A Model for the Creation of Cooperative e-Learning Spaces: Teaching early Childhood and Primary Preservice Teachers how to Teach Science.

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Abstract

In this article, we describe how we have translated our face-to-face teaching of a science curriculum subject in to an e-learning environment that provides preservice early childhood and primary teachers with opportunities to practise how they would program for, and teach, science in a school setting. Many of the preservice teachers who enter our subject possess negative attitudes toward science, display low personal science teaching efficacy and lack confidence in the subject area. In an attempt to combat these issues, and to conceptualise our practice in an e-learning setting, we situate our preservice teachers in an online, cooperative learning environment in which they engage with the learning experiences that directly feed in to the assessment tasks. Through asynchronous and synchronous interactions with the teaching-team and each other, they begin to develop their confidence and competence in the teaching of science. We present a model for the creation of cooperative e-learning spaces. The strategies and approaches we implement may also be useful in the professional learning of in-service teachers, other practice-based professions and, in the orientation of students to university.

In this exemplar, we draw on our experiences in two implementations of the subject to illustrate how we use the online tools afforded to us to generate a practice-based approach to the learning and teaching of science. We outline the action-research we are undertaking to inform the future implementation and iterations of the subject, identify the issues confronted, and, share our preservice teachers’ experiences in the subject based on the questionnaire, reflection and evaluation data we have collected. In the discussion, we consider the changes to both the subject design and e-learning environment that can be made based on the evidence collected from the action research. Broader implications for online tertiary education and future research are also discussed.

To cite this paper


Introduction
There has been a considerable push to establish effective e-learning environments at the tertiary level (Johnson, Adams & Cummings, 2012; Johnson, Adams Becker, Cummins & Estrada, 2014). It has been argued that education has lagged behind other fields in the use of Information and Communication Technologies (ICTs) to enhance both the productivity and efficiency of practice (Larsen & Vincent-Lancrin, 2005). The issues do not necessarily relate to the use of the ICTs, but rather the lack of core change to the processes of teaching (Keith, 2015). This paper presents a model for tertiary e-learning that aimed to improve learner outcomes through the use of ICTs to promote student-centred active learning.

New e-learning needs to be considered as conceptually separate from the old mode of distance education. During the earlier period of transition from print media to e-learning for distance education, there was a misconception that due to the multimodal affordances of ICTs constructivist learning would occur innately (Garrison & Anderson, 2003; Harasim, 2000). Without deep pedagogical consideration e-learning can resemble the more passive distance education models that have preceded it. McLoughlin and Lee (2010) argued that the use of ICTs in online environments need to be varied, personalised and supported to ensure that self-regulated learning can occur. The e-learning educational model described in this paper adopted various ICTs with clearly articulated standards for engagement and assessment achievement. The students were free to construct their own learning pathways with the available ICTs in the knowledge that their formal grades were tied to the assessment products rather than arbitrary processes. In order for students to construct their own learning pathways their own beliefs about the nature of learning needed to be addressed explicitly within the e-learning model.

Student-centred learning in e-learning environments can be hindered by students’ beliefs about teacher-centred learning (Westberry & Franken, 2012) and asynchronous learning experiences (Rockinson-Szapkiw & Wendt, 2015). According to Rockinson-Szapkiw and Wendt (2015) tertiary students with access to both synchronous and asynchronous online educational experiences showed better perceptions of online social presence, cognitive presence and teacher presence than those students who only utilised synchronous modes of communication. It would seem that access to a diverse array of scaffolded resources and strong expert teacher presence is needed to facilitate student-centred e-learning.

The call for integration of ICTs and development of e-learning environments that promote student-centred learning has grown within the Australian tertiary context. In 2014, the New Media Consortium, in collaboration with Open Universities Australia, released a national report on the technology outlook for Australian tertiary education. The report stated that online student-centred learning (i.e. flipped classrooms) needed to be adopted by tertiary institutions within a year. It was also acknowledged that scaling teaching innovations and keeping education relevant were barriers to establishing e-learning environments. The research presented in this paper explores the transition of an effective on-campus primary science subject to an e-learning format.

