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Abstract

This mixed-methods study examined the use of web-based portfolios for developing preservice teachers' reflective skills. Building on the work of previous research, the authors proposed a set of reflection-based tasks to enrich preservice teachers' internship experiences. Their purpose was to identify (a) whether preservice teachers demonstrated evidence of reflective thinking throughout a semester and, if so, the types of reflective thinking indicators; (b) whether there was an increase in the number of high-level reflective indicators over time; and (c) the role of the web-based portfolio construction, as perceived by the participants, in developing reflective skills. The findings suggested that preservice teachers demonstrated high- and low-level reflective skills throughout a semester. There was a statistically significant improvement in the number of high-level reflective indicators in the second reflection task compared with the first. In addition, the web-based platform was perceived by participants as a medium that enabled easy access and the development of better portfolio artifacts.

Keywords

teacher education/development, teacher learning, technology

> The reason I chose this class for my first teaching practice was because students in this class were quiet . . . I was overwhelmed with the ninth graders that I had observed [before] because they were loud and disruptive. Even my mentor teacher was having classroom management problems with them. On the other hand, they [ninth graders] were usually curious about the topics they learn so their participation was quite high. Thus, the lesson flows in this class. The class that I taught [10th grade], however, is not interested in learning. So it is the teacher's responsibility to make sure everyone participates. Class management used to be my top issue. However, my first teaching experience has made me realize that having students' participation was much more important [rather than having a quiet class]. (Student 9, Reflection Task 1)

This quote is from a preservice teacher who responded to a reflection task in her web-based portfolio in our study. The quote exemplifies a form of reflective thinking that we expected our participants to demonstrate throughout the last semester of their program of study.

Various commissions, boards, foundations, states, and local school districts identify developing reflective skills as a standard toward which all teachers and students must strive (Rodgers, 2002). Although the concept is difficult to operationalize, there exists a general agreement that reflection is an important goal of teacher education (Freese, 1999; Grimmett, Mackinnon, Erickson, & Riecken, 1990; Loughran, 2002; Wedman & Martin, 1986; Willard-Holt & Bottomley, 2000). Reflection is valued not only because it represents a frame of mind that serves as a powerful tool for problem solving but also for its outcome—meaningful professional knowledge (Loughran, 2002).

Teaching portfolios are described as tools that can be used to promote reflection (Borko, Michalec, Timmons, & Siddle, 1997; Evans, Daniel, Mikovch, Metze, & Norman, 2006). In this study, we employed web-based portfolios in which preservice teachers performed reflection tasks that were integrated into a teaching practicum course. Web-based portfolios offer several advantages over paper: They can be accessed anytime and from anywhere, and their products can be revised easily. One rationale for examining web-based portfolios was that there exists little research focusing on the use of web-based portfolios as tools for reflection (Avraamidou & Zembal-Saul, 2002; Zeichner & Wray, 2000). Another derived from the model that we adopted from Fuller and Bown (1975) to construct reflection tasks. We were interested in examining web-based portfolios because they provide affordances to implement the model. The web platform enabled us to add the *observations* by others easily into preservice teachers' reflective activities. Along with

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goals and *experiences*, *observations* are considered to be one of the anchor points of a teacher's life space (Fuller & Bown, 1975).

In this study, we aimed to examine the use of web-based portfolios for developing preservice science teachers' reflective skills. Building on the work of Fuller and Bown (1975), we proposed a set of reflection-based tasks to enrich preservice science teachers' internship experiences. More specifically, our purpose was to identify (a) whether preservice teachers demonstrated evidence of reflective thinking throughout a semester, and, if so, the types of reflective thinking indicators; (b) whether there was an increase in the number of high-level reflective indicators over time; and (c) the role of the web-based portfolio construction, as perceived by the participants, in developing reflective skills.

In what follows, we start by discussing the role of reflection in teacher education and that inseparable pair: reflection and teaching portfolios. We point out that what makes a teaching portfolio a powerful learning experience is reflection. We next examine the web-based portfolios and their unique advantages for use as reflection tools over traditional paper-based portfolios. However, we emphasize that we do not consider their technical aspects as the main determinants of their effectiveness. What we consider most important is the nature of the reflection tasks embedded in web-based portfolio construction. We next attempt to define the notion of reflection that guides the present study and introduce Fuller and Bown's (1975) model, on which we built our reflection tasks. The article then provides a description of the method, results, and a discussion of the findings.

Background

Role of Reflection in Teacher Education

Reflection as a means to initiate beginning teachers into a complex and demanding job has been on the agenda of many teacher educators. The emphasis on reflective practice is viewed as an attempt to merge theory and practice in teacher education (Orland-Barak & Yinon, 2007). It is believed that prospective teachers can establish relevant connections between theory and practice as they learn to reflect on their actions.

Meanwhile, the construct of reflection has been subject to philosophical critique (Fendler, 2003), and it is often conceptualized in different ways in the literature (Birmingham, 2004; Borko et al., 1997; Grimmett et al., 1990). However, there appears to be a general agreement that developing reflective skills is a valuable aim in teacher education (Freese, 1999; Loughran, 2002). Wedman and Martin's (1986) findings suggest that reflection helps to transcend the negative effects of the field experience. Willard-Holt and Bottomley (2000) find an association between teaching effectiveness and reflectivity. Freese (2006) shows that integrating reflection-based tasks into field-based experiences not only benefited preservice teachers but also benefited the author herself as a teacher educator by helping her to better understand the difficult process of becoming a teacher by reframing her assumptions. In learning to be reflective, teachers can go beyond being merely skilled technicians and develop the capacity to alter their teaching based on their ability to look back and make evaluations (Braun & Crumpler, 2004).

Reflection as the Key Element of Teaching Portfolios

Reflection is seen as the crucial component of teaching portfolios, transforming them from mere containers of information into powerful means of learning and assessment (Borko et al., 1997; Cambridge, 2001; Evans et al., 2006; Wolf, 1994; Yancey, 2001). In this regard, portfolios receive the most attention in teacher education because of their potential to foster reflective skills. Teaching portfolios can be viewed as spaces where preservice teachers represent their unique conceptions of what it means to teach by analyzing, discussing, and evaluating their own teaching practices and professional growth (Dana & Tippins, 1998). In addition, portfolio documents provide opportunities for initiating deeper conversations between teachers and supervisors concerning the act of teaching. These documents may also provide more focus and depth to consultations usually based on oral reports (Bird, 1990).

One can simply define a portfolio as "a collection of completed work" (Bobak, 2004). The general definition of portfolio lends itself to different types of portfolios serving a range of different purposes, such as (a) teaching portfolio as scrapbook, (b) portfolio as overflowing container, and (c) portfolio as extended resume (Wolf, 1994). Wolf considers each of these types of portfolios to be flawed for several reasons. Although they include artifacts related to teaching experience, these are not connected to the teacher's goals or the standards. Yet, the most critical flaw in these portfolios according to Wolf is the lack of "reflection by the teacher on the successes and problems encountered in teaching" (p. 114).

Although it looks good in theory, the value of portfolios for promoting reflection is not always validated in practice (Borko et al., 1997; Darling, 2001; Orland-Barak, 2005). To exploit the fullest potential of constructing portfolios, we made use of web-based technologies and carefully structured our participants' reflective activities, which are the next two topics we discuss.

Web-Based Portfolios

In this study, we employed electronic portfolios, specifically web-based portfolios, as tools for developing preservice science teachers' reflective skills. The term *electronic portfolio*, or simply *e-portfolio*, is used to refer to portfolios in

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electronic format, which allows users to collect portfolio artifacts in several media types (e.g., audio, video, text, graphics) and to organize these using hypertext links (Barrett, 2001). In this study, we preferred to use the term *web-based* portfolios, given that open source web-based e-portfolio software, namely, Mahara (2006), was utilized as the web-based platform.

