



COVER SHEET

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TRANSFORMING PRE-SERVICE TEACHER KNOWLEDGE IN SCIENCE EDUCATION THROUGH MULTIMEDIA AND ICT

The purpose of this study was to determine if the beliefs of elementary pre-service teachers had been influenced by the provision of an interactive CDROM of modeled case studies of teaching science. Through a grounded theory approach using constant comparative analysis the findings revealed that the modeled practices by themselves made little impact on the pre-service teachers' beliefs and practices. The twenty-four pre-service teachers in the study continued to use traditional teaching approaches in their lessons but at the same time espoused the concepts of constructivism. Nevertheless, toward the end of the semester through a combination of learning experiences of the pre-service teachers' critical reflection of their own video taped science lessons culminating in a focus group session, the pre-service teachers were able to differentiate between their own beliefs and teaching practices with what was presented on the interactive CD ROM. The outcome of this study provides a transformative learning model that uses multimedia and ICT as a strategy in bringing about conceptual change in pre-service teachers' beliefs and has application in professional development for in-service teachers.

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Objectives

The objective was to determine how the beliefs of pre-service teachers had been influenced by the practices of a classroom teacher demonstrating science teaching in the classroom via CDROM vignettes, pre recorded interviews and peer group discussions.

Significance

The way elementary teachers teach science is strongly influenced by the beliefs they hold about teaching, learning and science (Keys, 2003, 2005). These beliefs and practices are referred to as teacher knowledge (Munby, Russell, & Martin, 2001). The beliefs that a teacher holds concerning the nature of science and how science should be taught will influence all aspects of teaching science (Feldman, 2000; Grossman, 1990; Shulman, 1994). These beliefs are developed from his/her own personal experience as a student in science and later reinforced from his/her engagement as a pre-service teacher with that of in-service teachers in the field (Walls, Nardi, von Minden, & Hoffman, 2002; Zeichner & Liston, 1996). The problem is that many of the beliefs and practices that the pre-service and in service teachers hold do not reflect current contemporary theory and advocated practice in science education. We know the beliefs and practices of in-service teachers often influence pre-service teachers (Mulholland, & Wallace, 2003). However, a vicious cycle exists where in-service teachers unwittingly model ineffectual practices or provide no models of science teaching at all. Indeed, the knowledge and confidence that elementary teachers have is well known to be a major limitation in the implementation of effective science experiences for pupils (Watters & Ginns, 1995). What is needed is a means whereby the pre-service students are able to view models of exemplary science teaching practice and theory in action. This approach enables preservice teachers to discuss case studies of teachers teaching science (Loucks-Horsley, Love, Stiles, Mundry & Hewson, 2003). These cases, particularly as multimedia vignettes, provoke discussion, reflection, and reconceptualisation of teaching (Watters, & Diezmann, 2003; 2004). Used effectively, multimedia-based experiences of

effective teachers engaged in elementary science programs should provide rich opportunities for pre-service students to examine their beliefs.

Theoretical underpinnings

This study is theoretically positioned within two fields of knowledge; teacher knowledge (Munby, Russell, & Martin, 2001) and transformative learning (Mezirow, 1991, 1991, 2000). Teacher knowledge is influential because pre-service teachers have a set of beliefs shaped by their past experience as students of science and are further influenced by observations of the practices of existing teachers (Cranton & King, 2003; Mulholland, & Wallace, 2003). In order to implement change in beliefs it is necessary for the pre-service teacher to come face-to-face with their set of beliefs by being challenged through alternative teaching practices and provided the opportunity to critically reflect upon them (Cole & Knowles, 1995; Keys, 2003, 2005). For learners to change their "meaning schemes (specific beliefs, attitudes, and emotional reactions)," they must engage in critical reflection on their experiences, which in turn leads to a perspective transformation (Mezirow 1991, p. 167). For example in Keys (2003a, 2003b, 2004, 2005) which this study builds upon, it was found that teachers utilised three sets of beliefs to shape the implementation of a science curriculum. These were categorised as expressed, entrenched and manifested beliefs. The teachers were provided the opportunity to critically reflect on their teaching practice from which the three sets of beliefs emerged. The outcome of the study provided a theoretical framework to observe teachers beliefs in action and thereby assist the teacher to critically reflect on their beliefs and practices. Importantly, for this study it demonstrates the need for further research into how to facilitate change in the pre-service teacher's belief framework before he or she embarks on their teaching career.

