Web 2.0 Tools and the Reflections of Preservice Secondary Science Teachers

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Abstract

This study examined the effect of using blogs as reflective journals during a methods course and practicum period on preservice science teacher reflections. The researchers investigated blogging and commenting as potential catalysts for critical reflection using an action research approach. The participants were 10 graduate preservice secondary science teachers (3 male, 7 female) ranging in age from 21 to 33 years old at a public university in Virginia. The researchers assessed the quality of their reflections each week for 10 weeks using a 4-level scale. Thirty percent of the preservice teachers reflected critically. Significantly less commenting occurred during the second half of the study ($\chi^2(1) = 9.62$, p *= .002). A higher percentage of the two highest ratings occurred when reflections were about preservice teachers' own actions (95%) compared to their observations of cooperating teachers (54.5%). Blogs have the potential to support specialized professional learning communities. This article discusses recommendations for modifications to methods courses. (Keywords: secondary science, preservice teacher, critical reflection, blog, RSS)*

The development of reflective practitioners has become a goal of teacher education programs. According to Schön (1987), the reflective practitioner reflects in and on action to solve nonroutine problems of practice. Shulman (1987) describes *reflection* as the act of "reviewing, reconstructing, reenacting and critically analyzing one's own and the class' performance, and grounding explanations in evidence" (p. 15). Science education researchers have used reflective practice to understand the development of teachers' pedagogical content knowledge (PCK) over time (Abell, 2007). For preservice secondary science teachers, PCK is the professional knowledge they develop that makes science concepts accessible to students and distinguishes science teachers from science subject-matter experts (Shulman, 1987). Subject-matter experts possess personal understanding of science content, whereas science teachers know science content and how to design instruction that helps their students learn science concepts. The variability within and between classrooms implies that preservice science teachers will encounter many nonroutine situations and must engage in reflective practice, including critical analysis, to develop PCK.

One component of teacher education programs is the practicum experience. In a practicum, the preservice teacher is placed with a cooperating teacher and experiences a minimum of 20 hours in a classroom setting. Preservice teachers are asked to reflect *on* action in practicum observations and *in* action during their practicum teaching experiences in the classroom. Preservice teachers must grapple with new, complex situations in classrooms and determine if teaching practices are effective based on student outcomes. When student outcomes reveal ineffective teaching, preservice teachers must consider alternative methods. The multifaceted nature of teaching may require preservice teachers to try multiple methods to find the best solution to nonroutine problems of practice. Therefore, the reflection process is often iterative as preservice teachers continue to work to solve problems. They develop PCK through reflection on their own teaching, observations of experienced teachers, and student outcomes in science classrooms.

In the course that is the context of this study, reflections have been traditional journal entries that preservice teachers shared exclusively with the instructor. However, in this study, the researchers asked preservice teachers to engage in collaborative reflective practice using blogs to provide multiple perspectives and build a community of practice. This study examined interactivity within the cohort and the reflective practice of the participants when they used blogs. The researchers hypothesized that qualities inherent in Web-based journaling, such as the potential for increased readership and two-way communication between authors and readers, could facilitate positive interactivity within the cohort and support critical reflection during the development of PCK.

Literature Review

Reflective Practice

The quality and depth of preservice teacher reflections can vary widely (Bean & Stevens, 2002; Korthagen, 1999). For example, teacher reflections can be limited to retelling the events without any consideration of the reasons behind the events or reconsideration of how an event might be better handled in the future. Reflections that are limited to historical accounts of events are insufficient to qualify as reflective teaching. For teaching to be reflective, the teacher must evaluate classroom events in terms of student outcomes. Professional practice is defined by purposeful action based on self-evaluations (Schön, 1987). Thus, building the skill of reflective practice facilitates professional practice and is a desired outcome of teacher education programs.

Table 1. Levels of Reflection and Their Characteristics

Level	Description	Characteristics
0	Habitual action or nonreflection	Description of events without evaluation
1	Understanding	Textbook theories are understood but not applied to practical or personal experience
2	Reflection	Theory is applied to practical situations; personal insights that go beyond book theory are made
3	Critical reflection	A change in perspective about a key concept or phenomenon occurs

(Kember et al., 2008)

Preservice teachers' reflective thinking must be evaluated to assess reflective teaching skills. However, there are no universally accepted processes for the evaluation of reflective thinking (Rodgers, 2002) or commonly accepted criteria for what constitutes reflection (Thorpe, 2004). Previous studies of preservice teacher reflections have used multilevel categorization schemes to distinguish between levels of reflective practice (Hatton & Smith, 1995; Kember, McKay, Sinclair, & Wong, 2008; Lee, 2005; Ray & Coulter, 2008; Ward & McCotter, 2004). However, researchers have operationalized the highest levels of reflection in different ways. For example, Hatton and Smith (1996) define *critical reflection* as evaluating the goals and practices of one's profession using ethical criteria, whereas Lee (2005) defines *reflectivity* as analyzing experiences through multiple perspectives with the intent of improving in the future. Ward and McCotter (2004) identified the highest level of reflection as *transformative*, defined by a reframing of perspective that leads to a fundamental change in practice, whereas Ray and Coulter (2008) identified the highest level of reflection as *metareflection*. Kember et al. (2008) calls the highest level of reflection *critical reflection* and defines it similarly to previous researchers' highest levels of reflection. Although each method used to classify reflection levels has merit, only the Kember et al. (2008) rubric has been tested for reliability and validity.