Compared with traditional paper-based portfolios, electronic portfolios offer unique opportunities. Paper portfolios can be very cumbersome, whereas electronic portfolios can typically fit on a compact disc even when they contain large files. Thus, they are easier to manage (Johnson, Mims-Cox, & Doyle-Nichols, 2006; Kimball, 2003; Springfield, 2001). They can also be shared with a wider audience simultaneously, which increases their authenticity. In most schools, student work is usually kept private; it is visible only to the instructor and used only for assessment purposes. Kimball (2003) states that web-based portfolios are real publications with a real audience. Thus, sharing the portfolio with others has the potential to carry meaning beyond school assessment.

Electronic portfolios are also hypertext environments where portfolio elements can be linked in the most efficient ways. For Yancey (2001), this feature makes electronic portfolios different in kind rather than degree. The interactive character of the digital medium invites different types of interaction along with it. Electronic portfolios are viewed as live documents, as they are often works in progress (Johnson et al., 2006). Creators can easily edit and revise their previous entries, and can keep records of their progression which allow continuous documentation of their professional growth (Morris & Buckland, 2000). Some even argue that electronic portfolios support the "process" aspect of learning, as working with paper-based portfolios may cause the teacher to pay too much attention to the final product, rather than the process (Avraamidou & Zembal-Saul, 2002).

Web-based portfolios can be defined as electronic portfolios that incorporate web-based materials (Goldsby & Fazal, 2001). Thus, in addition to the advantages listed above, web-based portfolios enjoy all of the affordances provided by the web, such as easy access to the portfolio from anywhere and at anytime through the Internet (Pierson & Kumari, 2000), ease of sharing portfolio artifacts, and the ability to receive immediate feedback.

The potential of using web-based portfolios also manifests itself in the writings of the researchers who promote reflection and the use of portfolios in teacher education. Drawing from Dewey, Rodgers (2002) states that reflection needs to take place in interaction with others in a community. Recognizing reflection as a social process, Freese (1999) uses dialogue journals in her research. These journals were notebooks located in the mentors' classrooms for the preservice teachers to record their observations, questions, or comments about a lesson that they have observed. The mentor teachers respond to the preservice teachers' written questions or comments. It would be much easier to apply this idea on a web-based portfolio model in which both parties can easily access and edit the dialogue journals. One of the distinctive patterns found in electronic portfolios is that they are social; they are the vehicle for dialogue among students and faculty (Yancey, 2001).

Wolf (1994) states that constructing a portfolio is a collaborative performance. He emphasizes that portfolio elements need to initiate reflection and conversations about teaching rather than sitting in a container. He points out that regularly coming together and discussing teaching portfolios requires scheduling time. With web-based portfolios, arranging the time beforehand is unnecessary; moreover, web-based portfolios make the reflection and feedback cycle public to those involved in mentoring and coaching.

There is a limited body of research regarding web-based (or electronic) portfolio development in teacher education (Avraamidou & Zembal-Saul, 2002; Zeichner & Wray, 2000). In this respect, a few extant findings suggest that web-based portfolios also support meaningful reflection (Avraamidou & Zembal-Saul, 2003). Avraamidou and Zembal-Saul (2003) use web-based portfolios in a science methods course in conjunction with internship experience with preservice elementary science teachers. Their aim was to connect field experience and university coursework by supporting preservice teachers' reflection. The web-based portfolios included two components: course assignments and evidence-based philosophy about science teaching and learning. Concerning the evidence-based philosophy, preservice teachers were required to generate a series of assertions or claims and then support those claims with evidence (e.g., projects, observations, readings). Preservice teachers were also asked to write several versions of teaching philosophies throughout the semester. Avraamidou and Zembal-Saul concluded that web-based portfolio development could enhance preservice teachers' reflective and metacognitive activities.

Researchers have also addressed limitations posed by different forms of available software and technical skills necessary for constructing electronic portfolios (Springfield, 2001; Zeichner & Wray, 2000). Although web-based portfolios provide certain affordances to be used as reflection tools, we do not think that they are inherently better than paper-based portfolios. Following Zeichner and Wray (2000), what we consider most important is the nature of reflection tasks built on a sound theory and embedded in web-based portfolio construction. To move beyond the obvious conclusion that portfolios promote greater reflection, we carefully designed reflection tasks and examined how web-based portfolios afford preservice science teachers' reflection activities. In what follows, we discuss the notion of reflection that we adopt in this study and the theoretical framework that allowed us to construct reflection tasks.

Defining Reflection

The notion of reflection is ubiquitous in teacher education literature, yet its meanings differ—which perhaps signifies the difficulties of making the construct operational. In their

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review of the literature, Grimmett et al. (1990) identify three basic perspectives by focusing on the epistemological commitments of reflective processes studied in teacher education: studies focusing on (a) reflection as instrumental mediation of action, (b) reflection as deliberating among competing views of teaching, and (c) reflection as reconstructing experience. These views showed similarity with the three levels of reflectivity defined by Van Manen (1977), whose work builds on Habermas's (1971) three traditions of inquiry: *empirical*, *hermeneutic*, and *emancipatory*.

In the first perspective that Grimmett et al. (1990) define, reflective process is employed to help teachers recruit "technical" knowledge into their teaching to *direct* their practice. This view parallels to Van Manen's (1977) first level of reflectivity, which originates from the empirical–analytical paradigm. The second approach uses reflection not to direct practice but to *inform* it. The practitioner is expected to examine competing views of teaching and consider consequences of each in terms of student learning. For Van Manen, a similar perspective derives from the hermeneutic-phenomenological knowledge and represents a higher level of reflectivity. The third perspective includes an array of approaches that focuses on reflection as the *reorganization* or *reconstruction* of experience. This type of knowledge is used to transform practice, leading to new understandings of action situations, self-as-teacher, and taken-for-granted assumptions about teaching. In Van Manen's account, this type of reflectivity takes place at the critical-theoretical level and serves an emancipatory purpose.

Loughran (2002) suggests a view of reflection that enhances understanding of a situation from a variety of viewpoints. Freese (1999) defines reflection by drawing on the work of Loughran (1995) and Schön (1983) as "the process of making sense of one's experiences by deliberately and actively examining one's thoughts and actions to arrive at new ways of understanding oneself as a teacher" (p. 898). Korthagen and Wubbels (1996) characterize reflection as "the mental process of structuring or restructuring an experience, a problem or existing knowledge or insights" (p. 193). These perspectives highlight the idea that perception of experience and thoughts in new ways is essential, thus echoing the third perspective that Grimmett et al. (1990) identify in the literature.

Although the general, mostly implicit, contention is that reflection is a particular way of high-level thinking, some argue that the reflective cycle is only complete if it incorporates action as well (Birmingham, 2004; Rodgers, 2002). Loughran (2002) considers reflection that has an effect on practice as *effective* reflective practice. Yet the line between reflective thinking and action may be fuzzier than it first appears. Schön's (1983, 1987) two popular reflection constructs, *reflection-in-action* (RNA) and *reflection-on-action* (ROA), indicate the intertwined relationship between the two (Hatton & Smith, 1995).

Clearly, no teacher educator would value an isolated set of cognitive reflective skills if it has no impact on practice. In this study, reflection tasks are designed for the ultimate purpose of transforming our participants' action (i.e., their teaching). We hope to achieve this by enabling preservice science teachers to make sense of their teaching experiences and thoughts in new ways. In what follows, we discuss our strategy geared toward this goal that includes the processes of identifying and responding to the discrepancies among the three components of a teacher's life space, as suggested by Fuller and Bown (1975).

