Self-Study and the Apparatus

Weaving Student Feedback into a Useful Fabric

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Teaching through inquiry has long been promoted in science education as an authentic pedagogy for the discipline; it's the way scientists work. Learning how to scaffold inquiry learning for students, however, presents challenges for preservice and inservice teachers alike. Often, these relate to teachers' difficulties with moving beyond the 'standard classroom' and associated tensions between creativity and control (Hayes, 2011). More specifically in science, challenges arise due to teachers' lack of an embodied experience of inquiry learning as part of their own development as a learner (Cowie & Hipkins, 2009; Goodrum, et al., 2000; Windschitl, 2002). For preservice teachers, learning to teach through inquiry presents additional challenges previously described in terms of 'apprenticeship of observation' (Lortie, 1975), the school dilution effect (Ball & Cohen, 1999), simplistic views of the 'scientific method' (Windshitl & Thompson, 2006), and beliefs that inquiry needs to be 'esoteric, exotic, and expensive' (Lustick, 2012).

Preservice teachers' perceptions that there is a disconnect between what they learn at university and what they observe happening and learn to do in schools while on professional placement/practicum compounds the problem. Frequently, teaching in a university classroom employs a transmission model rather than the pedagogical procedures that preservice teachers are supposed to be learning to include in their own teaching practice. Russell, McPherson & Martin

(2001) focus our attention on the importance of university-based teacher education programs moving beyond a transmission model and aiming for greater 'coherence and collaboration' in a program that endeavours to bridge the gap between preparation and practice. In order to bridge the gap between preparation and practice, Russell et al. propose that the positioning of theory in relation to practice must be re-considered (p. 45). The authors draw on earlier work of Korthagen & Kessels (1999) to provide a nuanced discussion of the 'dissonance between an epistemology of knowledge and an epistemology of practice', representative of the gap that exists between what is taught at university and how it is taught (p. 51). An epistemology of practice, it may be argued, is the key consideration of effective teacher education programs (Russell, 2018; Russell & Martin, 2017). In April 2019, I experienced the privilege of professional learning time with Tom Russell during his last week of teaching at Queens University. I observed his students, in Physics education classes, on the cusp of becoming practicing teachers, joined in discussion groups, spoke one to one with several students, and listened to their feedback sessions with Tom. I also enjoyed the pleasure of rich debrief conversations with Tom and with Andrea Martin about the 'epistemology' problematic.

The issues outlined above inform a longitudinal self-study of my practice as a teacher educator supporting learning about inquiry pedagogies for preservice science teachers. The study is ongoing and situated in an Australian metropolitan university. Study participants are students enrolled in either a 5-year combined education and science undergraduate degree or a 2-year postgraduate teaching degree. I teach these students one or both of the two units of study, taken in sequential years, related to science teaching pedagogy with a focus on physics concepts. The Year 3 unit focuses on common physics misconceptions in the junior high school syllabus and the Year 4 unit is for those preservice teachers specialising in physics teaching for senior high school.

Working initially from university student evaluation surveys, I was struck, and quite hard, first by how few students bothered to complete the surveys. Second, and more significantly, by a general trend of satisfaction with the teaching and learning in each unit contradicted by usually one long qualitative response from a student reporting, what for them, had been a miserable experience. Taking this feedback to heart, I redesigned learning experiences in each of these units in response to the limited evidence at hand. More importantly, I included pedagogical moments in the redesigned units that would allow me to collect student feedback data in a range of different forms. Simultaneous with teaching the newly designed units, I continued the cycle of self-study in the spirit of an ongoing challenge (Bullough & Pinnegar, 2001) in order to deepen my understanding of how my students experience my teaching about teaching (Berry & Russell, 2018; Garbett & Ovens, 2016).

According to student feedback, I have made progress with my teaching balancing a genuine, embodied experience of well-scaffolded inquiry learning against the direct instruction favoured by my students. What is of most interest to me however, is the textile that has resulted from the weaving together of each of the reflective moments that form the data set for this study. The material-discursive intra-actions made possible by the apparatus (Barad, 2007; Gullion, 2018) employed for obtaining student feedback has had varying effects on the quality and nature of student reflections. Remaining open to research as an 'assemblage' allows for consideration of the affective interactions between participants, the setting, social formations, data collection events, and the researcher, that come to produce 'something' (Fox & Alldred, 2017, p. 155). When stitched together, not for the purposes of triangulation but to acknowledge the contribution that each piece makes to the finished textile, new understandings become possible of the ways in which preservice teachers perceive the tensions around learning to teach through inquiry.

