0 | 0 |
| **Total occurrences** | **9** | **39** | **80** |

| **Figure 18 - Section 1 Student Interactions By Pre-Observation GSE During Scaffolded Instruction (Powerpoint)** | | | |
|---|---|---|---|
| | *IF Pre-Obs GSE=* | | |
| *THEN Student Interactions =* | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE |
| Can't hear | 0 | 0 | 0 |
| Share content | 0 | 1 | 4 |
| Share project | 2 | 7 | 12 |
| Tech help | 0 | 4 | 4 |
| Design help | 0 | 0 | 0 |
| Clarify content | 0 | 0 | 0 |
| Clarify task | 2 | 4 | 7 |
| Validate perf | 0 | 0 | 2 |
| **Total occurrences** | **4** | **16** | **29** |

**Figure 19 - Section 3 Instructor Interactions By Pre-Observation GSE During Scaffolded Instruction (Powerpoint)**

| | *IF Pre-Obs GSE=* | | |
|---|---|---|---|
| *THEN Inst. Interactions =* | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE |
| Can't hear | 1 | 4 | 0 |
| Show n Tell | 5 | 12 | 10 |
| Progress Checking | 3 | 6 | 7 |
| Direction Maintenance | 3 | 11 | 10 |
| Prompt & hint | 0 | 0 | 1 |
| Frustration control | 0 | 0 | 0 |
| Share New Perspectives | 0 | 0 | 0 |
| Invite suggestions | 0 | 0 | 0 |
| **Total occurrences** | **12** | **33** | **28** |

**Figure 20 - Section 3 Student Interactions By Pre-Observation GSE During Scaffolded Instruction (Powerpoint)**

| | *IF Pre-Obs GSE=* | | |
|---|---|---|---|
| *THEN Student Interactions =* | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE |
| Can't hear | 2 | 6 | 1 |
| Share content | 0 | 0 | 2 |
| Share project | 0 | 1 | 0 |
| Tech help | 4 | 7 | 5 |
| Design help | 0 | 0 | 0 |
| Clarify content | 0 | 1 | 1 |
| Clarify task | 4 | 8 | 2 |
| Validate perf | 0 | 0 | 1 |
| **Total occurrences** | **10** | **23** | **12** |

**Figure 21 - Section 1 Instructor Interactions By Pre-Observation GSE During Scaffolded Instruction (Web Development)**

| | *IF Pre-Obs GSE=* | | |
|---|---|---|---|
| *THEN Inst. Interactions =* | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE |
| Can't hear | 0 | 1 | 1 |
| Show n Tell | 0 | 44 | 34 |
| Progress Checking | 3 | 37 | 60 |
| Direction Maintenance | 2 | 26 | 29 |
| Prompt & hint | 0 | 1 | 0 |
| Frustration control | 0 | 4 | 2 |
| Share New Perspectives | 1 | 3 | 10 |
| Invite suggestions | 0 | 0 | 0 |
| **Total occurrences** | **6** | **116** | **136** |

**Figure 22 - Section 1 Student Interactions By Pre-Observation GSE During Scaffolded Instruction (Web Development)**

| | *IF Pre-Obs GSE=* | | |
|---|---|---|---|
| *THEN Student Interactions =* | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE |
| Can't hear | 0 | 4 | 1 |
| Share content | 0 | 4 | 6 |
| Share project | 2 | 19 | 38 |
| Tech help | 0 | 23 | 13 |
| Design help | 0 | 0 | 3 |
| Clarify content | 0 | 5 | 3 |
| Clarify task | 0 | 3 | 4 |
| Validate perf | 0 | 3 | 1 |
| **Total occurrences** | **2** | **61** | **69** |