Reflection Strategies

Researchers have used a variety of strategies to stimulate preservice teachers' reflective thinking. Hatton and Smith (1995) identify four broad categories of approaches: (a) action research projects; (b) case studies and ethnographic studies of students, teachers, classrooms, and schools; (c) microteaching and other supervised practicum experiences; and (d) structured curriculum tasks. Within these general approaches, researchers mainly employed writing tasks, mostly in the form of journal writing, biographies, and reflective essays.

In a study in which autobiographical writing was required, social studies preservice teachers were provided opportunities to reflect on the experience of such writing (Braun & Crumpler, 2004). In the first part of this study, preservice teachers were asked to write about three life incidents drawn around one of the social science disciplines focusing on moments of "liminality," the transitional phase of personal change. Before submitting their assignments, participants shared their drafts in small groups and received feedback and comments. For the second part of the assignment, participants were asked to think about what they learned about themselves and what they learned about the social science concepts relevant to their experiences. They also developed ideas using the concepts they identified for instructional planning. This study showed that autobiographical writing in the form of social memoir helped preservice teachers to reflect on their life incidents through new lenses and to connect these incidents to their development as teachers. However, the participants in this study did not have a chance to implement the ideas that they developed in a real classroom setting and reflect on this experience.

Using the more structured form of essay writing, Chitpin, Simon, and Galipeau (2008) employ the objective knowledge growth framework (OKGF), which is based on the work of Karl Popper, to help preservice teachers develop reflective skills. Through this framework, preservice teachers went through cycles in which they were asked to offer a tentative theory for a given problem. They were then asked to refine their theories based on the results produced by testing them in empirical contexts. The OKGF framework proved useful in facilitating preservice teachers' reflective processes regarding classroom management problems.

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Table 1. Discrepancies Among the Three Aspects of Teachers' Life Space

Difference between experiences and goals	Difference between experiences and observations	Difference between observations and goals
The difference between what the teacher feels she or he is doing and what she or he wants to do (satisfaction with self).	The difference between what the teacher is seen to be doing and what she or he feels she or he is doing (incongruence).	The difference between what the teacher is seen to be doing and what she or he wants to do (evaluations).

Similarly, Orland-Barak and Yinon (2007) use a more structured approach with a set of guiding questions for preservice teachers to reflect on their classroom discourse. The purpose of these questions was to guide preservice teachers in identifying gaps or connections between what they planned to do and what actually happened in the classroom. In both of these studies, preservice teachers were provided opportunities to reflect on their practice by comparing their plans (or theories) with the actual implementation of their plans. Thus, the source of reflection included the preservice teachers' goals (guided by the theories they used) and their actual experiences.

We argue that a more comprehensive reflective process would consist of *observations* by others along with *goals* and *experiencing*. According to Fuller and Bown (1975), these three facets comprise the teacher's life space. More specifically, these are (a) the teacher's ongoing experiences, (b) the teacher's goals, and (c) the teacher's perceptions of observations about him or her.

Fuller and Bown (1975) state that for beginning teachers, there will be discrepancies among these three aspects of teacher's life space (see Table 1), and the experience of becoming a teacher entails coping with all three discrepancies. Reducing these differences is key to increasing teachers' satisfaction, genuineness, and self-control. And "[a]n important role of teacher education . . . is the provision of resources and remedies which reduce discrepancies among experiencing, observations, and goals" (Fuller & Bown, 1975, p. 45). Based on the model provided by Fuller and Bown, we designed reflection tasks in the context of web-based teaching portfolio construction.

Method

This is a mixed-methods study that combined qualitative data collection, analysis, and quantitative data analysis procedures. This type of design can be named as *exploratory mixed-method design* in which the researcher uses quantitative data analysis to refine and extend qualitative findings (Creswell, 2008). In our case, we collected qualitative data through web-based portfolio entries and an open-ended questionnaire. The qualitative data were analyzed both qualitatively and quantitatively. That is, we quantified some of our qualitative data and used statistical analyses to further support our qualitative findings (Shaffer & Serlin, 2004).

The Research Context

The study took place in a teaching practicum course offered at a research university in Istanbul, Turkey. Participants included 19 preservice chemistry teachers (eight male and 11 female) who were enrolled in the course in the last semester of their program of study. The participants were between 22 and 27 years old, and did not have any previous classroom teaching experience. The teaching practicum was a semester-long course in which student teachers were required to observe 60 lesson hours and teach at least two lessons at an assigned training school. They were asked to teach these lessons at different times during the semester to allow time for reflection and feedback.

The two members of the research team included an educational technologist and a teacher educator (first author), and a science educator (second author). The first author served as the principal investigator and as an "observer as participant" (Glesne, 1999). She had some interaction with the study participants, yet remained primarily an observer, providing technology support whenever needed. The second author was the instructor of the teaching practicum course in which the data were collected. Her role was more of a "participant as observer" (Glesne, 1999). She interacted with the study participants in and outside of class, observed the participants' teaching practices in the actual classroom settings, and graded and provided feedback on their portfolio artifacts.

The tasks defined below aimed to structure our teacher candidates' teaching practice experiences, involving preparing for the lesson (developing lesson plans), implementing the lesson plan in the classroom, and responding to reflection tasks following practice teaching.

Components of Web-Based Portfolios

An effective teaching portfolio is marked by three distinctive features. First, it articulates an educational philosophy and teaching goals (Wolf, 1994), which Dana and Tippins (1998) consider the essential purpose around which portfolios are structured. Second, it presents evidence to connect goals with practice. Finally, an effective teaching portfolio needs to include the owners' critical reflections on their decisions to become aware of their actions and thoughts (Wolf, 1994). Such a portfolio would be considered a *progress-oriented portfolio* rather than a *product-oriented proficiency*

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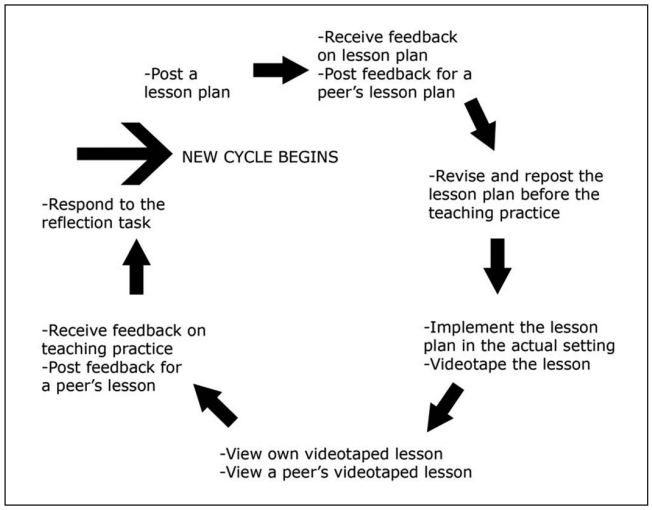

Figure 1. Internship assignments

portfolio, given that the main purpose of creating it is more to document the processes of learning than to demonstrate a showcase of exemplary work (Montgomery & Wiley, 2008).

In our study, the content of participants' web-based portfolios can be described in terms of two main parts: (a) internship course assignments and (b) reflection tasks based on these assignments. Both components were designed in ways that permit the preservice teachers to engage in all three essential processes of teaching portfolio construction: articulating goals, presenting evidence, and reflection.

Internship course assignments. Figure 1 shows the sequence of the course assignments. Preservice teachers posted their assignments to their web-based portfolios and revised their entries based on the ongoing feedback they received throughout the semester. All the artifact (lesson plans, teaching videos, and reflection task responses) submission and giving and receiving feedback were carried out through the web-based portfolios. The cycle started with posting a lesson plan.