Critical reflection. According to Kember et al. (2008), four levels of reflective practice illustrate the process by which preservice teachers use observed events to develop PCK (Table 1). The four levels of reflection are (a) nonreflection, (b) understanding, (c) reflection, and (d) critical reflection (Kember et al., 2008). At the lowest level (nonreflection), a teacher describes a specific action without attempting to understand it. For example, a teacher plans a science lesson that uses a worksheet to teach a science lesson because the worksheet was available in a teacher resource manual, and the teacher notices that students do not learn the science content well from this lesson. The teacher does not understand the cause of this problem, and her reflections about the lesson are simply a description of what occurred during the lesson. To reach the next level (understanding), the teacher shows understanding of the theory or underlying reasons for a particular observation. She may realize that a lack of student engagement is a potential cause of poor student comprehension. To reach the third level (reflection), the teacher applies the idea of student engagement to this situation. She decides that a more engaging method, such as a hands-on experiment, would be more appropriate. This personal insight takes the teacher to the fourth level, critical reflection. After reflecting on her own understanding, applying the theory to a specific personal experience, and gaining personal insight, the preservice teacher changes her perspective and resolves to make different choices in the future.

Critical reflection is distinguished by careful consideration of beliefs, practices, and outcomes and the intent to use this information to modify future teaching behaviors. The conclusions from these evaluations are then incorporated into the preservice teacher' PCK. To develop personal philosophies of teaching, preservice teachers must be able to reflect at the two highest levels; however, reaching the highest level, critical reflection, is not common (Hatton & Smith, 1995; Kember et al., 2008).

The literature base on the reflective practice of preservice teachers reveals many factors that can promote or hinder critical reflection (Grant & Zeichner, 1984; Hatton & Smith, 1995). These factors can be grouped into three categories: (a) preservice teacher personal characteristics, (b) peer interactions, and (c) university professor support. The disposition and personal characteristics of the preservice teacher that can hinder critical reflection include: (a) individual tendency to be reflective (Zeichner, 1987), (b) personal fear of risk-taking, (c) lack of open-mindedness, (d) concerns about the expectations of university professors and cooperating teachers, (e) weak problem-solving skills, (f) perceptions of locus of control, (g) impeding ability to act on results of reflection, (h) preconceptions about the teaching profession that do not include reflective practice, and (i) a lack of awareness of actions and consequences (Grant & Zeichner, 1984). Peer interaction promotes reflective practice by providing multiple perspectives (Bean & Stevens, 2002; Shoffner, 2009), such as the use of group and pair collaboration or critical friends (Francis, 1995; Hatton & Smith, 1995). Support from the university professor also promotes reflective practice. Examples of this support include providing feedback, direction, and guiding questions before and after preservice teachers write their reflections (Stiler & Philleo, 2003; Zeichner, 1987). Course components such as microteaching and other supervised practicum experiences also promote critical reflection (Hatton & Smith, 1995).

Web 2.0 tools for reflection: Blogs and RSS. How prepared are preservice teachers to thoughtfully reflect? Previous research has shown low rates of critical reflection among preservice teachers (Chuang, 2010; Hatton & Smith, 1995; Ray & Coulter, 2008; Ward & McCotter, 2004; Yang, 2009) and has recommended

that teacher educators model and scaffold reflective practice in teacher preparation programs (Francis, 1995; Hatton & Smith, 1995; Korthagen, 1999; Zeichner, 1987). One way to accomplish this may be to change the vehicle used for reflective practice. A shift from traditional journals to blogs can facilitate interactivity that augments reflective practice.

Richardson (2009) describes *blogs* as reflections and conversations that are updated frequently and designed to engage the reader. Comments from readers engage the author in an online conversation, promoting reflective thinking and discourse (Ray & Coulter, 2008). Previous research has shown that dialogue (Hatton & Smith, 1995; Yost, Sentner, & Forlenza-Bailey, 2000) and peer networks (Clark, 1995) enhance reflective thinking abilities. Unlike traditional journals, blogs feature inherent (and immediate) audience access on the Internet and enable two-way communication with that audience. In the context of reflective practice, these features provide a means for preservice teachers to further probe into the theoretical grounding of an observed event, how the course of that event might be altered in a positive way, and how these changes could affect student outcomes. Previous research on preservice teacher blog usage has found that awareness of this expanded audience resulted in teachers expending greater effort in reflective practice and higher-quality reflective practice in journal entries (Ray & Coulter, 2008; Stiler & Philleo, 2003). By engaging an audience of peers and a subject-matter expert (e.g., science methods professor), the comment section of the blog-based journal can become a place to collect and thoughtfully consider multiple perspectives. Thus, the blog provides a venue where members of the preservice teacher cohort can collaboratively construct PCK through social interaction. Vygotsky (1978) suggests that social interaction is fundamental to the construction of knowledge; thus, increasing social interaction should foster individual reflective practice (Chuang, 2010). Prior research has shown that access to multiple perspectives of peers enhances reflective practice (Clark, 1995).

Previous research has utilized blog-based reflective journals with preservice teachers (Shoffner, 2009; Stiler & Philleo, 2003; Yang, 2009), but the effects of automatic subscription or commenting on reflective practice remain unexplored. The two-way communication affordance of blogs benefits both authors and readers by enabling comments that provide feedback not usually available using traditional journals. Interactive communication strategies have been used with traditional journals. For example, Hatton and Smith (1995) asked preservice teachers to work in critical friend pairs to talk, question, and confront each other to examine the process of teaching, using peer feedback to foster reflective action. They found that discussions in which aspects of teaching practice are questioned and examined facilitate the development of reflective practice in a significant way. The commenting features of blogs provide built-in opportunities for this type of feedback and discussion.

