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ABSTRACT

This study examines a feedback portfolio developed by student teachers in their secondary science methods courses. The portfolio preparation requires students to reflect and select their best five learning experiences during the course and provide a short explanation regarding the value of those experiences. This study also involves emergency permit teachers. Findings indicate that students appreciate the different experiences explored during the secondary science methods course and the opportunity to reflect and develop the feedback portfolio. In order to prepare science teachers working on emergency permits, experience with immediate translation into the secondary science classroom should be provided to those student teachers. (KHR)

What is Necessary to Include in a Science Methods Course for Teachers on Emergency Permits?—The Role of the Feedback Portfolio

[Hedy Moscovici]

WHAT IS NECESSARY TO INCLUDE IN A SCIENCE METHODS COURSE FOR TEACHERS ON EMERGENCY PERMITS? - THE ROLE OF THE FEEDBACK PORTFOLIO

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In a period of dramatic changes in the area of science education it is necessary to take dramatic measures to improve the readiness of the teachers to employ teaching techniques that are consistent with the reform movement. Various major publications such as the National Science Education Standards (National Research Council, 1996) recommend that science should be taught in the same way that it is constructed – using inquiry. During inquiries, students ask questions and plan ways to answer them, collect, organize, and represent data to create knowledge, and then test the reliability of the generated knowledge. During this process, students learn to cope with difficulties and react to constructive criticism provided by the teacher and peers. As a result, students re-examine their research and decide if more data needs to be collected in order to enhance the generalizability of their findings. Despite these recommendations, in many secondary science classrooms science is still taught mainly using textbooks (Moscovici, 2000).

Shulman (1986) defines professional growth in three major areas: content knowledge (e.g., biology, chemistry, earth science), pedagogical knowledge (knowledge about how to better teach a specific subject or having a variety of techniques at the tip of one's fingers), and curricular knowledge (knowing about curricular resources and how to use them). As the requirements for secondary science teachers increase, so do the topics of the secondary methods courses. Anderson & Mitchener (1994) describe the science methods course as the bridge between the various areas of study, a place where prospective teachers integrate the various kinds of knowledge and apply it in a classroom with students or with peers.

Another area of importance in the secondary science methods courses is the reflective nature of knowledge integration. Schoen (1987) recognizes reflection as an essential tool in all professions (1986), while Nichols, Tippins, & Wieseman (1997), Howe & Nichols (2001), and Koballa & Tippins (2000) suggest using open and closed case studies as tools for reflection and professional growth in science education.

This study looks at another reflective tool – the feedback portfolio developed by students. This portfolio preparation required students to reflect and select their best five learning experiences during the course (or connected to the course, such as the implementation of one lesson in their own classrooms) and provide a short explanation regarding the value of the experience. The feedback portfolio serves two goals: (1) as an assessment tool for the various experiences in the secondary science methods course and (2) as a feedback mechanism for the instructor. Students in the secondary science methods course were required to create a feedback portfolio.

<u>Pre-in-service population – Emergency Permit Teachers (EPTs)</u>

A special quality of this study is that it involves emergency permit teachers. Emergency permits are allocated to practicing pre-service teachers that are in the process of completing their credentials. This category (emergency permits) emerged as the need for teachers in certain urban areas of the United States (such as New York, Chicago, Los Angeles, Las Vegas) exceeded the availability of qualified teachers. Teachers working on emergency permits are required by the school district where they teach to complete their certification requirements in a certain number of years (five years in the State of California) with a minimum of six semester units per year.

Emergency permit teachers are unique because they are at the same time pre-service (they do not have their teacher credential yet), and in-service (they teach during the day in their own classrooms). Their particular position requires science methods courses with unique features in order to satisfy their needs.

The Secondary Science Methods Course – Student Population Profile

As mentioned previously, the majority of the students enrolled in the secondary science methods courses are teachers working on emergency permits (between 87-95% over the last two years). They teach during the day in their own classrooms while in the evenings they enroll in teacher education classes (and sometimes additional content classes) in order to finish their credentials. It is interesting to point out that although some of these students (about 10-15% for the last two years) began the teaching credential program as "traditional students" intending to go through student teaching with a mentor teacher, they are finishing the program as EPTs.

