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Scaffolding Preservice Teachers' Use of Technology to Design Teaching-related Artifacts

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Abstract: This paper describes six methods used by teacher educators to scaffold preservice teachers during independent labwork, where they apply technology skills to design teaching-related artifacts. It discusses how varying tasks contexts affect the nature and practice of instructor scaffolding during technology skills instruction.

Keywords: scaffolding, technology, teaching, preservice teacher education

Introduction

Pre-service teachers apply software skills to design teaching-related artifacts such as lesson plans and presentation slides during educational technology courses. These types of hands-on application help them to develop positive attitudes towards technology integration (Pellegrino & Altman, 1997; Snider, 2003). However, there is a dearth of studies about how teacher educators support this process.

Wood, Bruner, and Ross (1976) found that adults used six "scaffolding" functions to support children during a problem-solving task. "Scaffolding" was used by the authors to describe how experts support novices to learn the complexities of task performance. Cazden (1979) established its concurrence with socio-cultural theory which posits that learning occurs through social interaction where experts customize support to help novices bridge their zones of proximal development (ZPD), i.e. the gaps between their developed and undeveloped capabilities (Vygotsky, 1978). This study investigates how the scaffolding functions derived by Wood et al. can be adapted to illustrate instructor scaffolding in educational technology courses. It also discusses how varying task contexts influence the nature and practice of instructor scaffolding.

1. Theoretical Background

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: Recruitment (tutor generates interest in the task), reduction in degrees of freedom (tutor supports the development of task mastery by controlling the size of the task), direction maintenance (tutor motivates the child to continue focusing on the task), marking critical features (tutor highlights aspects of task performance that are critical for detecting performance discrepancies), frustration control (Tutor helps the child to reduce stress and frustration with problem-solving), and demonstration (Tutor models an "idealized" version of the task solution).

Scaffolding occurs through social interaction between experts and novices. Firstly, it involves co-participation of both teachers and students in directing the process (Meyer, 1993). This is described as a form of intersubjectivity, or a shared understanding of the task to be learned (Rogoff, 1990) where learners "see the point of the task, beyond simple obedience to the teacher's demands" (Langer & Applebee, 1986, p. 185). Secondly, the instructor seeks to transfer responsibility for learning to students, so that they can gradually direct their own learning and perform tasks independently. 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). Thirdly, instructors conduct "ongoing diagnosis" (Puntambekar & Hubscher, 2005, p. 3) of students and "titrate assistance" (Stone, 1998, p.349) by providing the appropriate type of support at different points during the instructional process.

"Demonstration" as described by Wood et al. (1976) may be relevant when applying the construct of scaffolding to educational technology courses as software demonstrations have been found to better enhance learners' confidence with using computers than lectures (Gist, Schwoerer & Rosen, 1989). However, the other scaffolding functions described by Wood et al. have not been comprehensively explored in extant teacher education research.

2. Research Questions

In view of the preceding discussion, the research questions of this study are:

1. How do instructors scaffold preservice teachers when they apply software skills to design teaching-related artifacts?
2. What differences are there between the scaffolding functions of Wood et al. (1976) and those derived from this study?

3. Methodology

3.1 Subjects and Study Context

A 16-week educational technology course at a large Midwestern university in the USA was purposively selected for this study. In this 3-credit course, preservice teachers' are taught various software packages (e.g. Microsoft Office, Dreamweaver, and Adobe Photoshop) through lectures, demonstrations, or self-paced tutorials. After mastering each software package, preservice teachers attend lab sessions where they worked independently on design projects, consulting their instructors where necessary. These projects require them to design various teaching-related artifacts such as lesson plans, presentation slides, class websites, and educational boardgames with the software programs they have learned. In Wood et al. (1979)'s study, scaffolding occurred in the situation where children worked independently on a task; while adults provided support when needed. The lab sessions conducted by the three instructors in this study were purposively sampled as these corresponded with the context of Wood et al.'s study.