Science teacher education is a domain with a rich tradition of innovative pedagogical approaches. Many researchers have managed to successfully improve science teaching attitudes, capacity and content knowledge. Pedagogical innovations such as cooperative learning (Palmer, 2006), practical science teaching experience (Mulholland, Dorman &
inquiry learning (Leonard et al., 2011) and problem-based learning (Logerwell, 2009) have shown to improve student outcomes. The overwhelming majority of tertiary science education courses reported in the literature describe on-campus, face-to-face delivery of subjects. Some initial strides have been made to transfer science education subjects to online delivery models. Slater, Slater and Shaner (2008) incorporated interactive online learning modules as supplementary learning tasks that allowed students to complete more open-ended inquiry tasks during face-to-face workshops. The preservice teachers showed improvements in content knowledge, pedagogical understanding and science teaching efficacy. Such blending of online and on-campus approaches may be a valuable step in the transition from face-to-face to e-learning environments. Haeusler and Lozanovski (2010) progressed the literature further by separating on-campus and e-learning modes of delivery. The course required students to work collaboratively to design a science curriculum project over the course of the semester. The e-learning students were provided with group wikis and online forums in lieu of the face-to-face tutorial meetings offered to the on-campus cohort. The distance and internal cohorts both showed statistically significant increases to their personal science teaching efficacy beliefs. In fact, there was no significant difference between the groups, suggesting that there has been a successful transition from on-campus delivery to an e-learning environment. Online and blended modes of delivery are explored in this paper.

The purpose of this paper is to describe how we have translated our face-to-face teaching of a science curriculum subject into an e-learning environment that provides preservice early childhood and primary teachers with opportunities to practise how they would program for, and teach, science in a K-6 school setting. A key challenge was facilitating student-centred learning and practice-based experiences in an e-learning environment as we tried to overcome barriers of distance, time and students’ expectations of distance education. We outline the action-research we have undertaken within the subject and draw on our experiences in two iterations of the subject to illustrate the subject design. We identify the issues confronted and share our preservice teachers’ experiences in the subject based on the questionnaire, reflection and evaluation data we have collected. The discussion identifies broader implications for the design and implementation of future tertiary education subjects delivered in an e-learning environment.

Subject Description

At the start of the University year, we were charged with creating an e-learning environment for a science curriculum method subject that mirrors the outcomes and successes of the previous internal (face-to-face) deliveries. There were seven student learning outcomes identified for this subject. This meant that by engaging with the subject and successfully completing the assessment tasks, students should be able to: employ a range of instructional and collaborative learning strategies in the science curriculum area; develop a science unit of work (curriculum or program of work to implement with students); use a range of diagnostic, formative and summative assessment; demonstrate skills in the use of technology; differentiate student learning; apply their understandings of content in the science curriculum; and, incorporate skill development into science learning experiences.
Figure 1: Cooperative E-Learning Model for the Science Subject

Our approach to ensuring our students achieved these outcomes was to place them in a project-based scenario where they were required to work online in a cooperative learning environment in which they engaged with the content and learning experiences that directly
fed in to the assessment tasks. By using the technology afforded to us through our learning management system, we attempted to mirror how we had previously taught an equivalent science curriculum subject that was delivered internally using the traditional face-to-face mode (McKinnon, Danaia & Deehan 2015 – Under Review).

At the start of session, we randomly assigned our preservice teachers to online learning groups comprising four students per group. We provided them with a project-based scenario where they would be working as a group of teachers to develop a class program (unit of work) for the science curriculum area. This reflects what typically happens in a primary school context, where teachers often work together to create their class program for the school term.