Student population in the Secondary Science Methods course is compiled of about 50% minorities, with a relative large proportion of Hispanic and African-American students. On many occasions, science EPTs, especially from the minority groups, return to teach in the area where they grew up and become colleagues with their previous teachers. They know and understand the school context and, at the same time, receive support and advice from their colleagues and administration. These two elements are critical for beginning teachers' success, especially for those ones belonging to the EPT category.

The average age for the EPTs enrolled in the secondary science methods is higher than the average in other programs over the country that do not serve EPTs. The age average is about 29-35, with the range between 25 and almost 70 years of age. Most EPTs come to the science methods course after a number of careers, with a number showing up after retiring from one, or even two previous careers. They have experience as professionals and have experienced success in other fields (such as medicine, army, engineering, even teaching at the university level in a science department). They come into the credential program possessing Bachelor degrees, MSc. Degrees, Ph.D. degrees, degrees in engineering, etc. Their knowledge and previous experiences are strong assets to work with in the secondary science methods course, and they learn to use their previous experiences during their teaching.

Theoretical Underpinnings

This study finds its roots in constructivism, according to which learning is a social process of making sense of experiences in terms of extant knowledge (Glasersfeld, 1989, Tobin, Tippins, and Gallard, 1994). The learning experience needs to be perceived as relevant by the learner, in this case, teachers working on emergency permits and enrolling in credential programs to obtain a teaching credential.

Another theoretical dimension of this study comes from the area of critical pedagogy (Giroux & Simon, 1989). According to Giroux and Simon (1989), teachers are defined as transformative individuals if they respond professionally to content challenges, as well as challenges directed to social norms. In other words, such teachers applaud individuals that fight oppression of any kind (Freire, 1990).

The idea of integrating social constructivism with critical theory is essential for this study. It encourages emergency permit teachers enrolled in the secondary science methods to reflect and understand the experiences that proved to be extremely important for their development, while, at then same time encourages them to feel empowered to say what they think.

Design and Procedures

This study compiles data from four sections of secondary science methods courses taught during the past two years, with each section having between 15 and 25 students. The study is interpretive (Gallagher, 1991; Erickson, 1986; Eisner & Peshkin, 1990). Data for the analyses was developed from feedback portfolios, other writings such as personal theory for teaching, and informal interviews. Multiple member checks with participants and with individuals that were not directly connected to the study (and who served as non-stakeholdres - Guba & Lincoln, 1989), as well as the use of triangulation (the process of contrasting data obtained using various techniques - Berg, 1989) added to the validity of the results presented below.

From Portfolio to Feedback Portfolio

There is a vast literature regarding the use of portfolio in the assessment process (Collins, 1992; Doran, Chan, & Tamir, 1998). Portfolios proved to have the advantage of "containing several samples of students' work assembled in a purposeful manner" (Herman, Aschbacher, & Winters, 1992, p. 120). Collins (1990), a very well known scholar and researcher in the area of alternative assessments, defined portfolio as a "container of evidence of someone's knowledge, skills, and dispositions." I found it essential to take in consideration also the "disposition," meaning a "sensitivity for a particular type of intelligence" (Silver, Strong, & Perini, 2000). This way, each learner has the opportunity to learn and provide evidence for learning in her own way, according to her particular disposition(s) (using the multiple intelligences and learning styles as referents).

Collins' (1992) developed a list of questions regarding categories of purpose, structure, and authenticity of the portfolio. These questions need to be answered prior to assigning portfolios. After the portfolio is handed in, "the evidence in the portfolio is used to make judgements about the quality of the performance of the person who developed it" (Collins, 1990, p. 159). The advantage with the portfolio is that the collection of evidence is spread over a period of time showing progress and growth. The teacher can also provide feedback and suggestions during the preparation period (Fong, 1988).

More recent work on portfolios suggest the possibility to use them as reflective tools for the teacher as well as for the student (McMillan, 2001). After determining its purpose, its physical structure, and the sources for its content (Collins, 1992), the portfolio becomes the base for discussions between the teacher and the student, as well as an instrument for reflection (McMillan, 2001, p. 239). Portfolios are also used for determining teacher's progress and professional growth (Danielson & McGreal, 2000, National Board for Teacher Certification).