Aim/Objectives

The problem that this study engages with is the seemingly diametrically opposed views expressed by some students in one-off forms of feedback, such as the Unit of Study Survey (USS), regarding their learning about teaching with inquiry pedagogies. Further, the feedback obtained via USS often conflicts with feedback obtained progressively throughout the unit of study; the USS expressing negative views that had not previously been evident.

The inquiry question that drives this self-study is: How can I form a better understanding of my students' experiences of learning through and about inquiry pedagogies?

Method(s)

Participants

In 2019, 24 Year 3 students (12 undergraduate and 12 postgraduate) and 20 Year 4 students (13 undergraduate and 7 postgraduate) participated in the focus units. The study is ongoing in 2020 across the same Year 3 and Year 4 units with new cohorts of students. There will be a small overlap of participants between the 2019 Year 3 class and the 2020 Year 4 class. The Year 4 unit is taught as 2x2 hour seminars per week in Semester 1 Weeks 1-8 and is followed immediately by a 5-week practicum. The Year 3 unit is taught as 2x2 hour seminars per week in Weeks 1-4. Undergraduate students then complete a 4-week practicum (postgraduate students' practicum occurs later in the year). All students return for 2x 3hour seminars per week in Weeks 10-12.

Data Sources

Data for the initial reflection on practice was collected from the University's online Unit of Study Survey (USS) system completed by preservice teacher education students in and 2018. Across both units of study for the two-year period n= 25, a response rate of 32%.

In 2019, data continues to be collected in a range of different ways.

1. Exit slips: during the course of each unit exit slips with key questions were individually completed at critical points. Students also completed an individual final reflective exit slip. The pedagogical purpose of the exit slips was explained to students in terms of their own reflection on learning and a mechanism to inform my planning of subsequent learning experiences. In the 4th year class, these were anonymous while in the 3rd year class students were asked to identify their exit slips with their name, a pseudonym, or a symbol so that they could be collated and returned to them for their consideration prior to completion of the final reflective exercise.

2. Video: 4th-year class working groups of 3-4 students were asked to prepare a group response to the question: What do you think Deb has been doing in this unit? Students were given the option of presenting their discussion for video recording or handing in some bullet point notes.

3. USS: students completed the university online surveys (USS). The results of this survey are only released once all grades are uploaded.

4. Focus Groups: 4th-year students were invited to participate in a

focus group interview following practicum that explored the relationship between their learning in the unit and learning to implement inquiry pedagogies on practicum.

5. 3rd-year undergraduate students were interviewed in small groups by postgraduate students using a provided, semi-structured interview schedule that asked about their experiences of implementing inquiry pedagogies while on practicum. Notes recorded on the interview schedule were analysed for emerging themes.

Data Analysis & Trustworthiness

2017 -2019 USS surveys were analysed for overall satisfaction ratings. Qualitative comments were dialogically analysed guided by the questions: 'What is being spoken about here?' and 'How can sense be made of it in relation to the transcript as a whole?' (Talbot, 2016). Exit slips were analysed for patterns and emerging themes across each class cohort. In the Year 3 class, each student's progressive exit slips were collated with their final exit slip and analysed as a whole for emerging patterns of reflection on learning. Year 4 video or bullet point notes were analysed for evidence of learning aligned with the unit learning outcomes, course content, and learning intentions for each seminar. Year 4 focus group interviews were audio recorded, transcribed, and dialogically analysed.

Emerging themes across all data sets were compared to each other and to the analysis of the 2019 USS quantitative and qualitative data. Weaving together the analysis across all data sets creates a more detailed and textured fabric of student learning. This process of 'reading insights through one another' (Barad, 2007, p. 71) allows the researcher to respond to differences in the data and how they come to matter, at the same time as it enhances the trustworthiness of the

knowledge creation process.

Outcomes

In 2018 I did not teach the Year 4 unit having been seconded to another project, however, students were provided with the same unit outline and assessment tasks as I had designed in 2017. The combined return rate for the USS in 2018 was only 40% with an overall mean satisfaction rating of 3.90/6.00. Qualitative comments were rare and brief with one student indicating the belief that inquiry required 'exotic' equipment (Lustick, 2012) not necessarily available in schools. This informed my planning for equipment selection in 2019 and I also took great care, I thought, to provide better explanations of the assessment tasks, in response to the other two students comments.