| **Figure 23 - Section 3 Instructor Interactions By Pre-Observation GSE During Scaffolded Instruction (Web Development)** | | | | **Figure 24 - Section 3 Student Interactions By Pre-Observation GSE During Scaffolded Instruction (Web Development)** | | | |
|---|---|---|---|---|---|---|---|
| | *IF Pre-Obs GSE=* | | | | *IF Pre-Obs GSE=* | | |
| *THEN Inst. Interactions =* | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE | *THEN Student Interactions =* | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE |
| Can't hear | 0 | 2 | 2 | Can't hear | 0 | 4 | 0 |
| Show n Tell | 8 | 21 | 10 | Share content | 1 | 2 | 1 |
| Progress Checking | 2 | 6 | 6 | Share project | 0 | 1 | 1 |
| Direction Maintenance | 2 | 8 | 2 | Tech help | 7 | 11 | 12 |
| Prompt & hint | 0 | 0 | 0 | Design help | 0 | 0 | 1 |
| Frustration control | 1 | 1 | 0 | Clarify content | 1 | 2 | 0 |
| Share New Perspectives | 0 | 3 | 3 | Clarify task | 2 | 2 | 0 |
| Invite suggestions | 0 | 0 | 0 | Validate perf | 0 | 3 | 1 |
| **Total occurrences** | **13** | **41** | **23** | **Total occurrences** | **11** | **25** | **16** |

| **Figure 25 - Comparison of Section 2 Instructor Interactions by lesson** | | | **Figure 26 - Comparison of Section 2 Student Interactions by lesson** | | |
|---|---|---|---|---|---|
| | IF Lesson = | | | IF Lesson = | |
| *THEN Inst. Interaction =* | PowerPoint | Web Devt | *THEN Student Interaction =* | PowerPoint | Web Devt |
| Can't hear | 0 | 0 | Can't hear | 5 | 3 |
| Show n Tell | 70 | 34 | Share content | 44 | 8 |
| Progress Checking | 73 | 57 | Share project | 0 | 10 |
| Direction Maintenance | 26 | 19 | Tech help | 27 | 12 |
| Prompt & hint | 14 | 9 | Design help | 0 | 1 |
| Frustration control | 8 | 4 | Clarify content | 6 | 4 |
| Share New Perspectives | 2 | 4 | Clarify task | 24 | 5 |
| Invite suggestions | 0 | 0 | Validate perf | 12 | 4 |
| **Total occurrences** | **193** | **127** | **Total occurrences** | **118** | **47** |

**Figure 27 - Change In TSE For Making A Slide Presentation By Student Pre-Observation TSE**

27a) Section 1

| | IF Pre-Obs TSE (PPT)= | | |
|---|---|---|---|
| *THEN change in TSE (PPT)=* | Low Pre-Obs TSE (PPT) | Moderate Pre-Obs TSE (PPT) | High Pre-Obs TSE (PPT) |
| -1 | 0 | 0 | 0 |
| No change | 0 | 1 | 0 |
| +1 | 0 | 0 | 1 |
| +2 or more | 1 | 2 | 0 |
| **Total students** | **1** | **3** | **10** |

27b) Section 2

| | *IF Pre-Obs TSE (PPT)=* | | |
|---|---|---|---|
| *THEN change in TSE (PPT)=* | Low Pre-Obs TSE (PPT) | Moderate Pre-Obs TSE (PPT) | High Pre-Obs TSE (PPT) |
| -1 | 0 | 0 | 0 |
| No change | 0 | 0 | 2 |
| +1 | 0 | 0 | 1 |
| +2 or more | 1 | 1 | 0 |
| **Total students** | **1** | **1** | **3** |

27c) Section 3

| | *IF Pre-Obs TSE (PPT)=* | | |
|---|---|---|---|
| *THEN change in TSE (PPT)=* | Low Pre-Obs TSE (PPT) | Moderate Pre-Obs TSE (PPT) | High Pre-Obs TSE (PPT) |
| -1 | 0 | 0 | 1 |
| No change | 0 | 0 | 7 |
| +1 | 1 | 0 | 1 |
| +2 or more | 1 | 1 | 0 |
| **Total students** | **2** | **1** | **9** |