The feedback portfolio used in this study required the students enrolled in the secondary science methods class to reflect on their experiences in class or connected to class (such as implementing a science lesson observed during the science methods course in the secondary science classroom (6-12th grade). The class assignment required them to select the five best experiences and discuss their importance. Grading rubrics concentrated around the quality of the discussion/argument provided for each one of the experiences.

<u>The Secondary Science Methods Course – Experiences Provided</u>

During the secondary science methods course, emergency permit teachers (EPTs) get involved in a series of experiences addressing the three categories of knowledge necessary for teacher's professional growth – content, pedagogy, and pedagogical content – Shulman (1986). Table 1 summarizes these class experiences, while Table 2 provides a detailed list of the category of "Concepts addressed in class" found in Table 1.

While most of the experiences (unit plan preparation and poster presentation, development and presentation of inquiry labs, concepts addressed in class, etc…) engage students in all three dimensions of knowledge present in Shulman's framework for professional growth (1986), a few experiences concentrate on one or two dimensions (e.g., development of the case study, classroom environment). It is important to underline the fact that although in most cases the EPTs fulfilled their content requirements, I placed a strong emphasis on content development and content knowledge (in the way used by Shulman, 1986) in the course. In their laboratories, as well as in their unit plan, EPTs were required to develop their content in a way that it will satisfy a non-science substitute teacher.

Table 1 – A summary of EPTs main experiences in the secondary science methods course

Experience	Content Knowledge	Pedagogical Knowledge	Pedagogical/Content Knowledge
Preparing unit plan (use of 6 texts, 6 Internet sites, 2 experts & 2 peers)	√	√	√
Presenting unit using poster presentation format	√	√	√
Preparing and presenting inquiry laboratories which include data collection and interpretation	√	√	√
Developing theoretical framework for teaching science (includes 3 references)		√	√
Visit to the Challenger Center (use of NASA simulations)	√	√	√
Developing a case study on how a student unlike them learns science		√	√
Concepts addressed in class (see Table 2 for details)	√	√	√
Classroom environment based on trust and respect		√	
Building a spread sheet with the 10 best Internet sites on a science topic	√	√	√

Table 2 – A detailed list of subcategories of the category "Concepts addressed in class" (Table 1)

Experience	Content Knowledge	Pedagogical Knowledge	Pedagogical/Content Knowledge
Science classroom learning environments and learning	√	√	√
Reading and discussing National Science Education Standards & California Science Standards		√	√
Reacting to readings in class (inquiry, alternative assessment strategies, constructivism, teacher's growth, safety issues in science labs) using practical examples	√	√	√
Discussing invitations to inquiry presented by the instructor	√	√	√
Discussing power relationships in the science classrooms and their effect on learning		√	
Reacting to a guest speaker talking about integrated science and thematic teaching	√	√	√
Use of Casio probe collectors and graphic calculators during laboratory experiences			√
Belonging to science organizations and getting involved in professional development	√	√	√
Sharing resources	√		√
Reflecting on reflective practice and action research	√	√	
Application of topics	√	√	√

experienced in the course at the 6-12th grade level			

During the two years, and responding to students needs, I made various changes in the requirements of the course. For example, during the second semester I required each student in class to perform in class five laboratories, and write ten laboratory lesson plans. The requirement came as a response to the students' lack of laboratory preparation dexterity perceived during the first semester of the study, as well as from personal visitations during field experience and observations in secondary science classrooms. Although the increased number of laboratories proved to be effective in developing students' dexterity and comfort with planning, implementing, and discussing laboratory experiences, during the third semester I requested only three laboratories in order to increase the quality of discussions following the laboratory. Due to larger number of students, during the fourth semester of the study, the number of required labs decreased to two.

Another change I made was to move from reading journals on three occasions during the first semester of this four-semester study, to reading a "philosophy of teaching science" paper that incorporated journal writings and professional literature. The reason I had to give up reading journals was the large amount of time it took to read and respond to students' writings and questions.