Web technologies can instantly deliver new blog posts to subscribers, speeding up the feedback process. Really Simple Syndication (RSS) is a technology that pushes Web content, or feeds, to subscribers automatically when content changes (Richardson, 2009). Previous blog studies with preservice teachers recommended the use of RSS to automate blog subscriptions to facilitate peer review (Chuang, 2010; West, Wright, Gabbitas, & Graham, 2006). RSS pulls information from blogs automatically into one convenient location, called an aggregator, for browsing and reading (Warlick, 2009). Through RSS, teachers instantly and effortlessly receive updated blog postings increasing the probability that blog entries will be read and commented on.

In conclusion, teacher training programs have adopted Schön's (1987) concept of the reflective practitioner, but there is no uniform criteria for reflective practice. Shulman's (1987) definition of reflection highlights the importance of critical analysis in reflection, but preservice teachers' reflections may or may not reach the level of critical analysis. Thus, teacher preparation programs that train preservice teachers to be reflective practitioners must continually evaluate, model, and scaffold reflective practice to ensure this goal is met. Critical reflection is a necessary component for the development of PCK. The Kember et al. (2008) critical reflection criteria align well with Shulman's (1987) definition. Previous research has identified several factors that help or hinder preservice teacher reflection. Of particular interest to this study, peer interactions and university professor support promote preservice teacher reflective practice, both of which can be facilitated through blogs. Blogging has the potential to encourage more critical reflection via increased social interaction. The use of RSS feeds to push blog entries to participants rather than requiring participants to go to each blog entry webpage increases the probability that participants will read and respond to each other's blog entries. Therefore, the following study examined whether blogging could be an effective vehicle to support preservice teacher critical reflection.

Method

Research Questions

The purpose of this study was to investigate how qualities inherent to blog-based journaling, such as the potential for increased readership and two-way communication between authors and readers, could sustain positive interactivity within a science preservice teacher cohort and if this journaling experience would increase the participants' level of critical reflection. The researchers examined two research questions:

1. How will the use of blogs for reflective journals during a secondary science methods course and practicum period affect preservice secondary science teachers' reflections?
2. Does the use of blogs for reflection support the process of becoming a reflective practitioner for preservice science teachers?

Table 2. Reflection Prompts for Weekly Observations, Demonstration, and Microteaching

Weekly Observation	Demonstration & Microteaching
What did I learn in the past week (in both the course and the practicum), and how did I learn it?	What were my goals for this teaching activity?
What remained unclear?	What happened? How did the activity/lesson go?
What did I do or observe in practicum in that past week that corresponded to what we've talked about in the course?	What student outcomes did I observe?
What do you suggest your CT and/or your professor do to help you progress?	What will I keep?
	What will I change/do differently next time I teach this?
	What did I learn about teaching and teaching science?
	What did I learn about myself?
	What are my goals now?

(Matkins, 2010)

Table 3. Reflection Scores for Each Participant

	Week										
Participant	0	1	2	3	4	5	6	7	8	9	10
A (Ally)	1	2	2	1	2	2	3	2	2	2	2
B (Bob)	1	0	0	0	1	1	0	1	0	0	1
C (Chris)	1	0	0	0	1	1	3	1		3	2
D (Dale)	2	1	2	2	2	2	1	0	2	1	2
E (Eric)	2	2	2	2	3	2	1	2	1	2	2
F (Fern)	1	2	2	1	1	2	2	2	1	2	2
G (Gale)	2	1	1	2	2	2		2	2	2	2
H (Harry)	1	1	1	2	2	1	2	2	2	2	0
I (Iris)	1	2	2	2	2	2	2	2	2	2	
K (Kayla)	2	1	1	2	2	1	2	1	2	2	2

Note. Week 0 scores are reflections on personal philosophy of teaching. Shaded scores in other weeks are reflections on microteaching and substitute teaching.

Table 4. Reflection Levels for All Blog Entries (N = 107)

Level	*n*	%
0 - Nonreflection	11	10.3
1 - Understanding	31	29.0
2 - Reflection	61	57.0
3 - Critical Reflection	4	3.7

Participants

The participants for this study were students enrolled in a science teacher methods course at a public university in the southeastern United States. Of the total sample ($N = 10$), three were male and seven were female; all were Caucasian and ranged in age from 18 to 33 years old. Eight were first-year master's students, and two were undergraduate students pursuing certifications in earth and space science ($N = 1$), biology ($N = 5$), and chemistry ($N = 4$).

Context of the Study

This program uses a cohort model in which the cohort completes an intensive, three-semester program resulting in a degree and a science-teaching certificate. The students in the cohort are scheduled in most of their classes together. The students had completed one semester of educational foundations coursework prior to the start of the methods course to establish baseline knowledge. The methods course occurs concurrently with a practicum during the second semester of the program. Preservice teachers learn about research-based science teaching practices while observing and practicing teaching in the practicum setting. While observing, preservice teachers are expected to compare what they are learning in the methods course with the observations of their cooperating teacher's classrooms. Practice teaching experiences included presenting a demonstration and microteaching, where a small group of preservice teachers delivered a bell-to-bell lesson multiple times. A 200–300 word written reflection was submitted each week of the practicum. The methods professor (the second author) provided questions for the preservice teachers to respond to in the blog entries. The professor have used these questions in her methods course for the past several years. The prompts for the reflections on observations in the classroom are different than the prompts for the reflections about the demonstration and microteaching (see Table 2).