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3.2 Data Collection and Analysis

A qualitative, naturalistic approach was adopted (Creswell, 1998). All lab sessions conducted by the three instructors for Microsoft PowerPoint, and Web Development were videotaped for a semester during data collection. This amounted to 17 instructional hours of recording. An additional six hours of recording made on lab sessions for Microsoft Excel and Microsoft Publisher were used for inter-rater training.

The videotaped instructional sequences, ethnographic field notes and instructor interviews were analyzed using the constant comparative method (Creswell, 1998) to establish categories for coding instructional interactions related to instructors and students. Relative frequencies of categories were derived through coding of the video-recordings, and used as quantitative data to triangulate qualitative data from the field notes and interviews. A detailed description of this process, including the methods for establishing inter-rater reliability can be found in Koh and Frick (2009).

The six scaffolding functions derived by Wood et al. (1976) were used as initial categories of instructor interactions that were subsequently refined through the constant comparative method (Creswell, 1998). The refined categories had high inter-rater reliability (Flander's modification of π=0.82). This study focuses on the analysis of the types of instructor categories used to support preservice teachers during lab sessions where they were designing teaching-related artifacts with technology.

4. Results

4.1 Instructor Scaffolding Functions during Lab Sessions

Table 1 – Distribution of instructor scaffolding functions during Lab Sessions

Instructor Scaffolding Functions	Total	%
1. Can't hear (Audio from recording cannot be clearly coded)	13	1.23%
2. Show and Tell (Demonstrate procedure and explain technological concept)	341	32.17%
3. Progress Checking (Monitor student performance)	399	37.64%
4. Direction Maintenance (Encourage and motivate)	200	18.87%
5. Prompt and Hint (Probe student misconceptions)	29	2.74%
6. Frustration Control (Prevent student error)	43	4.06%
7. Share New Perspectives (Suggest new ways to approach project)	34	3.21%
Total	1,059	100%

Video analysis found that instructors executed a total of 1,059 scaffolding moves during the 17 hours of recording (See Table 1). Instances where the conversation between instructors and students could not be clearly heard were coded as *Can't Hear*. Six other categories of instructor scaffolding emerged from the analysis (See Koh & Frick (2009) for detailed description). Specifically for lab sessions, close to 89% of instructor scaffolding moves were in three categories: *Progress Checking*, *Show and Tell*, and *Direction Maintenance*.

During *Progress Checking*, instructors asked students about their design ideas and how their projects were progressing. Sometimes, instructors silently observed their computer screens, and chose not to interrupt if they were progressing well. *Progress Checking* allowed instructors to uncover student needs for support, which they followed up with *Show and Tell*. Instructors most often had to demonstrate how technology procedures and concepts learned previously could be related to students' design ideas. Close to 19% of instructor scaffolding was also related to *Direction Maintenance* where students were provided with feedback and encouragement about the plausibility of their design ideas. When asked technical questions by students whom they felt were more confident with using technology, instructors sometimes engaged in *Prompt and Hint* by scaffolding them to derive solutions through hints and leading questions. With these students, instructors also used *Share New Perspectives* to challenge them with new ways for approaching their projects, and *Show and Tell* them complex technology procedures not covered in the course syllabus. Instructors also found occasion for *Frustration Control* while *Progress Checking* students' work-in-progress, where they advised students about potential technical problems related to their current design. Nevertheless, *Frustration Control, Prompt and Hint*, and *Share New Perspectives* constituted only about 10% of the total instructor scaffolding moves.

4.2 Comparison With Wood et al. (1976)

This study found that some scaffolding functions described by Wood et al. (1976) were used differently in the context of technology skills training as it involved 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 was 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.

Several new scaffolding functions emerged in this study. While scaffolding independent design work, it was necessary for teacher educators to observe without interrupting students during *Progress Checking*. 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. Other examples of scaffolding functions that were unique to technology skills instruction were interactive questioning through *Prompt and Hint*, and helping preservice teachers visualize new ways of approaching design problems through *Share New Perspectives*.

5. Discussion

The results of this study supported Meyer (1993) who proposed that scaffolding is contextualized. The learners in Wood et al.'s study were of a younger age, and performing a less complex task as compared to the pre-service teachers in this study. The profile of learners, the open-endedness of task performance led to the emergence of new scaffolding categories, and the merging of categories from Wood et al. (1976).