The second field of knowledge that this study draws upon is transformative learning. Transformative learning focuses on the process of transforming a learner's frame of reference or mind set or set of beliefs (Cranton, 2002; Mezirow, 2000). Central to Mezirow transformative learning is the need to make learners critically aware of how and why their beliefs, knowledge or assumptions have come to direct the way they interact with the situation they are confronting. Boyd and Myers (1988) described three steps in transformative learning as receptivity, recognition, and grieving. This means that the learner has to be open to alternative perspectives or beliefs. For example, the learner is prepared to engage in the learning experience, then recognise some discrepancy in their beliefs and finally be able to reject their prior beliefs and adopt the new beliefs as more powerful or relevant. Therefore, transformative learning provides a framework that can be used in bringing about change in pre-service teachers' beliefs (Boyd & Myers, 1988). For the lecturer in this study it was assisting the pre-service teachers to move from their expressed beliefs (Keys, 2005) concerning constructivist teaching to putting into practice what they had said. The challenge was what can be done to enable the pre-service teacher to see and differentiate between their traditional teaching approaches and their expressed beliefs with what is being presented to them through the interactive CDROM and the learning experiences embedded in the course (Cranton, 2002; Jennings, & Smith, 2002; Mezirow, 1991, 1991, 2000)?

Design and procedure

Context of the Study

The study was conducted in a compulsory science education unit at a regional university in Australia. Twenty four of the thirty six students enrolled voluntarily participated in the study.

As part of the unit requirements students assembled a portfolio of responses to a CDROM entitled Teaching Science in the Upper Primary (Watters, & Diezmann, 2001; Diezmann & Watters, 2001). There are a series of six sections within the CDROM containing short video clips of the elementary teacher teaching a particular aspect in science and a series of interview responses provided by the teacher explaining and justifying her teaching approach. The students worked in pairs and completed a series of questions provided on the CDROM. The tasks were completed in the computer laboratories. The questions that were asked of the pre-service teachers were designed to encourage them to critically reflect on their science teaching in the light of the vignettes presented.

Other assignments and activities for the students included weekly contribution to online discussion forum, the teaching of a 30-40 minute science lesson to their peer, which was videotaped, and a written critical reflection of their lesson.

Methodology

A Grounded theory approach using constant comparative methods was used to analyse the data (Strauss & Corbin, 1990). This qualitative methodology was chosen because the purpose of the project is to build a theory of how pre-service teachers' beliefs might be influenced or changed. In order to accomplish this task it was necessary to allow what was relevant to the research questions to emerge from an analysis of the data (Strauss & Corbin, 1990). The data were taken from three main sources and what unfolded from one source was compared with the other three sources otherwise known as the triangulation of data:

1. Students' assignments
 - Critical reflection essay – This assignment required the student's to view their video taped science and write a critical reflective essay.
 - Students' on line discussion forum notes from 'Blackboard'.
 - Electronic Portfolio responses to the interactive CDROM
2. Observations of student's microteaching lessons which were reviewed on video combined with anecdotal notes from conversation with students.
3. Focus group sessions conducted at the end of the semester with the participants

Findings and Discussion

In development of the theory of how pre-service teachers might be influenced or changed two assertions have emerged from the data.