In fall 2010, the previous method of journal entries (i.e., individual e-mails to the methods professor) was replaced

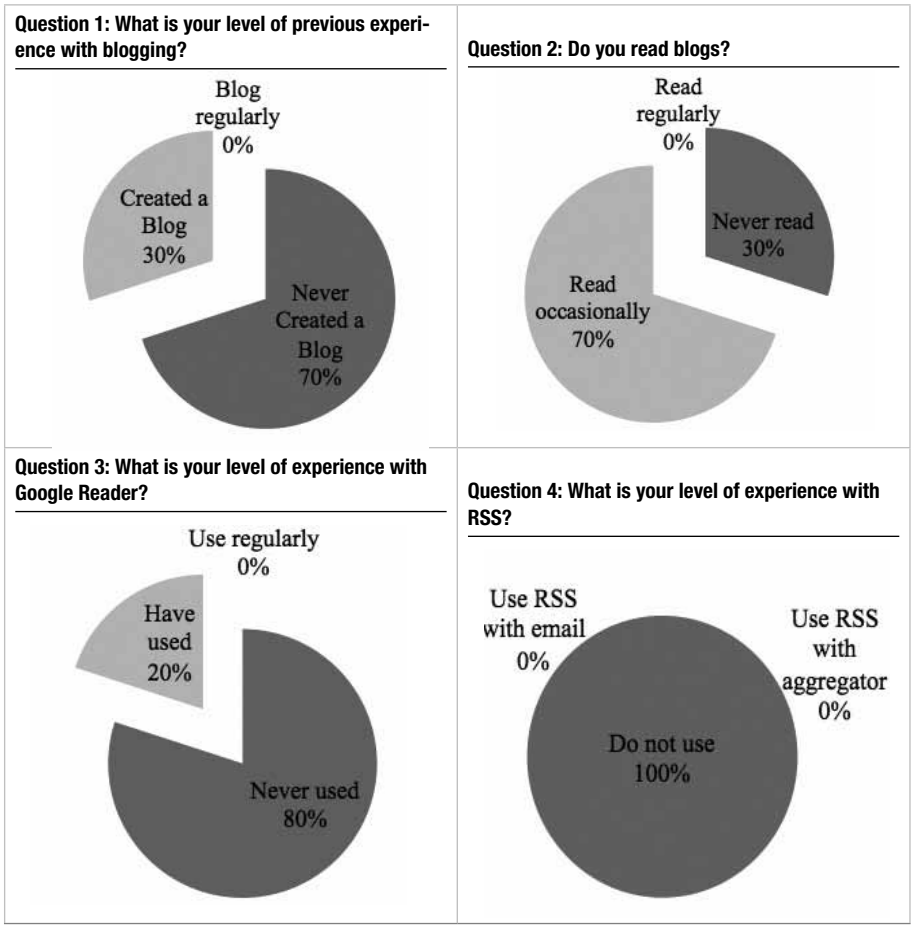

Figure 1. Results of technology survey ($N = 10$).

with individual preservice teacher blogs. The 10 preservice teachers in this cohort created blogs for personal reflective practice. The first author (a doctoral student and an experienced science teacher who participated in this course) and the second author (the methods instructor for this course) also created blogs. The cohort members, methods instructor, and first author each subscribed to the RSS feeds for the entire group.

The methods professor directed the preservice teachers to read the blog entries of at least three cohort members and comment on at least one blog entry each week. The preservice teachers wrote reflective blog entries each week, read the reflections of their cohort peers, and posted comments to cohort member's blogs. The authors read and commented on the preservice teacher blog entries to provide supportive feedback and asked questions of participants designed to promote critical reflection.

Participant Baseline Knowledge of Technologies

The term *digital native* (Prensky, 2001) has been used to describe people believed to have a higher comfort level with technology because of its ubiquity in their lives. Before embarking on this journey, it seemed wise to assess the participants' prior knowledge of the technologies we planned to use. Although the ages of the participants would place them in the digital native category, would they be comfortable using the technologies of blogs and RSS? The researchers administered a short survey to determine the participants' baseline level of knowledge (Figure 1). The survey clearly indicated that many of these participants did not have experience creating blogs or using RSS. In fact, none of the participants had blogged or read blogs regularly, used Google Reader regularly, or used RSS at all before this study began. Based on the survey results, the first author provided instruction during the first class meeting on how to set up a blog, set up an RSS reader, and establish RSS subscriptions.

Measuring the Level of Reflection

The researchers selected the Kember et al. (2008) method of assessing reflective writing for this study. Kember et al. (2008) utilizes four levels to categorize reflective practice (see Appendix A, pp. 37–38). Level 0, called *habitual action* or *nonreflection*, is characterized by the student's lack of attempt to understand the concept or theory that undergirds the topic. A nonreflective response is a historical account of events. An example of a Level 0 response would be the cooperating teacher delivering a description of a lesson without any attempt to conceptualize pedagogical decisions.

To reach the first level of *understanding*, evidence must be provided of understanding of a concept or topic without relating it to personal experience (Kember et al., 2008). For example, research on instructional strategies has identified the concept of wait time, a short period of silent thinking time that teachers use in classroom discourse, as an important variable in higher-cognitive-level learning (Tobin, Tippins, & Gallard, 1994). A Level 1 response might make reference to the use of wait time as a pedagogical theory but does not discuss how to apply it in the context of the observed lesson.

In the second level, *reflection*, the student applies theory to practical situations and makes personal insights (Kember et al., 2008). A Level 2 example could be a reflection where the preservice teacher specifically applies the concept of wait time to a lesson she observed or taught.

In the third level, *critical reflection*, there is evidence of a change in perspective in a belief about a concept or phenomenon (Kember et al., 2008). An example of this would be a preservice teacher who previously did not understand the need for structure in classroom activities, but after delivering a poor lesson in his own classroom, he realizes that structure serves a definite purpose and benefits students.

The researchers observed the blog entries and comments of the cohort over the course of a semester. The researchers used the method that Kember et al. (2008) established to rate the level of reflective practice in each journal entry (see Appendix A). The researchers rated each blog entry as a single, holistic unit. Because reflections were developed throughout each blog entry, the researchers assigned one rating for the entire entry based on the highest level of reflection in that entry (Kember et al., 2008). Two raters independently rated each blog entry. The researchers performed an inter-rater reliability analysis using the kappa statistic to determine consistency among raters.