Within the online groups, we enabled a number of tools that students could use to communicate, share and collaboratively work on tasks in either a synchronous or asynchronous fashion. The tools included: a file exchange; blogs; discussion boards; group tasks; wikis; and, a group email function. While we gave our students instruction on the use of each tool, how groups used these tools was left to their discretion. The most popular tools were the group wikis for shared editing and the ‘Group discussion board’ for asynchronous communication. Several groups communicated beyond these parameters via Skype, Facebook, phone calls and some even organised face-to-face meetings. We, the teaching staff, had access to all online groups and students became aware of this as we interacted with them and provided them with formative feedback at certain stages of the semester. Individual students only had access to their online group. If they wanted to communicate with the rest of the cohort they could use a general discussion forum available in the main area of the subject site. Adobe Connect software was used as a synchronous learning tool that allowed the students to communicate with academic staff and other students in more structured learning spaces.

During the first six weeks of the subject, students learned how to work collaboratively to develop an inquiry-based science curriculum that incorporated the 5Es teaching and learning model (Bybee, 2014) and a range of instructional strategies. The 5Es is a constructivist, inquiry-based instructional model that actively engages students in their learning (Skamp & Peers, 2012). The model is divided into five distinct phases that can occur both within and across science lessons; the phases are Engage, Explore, Explain, Elaborate and Evaluate. In designing learning experiences for their curriculums, students also had to apply their knowledge of the NSW K-10 science syllabus content (NSW Board of Studies, 2012) and the different assessment strategies that could be employed.

To help scaffold our students’ learning of the subject content we provided them with access to four online learning modules. The modules provided the students with essential information on a variety of topics, these included, but were not limited to: the nature of science, science teaching pedagogies and syllabus navigation. Embedded within the modules were movies modelling different instructional strategies used in the teaching of school science. The modules also comprised a number of tasks they engaged with both individually and collaboratively on the relevant Module discussion forum. To complement and extend their learning of the content they were covering within their groups coupled with the module work, we also held weekly online sessions using the aforementioned Adobe
connect software. The online sessions were recorded for those students who could not make the set time. This served the dual purpose of creating both a synchronous learning experience and an asynchronous resource.

The groups were organised and scaffolded to assist the students to share their concerns with each other. A non-threatening learning environment was created where they could establish rapport with each other. We gave them weekly tasks and required a weekly minimum standard where students had to make at least one meaningful contribution to their online group areas per week for the first half of the semester. This standard allowed for group communication to be fostered whilst still maintaining the flexibility afforded by distance education. We monitored students’ progress throughout this six week period.

Subject Assessment

The collaborative unit of work accounted for 60% of their marks within the subject. There were specific group components that were awarded a ‘group’ mark worth 15% in total. We found this provided the incentive for collaboration without overwhelming the students. It also drove the need for each of them to be individually accountable for their sections of the unit of work. We were instantiating one key principle of cooperative learning. The intention was to mirror professional practice, as the students worked on broader, overarching tasks together and completed the more complex tasks individually. In the process, they were employing a number of cooperative learning strategies such as jigsaw, brainstorming and think-pair-share. That is to say, they were gaining experience in using some of the strategies they will later implement in a classroom setting.

The second assessment task required students to create a digital learning resource that would facilitate the learning of a science concept and/or skill in an authentic way as part of a learning activity within the unit of work they constructed for the first assessment task. In this sense, the assessments were constructively aligned and carefully designed to enable our students to engage in the deep reflection and practical thinking that is required for effective science teaching. In designing the digital resource, our preservice teachers had to consider the differentiated learning needs of the pupils who would potentially be using the resource.

Groups were given the opportunity to receive formative feedback from us two weeks before the submission of the first assessment task. Feedback was delivered via the group areas. By doing this, we were modelling how teachers provide formative feedback to their students. It also allowed our students the opportunity to reflect and act on this feedback before having their assessment task summatively assessed. Essentially, this provided another avenue for formal student-lecturer communication that reduced the gap between online and distance deliveries. A list of suggested tasks was posted weekly to ensure that students maintained steady progress towards the completion of the assessment items. The tasks were presented as optional to allow for personalised learning and student agency. Through some of our Adobe Connect sessions, we provided our students with the opportunity to assess an assessment task. We supplied examples of different digital resources and asked them to first conduct a Strengths, Weaknesses, Opportunities and
Threats (SWOT) analysis on the resources and second, use the marking rubric we had supplied for this assessment to assess the task. We were providing them with an opportunity to learn about assessing a work sample by actively doing it.

