INCORPORATING COLLABORATIVE, INTERACTIVE EXPERIENCES INTO A TECHNOLOGY-FACILITATED PROFESSIONAL LEARNING NETWORK FOR PRE-SERVICE SCIENCE TEACHERS

Seamus Delaney and Christine Redman
Melbourne Graduate School of Education
The University of Melbourne, 3010, Victoria, Australia

ABSTRACT

This paper describes the utilisation of a technology-facilitated professional learning network (PLN) for pre-service teachers, centred on chemical demonstrations. The network provided direct experiences designed to extend their pedagogical content knowledge on demonstrations in Chemistry teaching. It provided scaffolded opportunities to collaborate as they ‘negotiated their identity’ as chemistry educators. Using technology to facilitate conversations around the use of chemical demonstrations was seen as advantageous as it provided an explorative workspace to discuss and refine pedagogical approaches. Importantly, it was anticipated that through these personal experiences the pre-service teachers would better understand ways to utilise technology within a PLN. The design of the PLN, and two examples of discussions designed to phenomenologically explore the teaching and learning associated with chemical demonstrations, ably facilitated by technology, are described here.

KEYWORDS

Professional learning network, Science, pre-service education.

1. INTRODUCTION

Today’s pre-service teachers are active users of a wide range of social technologies. Whilst their perceptions on how to utilize technology for learning varies, for the most part they share an obligation to use technology effectively (Linehan & McCarthy, 2000, Redman & Rodrigues, 2008). Within the Science Education program at the Melbourne Graduate School of Education, The University of Melbourne, the pre-service teachers are provided with strategically placed science education learning opportunities by explicitly embedding collaborative, engaging and integrated eLearning experiences within teaching practice. Research evidence (Redman, 2013) indicates that situating these new technologies within cognitively challenging, collaborative and engaging contexts leads to development of positive identities for pre-service teachers as learners and teachers with new technologies.

This paper presents one aspect of ongoing research to document and identify the thinking and pedagogical practices of pre-service teachers as they utilize technologies as learning and reflective tools. The researchers pay close attention to the pre-service teacher’s perceptions of technology for effective Science learning, as well as their visions for technology use for their Science teaching practice. This research is being supported by an eLearning Learning and Teaching Initiative (LTI) grant (The University of Melbourne). As pre-service teacher educators, this research also informs our own practice, and helps align Science teaching in the subjects with students’ current usage of technology (as well as helping us support their future needs).

This research reports on the utilization of a technology-facilitated professional learning network (PLN) with Chemistry pre-service teachers. Explicitly, the PLN provides direct experiences that extended their pedagogical content knowledge on chemistry demonstrations in Chemistry teaching practice. Implicitly, opportunities exist to collaborate as they ‘negotiate their identity’ as chemistry educators, and to develop an identifiable and shared language for teaching and learning. Focussing on discursive practice, incorporating ‘do’ and ‘say’ of the educator and the learners, is supported by the pedagogical standpoint that meaning is co-constructed in discussion with others. A key premise is that meaning is further improved by making learning and the language associated visible to the learner (Hattie, 2003). Supporting choice, curiosity, discovery and collaboration are seen as vital to the 21st century learner (Hayes, 2006), as is placing language at the centre of empowered teaching and learning (Bourdieu, 1994).

In Chemistry Education, which is largely the study and application of abstract concepts of atomic matter and sub-atomic interaction, educators and learners have always been challenged to teach and learn on multiple levels simultaneously. Students are required to think on a macroscopic level, that is the visible, the descriptive and functional, as well as the sub-microscopic level, that includes the invisible, but what explains why chemical substances behave as they do, and also the symbolic level, incorporating the visual, algebraic depictions of chemical understanding (Johnstone, 1982, 1993). Building an appreciation of pedagogical approaches that can be utilised to facilitate knowledge construction on these multiple levels (Gilbert et. al., 2002) has become an important aspect of Chemistry pre-service teacher education.

One such pedagogical approach to address the multiple levels is the chemical demonstration. The teacher demonstration, either with or without student involvement is a key teaching practice for Science pre-service teacher to learn to master. This involves questioning techniques, understanding methods of meaning making and facilitating the assimilation of concepts of Science through concrete observations.

Using technology to facilitate a conversation around the use of chemical demonstrations was seen as advantageous as it provided an effective way to support the explorative workspace to discuss, improve and ‘fine tune’ pedagogical approaches not only for individual demonstrations (timing, use of questioning, observations to highlight, opportunities for student involvement etc.), but also for the use of demonstrations as a whole. Importantly, it was hoped the pre-service teachers would begin to appreciate the benefit of these discussions, including a broad range of collaborative feedback and reflection experiences, occurring within a PLN, ably facilitated through technology. These approaches, along with a few examples of their use, are described below.