These assignments reflected the components of the model that Fuller and Bown (1975) provide in the following manner.

For the *goal setting*, we asked participants to determine a general teaching goal to guide their lesson plans at the very beginning of the semester. These goals were supposed to reflect the participants' vision of science teaching. For instance, some participants developed inquiry lesson plans, whereas some employed visual materials (animations, pictures, etc.) in their teaching. The student teachers' intent in terms of selecting these goals was to test whether they would be able to implement such approaches in the classroom and to evaluate how such approaches might affect student learning. The participants discussed their goals in the class and received feedback to further shape their teaching goals. If the participants were not able to decide on teaching goals, they were directed to the *Teaching Standard B* in the document of *National Science Education Standards* (National Research Council, 1996) as a resource from which they could get ideas. The participants were expected to construct two lesson plans, addressing their general teaching goals along with their content-related instructional objectives. They received feedback on these lesson plans from their peers and the course instructor, and were expected to revise their lesson plans in light of this feedback.

The participants engaged with the *experiencing* part of the model by implementing their lesson plans at their internship school. These sessions were videotaped, and media files were uploaded to their web-based portfolios. We asked our participants to watch their videotaped classroom teaching sessions to help them "get back into the moment" (Freese, 1999) before responding to the reflection questions based on their experiences.

Videotaped teaching sessions also served as means for getting evaluators' point of view, comprising the *observation* part of the model. There were two evaluators: the course instructor and a feedback peer, who was a classmate. As the videos were shared through the web-based portfolios, they became visible to the evaluators. Each participant received feedback on their teaching session from their instructor and one of their classmates (i.e., their feedback peer). These evaluations provided the means for preservice teachers to respond to the reflection questions based on the *observations* by others. However, other people were not the only evaluators; sometimes the participants themselves functioned as the third eye, resulting in new realizations about their teaching.

Reflection tasks. Participants went through the course assignments cycle twice (Figure 1) and thus completed two sets of reflection tasks within a semester. Responding to a reflection task meant responding to three main questions, which were intended to help preservice teachers realize the discrepancies among their goals, experiences, and observations (see Figure 2). We constructed more specific subquestions under each of the main questions to help students answer them (see appendix).

Web-Based Portfolio Experience Questionnaire

In this study, we also examined the participants' general web-based portfolio experience. At the end of the semester, we asked them to reply to a questionnaire that consisted of a set of open-ended questions to understand their experiences with the web-based portfolios. Of the 19 students, 18 filled out the questionnaire. We analyzed the responses to the following questions as they relate to the present study: (a) Has anytime and anywhere access to your portfolio affected your work? Please explain. (b) Has the public nature of your portfolio affected your work? Please explain.

The Web-Based Platform

In Mahara, "My Portfolio" tab is divided into three sections: *My Views*, *My Files*, and *My Blogs*. In our study, we mainly

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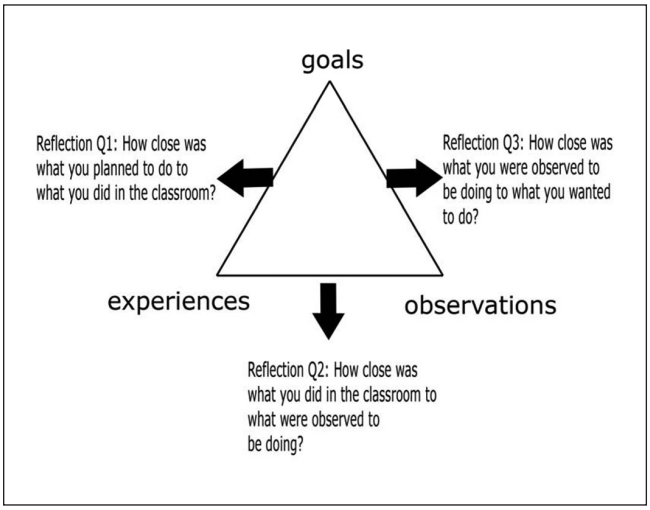

Figure 2. Reflection task questions

used the My Views and My Files sections for users to upload and share their portfolio products. Users were able to create separate *views* for each course assignment, such as their general teaching goals, lesson plans, reflection tasks, teaching practice videos, and feedback for classmates. Thus, each view corresponded to one portfolio artifact. They were able to create these views by directly typing the text or copying and pasting from an already available document into the text box provided by the system, or by uploading a file in any format. They could further edit their files at anytime they wished, even after other people viewed them. Participants were able to control who could access each view that they created. They were asked to allow their assigned feedback peer access to their views. Thus, the feedback that the participants received was not anonymous. Users also received email alerts when they received feedback on their portfolio artifacts. Both researchers were system administrators, so they were able to access all participants' portfolio pages.

Data Analysis

We analyzed two forms of data in this study: (a) the web-based portfolio entries of 19 preservice science teachers as a response to the two reflection tasks and (b) the same participants' replies to a questionnaire in which we asked them to evaluate their web-based portfolio experience.

The reflection data were thoroughly analyzed by reading, rereading, and coding to evaluate the participants' reflective skills. Specifically, the constant comparative method was employed in the data analysis (Glaser, 1965; Glaser & Strauss, 1967). Data coding started with dividing each participant's responses to each reflection question into meaningful units (Merriam, 1998). The length of a meaningful unit ranged from a minimum of two or three sentences to a large paragraph. Each unit of data was related to one particular event, feeling, idea, or issue, and conveyed information relevant to the aim of the study. The codes emerging from the data were named and defined, and as the coding proceeded, these codes were turned into categories (see below) according to the nature of participants' reflective skills. The subsequent coding either verified these categories or modified their definitions. NVivo8® qualitative data analysis software (QSR; 2008) was used to manage the data coding.

Data analysis indicated that students attempted to minimize the discrepancies among their *goals*, *experiences*, and *observations* (Fuller & Bown, 1975) in several different ways. The following categories were mostly observed when participants evaluated the congruency between their *goals* and *experiences*. However, this does not mean to suggest that these categories were nonexistent when evaluating the differences between *experiences* and *observations*, or between *goals* and *experiences*. Below we explain these categories and provide representative quotes. These quotes come from web-based portfolio entries in which students originally wrote in Turkish. The quotes were translated into English by the authors. The statements in brackets are added to make the meaning clearer, as the statements were situated within a broader context. Some irrelevant sentences are excluded by using bracketed ellipses. The categories identified from participants' evaluations of their *goals* and *experiences* follow:

1. Claim–Evidence (C-E): Making claims about whether certain goals are met during teaching and providing acceptable experience-based evidence to support the claims to associate goals and experiences. For example, we coded the following entry as C-E:

> Based both on students' responses to the questions in class and their written replies to the evaluation summary, I can say that all students grasped the topic. For instance, one student wrote, "A salt can be neutral, acidic, or basic. After finding its ions you need to check which compound they are coming from. If the acidic part is strong, it is acidic, or vice versa." Another student responded, "We have learned how to decide whether a salt is acidic, basic, or neutral by looking at its ion sources. Now, we know that a strong acid and base would give neutral salt, whereas the strong one dominates the salt when the other is weak. We need to know Ka/Kb values to calculate a weak acid and base reaction salt." (Student 10, Reflection Task 1)

2. Reflection-in-action (RNA): Evaluating experience and describing the emergent action taken (not always planned beforehand) during the experience to deal with the situation. For example, we coded the following as RNA: "I thought the class was 40 minutes, yet it was 45 minutes. So, I finished five min early. Then, I asked what other properties we would use [to separate compounds] (this was not in the plan)" (Student 1, Reflection Task 1).