Research Methodology

Underpinning our subject design was an action research framework where we collected both qualitative and quantitative data throughout the 14-week science subject from our two cohorts of preservice teachers in a reactive fashion (Stringer, 2007). This allowed us to make informed decisions about our teaching within the subject. We also monitored the online tool usage and student interactions in an attempt to track student engagement with the subject. Ethics approval for the research in this paper was gained through our University’s Ethics in Human Research Committee as part of an ongoing action research project into the delivery of our science curriculum subjects (Protocol Number 2006/122). In the sub-sections below we share results from some of the data we have collected. In keeping with the action research framework, data have been organised in relation to when they were collected across the semester in order to create a descriptive narrative. The qualitative and quantitative data collection methods are described as they appear within the results to develop an immediate, narrative structure to support the action research design.

Participants

The science curriculum subject was delivered to two different cohorts of students through our online learning management system. One cohort was purely online (cohort 1). They were Distance Education students enrolled in a Bachelor of Teaching. These students had previously obtained an undergraduate degree in another discipline and were looking to change career paths into teaching. Cohort 1 comprised 89 preservice teachers. The second cohort comprised internal students studying the subject via distance education (cohort 2). These students were third year undergraduates enrolled in a Bachelor of Education (Early Childhood and Primary) Degree. There were 141 preservice teachers in cohort 2. For the purpose of this paper, we will refer to the two cohorts as cohort 1: online and cohort 2: blended. Both cohorts were studying the same subject. The subject was run in a parallel fashion where the cohorts had separate e-learning sites and different subject coordinators yet the students accessed the same information, received the same educational experiences and completed the same assessment tasks. The data reported on in the results below has been taken from opportunistic sampling of both cohort groups.

Results

Start of semester: Attitude toward science survey

During the first two weeks of session, we asked students to complete the Your Attitude Toward Science survey (Koch, 2013) so that we could get a sense of their feelings, thoughts and experiences in relation to science. The survey comprised 20 rating scale
items where students had the option of selecting strongly agree, agree, no opinion, disagree or strongly disagree. Figure 2 below presents the pattern of student responses to each of the 20 items.

Most students (85%) felt that science was useful for the problems in everyday life. Just over 90% of students who responded to the survey revealed that they enjoy hands-on practical activities in science. Over half of the respondents enjoy watching science programs and talking to people about science. Despite this enjoyment factor, more than half indicated that science was difficult for them. It was interesting to note the percentage of students who selected no opinion in response to a number of the questions. Overall, these responses highlighted for us that students could see the value and benefits of science, enjoyed aspects of it but may have had some reservations about how they might perform within a science subject while a number were yet to still form opinions. We were left wondering how our online delivery of a very practical-based subject would inform their opinions.

Students worked in cooperative learning groups during the first six weeks of the session. In an attempt to overcome students’ reluctance to work in a group situation (Hansen, 2006; Kriflik & Mullan, 2007; Pfaff & Huddleston, 2003), we provided them with a justification as to why they needed to learn to work in a group context. We made a direct link back to their future profession in schools where they would need to have the skills to work with not only other teachers, but parents, community members and other relevant stakeholders. They began to see the purpose of working in a group and why we wanted them to experience this.
Together they developed a variety of professional science teaching skills as they developed their curriculum products for the first assessment task. Such complex, social-constructivist learning is inherently difficult to monitor and evaluate (Juan, Daradoumis, Faulin & Xhafa, 2008). With so many aspects and interactions, both within and beyond the subject design, it was difficult to find a clear measure for the success of the group learning. Due to the popularity of the tool, participation in group forums was analysed as an indicator of group activity for cohort 1. Across all forums within the subject activity levels were high. A total of 1786 posts were made during the first half of the semester, equating to 298 posts per week. Participation in the group discussion forums also exceeded the minimum standards. A total of 1452 forum posts were made across 27 group forums for an average of 53.8 posts per group.

