Evolution of New Teachers' Beliefs about Teaching STSE

Report to School Boards

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Acknowledgements

Introduction

This longitudinal multi-case study followed four new science teachers over the course of five years. Its purpose was to examine the ways in which new science teachers integrate science-technology-society-environment (STSE) and inquiry-based work into their teaching. I am particularly interested in new science teachers not only because of my work with prospective science teachers at York University's Faculty of Education but also because this is a group that is simultaneously expected to usher in new and innovative approaches to teaching while receiving very little subject-specific professional development to support their efforts (Luft, 2007).

STSE is the aspect of school science that goes beyond the facts and theories usually emphasized in traditional approaches. It consists of several content components, including sustainable development, decision-making, ethics & moral reasoning, personal & political dimensions, critical social reconstruction, action, philosophical aspects of science and inquiry (Alsop & Pedretti, 2001). Over the last twenty years, different jurisdictions and science associations have promoted the inclusion of STSE in science curricula (see, for example, Council of Ministers of Education (Canada), 1997; National Research Council (U.S.A), 2011) in order to develop talent in science and technology and to increase scientific literacy in citizens (De Boer, 2000). Here in Ontario, such innovations have been an explicit part of the science curriculum since 1999 (Ontario Ministry of Education, 1999) with the latest iteration (Ontario Ministry of Education and Training, 2007, , 2008a, , 2008b) foregrounding STSE as foundational to scientific literacy. Yet, in classrooms, STSE remains marginalized, generally treated as a disposable add-on in middle and high school science curricula (Bryce, 2010).

To address this problem, we need to better understand the decision-making process that goes into teachers' curricular choices, especially with respect to teaching in ways that they had not themselves been taught. While it is true that faculties of education in Ontario emphasize STSE, we know that new teachers are unlikely to teach differently than they were taught as science students unless their beliefs align with the innovation. However the process of decision-making that new teachers engage in as they determine how and what to teach is complex and the beliefs that shape those decisions rely on other contextual factors (Fletcher & Luft, 2011). Given this complexity, this process is unlikely to be adequately captured with a single interview at one moment in time. Thus, new science teachers need to be observed and interviewed in context over time. A case study methodology is ideal for exploring the curricular decision-making of new science teachers because, although a case study cannot be strictly generalized or yield statistically significance results, it can achieve conceptual significance. In other words, the detailed and narrative nature of case studies provides insight into process and fodder for in-depth discussion.

Methodology

This research was conducted in four different cities/towns in four different school boards/jurisdictions in Southern Ontario – a private rural religious high school, an urban alternative high school, an affluent suburban high school and an urban French immersion elementary school. The four participants were purposely sampled from among the graduates of two faculties of education in southern Ontario. They had been part of the physics and chemistry methods courses taught by the researcher. The four participants – all of European descent – were two women and two men, whose ages at the end of their participation were 43, 36, 33, and 30. In order to maintain anonymity, no more detail will be provided with regard to the participants personal attributes.

Ethical approval for this research was obtained from York University and each school board/jurisdiction before data collection began.

Data – collected between September 2009 and June 2013 – consisted of interviews, classroom observations, curricular planning documents and materials and email correspondence. Each participant was interviewed at least 15 times. These ½ to 1 ½ h interviews were audio recorded and fully-transcribed. Full day classroom observations occurred monthly from October to May and were documented via field notes, photographs and audio recordings that were partially transcribed.

Classroom observations provided context for interviews. Student names were never recorded and their faces were never photographed. Throughout, the teachers were the focus of observations.

Email correspondence with participants occurred between classroom visits. Each participant was part of the study for 3 years.

Data analysis was done in two stages. First, data was examined for emerging themes. Next, emerging themes were collapsed into larger themes, using a process of decontexualization and recontextualization (Tesch, 1990). Discernment of emergent themes was on-going throughout the data collection process. As a result, these themes were confirmed and/or modified through subsequent interviews and looking for counter examples in subsequent classroom observations. Larger themes were confirmed or modified in the final interview with each participant. Thus validity was established through long engagement with the participants, on-going data analysis, member-checking and looking for counter examples in the data as it was collected (Lincoln & Guba, 1985).

Findings and Discussion

For this report to school boards/jurisdictions, anonymity of the participants is my paramount concern. Since the detailed nature of the data could easily be used to identify these new teachers, the findings will not be presented as a series of single cases. Rather, this report consists of the multi-case analysis only.

Multi-case Analysis

Although participants taught in very different contexts and had dissimilar personalities – a feminist activist, a religious pacifist, a practical ex-engineer and an enthusiastic showman – their goals, struggles and concerns were remarkably similar. Further, while many of the themes in the data are relevant to the experiences of any new teacher, what will be presented here is specific to new *science* teachers who straddle two cultures (that of science practice and school science) in terms of their curricular decision-making process.

I will be describing three main themes; in loco parentis, becoming part of a professional culture, and professional growth as the universal antidote.