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3. Goal-experience discrepancy (GED): Simply realizing and stating that some goals are not met during teaching, as in this case: "I had planned on asking students what they liked or did not like about the class. However, I could not do that since I was out of time" (Student 16, Reflection Task 2).
4. Describing experience (DE): DE from the point of view of the student that does not qualify as C-E. That is, sometimes students simply described what happened in the classroom without making any claims about what those events might indicate:

> They [students] had difficulty understanding the transitions of ions when I explained the salt bridge. The battery picture that I showed them depicted the salt bridge with two cups and a wall between them, not with the [conventional] U tube shape. This confused them, but I think I resolved the problem by explaining it with a drawing and showing them the videos. (Student 4, Reflection Task 2)

Students also recognized discrepancies as a result of considering the observations by others (feedback provided by peers and the course instructor) and self-observation (after watching their videotaped teaching session). Attempts to minimize discrepancies between observations and experience and between observations and goals mainly took the following forms:

1. Recognizing discrepancies (RECD): Reflecting back on the peer and instructor feedback and recognizing discrepancies between goals and experiences after they are pointed out by peers or the course instructor. In addition, students sometimes elaborated on possible changes they could have made as a result of this feedback. When considering participants' replies to others' feedback, we primarily focused on discrepancies rather than similarities identified given that we were interested in minimizing the discrepancies among the three main aspects of teachers' life space. For example,

> I was thinking that with my questions they [students] were able to interpret the graph and at least learn what is what. However, the feedback I received from my course instructor stated that I generally asked the "what" questions rather than the "how" questions, which would have helped students think, interpret, and discuss, and other thought-provoking questions without providing the direct answer. When I watched my video again, I realized that my course instructor was right. I was not able to create a discussion environment. Students simply provided the definitions and when I received those, I stopped asking more questions. (Student 13, Reflection Task 2)

2. Reflection-on-action (ROA): Reflecting on self-experience regarding goals and experience and elaborating on possible changes as a result of observing oneself from outside. The following is a representative quote:

> [If I repeated this class] I would request more explanations from students by paying more attention to their responses, considering their responses more carefully, also considering responses from students who had spoken without being given permission. Listening to students' predictions and making explanations based on those predictions enables them to understand the concepts more easily. (Student 1, Reflection Task 1)

As a result of observing oneself from the outside, participants sometimes expressed a form of higher level awareness regarding their teaching, their students' characteristics, or student learning that went beyond *survival* concerns (Fuller & Bown, 1975). We categorized such statements as ROA as well. The quote at the very beginning of this article is an example.

The reliability of the reflection data coding was established in two different ways. The codes defined here were created a year prior to the present study by coding the same type of data that were collected from a different group of preservice chemistry teachers. While coding the data for the present study, we saw that the categories fit into the data with minor modifications. In addition, 21% of the reflection data were independently coded by the two authors. Considering the parsing and coding of the data into the categories we described, we calculated the interrater agreement at 82%. The discrepancies were then identified and resolved through discussion.

To address our first research question, we coded each participant's web-based portfolio entry at each data collection point (first and second reflection task replies) in terms of the categories that we described. (To be more precise, coding and creation of the coding scheme took place simultaneously.) We calculated the total frequencies of the six categories across participants in the first and the second reflection tasks.

We further divided the six categories into two main classes: high- and low-level reflective indicators. These classes came into being when we asked ourselves whether the six categories were equally insightful. Some of these categories appeared to be higher level recognitions than others in terms of showing promise of minimizing the discrepancies among the three aspects of a teacher's life space. That is to say, participants whose responses were coded as higher level would be more likely to close the gaps among their goals, experiences, and observations. The codes that showed this kind of promise were C-E, RNA, RECD, and ROA. It is worth stressing that our reference point in making such a distinction is the Fuller

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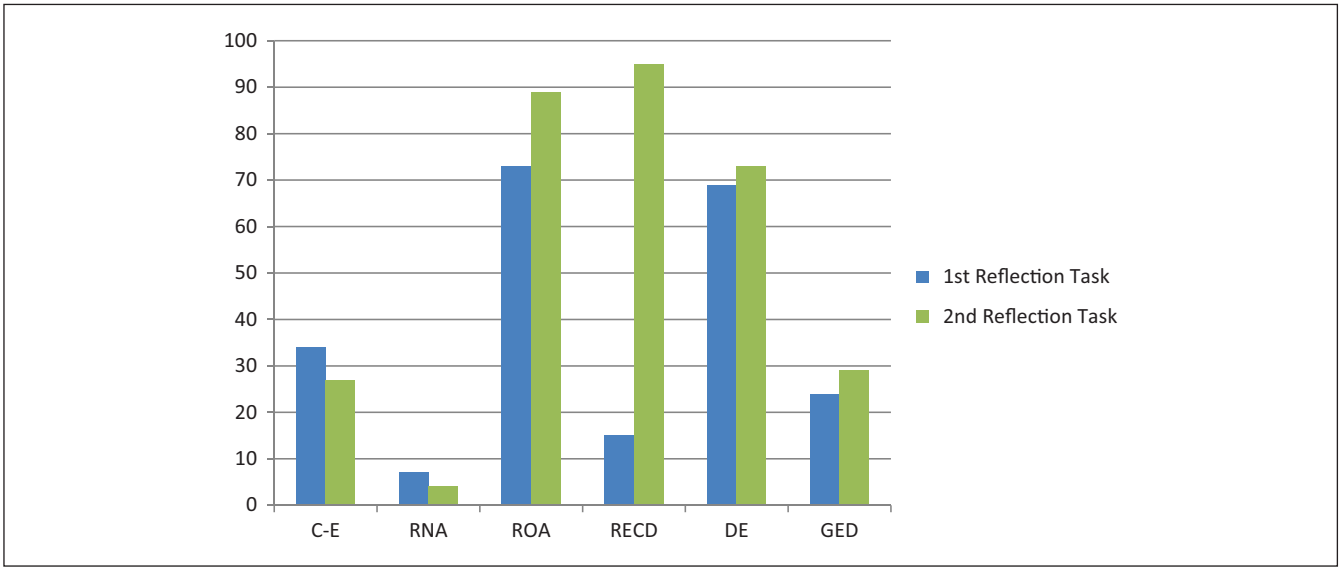

Figure 3. Distributions of reflection indicators in two reflection tasks (frequency)
Note: C-E = claim–evidence; RNA = reflection-in-action; ROA = reflection-on-action; RECD = recognizing discrepancies; DE = describing experience; GED = goal-experience discrepancy.

and Bown's (1975) model that we adopted in constructing the reflection task questions. Furthermore, closing the gaps does not mean "explaining away," or finding ways to evade the conflicting evidence coming from experience or feedback received. The codes that we defined capture the notion of reflection as a transformational act that we adopted in this study, indicating new ways of sense making regarding the teaching experience. The higher and lower level codes simply specify that there are different levels of doing this.

For our second research question, we calculated the frequency of high-level indicators for each participant for the first and the second reflection tasks (i.e., we summed the C-E, RNA, ROA, and RECD cases for each participant in two reflection tasks). We then conducted a Wilcoxon signed-rank test to identify the change in the number of high-level indicators from the first to the second reflection task.

To address our last question, we analyzed the questionnaire data by using NVivo8® (QSR, 2008). Similar to the analysis of the reflection data, we divided the participants' responses to each question into meaningful units (Merriam, 1998). Each of these units was taken to be a unit of analysis and was related to a particular idea or issue in response to the question we asked. In the initial reading, we categorized the meaningful units under tentative themes. In subsequent readings, the themes were refined and organized into larger themes that could help us to understand the role of web-based portfolios in developing participants' reflective thinking skills.