The numbers of group forum posts were assessed in relation to the number of active members within each group. This allowed for mean individual levels of participation to be compared to the minimum standard of one meaningful contribution per week. The average student was contributing to his/her group discussion 2.9 times per week, nearly triple the minimum standard. Only two of the 27 groups failed to reach the minimum standard. In fact, 66% of the groups had more than doubled the minimum requirement for weekly individual interactions. While the number of posts only provided a limited insight into the overall quality of the cooperative learning, it certainly showed a positive trend of student engagement.

**Mid-semester: Harvard one-minute feedback paper**

During the two-week mid-semester break, we asked students from both cohorts to complete a Harvard one-minute feedback paper based on their experiences within the subject during the first half of the session. The one-minute Harvard paper is a formative feedback instrument. It comprised five items that included: what worked for them; what did not work for them; three things they learned, three things they need to know more about; and, list five words to describe their stream of consciousness about how they felt in relation to the first half of the semester (Chizmar & Ostrosky, 1998).

There were 35 preservice teachers who elected to complete the Harvard one-minute paper. Overall, these students reported positive feelings towards their experiences in the subject during the first half of the semester. In response to the “What worked for you?” question, the overwhelming majority of respondents (74%) valued the learning opportunities afforded by the weekly Adobe Connect sessions. Quote such as “I liked the opportunity to ask questions during tutorials (S1)” and “The online meetings discussing the assignment were fantastic (S2)” highlight students’ positive response to these online sessions. “The ability to ask questions and get answers immediately made the task much more manageable and enjoyable (S3)”, shows that the students valued the inclusion of synchronous learning tools and opportunities. In fact, one student noted the scarcity of such experiences in his/her experience of distance education “I welcomed the weekly meetings; first time in a decade of study that I have had this opportunity (S4)”. Other elements that were deemed to have educational value by students were the group wikis, formative feedback and online learning.
modules. Clearly, they had responded positively to the inclusion of synchronous and asynchronous learning tools to facilitate cooperative, practice-based learning in the e-learning environment.

In relation to the stream of consciousness about the first half of the session 115 words were classified as positive while 21 words were classified as negative. Words such as ‘challenging’, ‘interesting’, ‘stimulating’ and ‘productive’ were used frequently, suggesting that the students had engaged deeply with the e-learning environment. Based on this, it could be suggested that the students were not simply ‘having fun’, rather they valued the academic rigour of the subject.

End of semester: Reflective STEBI-B

The science teaching efficacy beliefs of the students were assessed at the end of the semester as a way of determining whether the subject was aiding the students in meeting the core objectives. Teaching efficacy beliefs have been shown to affect resilience (de Laat & Watters, 1995), pedagogical choices (Tschannen-Moran, Woolfolk Hoy & Hoy, 1998) and even student achievement (Tschannen-Moran & Barr, 2004). The science teaching efficacy belief instrument B measures the personal science teaching efficacy beliefs (PSTE) and science teaching outcome expectancies (STOE) of preservice teachers through a series of Likert items (Bleicher, 2004; Enoch & Riggs, 1990). The STEBI-B was administered in reflective pre/ post form. This reflective delivery has been adopted in both preservice (Cartwright & Atwood, 2014) and in-service (Ulmer et al. 2014) science teaching research. Within the action research approach, the reflective pre/post administration of the instrument served the dual purpose of assessment science teaching efficacy growth and students’ perceptions of their own growth over the course of a science intervention. A total of 23 students from cohort 1 elected to complete the reflective pre/post STEBI-B survey. Cohort 2 were not given the opportunity to complete this survey as they had commenced professional experience at the end of the semester. Analysis of the STEBI-B data collected within this research project showed that both the PSTE (Cronbach’s α = 0.781) and STOE subscales (Cronbach’s α = 0.709) were both reliable.

