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Andrew Seen
University of Tasmania, andrew.seen@utas.edu.au

Sharon P. Fraser
University of Tasmania, sharon.fraser@utas.edu.au

Kim Beswick
kim.beswick@utas.edu.au

Margaret Penson
University of Tasmania, margaret.penson@utas.edu.au

Robert Whannell
University of Tasmania, rwhannel@une.edu.au

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Marketing an Alternate Model for Science and Mathematics Initial Teacher Education

Andrew Seen
Sharon Fraser
Kim Beswick
Margaret Penson
Robert Whannell
University of Tasmania

Abstract: An innovative initial teacher education undergraduate degree has been offered for the first time in 2016 at an Australian University. The degree provides for qualification as a secondary science and mathematics teacher through the completion of a four-year integrated science, mathematics and education program of study where the synergies available through concurrent, integrated study of content and teacher pedagogy are available. The paper describes the results of the analysis of data from science and mathematics school teachers and career advisors in relation to the potential market for the program and perceived advantages and barriers to students selecting the degree.

Introduction

There have been concerns for a number of years about the capacity of developed countries, such as Australia, the United States and England, to meet current and future needs in relation to the availability of graduates appropriately skilled in the science, technology, engineering and mathematics (STEM) fields (e.g. Atkinson, Hugo, Lundgren, Shapiro, & Thomas, 2007; Chubb, 2012; HM Treasury, 2007; Office of the Chief Scientist, 2013). In the Australian context, it has been proposed that the lack of STEM qualified graduates will reduce the capacity for research and development in the future to such an extent that the country will not be able to compete effectively on the world stage (Chubb, 2012). The importance of this challenge and the need for Australia to be at the forefront of innovation globally has been promoted by Australia's Prime Minister (2016) and has been accompanied by a federally funded innovation agenda (see http://www.innovation.gov.au/page/agenda). This agenda includes an allocation of $48 million over five years, commencing in 2016, to support the inspiration of scientific endeavour in STEM related activity.

Traditionally, the disciplines that comprise STEM have been taught as separate subjects in schools, with little or no overlap. While there has been substantial movement towards integrating the study of STEM disciplines in the United States (Becker & Park, 2011), including the creation of speciality mathematics and science high schools (Atkinson et al., 2007), the situation in Australia is such that school subjects targeting science, mathematics and technology are still largely taught as separate disciplines (Blackley & Howell, 2015). The Inspiring Mathematics and Science in Teacher Education (IMSITE) project funded by the federal government which commenced in 2014, involves a collaboration between six Australian universities, with a view to identifying approaches that will inspire innovation in the field of mathematics and science initial teacher education (ITE).

This paper reports on one initiative from the project, involving the development of an innovative four-year undergraduate initial teacher education degree for secondary teachers, the Bachelor of Education (Science and Mathematics) (BEdSM). The degree addresses the need to provide highly trained teacher graduates who are able to provide leadership in teaching STEM as an integrated field. The development of the degree involved the collaboration of academics from mathematics, science and education faculties. Students enrolled in the degree will simultaneously study mathematics, science and education content in units that have been designed to allow for teaching and learning with an integrated STEM approach.

The paper commences with a description of the process involved in the development of the degree, the structure of the unit offerings that comprise the four years of study and the challenges involved in gaining accreditation for an approach to initial teacher education that is outside that which has been traditionally used in Australia. Findings from a survey of attitudes towards the suitability of the integrated degree as an approach to initial teacher education of a number of stakeholders, including school career counsellors and current initial teacher education students, are then presented. The paper concludes with a discussion of the future of integrated STEM education in Australia and will identify a number of barriers that exist at a teacher, curriculum and systemic level that militate against realising this future.

STEM as an Integrated Field of Study

In Australia, as in other western countries, there has been an ongoing decline in the percentage of students who have been studying different science disciplines and mathematics at an advanced level (Ainley, Kos, & Nicholas, 2008; Goodrum, Druhan, & Abbs, 2011) with an associated reduction in mathematical and scientific literacy within the community (Thomson, De Bortoli, Nicholas, HIllman, & Buckley, 2011). A number of reasons have been offered for declining enrolments, including a lack of interest in the subjects, the inability of students to identify with career options in the STEM field, and a perception that STEM subjects are difficult conceptually. (Lyons & Quinn, 2010, 2012). There is also evidence that while understanding mathematics is essential to performance in other STEM fields (Australian Academy of Science, 2016), the majority of students dislike mathematics by year 4 (Trends in International Mathematics and Science Study (TIMSS), 2011), with a further reduction in the proportion of students who indicated they liked mathematics between Year 4 and Year 8. Factors such as these have been identified as a particular issue for students in rural and remote areas. It has been proposed that the point of disconnect with the study of science and mathematics occurs during the period associated with the transition from primary to secondary school (Lyons & Quinn, 2010; Tytler, 2007). One factor proposed as contributing to the problems with science and mathematics education at the lower secondary school level is the lack of qualified teachers available (Harris, Baldwin, & Jensz, 2005; Marginson, Tytler, Freeman, & Roberts, 2013).