Extant research for lecture-based software training found that vicarious experiences obtained through software demonstration was more effective for raising computer self-efficacy than verbal lectures alone (Gist et al., 1989). This study found that the scaffolding of technology learning through design activities involved using progress monitoring as a means to address students' knowledge gaps. This allowed instructors to provide interim feedback, encourage students, prevent technical errors, and challenge thinking. It required instructors to have knowledge of student technology competencies, and the ability to use appropriate scaffolding functions while interacting with students.

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2.2.1

6. Limitations and Future Research

This exploration of scaffolding is limited to the context of technology skills learning during independent lab work. Future studies could be replicated during lectures and software demonstrations to validate the generalizability of these scaffolding functions. Ertmer, Evenbeck, Cennamo, and Lehman (1994) found that instructor interactions with students had a greater influence on their confidence for using technology, as compared to their time spent using technology. An analysis of corresponding student support requests and patterns of interaction by student profile could help us better understand the relationship between scaffolding functions and preservice teacher learning.

7. Conclusion

This study found that instructor scaffolding is highly contextualized. The scaffolding of design projects during technology skills instruction is a multi-faceted and dynamic process that involves the use of six scaffolding functions. These functions, if further explored, could contribute to the development of effective pedagogy for educational technology courses.

References

[1] Cazden, C. B. (1979). Peekaboo as an instructional model: Discourse development at home and at school. In *Papers and reports on child language development* (No. 17). Palo Alto, CA: Stanford University, Department of Linguistics.
[2] Creswell, J. W. (1998). *Qualitative Inquiry and Research Design*. California: SAGE Publications.
[3] Ertmer, P.A., Evenbeck, E., Cennamo, K. S., & Lehman, J. D. (1994). Enhancing self-efficacy for computer technologies through the use of positive classroom experiences. *Educational Technology Research and Development*, *42*(3), 45-62.
[4] Gist, M.E., Schwoerer, C. and Rosen, B. (1989). Effects of alternative training methods on self-efficacy and performance in computer software training. *Journal of Applied Psychology*, 74(6), 884-891.
[5] Greenfield, P. M. (1999). Historical change and cognitive change: A two-decade follow-up study in Zincantan, a Maya community in Chiapas, Mexico. *Mind, Culture, and Activity, 6*, 92-98.
[6] Koh, J., & Frick, T.W. (2009). Instructor and student classroom interactions during technology skills instruction for facilitating preservice teachers' computer self-efficacy. *Journal of Educational Computing Research, 40*(2), 207-224.
[7] Langer, J. A., & Applebee, A. N. (1986). Reading and writing instruction: Toward a theory of teaching and learning. In E. Z. Rothkopf (Ed.), *Review of research in education* (Vol. 13, pp. 171-194). Washington, DC: American Educational Research Association.
[8] Meyer, D. K. (1993). What is scaffolded instruction? Definitions, Distinguishing Features, and Misnomers. In Examining Central Issues in Literacy Research, Theory, and Practice: Forty-second Yearbook of the National Reading Conference. The Reading Conference, Inc: Chicago
[9] Pellegrino, J. W., & Altman, J. E. (1997). Information technology and teacher preparation: Some critical issues and illustrative solutions. *Peabody Journal of Education*, 72(1), 89-121.
[10] Puntambekar, S., & Hubscher, R. (2005). Tools for scaffolding students in a complex learning environment: What have we gained and what have we missed? *Educational Psychologist, 40*(1), 1-12.
[11] Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. New York: Oxford University Press
[12] Snider, S. L. (2003). Exploring technology integration in a field-based teacher education program: Implementation efforts and findings. *Journal of Research on Technology in Education*, *34*(3), 230-249.
[13] Stone, C. A. (1998). The metaphor of scaffolding: Its utility for the field of learning disabilities. *Journal of Learning Disabilities, 31*, 344-364.
[14] Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: MIT Press.
[15] Wood, D., Bruner, J.S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 17*, 89-100.