**Figure 28 - Change In TSE For Making A Webpage By Student Pre-Observation TSE**

28a) Section 1

| | *IF Pre-Obs TSE (Web)=* | | |
|---|---|---|---|
| *THEN change in TSE (Web)=* | Low Pre-Obs TSE (Web) | Moderate Pre-Obs TSE (Web) | High Pre-Obs TSE (Web) |
| -1 | 0 | 0 | 1 |
| No change | 1 | 0 | 4 |
| +1 | 0 | 2 | 0 |
| +2 or more | 2 | 3 | 0 |
| **Total students** | **3** | **5** | **5** |

28b) Section 2

| | *IF Pre-Obs TSE (Web)=* | | |
|---|---|---|---|
| *THEN change in TSE (Web)=* | Low Pre-Obs TSE (Web) | Moderate Pre-Obs TSE (Web) | High Pre-Obs TSE (Web) |
| -1 | 0 | 0 | 0 |
| No change | 0 | 0 | 0 |
| +1 | 0 | 0 | 0 |
| +2 or more | 3 | 2 | 0 |
| **Total students** | **3** | **2** | **0** |

| 28c) Section 3 | | | |
|---|---|---|---|
| *THEN change in TSE (Web)=* | *IF Pre-Obs TSE (Web)=* | | |
| | Low Pre-Obs TSE (Web) | Moderate Pre-Obs TSE (Web) | High Pre-Obs TSE (Web) |
| -1 | 0 | 0 | 0 |
| No change | 0 | 0 | 2 |
| +1 | 0 | 1 | 3 |
| +2 or more | 3 | 3 | 0 |
| **Total students** | **3** | **4** | **5** |

**Figure 29 - Change In GSE By Student Pre-Observation GSE**

| 29a) Section 1 | | | | 29b) Section 2 | | | |
|---|---|---|---|---|---|---|---|
| *THEN change in GSE =* | *If Pre-Obs GSE =* | | | *THEN change in GSE =* | *If Pre-Obs GSE =* | | |
| | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE | | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE |
| -1 | 0 | 0 | 2 | -1 | 0 | 0 | 0 |
| No change | 1 | 5 | 2 | No change | 0 | 2 | 0 |
| +1 | 0 | 1 | 3 | +1 | 0 | 3 | 0 |
| +2 or more | 0 | 0 | 1 | +2 or more | 0 | 0 | 0 |
| **Total students** | **1** | **6** | **8** | **Total students** | **0** | **5** | **0** |

| 29c) Section 3 | | | |
|---|---|---|---|
| *THEN change in GSE =* | *If Pre-Obs GSE =* | | |
| | Low Pre-Obs GSE | Moderate Pre-Obs GSE | High Pre-Obs GSE |
| -1 | 0 | 0 | 0 |
| No change | 0 | 2 | 2 |
| +1 | 2 | 3 | 3 |
| +2 or more | 1 | 0 | 0 |
| **Total students** | **3** | **5** | **5** |

**Figure 30 - Change in Self-Efficacy for Technology Integration by student pre-observation self-efficacy**

30a) Section 1

| *THEN change in TSE (Tech Int) =* | *IF Pre-Obs SE (Tech Int)=* | | |
|---|---|---|---|
| | Low Pre-Obs TSE (Tech Int) | Moderate Pre-Obs TSE (Tech Int) | High Pre-Obs TSE (Tech Int) |
| 0 | 0 | 1 | 0 |
| 0 to <1 | 0 | 2 | 3 |
| 1 to <2 | 0 | 3 | 1 |
| 2 to <3 | 1 | 1 | 0 |
| **≥ 3** | **1** | **1** | **0** |
| **Total students** | **2** | **8** | **4** |

30b) Section 2

| *THEN change in TSE (Tech Int) =* | *IF Pre-Obs SE (Tech Int)=* | | |
|---|---|---|---|
| | Low Pre-Obs TSE (Tech Int) | Moderate Pre-Obs TSE (Tech Int) | High Pre-Obs TSE (Tech Int) |
| 0 | 0 | 0 | 0 |
| 0 to <1 | 0 | 1 | 1 |
| 1 to <2 | 1 | 1 | 0 |
| 2 to <3 | 0 | 1 | 0 |
| **≥ 3** | **0** | **0** | **0** |
| **Total students** | **1** | **3** | **1** |