A way of improving mathematics and science education is to approach the study of these subjects in an integrated manner in primary and lower secondary school, improving student engagement through focused inquiry, using mathematics, science, engineering and technology in real world contexts as appropriate (Becker & Park, 2011; Cantrell, Pekcan, Itani, & Velasquez-Bryant, 2006; Hurley, 2001). Moore and Smith (2014) define integrated

STEM education as "an effort to combine the four disciplines of science, technology, engineering, and mathematics into one class, unit or lesson that is based on connections among these disciplines and real-world problems" (p. 5). Tytler, Osborne, Williams, Tytler, and Cripps Clark (2008) support this integrated approach when they recommend that the teaching of science and mathematics should "reflect the way that these disciplines are represented and practiced in society more generally" (p. 15). Positive educational outcomes ensue from the successful integration of the STEM disciplines (Becker & Park, 2011; Stohlmann, Moore, & Roehrig, 2012) when students address their study in a work-based contextual environment where "students have to apply the science and mathematics knowledge they learn to an engineering problem and utilize technology in finding a solution" (Kennedy & Odell, 2014, p. 254).

While the political support for STEM education has continued since the 1990s, the teaching of the STEM disciplines in an integrated way has not been evidenced in practice. Blackley and Howell (2015) identify a core challenge to the effective integration of the STEM disciplines as the lack of understanding of what STEM education is, which is a view shared by others (Breiner & Johnson, 2012; Bruce-Davis et al., 2014; Dugger, 2010). They also argue that "the struggle to enact the STEM agenda, particularly in primary schools, has not been resolved as teachers have defaulted to the notion of S.T.E.M. rather than STEM" (p. 104). Blackley and Howell (2015) identify a number of factors that have given rise to this approach, including "the curriculum structure and the skill level and/or preparation of the teachers" (p. 106). Research has indicated that the views teachers hold of a subject, such as mathematics, influence the way they teach (Beswick, 2005; Beswick, Callingham, & Watson, 2012). Indeed, there is evidence from studies involving initial teacher education students in both mathematics (e.g. Furinghetti & Phkonen, 2002) and science (e.g. Mansour, 2013; Deniz, 2015), that their beliefs about the discipline are deeply rooted, and that a rethinking of curriculum beyond minor changes may be warranted. The need for 21st century skills in school and university graduates also prompts the view that the STEM disciplines should not be perceived as isolated, but should be taught in ways that emphasise and support the development of these skills (Donnelly & Wiltshire, 2014; Dugger, 2010) where student "apply the skills and knowledge they gain in one discipline to another and what they learn in school to other areas of their lives" (Saavedra & Opfer, 2012).

It is hypothesised that there exists within Australian education two principal reasons for the challenges that face the development of integrated STEM education in the future: the lack of a curriculum that adequately integrates the study of mathematics, science and technology, and the absence of an initial teacher training focus on STEM as an integrated area of teaching.

The Development of the New Degree

The new degree, the Bachelor of Education (Science and Mathematics) for secondary teachers, commenced development in 2014. The aim of the new program was to ensure that students were given the opportunity to develop their science and mathematics content knowledge at the same time, and integrated with, their studies in education. The BEdSM was offered for the first time in semester 1, 2016, with the opportunity to study majors in Biology or Chemistry, combined with a minor in Mathematics. A major in Physics is also being

developed. The program is offered in blended mode, incorporating online teaching and learning and the completion of on-campus intensive laboratory classes, tutorials or field trips in some units of science and mathematics. Blended learning has the potential to be collaborative and interactive, utilising information and communication technologies (ICTs), media-rich resources and personalised learning (Simpson, 2008). Not only does this mode of delivery potentially improve access to ITE study particularly for rural and remote students, it has been found that it can build a stronger sense of community among students (Rovai & Jordan, 2004) when compared with either traditional or fully online courses without any increase in dropout rate or decrease in achievement (Anderson & Simpson, 2004). By way of example, the program of study for a student completing a major in Biology and a minor in Mathematics is shown in Table 1 with all units in the program being equally weighted.

Year 1	**Year 2**	**Year 3**	**Year 4**
EDU102 Foundations of Teaching	EDU202 Planning for Positive Behaviour	EDU225 Thinking Mathematically	EDU325 Mathematics Pedagogical Content Knowledge 2
EDU112 Foundations of Literacy: Process and practices	EDU203 Teacher as Planner, Assessor & Reporter	EDU303 Inclusive Practices in Education Settings	EDU380 Digital Technologies
MAT153 Data Handling and Statistics 1	EDU204 The Sciences and Society	EDU355 Science Pedagogical Content Knowledge 2	EDU326 Social and Emotional Learning
EDU104 Human Development and Learning	MAT103 Mathematics I	EDU302 Education, Ethics and Professional Practice	EDU306 Preparing for the Profession
EDU125 Mathematics Pedagogical Content Knowledge 1	MAT104 Mathematics II	EDU356 Science Communication	EDU390 Cultural Awareness: The Non-indigenous and Aboriginal and Torres Strait Island Interface
EDU155 Science Pedagogical Content Knowledge 1	BIO101 Aquatic Biology A	MAT251 Algebra 2	MAT253 Data Handling and Statistics 2
BIO171 Cell Biology and Function	BIO209 Fisheries Biology and Population Dynamics	BIO210 Foundations of Ecology	BIO343 Aquatic Molecular Biology
1 Science Degree Elective	1 Science Degree Elective	BIO323 Directed Studies in Biology	EDU357 Work Integrated Learning

