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Leveraging the Potential of Design-Based Research to Improve Reflective Thinking in an Educational Assessment System

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Reflective practice has become an integral component of computer-based educational learning systems to develop preservice teachers' critically reflective thinking capability. Recently, design-based research has demonstrated its potential as a methodology suitable to guide the research and design of technology-enhanced learning environments. Guided by Ma and Harmon's (2009) detailed design-based research process, this case study presents an iteration of a project on how to embed computer-based scaffolds (question prompts and writing process display) in a technology-enhanced educational assessment system to facilitate preservice teachers' online reflective journal writing. Rapid prototyping was adopted as the development method of the Web-based scaffolds. Explanatory mixed-methods design served as the research methodology. Both quantitative and qualitative results revealed that the scaffolds did enhance preservice teachers' critically reflective thinking capability in the simulated system. A few design principles were generated hoping to guide those interested in working with the computer-based scaffolds tailored for reflective practice.

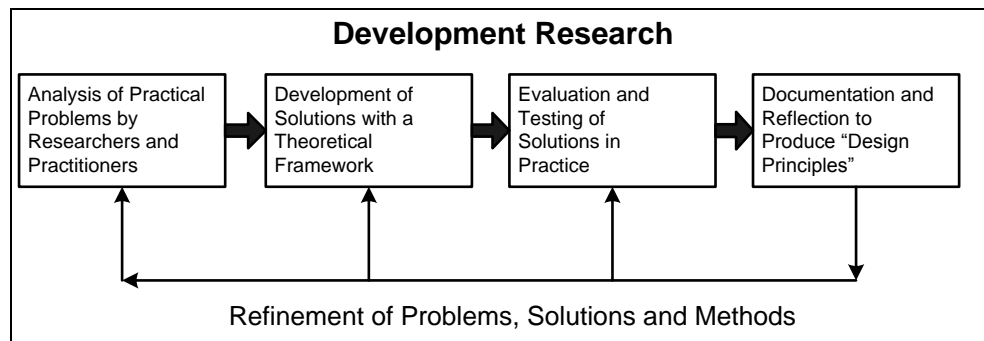
Keywords: design-based research, reflective practice, reflective journal writing, computer-based scaffolding, performance support

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INTRUCTION

Design-based research has demonstrated its potential as a methodology suitable to guide the research and design of technology-enhanced learning environments (Wang & Hannafin, 2005). As a long-term research engagement, design-based research usually serves three purposes: (a) supporting design and development of prototypical products to solve complex authentic context-specific problem, (b) generating methodological directions for the iterative design and evaluations of such products, and (c) constructing context-rich theoretical knowledge by reflecting on the design experience (Reeves, Herrington, & Oliver, 2004; The Design-Based Research Collective, 2003; van den Akker, 1999). Reeves (2000a) designed a set of overarching guidelines that outline a process he called development research. See Fig. 1. However, there is a lack of established guidance on how to conduct this type of research at the individual study level (as reviewed in Ma & Harmon, 2009). Hence, Ma and Harmon (2009) developed a detailed research and development process that may provide more specific guidance to researchers that are new to design-based research. See Fig. 2.

Figure 1. A Development Research Process. Recreated from Reeves (2000).



This paper reports how we adopted Ma and Harmon's (2009) model to design and develop the prototype of computer-based scaffolds for preservice teachers' reflective journal writing in a technology-enhanced educational assessment system. The purpose of the scaffolds was to facilitate preservice teachers' development of critically reflective thinking capability and habits. Since the focus of the paper is on a unique research approach to design and development of large-scale technology-based educational systems, each section of the paper was divided and labeled according to the model Ma and Harmon (2009) developed. However, minor modification has been made to fit in our specific research context.