Other changes such as the classroom for the meetings, and available materials, and equipment fluctuated during the course of the two years in a less intended way. Classrooms are assigned according to availability, and there are no laboratories that belong to our department. For semester #2 & #3 of this study (see Table 3) I was lucky to be able to use a chemistry laboratory. The laboratory was not available for the other two semesters. Table 3 presents the summaries of curricular preferences organized from the most to the least according to the firstt semester of this study. Percentages represent how many students voted for the experience from the whole class.

Findings

Findings show that students appreciated the different experiences explored during the secondary science methods course. They even appreciated the opportunity to reflect and develop the feedback portfolio. Here is how one of them expressed this idea:

> *The portfolio has given me the chance to think about what each assignment has meant to me. I have never sat down to search out assignments I have completed in order to consider what I had learned from the assignment. In most cases, the assignments I complete for a class go in a folder to be never seen again. This portfolio forces students (me) to look and review what was done, and finally, it requires us (me) to explain the significance of each assignment. Which in turn makes students (me) to work harder on the work they produce throughout the course. A-ha! So, this was your intention from the beginning. Tricky, tricky...*
>
> *By all means this course was one of the most difficult courses for me. Not because of the work, but because you forced me to really think about and reflect on the content of the course. Who would have imagined that a graduate student would find "really thinking" and "reflecting" so difficult? I thank you not for the five best, but the best learning opportunity!* (L.Ch., F00)

It is also interesting to add that a few of my students already employed the feedback portfolio as an assessment tool in their own classrooms. They were delighted with the results as their students learned to provide comments and suggestions that helped the EPTs modify their curriculum and increase learning in their classrooms.

Looking at the results summarized in Table 3, and since EPTs are required to teach every day in their own classrooms, it is not surprising to find that they appreciated assignments with immediate translation into their practice. The large category of "Concepts addressed in class," the laboratories that the EPTs prepared and showed in class, and the unit preparation were at the top of their list.

Table 3 – Summary of the curricular preferences as expressed by secondary science EPTs.

Experience	Semester #1	Semester #2	Semester #3	Semester #4
Concepts addressed in class (see Table 2 for details)	87.5	53.0	86.0	92.0
Preparing and presenting inquiry laboratories which include data collection and interpretation	81.0	100.0	86.0	76.0
Building a spreadsheet with the 10 best Internet sites on a science topic	44.0	53.0	57.0	40.0
Preparing unit plan (use of 6 texts, 6 Internet sites, 2 experts & 2 peers)	37.0	27.0	79.0	76.0
Developing a case study on how a student unlike them learns science	31.0	33.0	14.0	48.0
Visit to the Challenger Learning Center (NASA simulator)	NA	33.0	21.0	36.0
Developing theoretical framework for teaching science (includes 3 references)	NA	7.0	21.0	13.0
Classroom environment based on trust and respect	25.0	27.0	29.0	13.0
Presenting unit using poster presentation format	NA	7.0	29.0	12.0

Concepts Addressed in Class Category

The main attractions in this category were the following: the issue of inquiry science versus activitymania (Moscovici & Nelson, 1998) and the four-stage model for moving toward inquiry science (Moscovici, 2000), alternative assessment strategies (Moscovici & Gilmer, 1996) and differences between assessment, evaluation, and grading as applied in the secondary science classroom, the effect of misuse of power on students' learning (Moscovici, 1998; Moscovici, in press), and using action research to improve practices. Readings, explanations, and discussions on constructivism (epistemology versus methodology) increased students' knowledge on the subject and their capability to chose and employ methodology according to professional goals.

It was important to address these topics in class and engage participants in lengthy discussions with examples. Such a process helped them move towards inquiry science, understand and employ effective alternative assessment strategies at the secondary level, and be able to document one aspect of their teaching and make decisions based on teaching goals and collected data (rather than react to one vocal or disruptive student). In the following paragraphs I will concentrate on the top four experiences, as these are commonly found in science methods courses. The other experiences, such as encouraging a supportive atmosphere based on trust and respect, learning about how students that are different from you learn science, and developing a theoretical framework for teaching science are dimensions that seldom receive central attention. Poster presentations of units began as a way to help visualize the flow of the unit during the science unit presentations. During the fourth semester of this study, posters were placed around the room and EPTs had the choice to go to the posters that they were interested in and discussed details with the poster (unit) producer.