Assertion 1: Change in beliefs can be brought about by scaffolding reflection

Change in beliefs was evident during the semester but could not be attributed to solely one learning task. The various types of learning tasks combined together with the CDROM and the focus group session influenced the pre-service teachers' beliefs in teaching science. A synthesis of students' comments, behaviours and reports suggested students integrated the various experiences in productive ways (see Table 1). For example, toward the end of the semester, in the focus group sessions the pre-service teachers claimed they did not capitalize on the CDROM for preparing assignments. Nevertheless, when asked whether they thought about the CDROM while preparing their lesson the typical responses was, "It was in the back of my mind but I didn't apply any of it". However, when the video recordings of the participants' lessons were observed, it was evident that they had incorporated strategies such as establishing prior knowledge, questioning or group work all of which were aspects modelled in the CDROM. Yet it was uncertain whether it was just the influence of the CDROM or from other learning experiences provided to them during the course which influenced their teaching behaviors. There was no evidence in the pre-service teachers' critical reflective essay to suggest that they had compared their lesson with the lesson presented on the CDROM. Examination of online discussions highlighted students'

integration of the CDROM material. The online posting that occurred after the focus group suggest that the focus group possibly provided an experience which helped students to reflect on and integrate their experiences during the semester. Such a proposition is evident in the following online postings.

Pre-service teacher one

“I took part in the CD ROM discussion group and I found it to be very useful, it clarified my thoughts on why we would be doing something like this ... I found the connection between the CDROM the lectures, the science presentation and critique.”

Pre-service teacher two

... I think that the people who did not go to this interview will not quite make the connection that I got yesterday.”

The combined interactive influence of the learning tasks, the CDROM and the focus group session had become apparent. Each of the tasks including the voluntary focus group session brought together an effective learning experience for these teachers. The concluding focus group session became the catalyst of the pre-service teachers’ experience. This type of interactive process is consistent with transformative learning where the students are engaged in critical reflection, discussion with each other and taking appropriate action (Cranton, 2002; Mezirow, 2000). Only toward the end of the semester through the focus group sessions and the on line discussion forum were the pre-service teachers recognising the difference between their own teaching practice and their espoused beliefs in the teaching and learning of science: “What I did and what she did (referring to the CDROM) – you couldn’t compare the two”.

What also became apparent was that each of the learning experiences was not sufficient in itself and had to be linked together within the learner’s mind. The focus group session unintentionally had achieved this. In effect the discussion forum became a point where the students were able to engage in discourse and reach an informed consensus (Cranton, 2002).

Table 1

Assertion One – Scaffolding reflection

The scaffolding of students’ learning was accomplished through the interaction of different learning task.

Critical reflections	Video taped lessons
Student 1. The next time that I have to write a lesson on science I would make sure the students have more input over the lesson. By exploring and finding their own questions and answers working scientifically to find their own results.	Student 2 I too found the Critical Reflection very difficult. I think watching yourself (on recorded video) doing something can be more traumatic than the actual event, but watching the video was an excellent learning tool - and really gave me a chance to reflect on my teaching style and what I can improve.
Student 3 The approach I employed in my lesson to my peers was a transmission approach. This approach was largely unsuccessful as the “students” found my explanation difficult to follow because they were not experiencing it and participating in the explanation themselves	Student 4 After watching my science lesson (on video) I definitely could see what I was doing wrong and what I need to improve.

Student 5 From viewing the video, student's appeared to have a lot of ideas to offer that we just didn't extract because we rushed away from them. This is particularly disappointing considering there was plenty of time left to allow for such discussions.	Student 6 Watching myself conduct my lesson on the video was hard. Going on prac and observing my supervising teachers conduct, and reviewing the teachers practice on the CD Rom did not help. Compared to these teachers, I found so many things
Online discussion	Focus group session
Student 7 -The peer science lesson was a great way to see everyone's different interpretations of how to teach science... I thought my presentation went all right and then I watched the video.	Student 8 - "It was in the back of my mind but "I didn't apply any of it"
Student 9 - I did the focus group session with Phil and a few other people. It was funny, because I was thinking 'what questions could he possibly ask us regarding the CD- I hardly remember anything. I just made sure I answered every question.' At that time, I also thought that the video (video taped lesson) was a waste of time, and I took nothing away from it. Then when he started asking questions, I realised just how much that CD had affected me, and how differently I view science, and teaching in general because of the CD.	Student 10 - Didn't employ many of the strategies the CD suggested due differing environments and target audience At first when I saw the CD I thought that she was going a bit overboard. But after I had been to lectures you could see exactly what approaches she was taking. What we learned off the lectures you could see her doing it.
Student 11- I took part in the CD discussion group and i found it to be very useful, it clarified my thoughts on why we would be doing something like this (Responses to the CD) in science ed. I found the connection between the CD the lectures, the science presentation and critique ... so I am happy with that.	Student 12 – And it was easier to identify that after a couple of lectures. The first couple of weeks of looking at the CD, it was a bit like, "I don't know how to answer the questions" but as you learned about the approaches it did become a lot easier to answer the questions on the CD.