30c) Section 3

| *THEN change in SE (Tech Int) =* | *IF Pre-Obs SE (Tech Int)=* | | |
|---|---|---|---|
| | Low Pre-Obs SE (Tech Int) | Moderate Pre-Obs SE (Tech Int) | High Pre-Obs SE (Tech Int) |
| 0 | 0 | 1 | 0 |
| 0 to <1 | 0 | 3 | 2 |
| 1 to <2 | 1 | 3 | 1 |
| 2 to <3 | 0 | 0 | 0 |
| ≥ 3 | 0 | 1 | 0 |
| **Total students** | **1** | **8** | **3** |

## Appendix H - Student responses to open-ended questions in post-observation survey about factors that were most and least useful for raising their confidence with using technology

| Pre-observation GSE | Section 1 | Section 2 | Section 3 |
|---|---|---|---|
| Low GSE | **Most useful**<br>Personal help & encouragement<br>1. Extra help, patience while teaching, making sure we understand | NA | **Most useful**<br>Personal help & encouragement<br>1. She taught me well at my own pace. She gave individual help, and actually cared. She was patient, and knew what she was talking about.<br>Software/Task Mastery<br>1. Word processing<br>2. I thought that some if not all the information we learned helped me because I did not know most of the programs used.<br><br>**Least useful**<br>1. Honestly, absolutely no complaints<br>2. I can't think of anything at this point. |

| Pre-observation GSE | Section 1 | Section 2 | Section 3 |
|---|---|---|---|
| Moderate GSE | **Most useful**<br>Software/Task Mastery<br>1. Teaching me more about excel<br>2. Webpage; making a webpage<br>3. Excel; making charts etc<br>Structured Teaching<br>1. Her instructions were always clear<br>2. Step by step with overhead<br>Resources<br>1. Having notes to pen and follow helped so much<br><br>Social interaction<br>1. The discussions made me really understand<br><br>**Least useful**<br>1. Spreadsheets were the least useful to me because I know now schools give you software for things like gradebooks<br>2. Word | **Most useful**<br>Structured Teaching<br>1. Step by step walk through of each specific piece of material. Provided very useful knowledge for each.<br>2. Teaching us thoroughly on how to use all of the programs in the class<br>Resources<br>1. Excel in class exercises were very thorough and easy to follow/execute<br>Personal help & encouragement<br>1. He was very patient when teaching and allowed students to learn freely without stress<br>2. He was willing to give personal attention to me until I understand. He was very patient and helpful and willing to work with me.<br>**Least useful**<br>1. Some areas were just difficult<br>2. None<br>3. Nothing comes to mind<br>4. Word Graphic tutorial was confusing to me in some points | **Most useful**<br>Software/Task Mastery<br>1. Taught programs that we will now know how to use to our advantage. She applied the programs well to the way we will be using them in the classroom.<br>2. Teaching how to use new programs and giving info about programs I already know of, but going into detail about it<br>3. Learning Excel, particularly learning to chart grades, seemed very helpful and applicable to my future as a teacher<br>Structured Teaching<br>1. She explained the exercises well and made sure that everyone understood what was to be done.<br>2. Went slow and made sure everyone stayed together<br>3. Went into detailed instruction.<br>Personal help & encouragement<br>1. Always helped. Attentive<br>**Least useful**<br>1. Just drawing on a art design thing, most of us know how they worked<br>2. The majority of the reading assignments<br>3. Most of the readings were not useful |