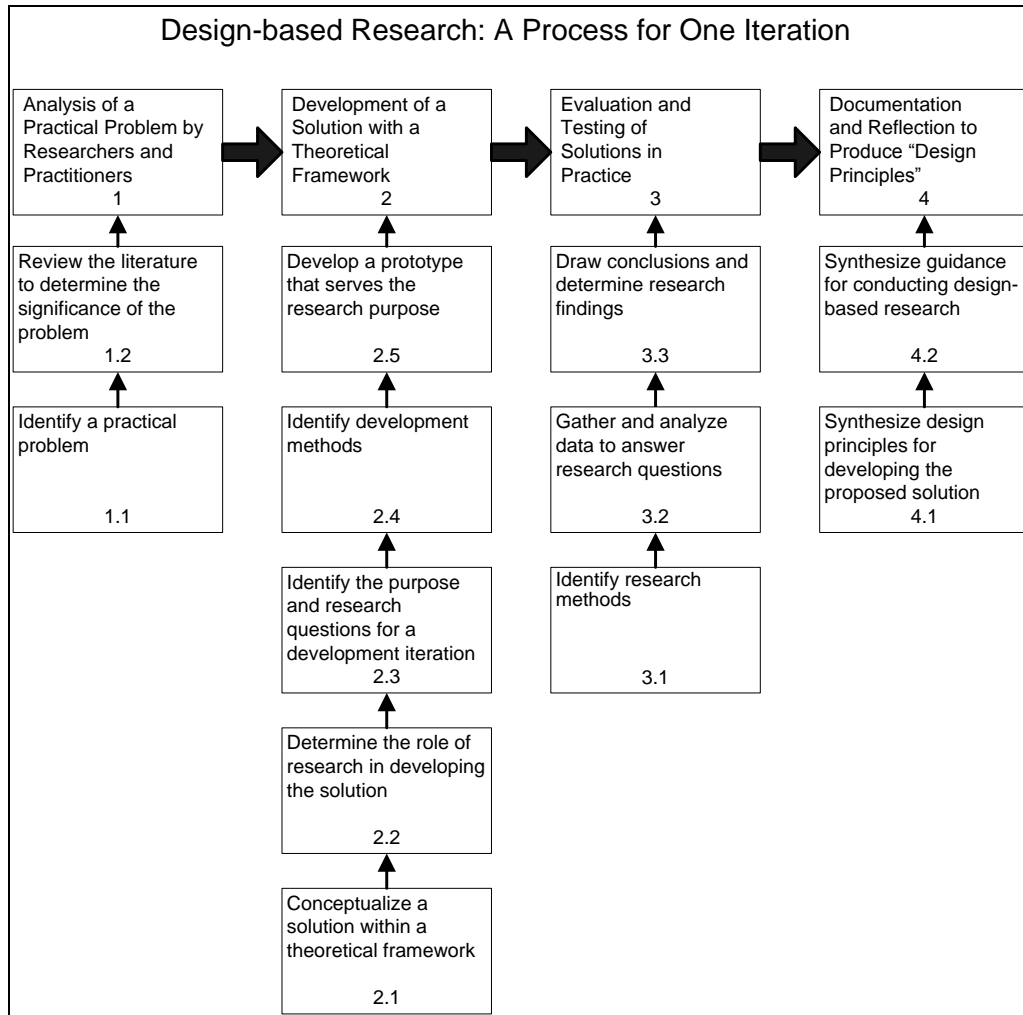
ANALYSIS OF A PRACTICAL PROBLEM

IDENTIFY THE PRACTICAL PROBLEM

Recent years have witnessed a sustained emergence of research on and development of Web-based educational systems tailored for teacher preparation and teachers' professional development. For example, the state of Louisiana's Board of Regents for Innovative Teaching & Learning funded the development of the Professional Accountability Support System Using a Portal Approach (PASS-PORT) (2002). Portfolio building is an integral component of preservice teachers' use of the system. During preservice teachers' portfolio building process, the PASS-PORT requires them to write

online journals about their professional and academic experiences (i.e., classroom observations and practice teaching). Despite the growing success of the PASS-PORT, conversations with teacher educators who worked with the system at a major southern university in the United States indicated that preservice teachers encountered numerous difficulties in their online journal writings in the system.

Figure 2. Design-Based Research: A Process for an Iteration.



Lai and Calandra (2007) conducted a qualitative study to explore the specific difficulties preservice teachers had during their journal writing in the PASS-PORT. Results showed teacher educators believed that preservice teachers' journal writings were often descriptive, technical, shallow, unfocused, and pointless, which is consistent with the findings in the literature (e.g., Hatton & Smith, 1995; Neijaard, Stellingwerf, & Verloop, 1997; Pultorak, 1996; Risko, Roskos, & Vukelich, 1999; Ward & McCotter, 2004). Preservice teachers' poor journal writing was attributed to four factors: (a) limited understanding of the concept of reflection, (b) lack of reflection writing experience prior to college, (c) disconnection between theories and concrete classroom teaching experiences, and (d) lack of sufficient guidance from teacher educators (Lai & Calandra, 2007). It is important to note that, the PASS-PORT currently does not provide any

intrinsic or extrinsic computer-based support or scaffolds to facilitate preservice teachers' reflective journal writing performance.

REVIEW THE LITERATURE

Reflection plays a crucial role in teachers' learning process which involves the interaction of experience, reflection, and knowledge (Shulman, 1987). For the past two decades, the professionalization of teaching – “the elevation of teaching to a more respected, more responsible, more rewarding and better rewarded occupation” has been one of the recurring themes of educational reform at both national and state levels (Cochran-Smith, 2001; Shulman, 1987, p. 3; Ward & McCotter, 2004). Teachers' ability to reflect is deemed an integral part of the professionalization agenda so that teachers can be empowered, reflective decision makers (Colton & Sparks-Langer, 1993) who can meet the increased challenges in their profession. Because of that, the reflective approach has become a major, encompassing paradigm in teacher education (Tochon, 1999). To ensure teacher candidates' reflective ability, the American National Council of Accreditation of Teacher Education (NCATE) (2006) has established standards that call for teacher candidates to be reflective practitioners, and demonstrate the ability to reflect. Currently, reflective journal writing has become one of the widely adopted reflective practices in teacher education to develop preservice teachers' reflective thinking capability and habits (Dunlap, 2006; Gordinier, Conway, & Journet, 2006; Hatton & Smith, 1995; Lai & Calandra, 2007; Roland, 1995).