Assertion 2 Fostering reflective practice requires an integrated approach of similar experiences.

Finally, the combined learning experiences required some form of integration i of the student's experiences. In this instance the interactive CDROM, which provided models of exemplary teaching practice in science, required the students to critically reflect on what they had viewed and heard. Then the students' own video taped micro science lesson required them to view themselves and to critically reflect on their teaching practice. The tasks were similar but different in that the subject under observation had changed. That is, they could compare and contrast their performances with those of the modeled episodes presented in the CDROM. Effectively the video became a mirror of the students' actions. Such a strategy in transformative learning would be considered as an *activating event* – an event that exposes the students to different viewpoints, an essential element in transformative learning (Cranton, 2002; Gilbert, 2003). Integration was achieved through in part the normal ongoing classroom discussion, but in particular the two video based experiences were facilitated by two noticeable forms of group interactions; the online discussion forum and the focus group session. The outcome enabled students to discern their practices and those of the teacher in the CDROM and to provide an opportunity to recognise that their were grounds to change their beliefs and practices

Through constant comparative analysis of the data two students; Robyn and Steven began to emerge as examples of what was taking place in the learning experience and group interactions of the science methods class (see Table 2). These two students, best represented

the student profile of the class; a mixture of mature age students and high school graduate entry students. Robyn is best described as a mature age student a mother in her mid thirties, and a wife of a military officer who was required to move to the regional centre and who decided to study education. Steven is best described as the typical high school graduate who is in his early 20s has entered university within a year or two after completing his high school diploma.

Plotting the experience of Robyn in each of the learning tasks from her lesson planning through to the focus group session a pattern of similar concerns and issues emerged revealing that she has thought through one aspect of teacher knowledge. Robyn continually referred to the idea of open-ended questions, or “provide opportunity for students to reflect and analyse their ideas or compare their findings with other students”. This can be seen in each of the tasks within Table 2. The following semester the participants were asked them to provide some feedback regarding their current science teaching and Robyn’s email once again supported this focus on open-ended questions and her beliefs about science teaching:

“... what we learned in class and from the CDROM has helped me with just my own children and when they have friends visit. I have found when they are doing something that is science I try and get them to answer their own questions but asking questions myself, that way they are learning something for themselves instead of me giving them the answer that they are likely to forget.”

There is evidence that Robyn is consciously and rationally making an effort to incorporating a constructivist learning approach within her framework of teacher knowledge.

In the case of Steven we see here how there is a conscious realisation and acknowledgement that what he believed in or espoused he did not practice. After coming from a lecture on teacher knowledge and beliefs, Steven writes in the online discussion forum; “I realised that I had many expressed beliefs about teaching science that didn’t match up with how I taught my science lesson in class.” Steven has realised toward the end of the semester that he failed to implement what he believed or espoused to believe. Steven also makes the admission in the focus group session of how he did not make the connection with the CDROM and lessons (see table 2). Steven’s admission illustrates how that none of the students made a conscious acknowledgement or connection in their assignments with that of the CDROM until the focus group session. Steven’s case also illustrates how the interactive online discussion forum and the focus group session provide a platform for critical reflection.