Results

Reflective Level of Blog Entries

Two raters rated each blog entry. The inter-rater reliability for the raters was found to be Kappa = 0.814 ($p < 0.001$), 95% CI (0.748, 0.934). This value of Kappa considers only exact matches. When categories are ordered, close matches are considered through linear weighting (Cohen, 1968), and the weighted Kappa = .873. This was considered a very good level of agreement between raters. For the purposes of further analyses, the raters resolved disagreements in ratings through discussion until reaching consensus. Table 3 displays the ratings, and Table 4 (p. 30) displays the frequency counts. The researchers assigned each participant a pseudonym for ease of reference.

Overall Distribution of Reflective Level Scores

Thirty-nine percent of blog entries were at the nonreflection (Level 0) or understanding (Level 1) levels, and 61% of the blog entries were at the reflection (Level 2) or critical reflection (Level 3) levels. Of the 107 entries assessed, only 3.7% were found to be at the highest level (critical reflection).

Differences in reflective practice levels. The data shows some differences between participants in reflective level. Most of the participants' reflective practice (86 %) falls in the range between 1 and 2. The following two examples illustrate reflective practice typical of Level 1 and 2. In this first example of a Level 1 reflection (understanding), Bob notes that baseline knowledge is an issue of concern but does not know how to address it:

> I went in on Wednesday and Thursday and subbed for her.… I got to run a PowerPoint on enzymes and chemical reactions. It was fun, but I ran into the same problem I had when I was doing my microteaching: assuming the students have more background knowledge than they do. (Bob, Week 5 blog entry)

Bob understands the concept of baseline knowledge but does not apply it to this context, nor does he have any insights about how to solve his problem. Understanding a concept but not applying it in context typifies a Level 1 reflection. For reflective practice to reach Level 2, the preservice teachers must apply concepts in the context of the classroom.

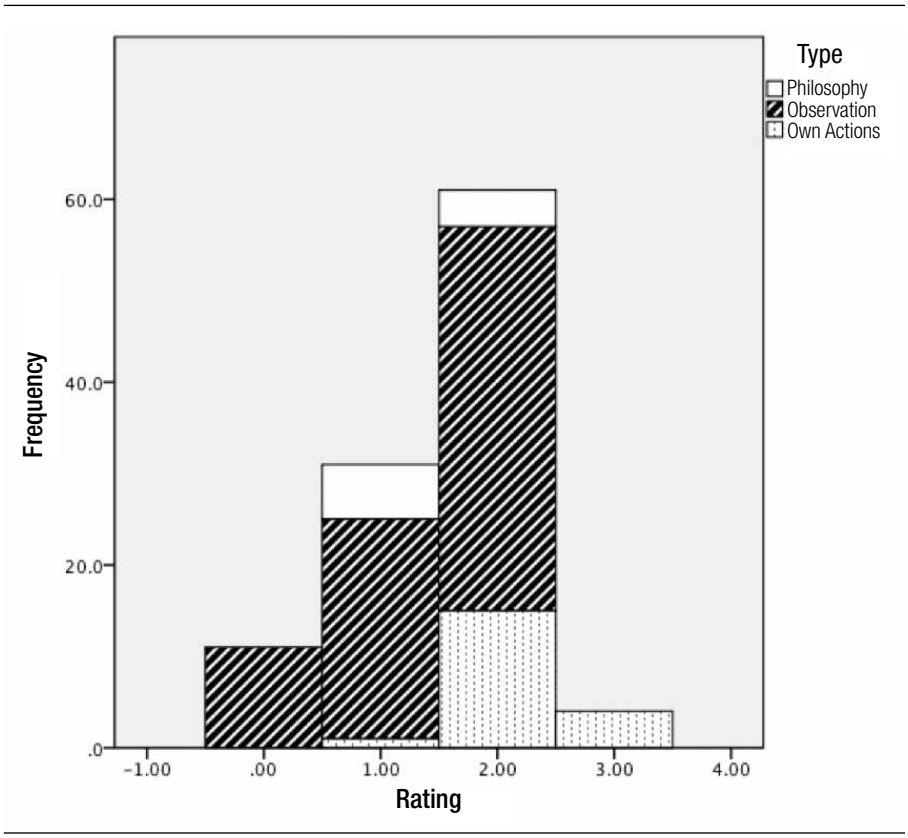

Figure 2. Reflection levels of blog entries by type.

In this example of a Level 2 reflection, Erin is attempting to compare her cooperating teacher's use of lecture to the methods she is learning at the university:

> Currently, the lessons I am observing strictly follow my cooperating teacher's philosophy on teaching "the students should be doing more work than me, they can teach themselves and teach their peers and I am simply there to guide them through the content when necessary." If a teacher lectures for an entire class period but the students are engaged the entire time, is that a bad lesson? ... My teaching style will be dependent on me, and what techniques works best for me to reach the most kids. (Erin, Week 3 blog entry)

Erin applies the concepts of direct instruction and engagement to her observation of her cooperating teacher, showing that she can apply the theory to a personal situation. Erin also makes

Table 5. Reflection Levels in Observation (n = 77), Own Actions (n = 20), and Philosophy (n = 10) Blog Entries

Level	Observations		Own Actions		Philosophy	
	n	%	*n*	%	*n*	%
0 - Nonreflection	11	14.3	0	0	0	0
1 - Understanding	24	31.2	1	5.0	6	60.0
2 - Reflection	42	54.5	15	75.0	4	40.0
3 - Critical Reflection	0	0	4	20.0	0	0

an insight about her own teaching style. Application of theory in context and personal insights exemplify Level 2 reflections.