| Pre-observation GSE | Section 1 | Section 2 | Section 3 |
|---|---|---|---|
| High GSE | **Most useful**<br>Personal help & encouragement<br>1. She answered our questions with a more than sufficient answer<br>2. My instructor helped with so many things during the class including dreamweaver and word<br><br>Software/Task Mastery<br>1. Showed us how to perfect things<br>2. Practice web pages<br>3. Learning how to make a webpage was the most useful and the most fun<br>4. Web pages practice sites<br>5. Websites although hard<br>6. Not allow us to use short cuts or cheats when completing a task to ensure we understood the use of functions in some programs<br>Structured Teaching<br>1. Go through every lesson plan slowly<br>2. Reviewing over and over on how to use the different programs | NA | **Most useful**<br>Structured Teaching<br>1. The detailed step-by-step process was most helpful.<br>2. She would do demonstrations in class for use to better understand the assignment.<br>Personal help & encouragement<br>1. My teacher was very attentive to different learning speeds<br><br>Software/Task mastery<br>1. Assign assignments using many different software programs that increased my familiarity with the programs<br>2. Doing instead of just saying<br>3. I think working with Dreamweaver was an important skill to learn. The Internet is a huge part in our society today and its important to know how to create a webpage<br>Resources<br>1. The handouts and also the visual more than verbal means of teaching<br>**Least useful**<br>1. Everything seemed related and useful<br>2. I think she did an excellent job teaching us.<br>3. Some of the articles<br>4. Wordprocessing is so common that we didn't really learn anything but more likely improve our skills.<br>5. Webpage |

| Pre-observation GSE | Section 1 | Section 2 | Section 3 |
|---|---|---|---|
| | <u>Resources</u><br>1. Have printouts that you can read<br><br>**Least useful**<br>1. Slow instruction<br>2. Slow instruction made it difficult to stay focused.<br>3. Too many practice exercises. I was sometimes bored and disinterested with the amount of practice. So much homework<br>4. Sometimes the worksheets don't have all the answers<br>5. I don't feel that my confidence was ever lowered, but starting out with email seemed too easy. I wish we could've spent more time on more difficult things<br>6. Excel | | |

## Appendix I - Comparison of Project Requirements by Instructor

| **Excel Project** | Instructor 1 | Instructor 2 | Instructor 3 |
|---|---|---|---|
| Description | *Gradebook project*<br>Make a gradebook for at least 10 students and 5 different types of grades for each student. Compute total points, percentage, average grade for each student and make a comparison graph.<br>*Boardgame project*<br>Create a instructional boardgame with at least 20 high quality content questions for a specific topic. Game should be easy to play, have clear description of rules, a tutorial or help tips and a strong story metaphor | Given raw data of scores for an 8th Grade Examination for various subjects, to format the worksheet, and use formula/function to compute total, minimum, maximum, average and standard deviations for the exam results. Students to format the axes, titles and legends of three charts provided. | Create a gradebook with grades that two classes of 10th grade history students obtained for similar assignments and exams. Draw charts to compare the performance of these two classes. |
| Grading rubric | *Gradebook Project*<br>Technical Skills: 100%<br>*Boardgame Project*<br>Content: 35%<br>Instructional feasibility: 35%<br>Technical skills: 30% | Technical Skills: 100% | Technical Skills: 80%<br>Analysis and design of charts: 20% |
| **PowerPoint Project** | Instructor 1 | Instructor 2 | Instructor 3 |
| Description | *Awards & Signs*<br>Create two different types of documents from the following:<br>- An award certificate<br>- A sign to hang in the classroom<br>- An Announcement or<br>- A map or class diagram<br>*Instructional Lesson*<br>Create a lesson where part of it is taught by PowerPoint. Create a lesson plan and two different practice or evaluation materials to accompany your PowerPoint slide presentation. The practice materials may be note-taking sheets, handouts, tests, puzzles, etc. | Design a PowerPoint presentation that you can use to support your teaching. You can select a topic of your choice, mention the intended audience in the 'Notes' pane of the 1st slide. | Review 3 articles on technology integration in K-12 settings. Create a PowerPoint which summarizes arguments for and against integration and then take a personal position. |