Critical reflection is the distinguishing attribute of reflective practitioners (Larrivee, 2000). Researchers suggest that a particular emphasis be placed on developing preservice teachers' critical reflection skills, because reflection is effective only when it incorporates moral, political, social, and ethical criteria into the discourse about their practical actions in education (Howard, 2003; Sparks-Langer & Colton, 1991; van Manen, 1977; Zeichner & Liston, 1987). Research has also demonstrated that preservice teachers' critically reflective thinking capability can be developed (Hatton & Smith, 1995; Pultorak, 1996) if certain conditions are met (Yost, Sentner, & Forlenza-Bailey, 2000). The conditions include (a) “supervised practical experiences” and (b) “a personally meaningful knowledge base in pedagogy, theories of learning, as well as social, political, and historical foundation to which they can connect their experiences” (Yost et al., 2000, p. 47). However, the existence of these two conditions independently does not guarantee preservice teachers' development of critically reflective thinking capability. Preservice teachers might need scaffold to help them connect the two independent conditions Yost et al. (2000) identified.

DEVELOPMENT OF A SOLUTION WITHIN A THEORETICAL FRAMEWORK

This complex step in the study included the following sub-steps: (a) conceptualize a solution within theoretical frameworks, (b) identify the purposes and research questions for first iteration of development, (c) identify development methods, and (d) develop a prototype for further investigation.

CONCEPTUALIZE A SOLUTION WITHIN THEORETICAL FRAMEWORK

The preliminary qualitative study (Lai & Calandra, 2007) revealed that purposefully designed scaffolding, if embedded within preservice teachers' journal writing interface in the PASS-PORT, might help assuage the disconnection between theories and concrete classroom teaching experiences. Scaffolding is a learner-centered strategy meant to assist

learners to reach goals which are beyond their unassisted efforts (Wood, Bruner, & Ross, 1976). The literature is replete with scaffolding strategies intended for enhancing the learning and practice of reflective journal writing. Some of these strategies include question prompts (Bean & Stevens, 2002), writing templates (Hoban, 2000), structured writing guidance (Griffin, 2003; Hamlin, 2004), modeling (J. Loughran & Berry, 2005; J. Loughran, 1997), peer collaboration (Nicholson & Bond, 2003), and feedback (Spalding & Wilson, 2002), to name just a few. Traditionally, scaffolding occurs through personal interactions between students and instructors. The scaffolding metaphor has recently been used by researchers to design features and functionality of computer-based educational software applications that can be used to facilitate and improve human performance within particular task domains (Barker, 1995; Sherin, Reiser, & Edelson, 2004). Jonassen (1999) even claims that various scaffolding mechanisms, e.g., conceptual, metacognitive, procedural, and strategic scaffolding (Hannafin, Land, & Oliver, 1999) should be inalienable components of computer-based learning environments.

Researchers have explored on how to present a continuum of scaffolding or support mechanisms in systems to facilitate human performance. For example, Gery (1995) identified three fundamental types of performance support with a computer-mediated work environment: intrinsic support, extrinsic support, and external support. *Intrinsic support* is inherent or embedded to the system itself. *Extrinsic support* is linked to the system, but not in the primary work place. It is usually context or user sensitive, and it can be turned on and off. *External support* is not automatically integrated or embedded into the computer display and tasks, but can be integrated by the user when needed. Similarly, Villachica and Stone (1999) developed a continuum of integration for performance support in computer-based systems, ranging from procedural tasks performed in a simple stepwise manner, to complex cognitive tasks typically performed by knowledge workers. They posit that intrinsic support is the application's user interface because it does not require performer to invoke it. Raybould (2000) went a step further by elaborating on the performance support taxonomy and the performance support continuum to conceptualize the types of supports as well as their efficiency and effectiveness. He proposed that a blended approach should be taken to provide support in a continuum: from embedded to linked and external supports. *Embedded supports* include menus, dialog boxes, and on-screen instructions; *Linked supports* are those such as online advisors, references, coaches, help, and wizards; *External supports* consist of tutorials, computer-based training (CBT), training courses, peer support, and telephone hotlines. Embedded supports are most powerful and least expensive. van Merriënboer, Kirschner, and Kester (2003) claim the same when they posit that intrinsically embedded support is clearly more effective than nonintegrated support.

Based on the research results of the qualitative study (Lai & Calandra, 2007), question prompts and writing process display were identified as the two preferred scaffolds to be intrinsically embedded in the PASS-PORT to enhance preservice teachers' journal writing performance. The following theoretical perspectives informed the design of the question prompts and writing process in the scaffolds: reflection types, reflection hierarchy, and critical incident analysis.

Schön (1987) identified two types of reflection: reflection-in-action and reflection-on-action, both reactive in nature and distinguishable by when reflection takes place. Reflection-in-action occurs during the event. It involves thinking about the current experiences, examining the feelings incurred, and evaluating the theories in use. Reflection-on-action refers to retrospective thinking after the event has taken place. This is when the practitioner explores what happened during the event and their motivations and the rationale for acting in a certain manner. Killion and Todnem (1991)

conceptualized reflection-for-action, which is the desired outcome of reflection-in-action and reflection-on-action. Reflection-for-action is more proactive in nature. The continuum of reflection-in-action, reflection-on-action, and reflection-for-action makes reflection “a process that encompasses all time designations, past, present, and future simultaneously” (Killion & Todnem, 1991, p. 15).