In Loco Parentis

All participants had goals for their students both with respect to the science curriculum and pan-curricular mandates such as environmental education and character education. By far, the most prominent goal from the perspectives of all four participants related to personal responsibility and critical thinking. Assessments were carefully designed so that expectations were clear, there were opportunities for constructive feedback and students were given leeway to be creative. However, the teachers struggled with their students' apparently low confidence in their abilities to take initiative and risk. As one participant, the Feminist Activist, put it:

> My biggest challenge last year was trying to figure out how to motivate students who had never felt or seen success and this took me a long time so I am trying to get them to become engaged and this was one of the biggest challenges. [Feminist Activist]

Even for students who had enjoyed a fair amount of academic success, there was a resistance to engaging in activities that did not have set answers, where their high marks could not be guaranteed. This was especially true in the two affluent schools, where students felt a great deal of pressure to succeed. Yet, all four participants were concerned with students' developing social responsibility through critical thinking about issues in society:

> And not just for the sake of questioning it but actually because they feel a moral obligation to question it - that there's some injustice that's happening there and that there needs to be questions raised about those injustices. [Feminist Activist]

The issues raised in the participants' classes ranged from power generation to the ethics of war to taking responsibility for one's own actions. Some of the teachers used structured discussion aids (see, for example, Starratt, 1994) while others relied on inquiry projects using the Smarter Science framework

(Youth Science Canada, 2012) that forced students to think for themselves. All participants wanted their students to integrate science both in approach and content into their lives. They all used project and inquiry-based instruction in varying degrees and with varying levels of success in order to cultivate the habits of mind necessary to do so. As the Practical Engineer said:

> [I want them to] walk away with a desire to learn more and the basic methodology of how to achieve it and to solve problems….I spend a lot of time on how to how to create a fair test and how to isolate a variable…If you read the newspaper, you get data pulled here and there and from everywhere and I want my kids to eventually be able to read that with some kind of intelligence [about how] they're being swayed by the media by just how somebody has put facts together. [Practical Engineer]

The specificity of their goals for students sometimes came into conflict with those of the parents who had a more global view of their child's success that these new teachers often had difficulty understanding:

> It's so interesting when I talk to a parent because they see things so fundamentally different. And I think that's a good thing. I've had way more positive experiences with parents than negative....But, at the end of the day, their goals are the same goals I have for their kids. And that's for their success. So it's interesting to watch how they perceive success differently. [Enthusiastic Showman]

This acceptance of the different perspectives parents bring came late for all four teachers, however this seemed to be because they were so engrossed in surviving their first year or two of teaching.

Becoming Part of a Professional Culture

> More experience has given me the chance to appreciate my colleagues' unique skills even though they're very different from mine. At first [I might have said], "Well why didn't you do it this way?" and you realize, "Okay, you know what, that does work for you." [Practical Engineer]

New science teachers are in an interesting position because they straddle two professional cultures – science practice (as represented to them by university science) and school science (Barrett & Nieswandt, 2010). A lot of what is expected of science teachers has its origins in their perceptions of what university science courses require (i.e. facts and theories). Few science teachers have any experience with actual science practice which emphasizes inquiry (Luft, 2001). As a result, these new science teachers were caught in the middle.

All of the new science teachers in this study tried to implement inquiry-based projects and most tried to introduce ethical issues into their teaching. This is in line with current science curriculum guidelines. However, the two teachers who were in science departments in high schools working with other science teachers faced resistance to these approaches from colleagues. The source of conflict was always the question of what students needed to be successful in university. For this reason, all of the participants felt caught between their duty to follow curriculum and their duty to prepare students for post-secondary education.

All of the teachers had the support of their school administrators and sometimes department heads to innovate and teach science differently than they had been taught themselves but when that support

was removed, the innovations became less prominent. Interestingly, those teachers running courses on their own expressed relief at being able to include inquiry and projects and STSE without the added burden of conflicts with co-teachers. This challenge of conflict with colleagues over levels of innovation within science curriculum was the second strongest theme in the study. It, however, cannot be completely separated from precarious employment. As one participant said, when asked about bringing relevant STSE topics up for discussion:

> I have to tread lightly….I can't say this is a good idea because then half of the class gets offended and it becomes an argument. As a first year teacher trying to get a permanent [contract], I can't afford that. [Enthusiastic Showman]

All of the participants had to worry about their jobs at some point during the study. While it impacted them in varying degrees, being a new science teacher hoping to keep their position did affect the types of STSE topics that they chose to teach.

Professional Growth as the Universal Antidote

Teaching in a way that was different from how they had been taught as science students and unlike what they had witnessed as student teachers meant that the participants had to figure out how to integrate inquiry and STSE on their own. All struggled with how to do this. In the beginning this was partially because they lacked vision of the big picture – a view of the entire curriculum and its direction – including past courses and future ones. Also, due to day-to-day concerns, there was also little opportunity to think about it:

> I don't have a good vision for what I will cover. I haven't sat down because the turn-around days we had were filled with marking exams and creating [report card] comments and reflections because I have 95 students. [Pacifist Philosopher]

However, over time, as this vision emerged through experience, the new teachers were able to integrate inquiry and STSE with more confidence and understand how these approaches fit into the larger K-12 science curriculum.