A Multivariate Analysis of Variance (MANOVA) was conducted on the reflective pre- and post-test STEBI-B data to determine if there was significant growth on the subscales over time. Table 1 shows the output from the STEBI-B MANOVA. There was a significant main effect due to occasion of testing (F(1,22)=42.44, p<0.0001). This indicates that the STEBI-B changes that occurred within the participants over the course of the semester were statistically significant. There was no significant main effect due to the STEB variable (F(1,22)=3.248, p=0.085). That is to say, there was no significant difference between the PSTE and STOE scores of the participants. This is a promising finding as much of the research in this area shows that the STOE subscale often lags behind the PSTE subscale.

Table 1: STEBI-B MANOVA

<table>
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<th>Variable</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
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<td>1</td>
<td>90.011</td>
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</table>
Both the PSTE and STOE subscales showed large increases with Cohen’s D effect sizes of 1.367 and 0.991 respectively. Such results are also noteworthy within the broader base of the STEBI-B literature. Across the 25-year history of the STEBI-B instrument the PSTE and STOE effect sizes found within this action research project are amongst the 10 largest effect size increases. The PSTE size would be the 9th highest reported growth and the STOE effect size would be the 4th largest pre-to-post increase. These trends should be taken with caution as the respondents had the benefit of hindsight in their responses. Nonetheless, the STEBI-B data is evidence that the students showed greater science teaching efficacy after they completed the online science subjects.

### Subject Evaluation Comments

At the completion of the semester, all students across the university were afforded the opportunity to provide open, de-identified feedback about their subjects. The open comments submitted allowed for open insight into their experiences in the online and blended e-learning science subjects. The students made thoughtful and detailed responses to the first open question “What about this subject did you find most helpful in your learning?” A total of 48 students across both cohorts elected to provide data on this item. Figure 3 shows the frequency that each positive theme emerged within the feedback. The qualitative data show that the students valued the communication pathways that were established in the e-learning environments. This can be seen in the prominence of the online meeting (31), student/lecturer communication (20) and student/student communication (12) themes. One student summarised his/her relief that the online learning environment had finally helped him/her to feel like an active member of a learning community:

> “James gave us a lot of support. He organised structures so we had audio and visual of him, and a chance to interact, both in real time and with an open invitation to send emails. I felt like I was a part of something, instead of being a remote student that could be attended to or not. I find it hard that each subject is a distinctive experience, without even continuity from corridors, classrooms and cafeteria, but this time there was an effort to include us. (S5)”

Despite the subject focuses framing of the “What worked” question, Lecturer (17) theme emerged as a central positive theme. This represents the core concepts of constructivism that have underpinned educational principles for decades (Vygotsky, 1977). The need for human connection needs to be considered within online education and the subject described in this paper presents a viable model for fostering such connection. The importance of people can have considerable implications for tertiary education. This is reflected in the quote below:
“Online chat sessions with Lena. These were fantastic. The nature of the assessment tasks meant that studying the subject by distance was difficult. The opportunities to engage in online meetings with Lena each week were wonderful opportunities to gain a better understanding of the subject content and/or assessment requirements. Without these sessions I believe that my performance in the subject would have been severely affected. (S6)”

The varied integration of assessment throughout the subject was valued by members of both cohorts. Concepts such as ‘Feedback’ (8), ‘Assessment’ (10) and ‘Relevance’ (5) combine to show that students were able to see how the subject reflected the requirements of professional science teaching. This also shows that the students understood the intended learning pathway at the centre of the e-learning environment. The ongoing support, supplemented by formative and summative feedback, and the relevance of the assessment tasks beyond the subjects appeared to help the students to make connections between the tertiary context and the profession which they were/are training to enter. This can be seen in the following quotes from two different students:

“The subject provided authentic assessment tasks which are relevant and useful when practising teaching. (S7)”

“The assessment tasks were directly relevant to what we will be required to do in the future, and the feedback given was helpful. (S8)”