van Manen (1977) developed a reflection hierarchy. The first level, *technical rationality*, is concerned with the application of educational knowledge to attain ends accepted as given. At this level, neither the ends nor the educational contexts are treated as problematic. In the second level, *deliberative rationality*, every action is seen as linked to particular value commitments. The actor interprets individual and cultural experiences, meanings, and perceptions to understand nature and quality of the educational experience. In the last level of *critical rationality*, both teaching and contexts of teaching are viewed as problematic as the actor tries to incorporate the consideration of political, moral, social, and ethical criteria to evaluate the experiences. After synthesizing the existing reflection rubrics in the literature, Lee (2005) found out that teacher educators generally use the terms practical/technical, contextual/deliberative/conceptual, and critical/dialectical/transformativ to identify the different domains of reflective thinking, much in alignment with van Manen’s (1977) hierarchical classification. The delineations of reflection types and reflection hierarchy guided us to design question prompts and step-by-step writing processes in the scaffolds.

The critical incident analysis technique Flannagan (1954) introduced has strongly influenced teacher education. From critical incident analysis, preservice teachers can interpret the significance of an incident following four steps (D. Tripp, 1993): (a) describe and explain an incident; find a general meaning and classification for the incident; (c) take a position regarding the general meaning; and (d) describe actions to be taken. Critical incident analysis technique played a key role in our study. In the study, we asked preservice teachers to recall a critical incident that occurred in their practice teaching field experience to anchor their online journal writing.

IDENTIFY THE PURPOSES AND RESEARCH QUESTIONS

Given the identified practical problems associated with preservice teachers’ journal writing performance in the PASS-PORT, this study served two research purposes, first, to examine whether the selected computer-based scaffolds (question prompts and writing process display), if intrinsically embedded in the PASS-PORT, can enhance preservice teachers’ critically reflective thinking in their online journal writing; and second, to explore how and why these scaffolds enhanced or failed to enhance preservice teachers’ critically reflective thinking in their writing. Six research questions guided the study:

1. Will preservice teachers, who are exposed to computer-based question prompts while writing their online reflective journals, demonstrate a higher level of reflection in their writing than those in the control group?
2. Will preservice teachers, who are exposed to computer-based writing process display while writing their online reflective journals, demonstrate a higher level of reflection in their writing than those in the control group?
3. Will preservice teachers, who are exposed to computer-based question prompts while writing their online reflective journals, write longer reflections than those in the control group?
4. Will preservice teachers, who are exposed to computer-based writing process display while writing their online reflective journals, write longer reflections than those in the control group?

5. Are there any correlations between the highest level of reflection achieved and the length of reflection writing?
6. How and why do the selected computer-based scaffolding tools (i.e., question prompts and writing process display) affect or fail to affect preservice teachers' reflective journal writing?

IDENTIFY DEVELOPMENT METHODS

Rapid prototyping (Gustafson & Branch, 1997; S. D. Tripp & Bichelmeyer, 1990) was adopted as the development method for question prompts and writing process display scaffolds. Rapid prototyping is a design and development methodology that may meet the design challenge of computer-based scaffolds when no established design guidelines exist and when there are no perfectly matching prescribed procedures to follow. As an instructional design model, rapid prototyping involves early development and evaluation of prototypes to ensure stakeholders' needs are met. Rapid prototyping was appropriate in this study where both paper-based and computer-based prototypes were used. First, paper-based prototype helped us conceptualize the identified scaffolds and quickly obtained feedback from an evaluation panel. Second, the use of computer-based development tools such as Macromedia Fireworks and Dreamweaver offered modularity and plasticity (S. D. Tripp & Bichelmeyer, 1990). Modularity allowed us to add, remove, or modify components of the scaffolds without much impact on the other components; and plasticity enabled us to make changes without extensive cost of time or money.

DEVELOP A PROTOTYPE

The scaffolding metaphors used for the study included: question prompts and a guided process display. We developed a series of paper-based and Web-based prototypes. We used Microsoft Office Visio, Microsoft Office Word, Macromedia Fireworks and Dreamweaver to create the Web-based treatments. To simulate reflection writing in the PASS-PORT, we saved a typical journal writing Web page of the system into a Hypertext Markup Language (HTML) file, and edited the HTML file into a template. Then we used the template to develop all the Web pages needed for the first iteration of the research.

A panel of three experts in both instructional technology and teacher education critiqued the design and development of each iteration of both paper-based and Web-based prototype, with focus on the conceptualization and the Web presentation of the scaffolds. After six iterations of the prototype evaluation, the panel confirmed the design and development of the treatment prototype. Their suggestions for improvement included: concise and easy-to-understand definition and explanation of the critical incident; explicit requirements that guide participants' reflection writing; navigation of the Web pages; clarity of the question prompts; juxtaposition of the writing process flowcharts and text box for writing; and easy-to-read content presentation on the Web pages. The most critical suggestions from the panel were as follows: the panel perceived that the participants would be overwhelmed by the immediate and comprehensive presentation of the question prompts and the writing process flowchart. They suggested that, for the question prompts treatment, the participants be first provided a Web interface where they can write their reflection after each question prompt, and then be provided with the comprehensive set of question prompts while previewing their reflective writing. For the writing process display treatment, the panel suggested that the system first present a high-level overview of the writing process flowchart, then the elaborated writing process of the three overarching writing steps to reduce cognitive load. Moreover, illuminated by the temporal contiguity principle of Mayer's (2001) multimedia learning -