Two of the preservice teachers, Bob and Chris, had reflective scores that were consistently lower than those of their peers. An example of a Level 0 response is:

> Soon enough the classes began, and I was introduced, and proceeded to receive a lot of questions about my beard (the students seemed really interested in it). My teacher used a Promethean throughout the day, and I was pretty interested to see how it worked. There were a couple of really neat things that [my cooperating teacher] does that I'm already very interested in. For example, she has her kids keep their own grade log that includes an overall goal for grades that they set at the beginning of the year. (Chris, Week 3 blog entry)

Chris gives an historical account of his observation of his cooperating teacher's classroom. He makes no mention of concepts or theories, typical of a Level 0 reflection (nonreflection).

Participants with lower mean reflection levels may have lower levels of PCK. However, an alternate explanation may be an individual preference for nonwritten modes of reflection over written reflection. For example, a case study by Lee (2005) compared written and oral reflections for individual preservice teacher in the practicum and found higher levels of reflection for oral reflections compared to written reflections for the same preservice teacher. Future studies should triangulate findings by using periodic interviews to determine if the written reflections are truly representative of the actual reflective practice of that individual.

Reflections on own actions compared to reflections on observations. The reflection scores for the blog entries of most participants do not show growth in reflective level over the course of the study. However, some blog entries were at notably higher levels than other entries. Closer inspection revealed that the blog entries with the higher scores were consistently about the participants' own actions in microteaching or substitute teaching. We reviewed each blog entry and assigned it a code of *own actions* or *observations* to indicate the subject matter of the blog entry. Blog entries labeled *own actions* were participants' discussions of classroom experiences in which they were the teacher in the classroom. Blog entries labeled *observations* were participants' discussions of classroom experiences in which they were an observer of activities that the cooperating teacher conducted. In Table 3, the scores for blog entries coded as *own actions* are shaded. In Week 0, participants posted their personal philosophies and visions of teaching, and these entries were coded as *philosophy*. The other highlighted entries represent microteaching, demonstrations, or substitute teaching experiences. Figure 2 shows the breakdown of the blog entries by code.

The researchers then compared the three different categories of blog entries—own actions, observation, and philosophy—by reflective level breakdown (see Table 5). This breakdown shows that levels of reflection were generally higher when participants reflected on their own actions, such as demonstrations and microteaching, rather than the observations of their cooperating teacher's classroom. Ninety-five percent of preservice teachers' reflections about their own actions were at Level 2 or 3, compared to 54.5% of reflections about observations. Therefore, reflections about preservice teachers' own actions were more likely to be at Level 2 or 3 than reflections about their observations of the cooperating teacher.

Level 2 or 3 should be the target level for preservice teacher reflection. A goal of the methods course should be to have the majority of preservice teacher reflective practice at Level 2 (reflection) or 3 (critical reflection). At Level 2, teachers are applying theory to practice in the context of a real classroom and beginning to form insights that could transform practice. This is the level where reflective teaching begins.

An examination of two examples from this study shows how critical reflection helps preservice teachers develop PCK. In this example, Iris describes insights she has after her demonstration of strawberry DNA extraction that begins this process of transformation:

> One question asked, "…Would you expect the method of DNA extraction to be the same for human DNA? … One answer I received was "probably not because we aren't strawberries." I was very disappointed with the answer. Only one person put down the fact that human cells do not have a cell wall because they are animals cells.
>
> In the future, I would not use this lab as a demo. I feel that the students would learn better if they got to extract the DNA themselves rather than watch me do it. I also feel that a demo is very hard to do in a class of 25 students… I do not feel that all the students were able to see very well…I would allow time to discuss the questions at the end of the lab. (Iris, Week 6 blog entry)

Iris develops insights that guide her decisions for changing this activity through examination of student outcomes. This reflection is at Level 3, critical reflection. In another example,

Table 6. Prevalence of Participant Commenting for the First Half and Second Half of the Study

	First Half		Second Half			
Type of Comment	*n*	%	*n*	%	$\chi^2(1)$	*p*
Left by Participants	39	70.9	16	29.1	9.62	< .01
Received by Participants	103	73.0	38	27.0	30.0	< .01

Erin describes insights and changes to practice that she and Bob will make during their microteaching experience:

> We looked through the students' textbook in order to decide what content we wanted to cover on macromolecules making sure it lined up with an SOL objective … we went into way too much detail…. We were both shocked at how little the students really needed to know. We started off with 33 slides and whittled it down to 21 by lecture three.… When presenting our content, I think it would have been more beneficial if we had split up our material with an activity, because it was a lot of new information and some students looked a little overwhelmed. (Erin, Week 4 blog entry)

Erin's personal insights led to transformations of thinking and changes in practice. These qualities exemplify a Level 3 reflection.

When reflections were about classroom observations, 45.5% of the reflections were at Level 0 or 1. Thirty-one percent of the reflections made about observations of the cooperating teacher were at Level 1, indicating that some preservice teachers did attempt to make connections between the cooperating teacher's choices and theories discussed in the methods course but did not form insights as to what changes could be made to improve instruction. This implies that critical reflection at the highest level is facilitated by active engagement in and responsibility for the teaching process. Without personal responsibility, preservice teachers may not be prompted to recognize the need for change.