It is notable that we tried to create a collaborative environment for learning that had invited the technology to show effective uses. Salomon, Perkins and Globerson (1991) stated that “it is not technology alone affecting minds, but the whole ‘cloud of correlated variables’, technology, activity, goal setting, teacher’s role, culture…exerting the combined attempt” (p. 8).

2. METHODOLOGY

2.1 Participants

The participants were a cohort of Chemistry method pre-service teachers enrolled in their first semester of the Master of Teaching (Secondary) course at the University of Melbourne. During their first week, the pre-service teachers were provided with a link to an on-line survey, of which 50 of 56 enrolled students responded. The survey focused on a number of areas including; their use and relationship to new technologies; perceived benefits of using technology in the classroom; goals and vision for teaching and learning; perceptions of how ICT can be used to support their own professional learning. The survey also asked some chemistry-specific questions including about their own chemistry education background, their perceptions of effectiveness of chemistry demonstrations, and their current confidence in Science pedagogy.

The survey responses are being coded and analysed using Positioning Theory (Harré, 1997) and referenced against Bloom’s taxonomy (Anderson & Krathwohl, 2001) to determine their existing perceptions and approaches for using technology. Comparing these to a similar survey completed at the end of the semester provides some insight as to how their perceptions of effectiveness of technology changed, for using technology for their professional learning, and their emerging confidence in teaching chemistry.

2.2 Design of the Professional Learning Network

Each week, two-three pre-service teachers present a chemistry demonstration to the rest of the pre-service teachers, around a central theme for the week (acid-base, gases, teaching junior levels etc.). As part of this presentation, they describe what they see as the challenges of teaching and learning associated with the theme for the week, and how their demonstration could be used and conducted as an educative experience.

A series of collaborative feedback and reflective experiences then follow. Depending on the week, two-four fellow pre-service teachers are pre-allocated to participate in an online discussion around the particular demonstration presented that week. These online discussions were framed by the use of one of four different diagnostic tools that gather perceptions of effectiveness, and the perspectives of the teacher and learner. These are described in more detail in the next section.

All discussions took place in google drive documents, in a shared google drive folder between the pre-service teachers and the educators. The pre-service teachers were given a session on how to utilize and collaborate within the google drive documents together as a group at the start of the semester, but other than that the pre-service teachers were left to decide on how best to participate and complete the collaborative exercises together.

At the start of the next week, the entire cohort gather around two-three tables to have an informal 'summing up' discussion. This includes the presenter of the demonstration, those who were allocated to participate in the online discussion, and other interested members of the cohort. Whilst largely an informal 'chat', this was seen as vital to the researchers, as it brought to the fore the meta-cognitive nature of these discussions, and provided further opportunity for voice and to question, providing a more enriching personalized learning experience.

Finally, the demonstration presenter is also tasked with writing a brief reflection and posting this in another shared exploratory workspace. *Edmodo* was used for this purpose, given that it provided a highly personalized experience, and allowed for the cohort to post and share resources with each other in a free, secure social learning platform. The posts written by the demonstration presenters summarized some of the feedback and comments from the online discussion and the follow-up discussion. These were written as a self-reflection on their ability to conduct the demonstration as an educative experience.

3. RESULTS AND DISCUSSION

Four different approaches were trialed as collaborative experiences facilitated by technology. Each were chosen for their ability to gather and document perspectives of the participants, from a phenomenological view, i.e. what the teacher and the students were 'seeing' and 'doing' during the delivery of the chemistry demonstration. Each required little or no modification to be utilized in an online exploratory workspace.

The four approaches were a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis; the SCAMPER (Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, Reverse) technique; a Collaborative Interactive Discussion (CID), and; a Personal Meaning-Making Map (PMMM). The first two were known to the pre-service teachers. For the later two, class-time in an early session was allocated to allow the teachers to undertake one of each, to promote how these could be used to make thinking visible, document and discuss their perspectives, and how this could be done in an online social environment.

Figure 1 below shows a CID about a chemistry demonstration, lead iodide precipitation with different reagents in excess (Commons & Hoogendoorn, 1990), which took place in an online environment. Briefly, the pre-service teachers are all shown the same 'focus statement', and are then given different 'focus questions'. Each participant fills in the response in the first row, with a 1-2 word response in the left column, and a longer response in the right. They then move on to responding to another participant's initial response to a different focus question and so on (Ryan and Jones, 2014).

An analysis of their utilization suggested that the participants were able to deeply explore the discursive practice of each chemical demonstration. Facilitated by technology, this gave individuals time to consider their response and the comments of others, and provided an equal voice to all participants. One negative was that as the duration of the discussion was considerably longer than if it had occurred during a class workshop, participants often had to wait for their turn to respond, which perhaps limited the buildup of narratives in the shared workspace.