> I have more of a vision of that and I see that [the goals of the government]….[If] I had an [STSE] issue, before, I could look through [the curriculum] and read "Oh, okay, I can use that expectation" or "I can use this for this expectation." But I never really had any connectivity between the whole thing. I never really saw it as a whole document. I feel like I really can see that now, after looking through it a number of times and teaching the expectations a number of times. [Feminist Activist]

This transition was aided by professional development that was specifically geared to science teaching. Those who were involved in the provincially mandated New Teacher Induction Program (NTIP) appreciated their mentor's guidance and having opportunities to meet with other new teachers discussing their challenges and potential solutions or approaches. They appreciated workshops about specific inquiry projects and time to reflect on their practice:

> PD has been so exciting. For me, one of the best parts of being a teacher is that you get to be a student and think about big ideas that aren't just about teaching. They're about who you are

and about what our society is and about what education is and how we shape students and how they're shaped by us. I really have appreciated all of the professional development that I've gotten to do. [Pacifist Philosopher]

Indeed, three out of the four participants said that they appreciated being part of this research project simply because it forced them to make the time to reflect – a luxury that tended to otherwise be set aside in the day-to-day busy-ness of their work.

Advice to Self: New Teachers' Recommendations to New Science Teachers

At the end of each school year, each participant was asked: If you could go back in time and talk to your New Teacher Self, just finished your bachelor of education, what advice would you give him or her? What follows are selected answers from each:

The advice I think I would've given myself was to know that I would be overwhelmed and that being overwhelmed does not mean that I am never going to be able to go back to including the things that I like to include like social justice topics in my science and that I am not going to be able to get it done overnight but piece by piece I am going to be able to include these things in my work. [Feminist Activist]

Be organized from the start…. That's a logistical thing that I can think of. Read some of the restorative justice stuff earlier in your course. Think about what you expect of your students and make that explicit to them….Think about expectations from the beginning because I think I didn't realize what I expected and then received a shock when I realized that I had it but then hadn't communicated it. [Pacifist Philosopher]

I would want to say to myself, "Sleep more." You know? "Get it more managed." But I feel that if I hadn't…if I didn't put in this many hours, they wouldn't have bent over backwards to keep me here.…the one advice would be to not be afraid to try things, whether it be doing a lesson on the fly, trying a new experiment…because none of it matters in the long run. You failed? So what? The kids are not going to remember a bad lesson. It will not screw up their education for life. [Enthusiastic Showman]

I guess one of the biggest problems with a new teacher and even the same problem that I had…you want to be good at everything. You never want to let your students down. You never want to give them a test or something like that that could in the least bit possibly be unfair for any reason because you wrote a stupid question.… But I would probably say, "Just try and relax a bit. Don't take it quite so seriously. It's all part of the process. You can't circumvent the process. You can't jump over stages. You have to go through it. So don't beat yourself up about it because you waste too much energy doing that and you might as well just use it on putting your lessons together and making sure that the key things are taught." [Practical Engineer]

The above quotes could have been said by any new teacher but it is important to note that for a subject specialist, all of their teaching experiences are filtered through teaching that subject. There are reasons specific to science teaching why it is difficult to include social justice topics. There are logistical concerns specific to teaching science, from equipment to lab safety to demonstrations to the level of math that students have attained. Finally, the sheer volume of facts and theories that a new science teacher must master in order to field student questions can undermine a new science teacher's confidence.

Implications and Recommendations

My purpose in this research was not to evaluate the participants' competence as educators. Rather, it was to document the experiences of new science teachers that are highly specific to teaching science in a way that is different from the way science is traditionally taught in the schools.

Because the focus of this research was those experiences unique to new science teachers, I did not emphasize such challenges as classroom management, organization and work-life balance. These topics were important aspects of the participants' first years of teaching but this is universal to all new teachers. Instead, this research has been designed to shed light on the specific needs of new science teachers, who are rarely studied.

Based on the data collected over the last five years, it is clear that these new science teachers were enthusiastic about innovations in science curriculum such as inquiry and a more central role for STSE. However, in the beginning, they lacked vision with respect to the overall science curriculum and had difficulties balancing urgent day-to-day concerns with important long-term ones. They lacked time to think, reflect and plan. When they enjoyed the support of administrators in terms of approval of their inquiry and STSE work, they usually lacked resources in terms of time and materials to do so. They also faced resistance from students – more accustomed to traditional and less demanding approaches – and colleagues – influenced by their interpretation of what university required – and, sometimes parents whose goals were not always clear to the new science teachers. In light of all of this, I make the following recommendations for professional development that school boards may like to take into account when planning professional development for new science teachers.

- make time for reflection and planning a priority for new science teachers and provide time and resources for them to do so
- connect new science teachers with other new science teachers doing similar work in different schools and provide time and resources for them to meet
- help new science teachers develop time management skills that take the unique work of science teaching into account
- consider creating opportunities for entire science departments to engage in discussions with university professors and working scientists. All three groups could learn a great deal from each other

This research occurred with particular teachers in particular contexts and therefore the findings cannot be strictly generalized. However, the case studies developed from this research will be used as teaching tools with prospective science teachers and to generate further research in effective professional development for new science teachers.

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