At the end of the first week of 4 hours of seminar time, students were asked to complete an exit slip. In response to the reflective prompt 'What are my personal challenges as I prepare to teach Stage 6 Physics?' 13/21 students commented that they did not feel confident with the physics content that they would be required to teach. Circular motion was specifically mentioned. Other common responses expressed concerns about teaching physics in a way that was engaging and relatable for students while still managing to cover the mandated syllabus content. For the first assessment task, students were required to prepare a short demonstration that would challenge misconceptions of a selected physics concept included in the syllabus. One student chose circular motion and presented a demonstration accompanied by an explanation that revealed many incorrect conceptions. During this student's explanation, I scanned the faces of other students in the room. Except for two notable exceptions, facial expressions did not reveal any signs that what was being said was incorrect. In the following week, I provided a different circular motion demonstration and challenged students to explain, using diagrams, what they had observed. To my dismay, many students held

misconceptions in relation to the forces involved in producing motion in a circle. We spent some time exploring further and I asked students to continue their own inquiry and come back to me with any further questions that arose for them, personally. None did!

The video reflective pieces were recorded at the end of Week 8, the last week of teaching following 32 hours of seminar time. At least two people from each of the five collaborative working groups within the class offered to be recorded. The most significant comment repeated across groups related to their new understanding of what it meant to engage metacognitively (they actually used that word!) with their own learning in order to better understand how to prepare learning experiences for their future students. I was conscious of the effect of the 'apparatus' in producing positive responses to my teaching when I was on the other side of the video recording device. Nevertheless, I enjoyed the sense that they genuinely seemed to get what I 'was doing in this unit'. The shock of the USS results did not arrive for several more weeks.

The 2019 USS had a combined response rate of 85% but the overall satisfaction rate decreased from 3.90 in 2018 to 3.69. This decrease may not be significant, statistically, but it is low, nevertheless. On first reading of the qualitative comments from students, I was devasted. As many teachers tell me they do, I skipped over the positive comments and became emotionally mired in a smattering of slightly negative comments and the one long, negative response from a student who specifically mentioned the discomfort they had experienced as a result of the circular motion lessons. Dialogic analysis of this long response and a dialogic positioning of the response in relation to the other forms of feedback obtained throughout the unit has allowed me to not only get some perspective and emotional relief in relation to such negativity but also to better understand the severity of the emotional impact some students experience when they are confronted with the realisation that their understanding of the material they will soon be teaching is incomplete and they don't know how to learn it let alone

teach it. What was interesting in this students' response was the attribution of that confrontation to me, personally, as if I were deliberately trying to humiliate them by showing them that they hold a misconception. Yes, I had selected the concept, based on their demonstrated lack of understanding and published prior research of common physics misconceptions but it was the inquiry pedagogical procedure of predict-observe-explain that actually revealed to them that they held misconceptions.

In the final phase of Year 4 data collection, the focus group interviews, one student responded with the following:

> I think during the unit, even after the unit - I haven't reflected on this much, it's good I'm here actually. During the unit and after the unit my gut feeling was, I didn't like it really. But now that you mentioned that [teaching/learning physics differently] and now that I've mentioned what I'm talking about now, is that that may have been the reason and I just wanted the same and it wasn't the same but that was a good thing and we just didn't know it yet. You know what I mean? [Mm hmm] What it did make me realise certainly every single week it was like, as you said, even though I've learnt this, multiple times I can't explain the difference between centripetal and this centrifugal force that doesn't exist. For example, that... [It's quite nasty of me isn't it. I exposed you.] Well, yeah and I sit there like, why am I here. Like I should have already known this and I don't. And do other people know this, maybe they do, maybe I'm - you know...

I wondered if this student was also the author of the long and negative USS response. If so, it is interesting to note the comment that they hadn't really 'reflected on this much' at the time of filling in

the USS. Thus, it would just have been a very raw, emotional response provided on the USS. This sudden realisation of how important immersion in inquiry learning had actually been to this student's learning about teaching through inquiry is consistent with earlier research findings (Windschitl, 2002) claiming preservice teachers cannot teach through inquiry if they have never learned in that way. Already, an appreciation of the different diffractive patterns produced by each apparatus employed for collecting student feedback was contributing to my more nuanced understanding of the challenges these preservice teachers were facing in learning to teach through and with inquiry pedagogies.