Results

The results section is organized around our three research questions.

Evidence of Reflective Thinking

In their responses to the reflection tasks, preservice teachers demonstrated evidence of recognizing discrepancies among experiences, observations, and goals. As discussed earlier, these realizations took several forms with different levels of sophistication, resulting in high-level or low-level classification of these indicators.

As can be seen in Figure 3, both high-level and low-level reflective indicators were evident in the first and the second reflection task replies of participants' portfolio entries. However, the distribution of the categories differed in two reflection tasks. Among low-level reflective indicators, the largest number of cases observed was DE cases in the first reflection task. Only a slight increase was observed in these cases in the second reflection task. We identified fewer GED cases in comparison with DE ones in the first reflection task, yet we also saw a slight increase in the GED category in the second reflection task. The preservice teachers also demonstrated high-level reflective skills in both tasks. In the first reflection task, the top two high-level reflective indicators were ROA and C-E cases. However, in the second reflection task, besides a noticeable increase in ROA cases, we also saw a substantial increase in the RECD cases. In the meantime, there was a small decrease in the C-E and RNA categories.

The following quote is an example of a lower level indicator (i.e., DE), in which the participant simply describes her teaching experience without making any claims about this experience:

> My lesson plan consisted of three different types of chemical reactions, but I only talked about the combustion reaction

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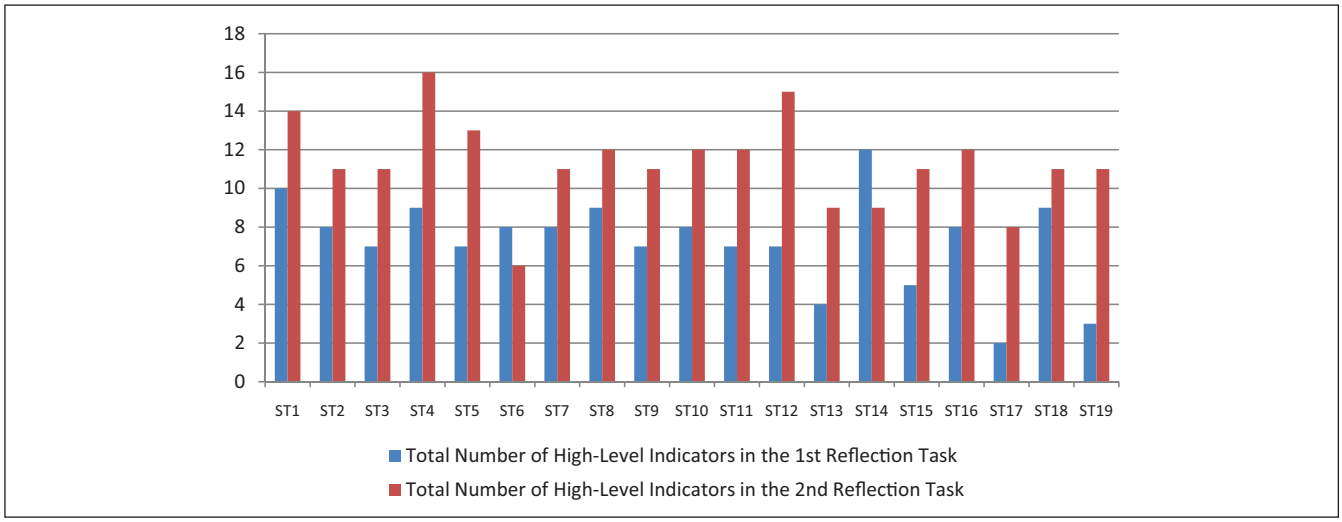

Figure 4. The total number of high-level reflection indicators in two reflection tasks across each participant
Note: ST = student.

> of different metals in the class. The aim was that students would be able to explain the properties of combustion reactions and relate such properties to metals reactivity. As I mentioned in my general teaching goal, I tried to help students think about the topic at hand and make meaningful connections between their observations and their previous knowledge. Therefore, I made use of the questions I asked in class and on the worksheet. In addition, I responded to students' questions with guiding questions, trying to make them question their own knowledge. I applied the POE [predict-observe-explain] method by asking the worksheet questions and following the students' responses. (Student 5, Reflection Task 1)

The same student wrote the following in the second reflection task that we coded as a high-level indicator (i.e., ROA), in which the participant articulated a deeper awareness about her teaching realizing that her questions may not be always clear to her students:

> It was beneficial to teach in a different class. This allowed me to meet students at different levels. In my first class [where I taught my first lesson], student participation was very high. I got answers to my questions from most of the students. So, in this plan I had not thought about question variability. However, students were not willing to participate in my lesson [this time]. And I realized that, besides preparing the main questions, it was necessary and important to be ready to ask further questions with several different probes. I learned that if we could craft our questions with respect to students' level of understanding, it would increase student participation. (Student 5, Reflection Task 2)

The Development of High-Level Reflective Skills

We also expected to see more high-level awareness regarding the discrepancies between goals, experience, and observations in the second reflection task. Calculating the total number of high-level indicators in each reflection task for each participant (see Figure 4), we conducted a Wilcoxon signed-rank test to determine whether there was a significant increase in the number of high-level reflection indicators (ST1 stands for Student 1, ST2 stands for Student 2, etc.). We used the Wilcoxon signed-rank test instead of a paired samples *t* test, as we did not assume normality due to small sample size. The *p* value for the one-tailed test was statistically significant ($Z = -3.595$, $p < .01$), indicating that there was a considerable improvement in student teachers' reflective skills from the first to the second reflection task.

Figure 5 shows the distribution of high-level indicators in the first reflection task replies for each participant. When compared with the same distribution in the second reflection task (see Figure 6), the biggest increase appears to be in the RECD cases for almost all students.

The Role of the Web-Based Portfolio Construction in Developing Reflective Skills

This section is organized around the two questions that we analyzed in the questionnaire data.

Effects of anytime and anywhere access to the portfolio. When asked about the effects of anytime and anywhere access to their portfolios on their work, only one student (Student 10) mentioned a negative drawback. She said that

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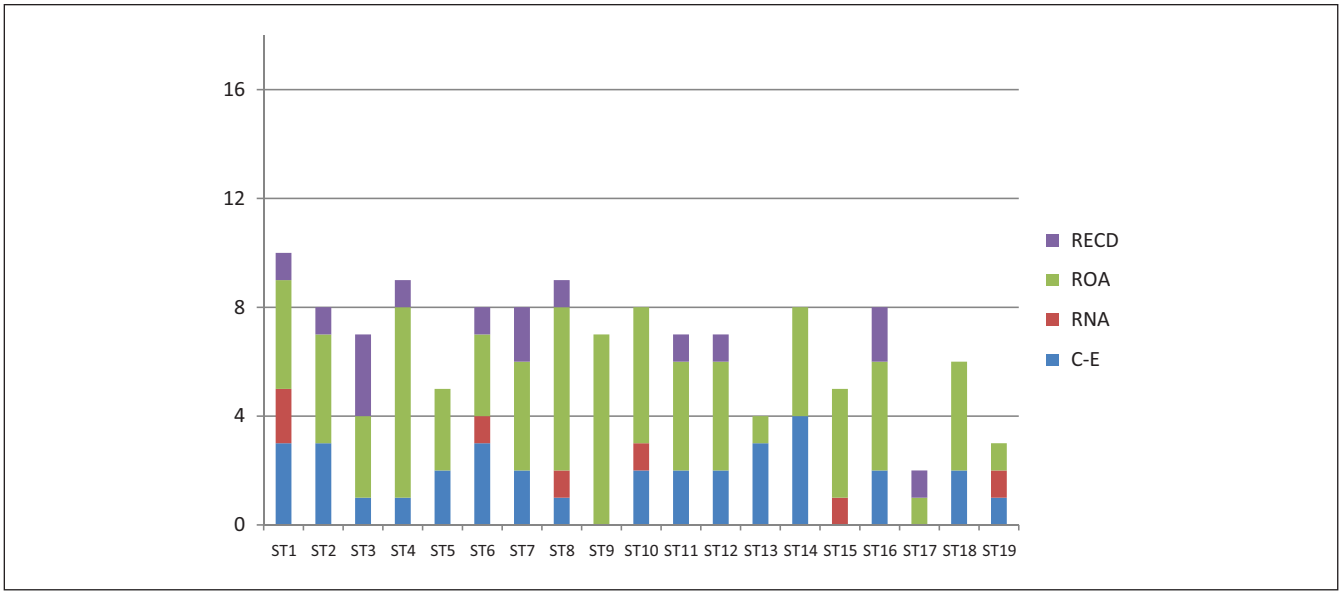