“students learn better when corresponding words and pictures are presented simultaneously rather than successively” (p. 184), the panel suggested we horizontally juxtapose the writing process flowchart and the text box for writing to facilitate the participants’ effortless reference to the flowchart for scaffolding. Finally, the complete writing process flowchart was provided to the participants on top of the preview text to reinforce their understanding of the complete writing process. Upon their feedback, we modified the prototype and sent it to them for another round of critiques. The same procedure continued until the panel had no recommended changes. A Web programmer then created a database and wrote the ASP .net codes to make the Web pages dynamic.

Figure 3: Computer Interface for the Control Group.

The introduction page for no-treatment group and treatment groups was the same, providing brief instructions on how to use the scaffolding tool to finish the journal entry. After the participants entered their unique student identification (ID) numbers, the system looked up their IDs in the database and evenly and randomly redirected them to one of three Web pages associated with different scaffold treatment. First, the Web page for the control group presents the computer interface where the participants completed their journal writing in the specified text area following the requirements as provided. See Fig. 3. Second, the Web page for the question prompts treatment presents the computer screen where the participants completed the journal writing in the specified text areas following the requirements and the question prompts (Figure 4). After the participants finished the writing in each specified text area, they were presented with a preview page containing the recap of all the question prompts and the combined writing for them to edit before submission. And third, the Web page for the writing process display treatment presents the participants with a flowchart depicting a model process for their reflective journaling. In the following three pages, each writing step was further branched out. For example, see Fig. 5 for the computer interface for the first writing step. After the participants

finished the three steps, they were presented with a preview page containing the complete writing process as well as an editable recap of their journal writing before submission.
 Figure 4. Question Prompts as a Scaffold Strategy – Step by Step.

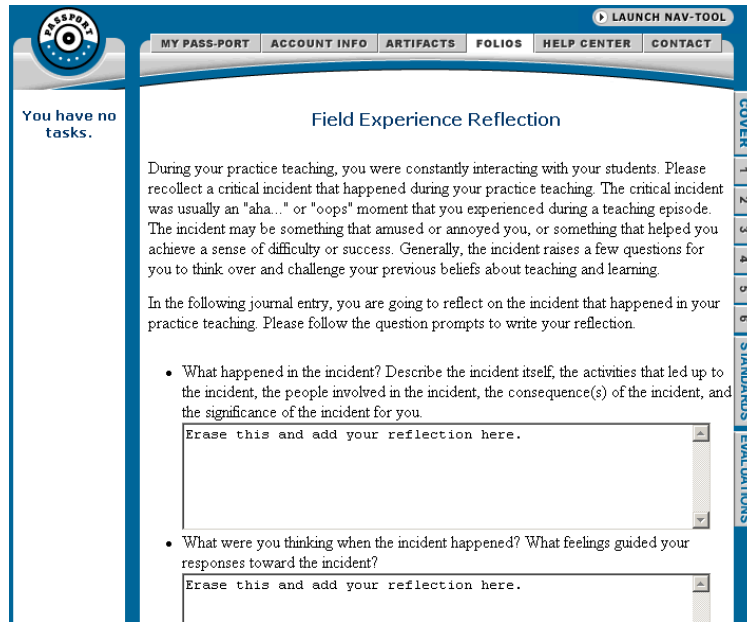
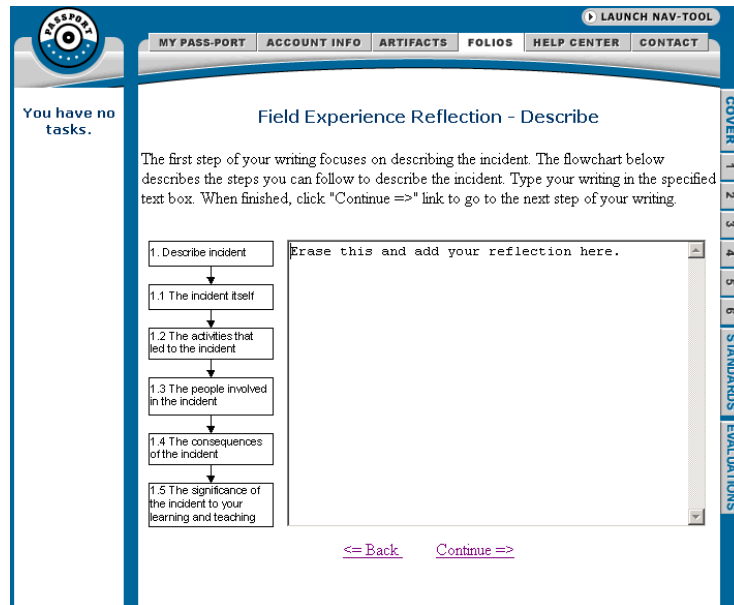


Figure 5. Visual Writing Process Display as a Scaffolding Strategy – Step One.