The preservice teachers were invited to give an honest appraisal of the elements of the subjects that were ‘least helpful’ in their learning. Figure 4 shows the frequency that each negative theme was cited within the open ended, written submissions. Overall there were fewer negative responses than positive responses to the science subject. The students’ negative comments about assessment (14) and student/student communication (6) refer to their poor responses to the group work that was embedded in the first assessment task. Students bemoaned the difficulty in establishing reliable communication patterns with other students both within and beyond the confines of the e-learning environment. However, despite their concerns, it was evident in the student responses that they understood the necessity and value of working collaboratively. Their negative reporting of group work may be a reflection of their past, individualistic learning experiences within subjects. Perhaps the issue remains with fostering communication pathways rather than student aversion to group
learning. Certainly, the following students saw the value of collaborative learning despite their criticisms:

“Working as a group in assessment one, gave the opportunity for peers to have other ideas and conversation about the topic. (S9)"

“In reference to assessment 1, the allocation of groups meant that all other members who I collaborated with were extremely unreliable and unwilling to participate. This was very stressful but I can see that it also taught me a lot. (S10)”

The evaluative comments revealed a tension between students’ traditional views of distance education and their new experiences within a cooperative, student-centred e-learning environment. It appears as though the absence of synchronous means of peer communication hindered the learning process and production of assessment items. When these trends are considered along with the emergence of the negative Distance Education theme (7), there is evidence that students may be holding onto traditionalist, teacher centred views of education. This may also be supported by some of the negative reports of group work. The singular presence of the distance education theme and blended delivery of the subject may be an indicator of deeper issues with mixed modes of delivery within single subjects. The tension emerges from their negative reports of the modules/ readings (11). While they may still be holding onto more traditional views of distance education, it was clear that they began to value the cooperative and more active components of the e-learning environment. This is reflected in Figure 3 where there was a greater positive response to the online meetings (32) in relation to the modules and readings (2).

Time spent in the E-learning environment

We investigated the relationship between the time spent in the e-learning environment and the final grade achieved by each student. Our analysis revealed that there was a statistically significant relationship between these two variables. That is to say, the more time a student spent in the e-learning environment the higher the grade awarded. It should be noted however that, across both cohorts, the correlations between the variables were weak-to-moderate. This prompted us to further investigate students’ time spent in the e-
learning environment. Online activity reports allowed us to track how long each course participant was logged into the online learning environment. While this measure does not account for the complexity of learning within the broader subject, it does provide an insight into the level of online engagement for each student. Within the blended subject (cohort 2) students spent an average of 15.85 hours logged onto the online learning environment across the three-month semester. The mixed delivery of this subject may have skewed this data because a number of students had access to on-campus learning activities to supplement the online subject delivery. One student spent a staggering 154.22 hours within the online learning environment. The students enrolled in the parallel online subject (cohort 1) spent an average of 31.52 logged into the online learning environment. Across the 12 active teaching weeks of the semester this equated to 2.6 hours of direct subject engagement per student per week. From a simple time perspective, this is very close to the direct course contact expected within an on-campus subject delivery. Typically on campus subjects offer a single one-hour lecture and a two-hour tutorial. These analyses are somewhat diminished because factors such as off-line learning, specific activities within the online learning environment and time spent away from the computer. Nonetheless, there is strong evidence to suggest that our e-learning science education model is making tangible progress in diminishing potential engagement gaps between on-campus and distance modes of learning.

Summary of Results

In relation to the data we collected and tracked throughout the session, we cannot establish a definitive link between student achievement and course participation. We can note, however, that engagement as measured by time spent in the e-learning environment was close to the expectation of an on-campus subject: 2.6 hours versus 3.0 hours. Our university does not have an on-campus attendance policy. So, in essence, our students who were in the e-learning setting may have even had more contact or engagement compared with their on-campus counterparts. We can also note from our students’ feedback that they valued the academic rigour of the subject. One student sent the following in an unsolicited email:

“Thanks for all your guidance through this unit [subject], it has been one of my more challenging ones – although I did 3 unit science at high school, certainly a different approach these days :). Talk about having to think about what I bring with me to the classroom! (S9)”