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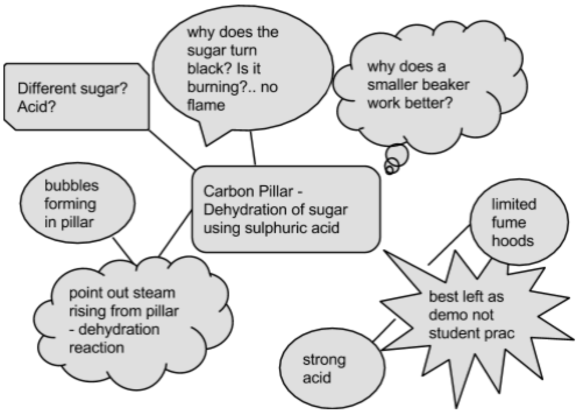
24		
25	**Focus statement**	
26–28	A good 'mole' demonstration makes an amount of substance visual to the learner. A great 'mole' demonstration goes further and shows the amount of substance to not be defined by its mass and/or its volume.	
29		
30	**Focus question**	
31	What could be done to enhance the key observation in this demonstration. What do we want to learner to focus on, and make use of building new knowledge?	
32		It was very hard to actually see the total height of the solid/liquid mixture, as well as the position of the interface. Preparing the samples more carefully and earlier, to give a longer sedimentation time, could make things clearer. Using a thinner stirrer to mix the solutions together would help.
33	Slow though	Maybe by inserting the second solution slowly into the bottom of the measuring cylinders might help "neaten" up the experiment so we can easily visualise the heights of the precipiates.
34	not clear interface	Much bigger samples, in bigger vessels will allow clearer view of the solids-liquid interface and the main key of this demonstration will be much clearer
35	Yes, but...	Perhaps another compound that precipitates so students could compare and do a few formulas at once may also enhance their experience and learning
36		
37		
38		
39		

Figure 1. Excerpt from an online collaborative interactive discussion (CID) around a chemical demonstration.

Figure 2 below shows a personal meaning-making map (PMMM) of one participant written after observing the Carbon pillar demonstration (Commons & Hoogendoorn, 1990), and the follow-up discussion had with another participant (which would appear underneath the map in the google drive document). Inside the online document, the pre-service teacher was easily able to gather their perspectives using the figure drawing function, as shown here, or take a photo of a hand-drawn picture and upload the picture with any device. Having generated the discursive ideas to discuss, a second participant (another pre-service teacher in the cohort) then came into the online workspace to ask clarifying questions, providing an opportunity for the map maker to elaborate on their ideas and further identify and document their meaning making processes (Falk & Dierking, 2002).

Collaborator 2's Drawing



Discussion (*Collaborator 1 as educator, Collaborator 2 as learner*)

Why do you think the small beaker makes it work better?

The column rises more.. possibly because of the volume to surface area ratio of the beaker.

What were you thinking about when you wrote "Is it burning?... no flame"?

I was wondering why it turned black if there was no flame, it didn't look like it was burning.

I think a student would ask that question too

What would your answer be?

I believe it's because all that is left in the pillar is carbon, which is black.

hmmmm

Do you think there is a way to relate this demo to a real world application?

This demo shows that there is a lot of energy in sugar, even though it's not a form of energy that students are used to seeing. It may have applications in the food industry.

Figure 2. Excerpt from an online PMMM drawing and discussion (modified from original)

Each of the four approaches trialed, including the SWOT analysis and SCAMPER technique, did not appear to lose any authenticity or capacity for free choice by moving the discussion into an online exploratory workspace. As described above, the 'drawn out' nature of the discussion was seen as the main negative, but perhaps this also highlighted to the participants how learning with others in an online social environment can be a constant, ongoing journey of reflection and discovery.

A follow-up survey of participants occurs at the end of semester, and is used to analyze and track how their perceptions of the use of ICT for professional learning have changed, and their 'goals' and 'visions' statements for their use of ICT in teaching practice will again be coded and analyzed to determine if the 21st century skills we as higher education educators have tried to demonstrate have started to translate into their own teaching practice.

4. CONCLUSION

This study examined how a combination of pedagogical approaches were utilized to help redefine teacher identities. Through these experiences we anticipate these teachers are more likely to be willing to incorporate technology in their classrooms. A number of approaches were utilized to facilitate novel collaborative and reflective online discussions around language and discursive practice associated with a series of chemistry demonstrations. Technology ably facilitated this approach, and its affordances allowed for more voice and authentic responses from its participants. A survey of initial perceptions of the use of ICT for professional learning showed a broad range of opinions and abilities, and so it is expected the upcoming follow-up survey will show a cohort of pre-service teachers who are building an appreciation of how technology can be used to analyze and improve their professional learning and teaching practice.

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