Figure 5. Distributions of high-level reflection indicators in the first reflection task for each participant
Note: ST = student; RECD = recognizing discrepancies; ROA = reflection-on-action; RNA = reflection-in-action; C-E = claim–evidence.

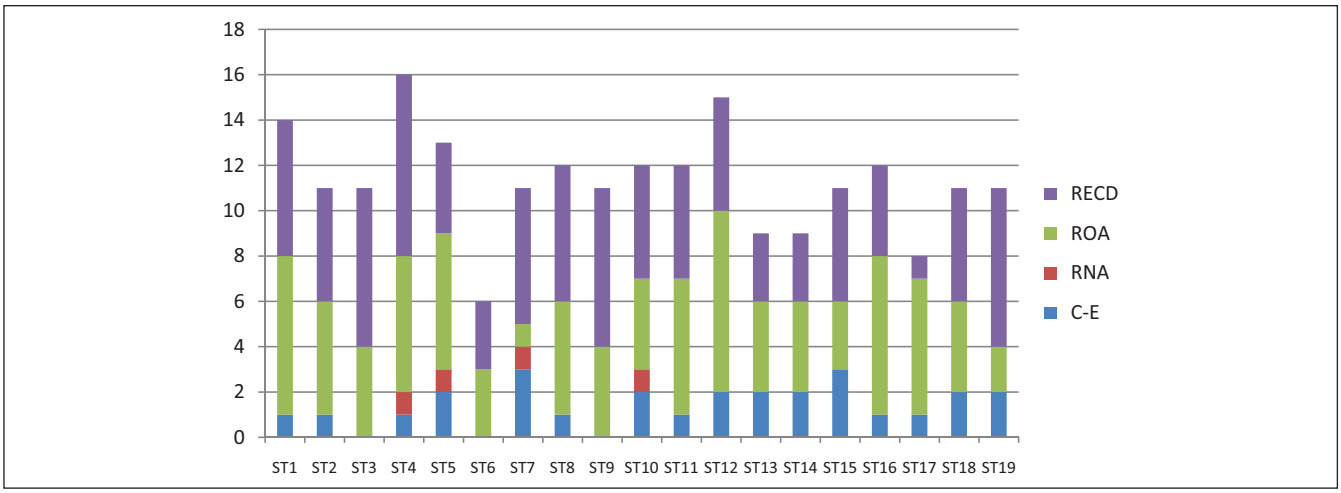

Figure 6. Distributions of high-level reflection indicators in the second reflection task for each participant
Note: ST = student; RECD = recognizing discrepancies; ROA = reflection-on-action; RNA = reflection-in-action; C-E = claim–evidence.

as the Internet environment does not require any printouts or actual handing in of the assignments, she procrastinated. However, all other students (94%) expressed positive reactions toward using the web-based platform. These students all articulated the benefits of easy access. For some of these students, the web environment was preferable, as they did not have to deal with paper, and it helped them organize their work more effectively. Some other students stated that with web-based portfolios, sharing work, and giving and receiving feedback was time efficient, it made communication and handing in assignments much easier, and it permitted editing of their work at any time. The following quotes represent some of these themes:

> It was easier to upload our assignments rather than handing them in. We were able to make changes until our work got its final shape. Being able to access the website made this easier. We were also notified about the changes made. It also made it easier to make use of the feedback that we received. (Student 5, Questionnaire Data)

> [Using the web platform] I do not [have to] work with only the documents on my computer. When I need to work on my assignments or check my portfolio, I can access it from different places. And this situation eliminates the problem of working at a specific time and place. I think this is very good. (Student 13, Questionnaire Data)

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Effects of the public nature of the portfolio. We also asked participants what effect the public nature of their portfolios had, if any, on their work. Among the responses to this question, an apparent theme was a perceived increase in the quality of participants' work due to the public nature of their portfolios. Half of the students ($n = 9$) clearly stated that they were able to produce better assignments as a result of two factors: (a) receiving feedback over the web (five of the nine students stated this) and (b) having to write to an audience (four of the nine students stated this). For example, one student said,

> The fact that the course instructor and my friends were able to view my portfolio helped me in two ways: (a) Rather than being merely a personal document, my portfolio became a document that could be improved with constructive feedback and (b) having this interaction over the web helped me save time. (Student 8, Questionnaire Data)

The following quote represents the subtheme that participants tried to make their assignments more comprehensible before posting them.

> Knowing that the course instructor and my friends would be able to view and evaluate these assignments forced me to write more clearly. Thus, I tried to write in a clear and detailed way. This also means that when I revisit [my page], I do not have to try to remember what was on my mind then (even many years from now). (Student 6, Questionnaire Data)

To summarize, a large majority of the students indicated the benefits of easy access to their portfolios through the web (94%). This enabled them to organize, edit, and share their work, and to hand in their assignments easily. Moreover, they were able to view each other's pages and receive and provide feedback on a timely manner with ease. In addition, half of the students clearly stated that the use of web-based portfolios positively affected the quality of their assignments. This was because participants felt the need to write more clearly to an audience, and receiving feedback helped them to improve their work. Revisions took place as a result of how others viewed their lesson plans and teaching performances. This also gave them the opportunity to reflect on the discrepancies among their goals, experiences, and how they are being perceived by others.

Discussion and Conclusions

The present study explored the development of preservice chemistry teachers' reflective skills as they were involved in web-based portfolio construction as part of their teaching practicum course. We analyzed the frequency and the nature of, what we called *reflective indicators*, in participants' replies to the reflection tasks. We also examined the role of web-based portfolio construction in developing preservice chemistry teachers' reflective skills, as perceived by them. The findings of the study showed that the participants demonstrated high- and low-level reflective skills in each reflection task. Moreover, we identified a statistically significant increase in the frequency of high-level indicators from the first to the second reflection task. In addition, the participants perceived the web-based portfolios as tools that allowed easy access and the development of better portfolio artifacts.

As Hatton and Smith (1995) point out, the notion of reflection is difficult to pin down, let alone render operational. The means for gathering and analyzing data are both challenges. However, this does not undermine the importance of reflection in the portfolio literature: It is considered to be the key aspect in transforming any collection of artifacts into a portfolio. In this study, we undertook the task of designing a reflection context and analyzing the data. We developed a reflective framework—a combination of course assignments and reflection task questions—that was embedded in a teaching practicum course in the context of web-based portfolio construction. We also developed a coding scheme that enabled us to distinguish among different forms of reflective approaches taken by preservice teachers throughout a semester.