In the subject evaluation data, there was evidence to suggest that there is a tension between students’ conceptions or expectations of distance learning and the reality of studying in the e-learning environment. Despite some of the limitations and problems we encountered, our subject design appears to have professionally engaged many as highlighted in the following thank you from one of our students:

“I must say a huge thank you to James and yourself [Lena]. This has really been one of the best and well organised subjects I’ve completed in 18 months with [this institution]. It has been a truly enjoyable subject. (S10)”

Discussion
In this article, we have described how we have conceptualised our practice of teaching preservice teachers how to teach science in an e-learning environment and reflected on how our students interacted within this environment. There was evidence to suggest that our approach generated a community of inquiry. We required students to work collaboratively for their first assessment task and used the digital technologies afforded to us to create the cooperative learning groups. Doing this facilitated the co-generation of knowledge for the first assessment and established learning connections between students.

The synchronous interaction between students and teaching staff was of critical importance as it provided a means through which genuine relationships could be established between students and staff. This has major implications for the delivery of online subjects. It highlights that the e-learning environment should facilitate teacher presence rather than replace it. It also raises issues around the staffing of online subjects and the commitment needed to maintain an online presence. With the increased casualisation of academic teaching loads (Bryson & Barnes, 2000; Kimber, 2003), online teaching presence is a factor that must be considered in sessional workloads. In reconceptualising our practice, we also need to consider our commitment to synchronous interactions and perhaps reconsider our more traditional working hours. The majority of students within our subject worked during the day. This meant we had to be flexible and offer evening synchronous sessions to cater for the needs of our students.

The cooperative e-learning model we present appears to be a viable and effective way of transitioning tertiary education subjects from face-to-face to online modalities. The variable communication methods, both synchronous and asynchronous, allowed the participants to choose the ways that they entered the designated learning pathway. The qualitative and quantitative data presented in this paper shows that the preservice teachers who utilised the e-learning environment to assist in the achievement of the learning outcomes showed increased science teaching efficacy beliefs, high levels of subject engagement and high levels of satisfaction with their educational experiences.

One element that was hard to replicate within the e-learning environment was providing our students with the opportunity of a school-based teaching experience within the science curriculum area. Embedding a school-based experience in future e-learning versions of the subject is one aspect we would like to continue to explore.

The action research presented in this paper can be used as a model for other practitioners to not only interrogate the design and delivery of a subject but to inform and refine future iterations of subjects. Ongoing in-subject action research is a realistic way of ensuring that tertiary students continue to receive adaptive, rigorous and satisfying education experiences. Despite the positive impact of the first iterations of the online science subject, the data collected through our action research have been used to inform several changes to future iterations of the science subject. The weighting of the group component of the first assessment task will be reduced and separated in response to students’ negative reactions to cooperative learning and traditional expectations of distance education. The single page report in the second assessment task will be replaced with an adapted and annotated lesson plan to both strengthen the connection to the first assignment and promote reflective teaching practice. The e-learning resource base will also be developed further to cover
contemporary science issues in society, scientific reasoning, technical skills and group interactions.

There are a number of limitations to the action research described in this paper that have implications for future research. The action research approach, while appropriate, produced limited sample sizes due to time restraints and the opportunistic sampling of the target population. In future iterations of the subject, data collection methodologies could be imbedded within the e-learning environment and learning pathway to enhance response rates. Future research could compare traditional distance education approaches with cooperative e-learning environments. Another key step in this line of research would be to bridge the gap between on-campus and distance forms of science education. Such research could help to determine if cooperative e-learning can replicate the learning outcomes of face-to-face cooperative learning.

We encourage others working in this e-learning environment to adopt an action-research framework to interrogate and inform their teaching and to monitor their students’ learning and engagement. At the end of this action research cycle, we see our approach as being fluid, contextually bound and reactive to the needs of our students. The educational objectives of our subject inform our pedagogical choices and the tools we use within an e-learning environment. No matter what delivery method (online, blended or face to face), subject design, teacher presence and students’ needs should always be given deep consideration. Given this, should the discussion move from reconceptualising practice in an e-learning environment to conceptualising best practice for your current group of students?

References


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