EVALUATION AND TESTING OF THE SOLUTION

IDENTIFY RESEARCH METHODS

Explanatory mixed-methods design (Creswell, 2005) served as the research methodology. We started by using quantitative techniques to determine whether the

participants, who were exposed to computer-based scaffolds including question prompts and writing process display, demonstrated a higher level of reflection in their writing and wrote a longer piece of reflection than those participants who were not exposed to, as well as the correlation between the level of reflection and the length of reflection. We then supplemented the quantitative findings with qualitative data to explore various factors that might have contributed to the effect of the scaffolds.

GATHER AND ANALYZE DATA TO ANSWER RESEARCH QUESTIONS

Quantitative Methods

Participants. Preservice teachers from five sections of a technology integration course at the College of Education of a major southern university in the United States participated in the study. This course requires preservice teachers to have ten hours of field experience. Seventy-four preservice teachers enrolled in these sections taught by three professors. All three professors agreed to allow their students to use the simulated PASS-PORT interface for their online journal writing, a requirement for their field experience. However, the sample for the quantitative phase of the study included only sixty-five participants. In one section, practical teaching was not required for the field experience, so four out of ten preservice teachers did not participate in the Saturday Technology Program where preservice teachers tried out new strategies, observed student learning, and reflected on the strategies used, and thus they were not required to finish the online journal writing. In addition, five more preservice teachers declined to sign on the consent form, and their participation in the study was dropped.

Data Collection. After the participants' field practice teaching in Saturday Technology Program, they completed the journal writing in the classrooms where they were provided with a URL to log in using their student ID. The system then randomly and evenly assigned them to three different Web pages associated with their treatment conditions: control treatment, question prompts scaffold, and writing process display scaffold. All participants were required to reflect on a critical incident that happened during their practical teaching. Their one-time in-class journal writings were automatically captured in the database upon submission. Given attrition factors explained earlier, only 65 journal writings were included for data analysis (20 from the control group, 23 from the question prompts group, and 22 from the process display group).

Measurement. The dependent variables for quantitative analysis included the coded highest level of reflection and the total number of English words in journal writing, independent variable were the three journal writing groups including control group, question prompts group, and writing process display group. Word count tool available in Microsoft Word was used to get the total number of English words for each journal. In order to evaluate the highest level of reflection achieved in participants' journal writing, we adopted the reflection rubric developed by Ward and McCotter (2004). The rubric includes four levels: routine, technical, dialogic and critical reflection. In routine reflection, preservice teachers focus on definitive statements related to their experiences or phenomena. In technical reflection, preservice teachers attempt to solve specific problems related to teaching tasks, but fail to question the nature of the problems. In dialogic reflection, preservice teachers are involved in an ongoing process of probing the situated questions, taking action, considering others' perspectives, and gaining new insights into the problems. In critical reflection, preservice teachers question fundamental assumptions and purposes more deeply. Exemplar writings for the four levels of

reflection were drawn from Ward and McCotter (2004) and Dinkelman (2000) and were provided to the journal writing raters for reference. Journals were rated by two raters blind to the participants' treatment conditions. An ordinal scale ranging from 1-4 was coded for the highest reflection level reached in the writing. For example, if the highest level of reflection reached was critical reflection, a score of number 4 was coded. Each rater independently completed the initial evaluation of all the journal writings. Coded scores for each journal were then compared. If scores differed, for example, if one rater coded one journal as 3, but the other rater coded it as 4, then the two raters reconciled the difference through discussion until mutual agreement on a same score was achieved. The initial agreement between the raters was 88%.

It is widely believed that categorical outcomes, e.g., the reflection level in the study, can be safely analyzed using ANOVA (e.g., Cochran, 1940; Glass, Peckham, & Sanders, 1972; Rao, 1960; Winer, Brown, & Michels, 1971). ANOVA tests were thus adopted to examine treatment group differences in the highest level of reflection and the length of reflection achieved, as well as the correlation between the level of reflection and the length of reflection achieved.

Qualitative Methods

Participants. Sixteen participants were purposefully drawn from those who participated in the quantitative data collection. To ensure a well-represented sample, we selected one participant to present each level of reflection for the control group. For the two treatment groups, we chose one participant to present routine and technical level; because higher levels of reflection were expected, we selected two participants to present each level of dialogic and transformative reflection.

Data Collection. The data sources for the qualitative analyses included the interview transcripts and the journal writings captured in the database. Following an interview protocol, the first author conducted the one-on-one interviews. The interview was structured by open-ended questions. The length of the interviews ranged from 7 minutes to 29 minutes.

Data Analysis Procedures. The first author transcribed the interviews, and used qualitative research software NVivo 7 to code and organize the interview transcripts. Miles and Huberman's (1994) data analysis procedures guided data analysis. First, in data reduction step, we coded the transcripts and journals into conceptual chunks and grouped the chunks into categories. In data display step, we ran queries to make sense of the relationship among the categories. And lastly, we wrote conclusions that will help explain the quantitative results.