| **PowerPoint Project (cont'd)** | Instructor 1 | Instructor 2 | Instructor 3 |
| --- | --- | --- | --- |
| Grading rubric | *Awards & Signs*<br>Technical skills: 60%<br>Contents: 40%<br>*Instructional Lesson*<br>Lesson Plan: 20%<br>PowerPoint design: 50%<br>Practice materials: 30% | Technical skills: 58.3%<br>Design: 41.7% | Content: 29.4%<br>Technical skills: 58.8%<br>Design: 11.8% |
| **Web Development** | Instructor 1 | Instructor 2 | Instructor 3 |
| Description | Create a web site for your personal or professional use. It must have at least 5 pages. You can choose from the following types of sites:<br>- An electronic portfolio web site to present your teaching work to potential employers<br>- A personal web site<br>- A classroom or team web site for a future school where you might work<br>- An instructional web site that contains content information, activities and a lesson plan on a certain topic. | Create a personal website with at least 4 pages. | Create a personal web site that has 3 pages: Introduction of yourself, Professional Page (resume), and a Personal Interests Page. |
| Grading rubric | Technical skills: 20%<br>Content: 40%<br>Design: 40% | Technical skills: 83.3%<br>Design: 16.7% | Technical Skills: 60%<br>Contents: 27.5%<br>Banner Design: 12.5% |

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# Joyce Koh Hwee Ling

## Objective

To be a faculty in the area of instructional systems technology, educational technology or learning science. My research interests are motivation, pre-service teacher technology education, simulation games, and the measurement of learning context.

## Education

**Doctor of Philosophy (Instructional Systems Technology)** **08/04 - 07/08**
**Indiana University, USA**

- Dissertation on "The use of scaffolding in introductory technology skills instruction for pre-service teachers" successfully defended on 28 April 2008. Currently doing edits.
- Member of SimTIE Research Group that studies how simulation games can be used in pre-service teacher education for improvement of technology integration in P-12 classrooms (2006-current)
- Beechlar Dissertation Proposal Award, School of Education, Indiana University (2007)
- Kemp SimEd Fellowship, Department of IST, Indiana University (2005)
- Minor: Educational Psychology

**Masters of Science in Education (Instructional Systems Technology)** **08/99 – 05/01**
**Indiana University, USA**

**Bachelor of Business Administration (2nd Upper Honors)** **07/89 -07/93**
*National University of Singapore, Singapore*

- Dean's Distinction List (1993)
- Sanwa Bank Foundation Trust Scholarship (1993)

## Professional Experience

**Contract Instructional Designer** **09/07 – 05/08**
**Option Six Inc, USA**

- Develop e-learning courses for product training of sales representatives from Eli Lilly and Company.

**Teaching Assistant for R521 – Instructional Design & Development I (Blended Course)** **08/06 – 10/07**
**Teaching Assistant for R547 – Computer-Mediated Learning (Online Course)**
**Associate Instructor for W200 – Computers in Education (Onsite Course)**
*Indiana University, USA*

- Provide online technical consultation to distance students of the R547 course on web development software and processes.
- Assist in providing written feedback and critique of development projects for students of R547 and R521.

*1750 N. Range Road K302, Bloomington, IN 47408*
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- Develop and facilitate application-based projects that enable pre-service teachers' in the W200 course to raise their technology proficiency, and explore technology integration strategies for a K-12 classroom environment.

**Lab Manager for IST Technology Suite**
**Indiana University, USA** **08/04 – 05/07**

- Managed day-to-day operations, and the software cataloguing and archival processes in the Suite.
- Assisted students with technology problems faced with using hardware and software in the Suite.
- Scheduled, coached and monitored weekly maintenance activities performed by support staff with special needs.

**Senior Instructional Consultant** **07/01 – 08/04**
**PSB Academy, Singapore**

- Worked with faculty to develop undergraduate courses in business and computer science. These have been accredited by universities in USA, UK, and Australia for credit transfers.
- Spearheaded the integration of blended learning into the Academy's course curriculum, and the development of a customized LMS to support the Academy's e-learning initiative.