In the literature, preservice teachers are inducted into the reflective discourse in several ways. Some researchers asked preservice teachers to relate the topics that they were to teach to their lives without actually implementing their ideas (Braun & Crumpler, 2004), whereas others required comparisons between plans and their actual implementation as the focus of reflection tasks (Chitpin et al., 2008; Orland-Barak & Yinon, 2007). Our study differed from these in that we asked preservice teachers to reflect based on a triangulation derived from goals, experiences, and observations, and articulate the discrepancies they found among these components. Using web-based portfolios enabled us to effectively add the crucial piece of others' *observations* into preservice teachers' considerations. Participants easily accessed each other's portfolios through the Internet and shared feedback on the artifacts they posted. This allowed them to consider their teaching practice from multiple viewpoints.

Our findings suggest that with carefully designed tasks and a medium that supports easy access and revision, preservice teachers can engage in meaningful reflection. Hatton and Smith (1995) argue that it is not sufficient to promote the potential of a strategy to encourage reflection; rather, it is necessary to document the particular types of reflection taking place. Along the same lines, we characterized the nature of reflective thinking demonstrated by our participants into six main categories (i.e., C-E, RNA, RECD, ROA, GED, and DE).

We do not, as Hatton and Smith (1995) do, suggest a hierarchical development sequence among the forms of reflection we identified. They considered RNA as the most complex kind of reflection. Their definition of this construct

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was derived from Schön (1983), just like ours, and referred to the utilization of multiple forms of reflection and perspectives during an unfolding professional situation. They argued that preservice teachers may follow a trajectory progressing toward *RNA* by first passing through the *technical* and ROA stages. As Schön himself stated, RNA requires extensive experience to develop. Given that our participants had limited opportunities to teach in real classroom settings, this may explain why we observed a low number of RNA cases in the data.

Although we did not suggest a developmental sequence among reflective indicators, we classified them into two main categories, considering some of them high level (i.e., C-E, RNA, RECD, and ROA). The common nature of these indicators was that they signified a deeper level of understanding about the discrepancies among goals, experiences, and observations. When we compared the total number of high-level indicators between two reflection cycles, we saw that our participants demonstrated more high-level reflective indicators over time. The biggest increase observed was on RECD cases. Student teachers received feedback on their first teaching practice from their peers only. However, the second teaching practice was evaluated by the course instructor. This shows the value of extensive expert feedback in the process of developing a reflective disposition. This finding corroborates Freese (2006), who emphasizes the importance of extended student teaching experiences with the guided assistance of mentors. It is worth noting that the increasing number of RECD cases in the second reflection task may also be explained by the power relationship between participants and the course instructor. Due to this relationship, participants may have felt the need to acknowledge their instructors' feedback. However, we still do not think that this undermines the reflective act taken by the participants. The realization still holds its promise, although it may represent a less mature stage.

We also observed an increase in the number of ROA cases in the second reflection task. This suggested that participants became more skilled in identifying areas that needed development in their teaching and proposing alternative actions for similar situations in the future. This may also mean that they got better at demonstrating a higher level of awareness about their teaching that has to do more with their students than with concerns about themselves.

Regarding the strategies that resulted in preservice teachers demonstrating evidence of reflective thinking, one may be inclined to consider the pieces of the reflective framework as the major factors helping them to articulate high-level reflective skills. However, this would disguise the role of the web-based platform. Although it may appear to be just a tool that mediated students' work, it is reasonable to argue that Mahara (2006) plays a much more important role in this study, facilitating the instructor's and participants' work in significant ways.

For the course instructor, providing timely feedback for an ongoing set of activities and monitoring student work usually requires very organized face-to-face meetings with the students. When other students are added to the feedback cycle, things may become even more complicated. Without using the web-based platform, it would be very hard, if not impossible, to coordinate the course requirements as they are designed in the present study. With Mahara (2006), the course instructor was able to access and monitor the students' work easily.

Mahara (2006) software enables participants to access their portfolios through the Internet at any time. This allowed them to post and edit their assignments easily. Participants were also able to access their feedback peers' portfolios so that they could easily write feedback on each other's lesson plans and teaching practice videos. We also saw that having a wider audience increased the authenticity of participants' work, as stated by Kimball (2003) and Rodgers (2002), causing them to write more clearly and understandably. But web-based portfolio use was perhaps the most critical with regard to the third component of the teacher's life space. That is to say, the *observations* aspect of the triangle would have broken down, or even been totally absent, without such a tool.

We do not mean to suggest that the web use could replace all the collaborative work taking place in the classrooms that focuses on helping teachers identify and deal with discrepancies among their goals, experiences, and observations. However, as teacher educators, we believe that it would be to the benefit of our students to couple technology use with a set of reflective activities that derive from a sound theory. We believe that doing this is especially important in a context where preservice teachers have very limited opportunities to engage in a reflective practicum, as in our case. We may also need to reroute our research endeavors regarding technology use in teacher education. Rather than asking whether technology is more effective than paper-based portfolios, we should be more concerned with what blend of activities would support reflective thought processes of preservice teachers—technology use being only one.

This study contributes to the existing literature by operationalizing the construct of reflection. It provides specific tasks for reflective practice for preservice teachers and a coding scheme for analyzing the outcomes of such practice. The study also identifies ways in which the advantages of the web can be utilized to develop reflective skills and suggests how teacher educators can integrate web-based technologies into preservice teacher education.

The preservice teachers in this study went through the reflective cycle only twice. Although we were able to identify significant gains in terms of the reflective indicators that we defined within these two cycles, the internalization of the reflection questions will probably require more time. Thus, one limitation of the study might be the time our participants had to work with such a model due to a semester-long

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practicum in which they only had two teaching practice opportunities. If we were able to implement more cycles, we might observe a further increase in C-E, ROA, and RNA indicators along with the RECD indicator. However, the model that we suggested still holds promise for developing reflective skills in contexts similar to ours. That is, we believe that the findings are transferable for preservice teachers who have limited opportunities for reflective practicum and practice teaching. Yet, further research is needed to confirm the effectiveness of the model in similar or different contexts.

For such a model to work more effectively, preservice teachers would need more reflective practicum opportunities in terms of the length and the number of teaching practices. However, simply increasing the time and the number of teaching practice occasions will not be sufficient. Teacher education programs need to structure preservice teachers' reflective practice experiences carefully. The present study offers an example of how that may be possible.

Appendix

Reflection Question 1: How close was what you planned to do to what you did in the classroom?

(1a) What were some of the indicators that you were able to achieve your lesson plan goals (both in terms of your general teaching goal and instructional objectives)? Please answer by providing specific examples of student responses and your interactions with students.

(1b) Were you able to implement your learning activities as you planned, or not? Were there any instances that did not go as planned in the classroom? Please discuss.

(1c) Please evaluate your teaching practice in terms of student learning based on students' learning products and your assessment at the end of the lesson.

(1d) Please explain at least two issues that you noticed regarding students' conceptual understanding or learning difficulties during your teaching practice by providing concrete examples.

(1e) If you were to repeat your lesson, what would you have changed to better meet your general teaching goal and instructional objectives? Please discuss at least three changes and your reasons for making them.

After receiving feedback, please answer the following questions.

Reflection Question 2: How close was what you did in the classroom to what you were observed to be doing?

(2a) According to your instructor and feedback peer, what were some of the indicators that you were able to achieve your lesson plan goals (both in terms of your general teaching goal and instructional objectives)? Compare and contrast their feedback with what you wrote as a reply to Question 1a. (Please summarize the feedback you received item by item, and respond.)

Reflection Question 3: How close was what you were observed to be doing to what you wanted to do?

(3a) According to your instructor and feedback peer, were you able to implement your learning activities as you had planned or not? Were there any instances that did not go as planned in the classroom? Compare and contrast their feedback with what you wrote as a reply to the Question 1b. (Please summarize the feedback you received item by item, and respond.)

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