RESULTS

Quantitative Results

ANOVA revealed that the reflection writing scaffolds significantly influenced the highest level of reflection achieved in the participants' online journal writing, $F_{(2, 62)} = 13.741$, $p < .0001$, with effect size $\omega = .53$ (Table 1). Planned contrast revealed that journal writing scaffolding significantly improved reflection level if compared with the control group, $t_{(62)} = -2.848$, $p < 0.05$, $r = 0.34$. *Post hoc* multiple comparisons tests further indicated a statistically significant difference between the control group and the question prompts group ($p < .0001$), between the control group and the writing process

display group ($p < .0001$), and no difference between the question prompts group and the writing process display group ($p = .980$) (Table 2). ANOVA showed that the participants in the two treatment groups wrote significantly longer reflections as well, $F_{(2, 62)} = 14.895$, $P < .05$, with effect size $\omega = .55$ (Table 3). Planned contrast revealed that participants in journal writing scaffolding groups significantly wrote significantly longer journals than those in the control group, $t_{(62)} = -4.33$, $p < 0.05$, $r = 0.48$. *Post hoc* multiple comparison tests then revealed a statistically significant difference between control group and question prompts group ($p = .002$), between control group and process display group ($p < .0001$), and no difference between the question prompts group and the writing process display group ($p = .117$) (Table 4). Correlation analysis revealed that there was a positive relationship between the level of reflection and the length of journal, $r = .344$, $p < .05$ (Table 5).

Table 1: ANOVA Summary Table for the Highest Level of Reflection Achieved

	Sum of Squares	<i>df</i>	Mean Square	<i>F</i>	Sig.
Between Groups	18.871	2	9.436	13.741	.000
Within Groups	42.575	62	.687		
Total	61.446	64			

Table 2: Post hoc Multiple Comparisons on Levels of Reflection Achieved

(I) TreatmentType	(J) TreatmentType	Mean Difference (I-J)	Std. Error	Sig.
CG	QP Treatment	-1.143	.253	.000
	PD Treatment	-1.191	.256	.000
PD Treatment	QP Treatment	.047	.247	.996

Note: CG = Control Group; QP = Question Prompts; PD = Process Display

Table 3: ANOVA Summary Table for the Length of Journal Writing

	Sum of Squares	<i>df</i>	Mean Square	<i>F</i>	Sig.
Between Groups	754596.3	2	377298.174	14.895	.000
Within Groups	1570471	62	25330.172		
Total	2325067	64			

Table 4: Post hoc Multiple Comparisons on Length of Journal Writing

(I) TreatmentType	(J) TreatmentType	Mean Difference (I-J)	Std. Error	Sig.
CG	QP Treatment	-170.117	48.660	.003
	PD Treatment	-265.855	49.172	.000
PD Treatment	QP Treatment	95.737	47.462	.136

Note: CG = Control Group; QP = Question Prompts; PD = Process Display

Table 5: Correlation Between Reflection Level and Length of Reflection Writing

Control Variables			Level	Length
TreatmentType	Level	Correlation	1.000	.344
		Sig. (1- tailed)	.	.003
		df	0	62
	Length	Correlation	.344	1.000
		Sig. (1- tailed)	.003	.
		df	62	0

Qualitative Results

Three overarching factors emerged that might explain how and why question prompts and writing process display not only helped the participants achieve higher level of reflection in their journal writing but also wrote longer journal writing. The factors include (a) the specific requirements conveyed in the scaffolds; (b) the structure of the scaffolds; and (c) the use of the critical incidents to anchor journal writing.

First, the participants treated the question prompts and the step-by-step writing guidelines conveyed in the scaffolds as specific reflection writing requirements that they needed to follow. In general, they perceived that these specific requirements helped them not only think a lot more, but also reflected on the situations or problems in depth. The scaffold instructed them exactly what to write, and thus making their reflection writing easier. Quite a few of them acknowledged that, without the specific questions in the question prompts scaffold and the detailed writing guidelines in process display scaffold, they would probably have left out some aspects associated with the critical incident which were critical to higher level of reflection. For example, one participant commented that, without the writing process display scaffold, she would not consider the significance of the incident while describing it; nor would she reflect on her thinking when the incident occurred and after the incident was over, as well as the various factors that might have influenced her decision making during the incident; nor would she reflect on her beliefs change.

Second, the participants believed that the structure of the scaffolds impacted their reflective thinking in their journal writing. From the interviews, it was noted that these participants lacked authentic classroom teaching experiences because their previous field experiences were restricted to classroom observations. For the participants in the question prompts treatment group, they acknowledged that the structure of the question prompts scaffold was conducive to their reflection writing on their practice teaching. One participant pointed out, because of her lack of authentic classroom teaching experience, she desired a well-designed structure to guide her reflection on her practice teaching and her learning from the practice teaching. Another participant perceived that the question prompts scaffold provided him with a structure where he had an overall picture of the reflection writing. The structure made it easy for him to consider various aspects associated with the critical incident. For the participants in the writing process display treatment group, they appreciated to have their writing process broken down into three major steps: (a) describing the incident, (b) rationalizing their decision making in the incident, and (c) reconstructing their beliefs in teaching and learning. They found it easy to organize their reflective thinking within such a framework. Moreover, they perceived that the juxtaposition of writing process flow chart with writing text box was conducive to their thought process in reflection writing, preventing them from flipping back and forth between Web pages.