Assertion 2 Fostering reflective practice requires an integrated approach

**Pre service teacher -
Robyn**

The written lesson plan	Critical reflection essay of their lesson	Observation from the video taped lesson	Online discussion	Focus group response
<p>Introduction: Brainstorm with the students to find their concept of motion. What types of forces can move objects. The teacher writes these on the whiteboard. The teacher is to elaborate on what is said and add whatever (additional forces), is needed to complete the concepts of force and motion. Discuss with the students. What is the nature of force?</p> <p>Conclusion - Students will come together to discuss their findings and observations. What other forces were in play before and after the motion was created (if any)?</p>	<p>...The activities (referring to her own lesson)encouraged the students to seek out their own ideas of making different types of force to make objects move differently. Students in both the introduction and conclusion were encouraged through the use of open-ended questions, to explain how things were moved by the forces that had been placed on them. My Key learnings from this experience - The next time that I approached this science education lesson I would have to ensure that there is sufficient time available for the students to not only carry out the described activity, but to also have enough time to investigate their own ideas and to then be able to challenge the ideas of others in the classroom If you do not allow enough Time for the lesson, then students will not be able to benefit from being able to reflect and analyse their ideas or to compare their findings with other students.</p>	<p>Kerri commenced the lesson by asking how do we make things move - "Are there ways that you can make things move?" The students provided a variety of responses which she recorded on the white board. The students then were then divided into groups and given three sets of activities about force to explore. Kerri moved around the room assisting the students with their investigations. The concluding part of the lesson focused on an explanation of each of the three investigative tasks of force.</p>	<p>After completing it (CD ROM) however, I found that I could take a lot away from her teaching style. She incorporates a hands on approach to her teaching with lots of open ended questions. She not once gives the students answers, but by using the right questions is able to allow the students to work out the answer for themselves....I hope that I too can teach a science lesson like that one day.</p>	<p>So when you were observing each others lesson did you ever think about the CD rom? Kerri – Occasionally I did, “I like the way she uses, she constantly uses, like, the open-ended questions – and trying to draw more information out of the students without actually giving them an answer”</p>

Pre service teacher - Steven

The written lesson plan	Critical reflection essay of their lesson	Observation from the video taped lesson	Online discussion	Focus group response
<p>Introduction: Students will be asked to sit at their desks they will be asked questions about what they know about static electricity. The teacher will then show a PowerPoint slide that has pictures on it of examples of static electricity that occur in everyday life and a discussion will be held about the student’s experiences of static electricity. Conclusion: Click to the last page of the PowerPoint and discuss with the students what static electricity is.</p>	<p>In the first part of our lesson, the experiment, we used the discovery approach and for the explanation about static electricity we used the transmission approach without connecting the two. ... We used the transmission method because we were not confident in teaching this topic and it seemed to be the easiest method of explaining a hard concept like static electricity</p>	<p>Today we are learning about static electricity. Can anyone tell me about what they know about static electricity. Can anyone give me an example - Students gave typical responses; windy days - Steven goes on to provide a slide - This slide shows examples of static electricity - Karisa is going to give a demonstration about what you are going to do in one of your experiments with a balloon. Students were then placed into groups to complete various activities on static electricity. The concluding part involved a questioning, sharing and discussion about what the students experienced. Using a power point slide Steven and his teaching partner went on to explain static electricity.</p>	<p>I was interested in the expressed beliefs that Dr. Phil talked about in this weeks lecture. Thinking and looking over my old posts I realised that I had many expressed beliefs about teaching science that didn't match up to how I taught my science lesson in this class....</p>	<p>. Phil - When you were preparing your own micro teaching lessons did you give any thought to the CD? Steven: “Should have.” Should have thought about it So did you reflect on it while you were teaching or when you were evaluating? Steven – Afterwards; I had it in my mind. The CD Rom was definitely there. Thinking about what I did and what she did you couldn’t compare the two. Our lesson was more standing up there giving the information and with her lesson she was getting the students getting to find out the information</p>

Concluding Thoughts –Implications for Teaching

The intention of this study was to determine if the beliefs of elementary pre-service teachers had been influenced by the provision of an interactive CDROM of modelled case studies of teaching science. The results of the study revealed that the CDROM alone did not make an impact on changing the beliefs of pre-service teachers but rather it was the combination of reflective tasks that brought about an impact on the pre-service teachers thinking. The resource did provide an experience through which students could compare and contrast their own beliefs and practices and hence recognise the discrepancies between their existing beliefs and knowledge and that espoused by contemporary science teachers.