**Associate Instructor for A110 – Introduction to Computers and Computing** **01/00 – 05/01**
*Computer Science Department, Indiana University, USA*

- Developed practice exercises, and conducted lab sections to prepare students for skills-based assessments in Microsoft Word, Excel, Powerpoint, and HTML.

**Instructional Designer** **03/98 – 08/99**
**Singapore Computer Systems Pte. Ltd., Singapore**

- Developed multi-media military training courseware.
- Managed production team of programmers, graphic designers, photographers, video crew, and sound engineers to ensure quality and prompt delivery.

**Manpower Development Officer** **05/93 – 09/97**
**Singapore Productivity & Standards Board, Singapore**

- Developed public worker training programs in communication skills, computer literacy, and quality consciousness.
- Worked in multi-agency teams comprising officials from the Labor Ministry, and the National Trades Union Congress of Singapore to market these programs to corporations.

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## Publications

**Journal Articles**

- Koh, J. (2006). Motivating students of mixed efficacy profiles in technology skills classes: A case study. *Instructional Science*, *34*, 423-449.
- Frick, T., Thompson, K. & Koh, J. (2006). Systemic Change: Get Ready, SET, Go! - Where? *TechTrends*, *50*(2), 47-48.

**Conference Proceedings**

- Koh, J.; Frick, T. (2007). Measuring System Structural Properties of Autonomy-Support in a Montessori Classroom. *Proceedings of the Association for Communications and Technology*.
- Frick, T., An, J. S. & Koh, J. (2006). Patterns in education: Linking theory to practice. *Proceedings of the Association for Communications and Technology*, 29.
- Frick, T., Thompson, K. & Koh, J. (2006). Predicting education system outcomes: A scientific approach. *Proceedings of the Association for Communications and Technology*, 29.
- Koh, J. (2006). Transitioning technology integration strategies from classroom to practice: A case-based instructional model. *Proceedings of the Society for Information Technology & Teacher Education, 17*, 3471-3478.
- Frick, T., Thompson, K. & Koh, J. (2005). Simulating and stimulating systemic change in education: SimEd. *Proceedings of the Association for Communications and Technology, 28*, 200-206.

**Book Chapters**

- Ling, S.C. & Koh, J. (1995). The Hour Glass - Nothing is Impossible, A Philosophy That Works. *Higher Productivity Through HRD & Franchising – An NUS-NPB Productivity Casebook*, National Productivity Board: Singapore.
- Lau, G.T. & Koh, J. (1995). Niching Through Franchising. *Higher Productivity Through HRD & Franchising – An NUS-NPB Productivity Casebook*, National Productivity Board: Singapore.

## Conference Presentations

- Frick, T., Thompson, K. & Koh, J. (2007). *Measuring Student Autonomy Structures in a Montessori Classroom: Analysis of Patterns in Time and Configuration*. Round-table presentation at the Annual Convention of American Educational Research Association, 2007, Chicago, IL.
- Frick, T., Thompson, K. & Koh, J. (2006). *Predicting Educational Outcomes: A Scientific Approach*. Paper presented at the Association for Communications and Technology Research Symposium, Bloomington, IN.
- Koh, J. (2006). *An Application of the Axiomatic Theory of Intentional Systems (ATIS) to the Implementation of Autonomy Supportive Strategies in Classrooms*. Paper presented at the IST Conference, Bloomington, IN.
- Koh, J. (2006). *Transitioning Technology Integration Strategies from Classroom to Practice: A Case-Based Instructional Model*. Paper presented at the Annual Conference of the Society for Information Technology & Teacher Education, Orlando, FL.

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- Frick, T., Thompson, K. & Koh, J. (2005). *Simulating and Stimulating Systemic Change in Education: SimEd*. Paper presented at the Annual Convention of the Association for Communications and Technology, Orlando, FL.

## Technology Proficiency

- Microsoft Office
- Web-Development - HTML, Macromedia Dreamweaver, Macromedia Flash, NVU
- Graphics & Multimedia - Adobe Photoshop, Adobe Premiere, Sound Forge

## References

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