Specific prompts scaffold reflection levels. An alternate explanation for the lower reflection levels may simply be because the professor did not specifically ask the preservice teachers to use the same guidelines to analyze the cooperating teacher's classroom as they used when they analyzed the demonstration and microteaching activities. In Table 2, the prompts given to the preservice teachers are shown. Analysis of these prompts shows that several of the response prompts for the reflections on their own actions provide scaffolding to facilitate critical reflection. Level 2 (reflection) requires application of concepts to personal experience to form personal insights. The majority of the prompts are directed at the personal experience of the preservice teacher, which elevated the reflection level to Level 2. Level 3 (critical reflection) occurs when the preservice teacher expresses intent to change his or her teaching practice as a result of an insight. Questions 5 and 8 specifically target critical reflection by asking the preservice teachers what they will change or do differently and what their goals are after this experience. Thus, the differences observed between preservice teachers' reflections on their own actions compared to classroom observations may indicate that they followed the guidance provided by the prompts. This implies that the use of different prompts for the classroom observations could make a substantial difference in the quality of preservice teachers' reflections.

Discussion

Development of Reflective Practice in Preservice Teachers

A notable finding of this study is a lower level of reflection when preservice teachers are reflecting on observations of their cooperating teachers. One way to improve this practice may be to provide more specific guidance to cooperating teachers on useful conversations they should have with the preservice teacher. In particular, metacognitive discourse between the cooperating teacher and the preservice teacher could provide pedagogical grounding for choices made by the cooperating teacher. If cooperating teachers communicated the reasons for their planning and instructional choices, preservice teachers could then compare those reasons to their own personal philosophies of teaching and observed student outcomes to evaluate them. Bridging the gap between the PCK of the preservice teacher and that of the experienced teacher could improve preservice teachers' reflective practice. If cooperating teachers are aware of the objectives of the methods course, those objectives could be focal points for productive discussions. There was evidence of the value of metacognitive discourse when one cooperating teacher created a panel discussion for his preservice teacher to give her feedback on an activity she developed:

> My [cooperating] teacher invited me to attend because he wanted to present my unit conversion lesson to the committee to gain feedback and give the rest of the group.… It was a great experience to hear from other experienced teachers, but also see their metacognition about what students need to greater enhance the lesson to meet those needs. (Fern, blog entry Week 7)

In future studies, preservice teachers might reach greater degrees of reflection if the methods instructor established a focus for the observation. For example, after a class spent discussing levels of inquiry in science investigations, preservice teachers could be instructed to analyze a practicum observation in terms of the level of inquiry the teacher selected and its appropriateness for instruction considering the readiness of the students and the complexity of the content. If scaffolded reflective experiences are provided, preservice teachers could develop greater reflective skills during the practicum period. However, it is important to note that critical reflection may develop over extended time

Table 7. Exit Survey

Questions
1. Overall, how would you rate your satisfaction with using a blog for a reflective journal? Use a scale of 1 to 10, where 1 = completely dissatisfied and 10 = very satisfied.
2. How would you rate the ease of use of Wordpress? Use a scale of 1 to 10, where 1 = very difficult to use and 10 = very easy to use.
3. How would you rate the usefulness of Google Reader? Use a scale of 1 to 10, where 1 = not useful at all and 10 = very useful.
4. How would you rate the usefulness of having your peers read and comment on your reflections? Use a scale of 1 to 10, where 1 = not useful at all and 10 = very useful.
5. How would you rate the usefulness of Google Reader for keeping current on science topics? Use a scale of 1 to 10, where 1 = not useful at all and 10 = very useful.
6. How comfortable are you with writing reflections online in a blog? Use a scale of 1 to 10, where 1 = very uncomfortable and 10 = very comfortable.
7. Do you have any suggestions to change how technology tools were used in this course?
8. Which of the following items do you think affected the level of participation in blogging and commenting in this course? Check as many as apply.
a. Lack of time
b. Concern for privacy
c. Did not remember to do it
d. Technology problems
e. Other (write in)

periods rather than in one entry in a blog (Clark, 1995). Preservice teachers may have to reframe a problem of practice in an iterative manner, over time, before an insight that triggers a transformation of thinking occurs. Future studies should track these problem themes over an extended time period to observe how they are resolved.

In this study, the researchers observed higher levels of reflection when teachers analyzed their own performances. However, in practica, preservice teachers spend more time observing the actions and decisions of the cooperating teacher. Richer information would probably be obtained by conducting this study during the student teaching time period, because the teachers have more opportunities to learn by doing instead of learning from observing. It is likely that the reflections the preservice teachers made during the student teaching period would be at higher reflective levels and that they would have more personal insights that might change beliefs about teaching. This finding of lower levels of reflective practice in observations of the cooperating teacher implies that reflections during the practicum period might be better utilized in a more structured way by providing teachers with specific prompts or foci to direct their observations.

Specific instruction is needed to inform preservice teachers of the critical features of reflective practice. Methods instructors should model the process of reflective practice. This recommendation is supported by a comment made by a preservice teacher during an interview: "Someone should have told us what reflection is at the beginning of the course. Everyone wants us to reflect and no one explains exactly what reflection should be" (Harry, personal communication, December 13, 2010). Implementing a curriculum to purposefully build reflective practice skills during the practicum period could result in higher-quality reflections during the student teaching period (and beyond) that may better facilitate the development of personal philosophies of teaching. Careful selection of topics that map to the objectives of the methods course would help preservice teachers to synthesize theory and practice. These topics might include:

- Planning instruction guided by student misconceptions
- Teaching about the nature of science
- Questioning and wait time
- Levels of inquiry and experimental design
- Strategies for working with high-needs students
- Strategies for making science relevant and meaningful for all students

If preservice teachers reflect on common topics, they will share multiple perspectives. Critical discourse could result as preservice teachers question their beliefs and the rationale behind the beliefs. However, to have discourse within the blogs requires a high rate of interaction between participants.