As an outcome of this study a theoretical model (see Figure 1) has been developed that illustrates what took place during the course and how this process demonstrates transformative learning (Cranton, 2002; Mezirow, 1991, 1991, 2000). What is unique in this transformative learning process are two issues. Firstly, the model highlights the value of providing on going opportunities for interaction. In this research on line interactive forums played an important role and were supported with culminating focus group sessions. Secondly, the model emphasises the need to provide strategies to enable students to compare their own practices with those modeled by an experienced teacher. The reflective discussions that took place during the focus sessions achieved this.

Furthermore, this research has highlighted that the use of ICT and multimedia resources by themselves do not affirm progress in learning. In order to bring about transformational change in adult learners there needs to be a scaffolding of the learning that interconnects one learning experience with the next culminating in a discourse that is reflective requiring an action on the part of the participant. For the pre-service teachers it was the comparison of their own video taped lessons with that of the modelled teaching practice provided on the CDROM and the acknowledgement that their beliefs and practices differed from their espoused beliefs. It is at this point when there is an acknowledgement that change in a pre-service teacher's beliefs can begin. As Steven said, "I realised that I had many expressed beliefs about teaching science that didn't match up."

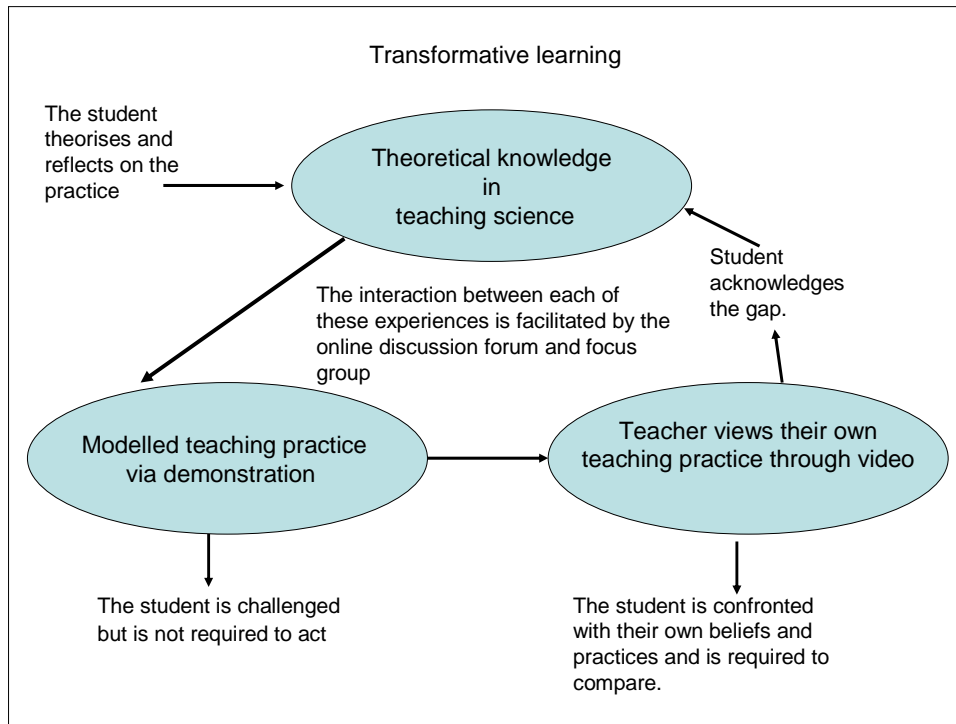


Figure 1 Transformative learning

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