Preparing and Presenting Inquiry Laboratories in Class

This was an essential experience for EPTs. They left the classroom every night with lots of laboratory experiences, ideas that found their way into the secondary science classrooms on the following day. I am very fortunate to work with EPTs as they tend to implement immediately class laboratories and ideas, and report back with results from the field (secondary science classes) during the following science methods session. Such quick turnover is only possible with EPTs or practicing teachers in a workshop situation. A comprehensive folder with laboratory experiences from class is placed on reserve in the Teacher Education Department for the use of our students.

Building the Spreadsheet with 10 Best Internet Sites and Email the Assignment Using Attachments

As not all the students are comfortable with computers, with email, and with the Internet, I decided to introduce such an experience into the course. During the first semester of the study I allocated two class sessions to that experience. As some of the students were comfortable with the computer applications, as well as with the Internet, I decided to reduce the number of sessions to only one and continue to support individual EPTs according to their individual needs. Due to this assignment, EPTs realize that they do not need to invent laboratories for every concept they want to address in their classes. Lots of laboratories, simulations, content sites, are already available for teachers to modify and use in their classrooms. Some EPTs get into professional groups, chats with colleagues, and learn to use email for their professional growth.

Preparing a Unit Plan (including 6 texts, 6 Internet sites, 2 experts and 2 peers)

Preparing a teaching unit required EPTs to use resources, the Internet, and people they know in order to organize three weeks of instruction. Beginning with a concept map (or another visual organizer), EPTs explored the topics they want to address, organized it, and correlated developed curriculum to the science standards (for California or for the specific district). The three-week curriculum also required two laboratories, one of them including data collection (at least six points), data processing, visual representation, and interpretation. In a way, it is the culminating act of the course that integrates all the various experiences provided during the course. The advantage of working with EPTs, again, is that they immediately use everything they can in their own classrooms. It is not unusual to have poster presentations of the three-week unit that include work from the students in the secondary science classroom (6-12th grade) – just the opposite. In most cases, EPTs are able to describe the effect of teaching their unit in the secondary science class, and the modifications that they are going to make in the future. Like with the inquiry laboratories, EPTs are encouraged to leave a copy of their units in the Teacher Education Department for the secondary science students of the following semesters. They learn that gathering ideas from others in the process of creation is not cheating, but good use of available materials and resources.

Implications

Teachers working on emergency permits (EPTs) are different from the usual student-teacher population where participants have the time to build part of their resources prior to entering the classroom. They are also different from the teachers coming for enrichment during in-service workshops or courses. Findings show that in order to prepare science EPTs we need to provide experiences with immediate translation into the secondary science classroom. This way they are interested to participate as they find the experience relevant to their teaching.

As the goal of the science education reform is to infuse science in the secondary science classroom using inquiry (National Research Council, 1996), we need to emphasize inquiry laboratories and how to modify available resources during the science methods course. Learning about the difference between activity and inquiry (Moscovici & Nelson, 1998) helps EPTs with their work of developing thinkers in their secondary science classes rather than technicians (Moscovici, 1998).

Shulman's (1986) framework regarding the three categories of knowledge essential for professional teachers (content, pedagogy, and pedagogical content) provides us with an elegant tool to structure experiences. Experiences that address these categories are welcome, and, with EPTs, have the potential for immediate translation into the secondary science classrooms.

Lastly, but not last, none of the above-described experiences would succeed if the EPTs did not have time for reflection in and on-action (Schoen, 1987) during the secondary science methods class. EPTs reflected during in-class discussions, while preparing homework assignments (such as the feedback portfolio, reaction to an experience in class, reaction to content standards, etc…) and when they used case studies (as an assignment such as developing a case study, or using case studies from the literature – e.g., Koballa & Tippins, 2000)

In conclusion, it is important to design a secondary science methods course that takes into consideration the student population and makes the experiences relevant and useful for beginning teachers. Such a curriculum has the potential to help reach the goals of the science education reform. The feedback portfolio described in this study proved to be an excellent tool that helps us (as course instructors) make the right choices (right for our student population).

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