Limitations of the Present Study

A limitation of this study is a low rate of interaction among cohort members using the blogs. Table 6 shows the number of comments that each participant left and received. The average number of comments each participant left was fewer than one per week. The researchers noted a trend in which the number of comments left dropped dramatically when comparing the first half of the study to the second half. The researchers used the chi-square test for goodness of fit to compare the comments the participants left in the first and second halves of the study. Table 6 presents the observed frequencies for participant commenting for each half of the study. With alpha equal to .05, a chi-square test on these frequencies was statistically significant, $\chi^2(1, N = 55) = 9.62$, $p < .05$. Participants were significantly more likely to comment in the first half of the study than the second half. This may indicate a novelty effect; perhaps participants were more interested in the blogs at the beginning of the semester than at the end of the semester. This may also be because the instructor was not as consistent with her own blog posting and comments as she would have preferred. In this setting, the methods professor travels to each preservice teacher placement site for multiple observations during the semester. Time constraints limited the amount of interaction that this professor can facilitate via blogs, which may have affected participant perceptions of the importance of keeping up with blog posting and commenting. However, the amount of feedback the preservice teachers received in discussions with the professor after observations is probably more valuable

than comments in a blog. In future studies, instructors should strive to model appropriate blog posting and commenting habits to participants until the preservice teachers establish habits.

To investigate the cause of the low interaction rate, the researchers gave an anonymous exit survey (see Table 7, p. 35). Nine of the ten participants responded to the exit survey; Table 8 displays survey results. Question 4, "How would you rate the usefulness of having your peers read and comment on your reflections?" had a mean score of 7.6 (on a 10-point scale), which indicates participants valued the interactivity afforded through reflective blogging. This was supported by comments that participants left for Question 7, "Do you have any suggestions to change how technology tools were used in this course?" Comments were generally positive about blog usage; there were no negative comments about blog usage. One student commented, "I really liked the submission of blog entries which made it feel much more casual for entering information for the week" (Anonymous survey response, December 5, 2010). Interviews with the preservice teachers revealed the common perception that blogs were easier to write because of the more informal setting.

Interestingly, although the level of interaction dropped in the second half of the study, the preservice teachers expressed a desire for more interactivity. One student commented on the exit survey:

> My only suggestion would be to put more emphasis on the blogs. I really found the information useful. I would have liked to communicate more on the blogs; however, time and the amount of work I had to accomplish each week prevented me from doing so. (Anonymous survey response, December 8, 2010)

However, the primary limiting factors on interactivity that preservice teachers cited were "not remembering to do it" (six responses) and "lack of time" (four responses).

Recommendations

A recommendation for future studies is to assign participants to blogging groups, in which the preservice teachers read the blogs of the same cohort peers each week, similar to the successful reflection dyads that Hatton and Smith (1995) used. Grouping preservice teachers would reduce the amount of reading and limit commenting responsibilities to a more manageable amount. Using small groups could develop closer relationships among cohort members that may motivate participants to pay greater attention to the blog entries. Higher rates of interaction than what was observed in this study are needed to attain adequate amounts of social interaction and realize the potential impact of blogging on developing communities of practice and improving reflective practice.

In conclusion, the analysis of the data collected in this study has revealed patterns in preservice teacher reflections. Examination of these patterns led to several recommendations for improvements to preservice teacher programs, which can be grouped into two categories: (a) methods course curriculum changes and (b) organization of reflective practice (see Table 9).

Implications

Web 2.0 technologies provide opportunities for interactivity that research has only begun to explore. Developing critical reflective practice abilities in teachers establishes skills that preservice teachers need to reflect "on action" and become skilled reflective practitioners. Reflective skill can lead to the articulation of professional knowledge that intertwines theory and practice (Loughran, 2002). Technology tools that could fundamentally change reflective practice are readily available and easy to use. By continuing to experiment with implementations of these tools, methods can be developed that could build specialized communities of practice that can support preservice and novice teachers in the early years of their careers and beyond, scaffold the development of professional knowledge, and possibly lead to improved science teacher retention.

Table 8. Results of Exit Survey ($N = 9$)

Question	Mean	*SD*
1	8.1	1.7
2	7.8	1.2
3	8.1	2.2
4	7.6	1.1
5	5.9	3.3
6	7.8	1.3

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Table 9. Summary of Recommendations for Preservice Teacher Programs

Methods Course Curriculum	Organization of Reflective Practice
1. Implement curriculum to purposefully build reflective skill. 2. Provide foci for classroom observations that align with methods course objectives. 3. Inform cooperating teachers of methods course objectives. 4. Encourage metacognitive discourse between cooperating teachers and preservice teachers. 5. Provide direct instruction to preservice teachers on reflection practice. 6. Scaffold reflective practice with prompts that guide preservice teachers to higher levels of reflection.	1. Provide instruction on the technical aspects of blogging and RSS. 2. Model blogging and posting habits. 3. Assign participants to blogging groups to make reading and commenting load more manageable.

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Appendix A

Kember Four-Category Coding Scheme

Nonreflection (0 points)

- The answer shows no evidence of the student attempting to reach an understanding of the concept or theory that underpins the topic.
- Material has been placed into an essay without the student thinking seriously about it, trying to interpret the material, or forming a view.
- Largely reproduction, with or without adaptation, of the work of others.

Understanding (1 points)

- Evidence of understanding of a concept or topic.
- Material is confined to theory.
- Reliance upon what was in the textbook or the lecture notes.
- Theory is not related to personal experiences, real-life applications, or practical situations.

Reflection (2 points)

- Theory is applied to practical situations
- Situations encountered in practice will be considered and successfully discussed in relationship to what has been taught.
- There will be personal insights that go beyond book theory.

Critical reflection (3 points)

- Evidence of a change in perspective over a fundamental belief of the understanding of a key concept or phenomenon.
- Critical reflection is unlikely to occur frequently.

N.B. Intermediate scores are permitted.
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