Third, the use of the critical incident anchored their reflective journal writing. No matter what their scaffold treatment was, the participants were provided with the same opening statement introducing the critical incident, and were asked to reflect on a critical incident that occurred in their practice teaching. Analysis revealed that using critical incident to anchor their reflection writing was quite a novel experience for them. They perceived that the use of the critical incident sparked their memory of what occurred in their field experience. This made it easy for them to rationalize their decision making in the incident and reconstruct their learning. They perceived that the critical incident was an excellent starting point for their reflective thinking. One participant explained to us her approach to her previous reflection writings and attributed her ease of reflection writing in the study to the use of critical incident.

Basically, I will follow my notes I have taken when I was there, looking at the classroom, the teacher-student interactions or whatever, I will focus on that and write a paper. Whereas this, it was so much easier, and took less time to write it, because I didn't have to sit there for so much time thinking how to formulate it, and transition it...I liked it because instead of having me to sit there and think the drawbacks from what happened and everything, it just threw me into it, I just started and it went.

They also perceived that the use of the critical incident to anchor their reflection writing would work best when they have the opportunities to practice authentic teaching or at least assist in teaching in classrooms. According to one participant, when she went into classrooms to observe teachers' teaching, even though she carefully observed and saw what was happening in the classrooms, she felt detached and thought that there was nothing critical that happened that she could write about. However, after her hands-on practice teaching and her reflection writing anchored on the critical incidents that occurred in her practice teaching, she began reshaping her perspectives on the various critical incidents that might occur in the classroom and how she should investigate them.

DOCUMENTATION AND REFLECTION TO PRODUCE DESIGN PRINCIPLES

As reviewed by Ma and Harmon (2009), design principles are needed in order to address unresolved methodological issues in design-based research. For this reason, we generated the following design principles that were intended to guide those interested in working with computer-based reflection writing scaffolds in Web-based educational learning environments. The principles were derived from the research findings of our research.

Principle 1: Intrinsic support should be provided as the user interface to effectively eliminate any break from the user's reflection writing within the learning environments. All in all, the goal of intrinsic support is to enhance reflection writing performance - the greater the integration of various elements of writing performance support within the computer interface, the fewer breaks in context; the less interference with reflection writing performance, then the greater the potential improvement in efficiency and effectiveness of the users' reflection writing performance.

Principle 2: Proven theories from the literature on reflective practice should be strategically and smoothly embedded in the scaffolds. In our case, we incorporated reflection types including reflection-in, -on, and -for-action in the question prompts and writing process guidelines, in the hope of soliciting different levels of reflection in their

journal writing. For example, the first question in the question prompts scaffold went like this: “What happened in the incident? Describe the incident itself, the activities that led up to the incident, the people involved in the incident, the consequence(s) of the incident, and the significance of the incident for you.” This question focuses on reflection-on-action, in the hope of soliciting routine reflection, technical reflection, and dialogic reflection from the users. The other questions respectively focus on reflection-in-action and reflection-for-action. Moreover, we designed the question prompts and writing process guidelines following Lee’s (2005) hierarchy/domains of reflective thinking, hoping that preservice teacher’s journal writing can cover all three levels:

- practical/technical
- contextual/deliberative/conceptual
- critical/dialectical/transformativ

Principle 3: The scaffolds should provide clearly-defined and common language to the user. In our study, even though the definition of critical incident was provided in the scaffold, some participants perceived critical incident as negative incident. Moreover, some questions and writing guidelines were deemed fuzzy or unclear, and some participants suggested rephrasing.

Principle 4: Alternative options related to reflection writing should be offered to the users. In the study, we requested the participants to anchor their reflection in a critical incident that occurred during their practice teaching. However, a few participants pointed out that their teaching experience went so smoothly that they did not encounter any critical incidents and found it hard to complete their reflection as required.

Principle 5: Gradually increase the complexity of prototypes during the design phase of the prototyping. For example, in the preliminary study (Lai & Calandra, 2007), paper-based prototypes were used to identify target users’ preference toward selected scaffolds. As the research and development progressed, paper-based sketches of scaffold conceptualization and static Web-based scaffold prototypes were used to solicit the feedback from a panel of experts. Finally, functioning Web-based prototypes were developed and employed in the data collection

CONCLUSIONS

Preservice teachers’ critically reflective thinking capability is highly desired in teacher preparation (Howard, 2003; Sparks-Langer & Colton, 1991; van Manen, 1977; Zeichner & Liston, 1987). By following Ma and Harmon’s (2009) design-based research and development process, we a) identified preservice teachers’ reflective journal writing problems in a Web-based educational assessment system and the tentative solutions to the problems, b) designed and developed the prototype of the journal writing scaffolds within certain theoretical frameworks, c) evaluated the effects of the prototype on preservice teachers’ critically reflective thinking in their journal writing, and d) generated the design principles for future similar undertakings.

Reeves (1995) and Richey (1998) believe that traditional research methodologies have largely failed to generate useful knowledge to guide instructional practice. Reeves (2000b) called for the validity and social relevance of research in the field of instructional technology. As a burgeoning research paradigm, design-based research holds the promise of introducing more socially responsible studies to help transform education (Collins, Joseph, & Bielaczyc, 2004; Design-Based Research Collective, 2003; Reeves et al., 2004). It is hoped that this study is a step in that direction.

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