I reflected on this new understanding as I prepared for my Year 3 unit before the start of Semester 2. I thought long and hard about how I could improve my practice to create an even safer space in which all, not just the majority, of my students could become aware that they hold misconceptions. I needed to make this introductory course about inquiry pedagogies gentle, in the sense that it was carefully scaffolded, while at the same time keeping them on the edge of their comfort zone to enable their learning through and about inquiry. Along with regular exit slips I collected 'worksheets' completed as we explored a concept. I asked them to write & draw their individual explanations, to discuss their explanation with other class members, check against a standard textbook, and be honest about editing their original response in a different coloured pen. I used my analysis of all of these pieces of evidence to inform my teaching and monitor their comfort levels both before and after they went out for professional experience mid-way through the unit. At the end of the unit, I handed back a collated set of their feedback for them to use in their final reflection.

My hope was that this would help to focus their attention on the teaching and learning they had experienced rather than just their grades on assignments. On the final reflection student comments were very positive about how they had learned to design each of the stages

in a 5E scaffold for inquiry to reveal and address misconceptions. Many students commented that the most powerful learning for them related to effective modelling, by me and their peers, of pedagogical procedures that support inquiry learning. There was no opportunity on any of the data collection strategies I used to give a numerical rating, only qualitative comments as responses to open ended prompts.

In the 2019 USS for this unit, where a quantitative response is required before the optional qualitative comment, there was a 67% response with an overall satisfaction rating of 4.53/6. While this is an improvement of 1.30 on the previous year it still doesn't seem to reflect the level of satisfaction students expressed through the regular feedback opportunities and enthusiasm in class. Again, I questioned the effect of the apparatus. The qualitative comments on the USS, however, represented the breakthrough. While there was a bit of grumbling about the assessment task timing or instructions, most of the comments were very positive and affirmed that students appreciated being asked to learn differently even when they found it challenging. There wasn't even one long, negative diatribe! Just a slightly crazy one which essentially asked me to flag when I was about to say something brilliant so they would know to write it down.

Conclusion

This ongoing self-study continues to provide important insights into preservice teachers' experiences of learning *about* inquiry *through* inquiry and the implications for their pedagogical practice as they try to embed learning through inquiry approaches for secondary school students during professional placements. The introduction of a mandatory 'depth study' in new syllabi for Science subjects studied in the last two years of high school (NESA, 2018) and the reported lack of effective modeling currently occurring in schools when these preservice teachers are on placement makes it even more critical that

they experience inquiry learning. What preservice teachers have said, however, reflects the continuing dissonance occurring for them between understanding that 'traditional' teaching has not served them well and the discomfort experienced as they simultaneously learn about inquiry through inquiry.

According to my students, my teaching about and through inquiry is becoming more effective even while they struggle with the challenges of implementing inquiry pedagogies in their own classrooms. Having a clearer picture of where my students face their most significant challenges has given me the guidance I was seeking to improve and supplement my pedagogical procedures in support of their learning. It has been enormously important to *my* sense of self-efficacy as a teacher educator to have this clearer picture of students' experiences than was previously available through Unit of Study Surveys alone, an endpoint survey highly dependent on students' personal satisfaction with their grade in the subject.

The study has broader implications for learning as the University in which the study is based moves to support the extension of student learning through the inclusion of mandatory interdisciplinary inquiry units across undergraduate degree programs, including teacher education.

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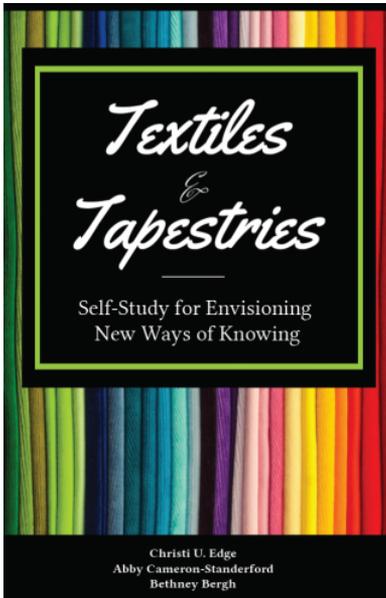
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