Table 1: Program requirements for a Biology major in the Bachelor of Education (Science and Mathematics)

The approach used in the BEdSM stands in contrast to those that have been used for many years for initial teacher education (ITE) in Australia. A common approach is for students to complete an initial Bachelor's degree that includes science and/or mathematics content, followed by the completion of a shorter ITE qualification. The second approach involves the completion of a dual degree, where the undergraduate degree in the relevant content field is completed at the same time as an undergraduate degree in education. A feature of both of these approaches is that there is a segregation of the study of the discipline content and what is required to teach it. The major innovation of the BEdSM is that the units included in the program have been developed by a collaboration between academics from the content disciplines e.g. mathematics, and academics from education. The units comprising the degree, including those that are delivered by the mathematics and science academics, have been developed to support the development of the individual ITE student in their role as

a future teacher of an integrated STEM program. Of particular importance are units that address scientific and mathematical thinking, and communication, where content from discipline units and pedagogy from education units is brought together through co-teaching by specialists from the different disciplines. These units are completed in the third year of the program. The development of the program as a whole has aimed to ensure that graduates complete a science major and mathematics minor comparable to that which would be completed in a Bachelor of Science degree.

The introduction of a new degree that adopts a non-traditional approach to delivery presents a number of potential hurdles to the acceptance of the qualification by various stakeholders, including accrediting bodies. The qualification needs to be attractive to potential future students in the program and people in the education sector such as school guidance counsellors, who would be involved in the promotion of the program in the marketplace.

Methodology

Prior to commencement of the program, course developers gained an initial view of the potential for the BEdSM to attract students based on direct entry from secondary schools, through face-to-face interviews with staff in schools. Interviews were conducted in March 2015 with 12 participants from eight secondary schools, comprising nine teachers or heads of department of science and/or mathematics and three school career counsellors. The prompts used for the interviews were:

1. How well will the BEd Secondary (Science/Maths) course prepare graduates who are eligible to teach in your system?
2. In what ways do you think the BEd Secondary (Science/Maths) course will enhance science and mathematics classroom teaching?
3. What other comments do you have in relation to the BEd Secondary (Science/Maths)?

All interviews were digitally recorded and subsequently transcribed. Prior to the interview, each participant was provided with an overview of the BEdSM, with a focus on the integrated STEM approach being utilised and the differences in delivery style with other ITE programs. Following this, participants were asked for their views in relation to the approach being taken, how attractive the program might be to future ITE students and how likely they were to recommend the program. The qualitative analysis presented includes examples of comments made to support the claims being made. Comments are coded to identify the source, with the initial letters of the code indicating the type of teacher making the comment: SC for science teacher, MT for mathematics teacher, HODSC for a science head of department and GC for a guidance counsellor.

Data Analysis

The data were coded through an open coding approach (Strauss & Corbin, 1990) which focussed on the text to unearth discrete concepts and categories across the dataset, resulting in the identification of common themes. Specific comments were coded to identify the source, with the initial letters of the code indicating the type of teacher making the comment: SC for science teacher, MT for mathematics teacher, HODSC for a science head of department and GC for a guidance counsellor.

Results

When the views expressed by the 12 interview participants in relation to the BEdSM were considered, it was concluded that six held positive views, three were ambivalent, expressing both positive and negative views, while three expressed views that were considered negative only.

Shortened Study Period

Participants who expressed primarily positive views focussed on the fact that the BEdSM provides a relatively quick method of entering the profession of mathematics and science teaching. A number of the participants expressed the view that the standard program of study for someone who was going to be a mathematics and/or science teacher is five years, that is an undergraduate degree (three years), followed by a post graduate education qualification (two year Masters). The capacity to enter the workforce after four years, as opposed to at least five, was considered to be a major advantage.

> *I just think that if they can see an end, and a four-year end rather than five years, or having to do a Masters…so they come out knowing what they're going to be doing, then I think that's a huge advantage to them. (GC0028)*
>
> *If you were wanting to be a science teacher, then obviously you're going to get your needs met quicker…I think it's a good idea. Yeah, it might, hopefully it catches those students who don't want to do 3 or 4 years of pure science but want to teach it. (SC0034)*
>
> *For somebody who at that level is enjoying their science and says that they want to be a teacher at the moment to get there you then have to do your undergraduate degree in science and then go on and do a Master of Teaching which is going to be a minimum of five years. So I can see that being advantageous for them in that they're getting into the teaching earlier rather than doing the straight science degree first. (SC0032)*

Interestingly, the short length of the program also formed the basis for the negative views expressed. The lack of perceived competence in the mathematics and science disciplines, due to the shortened period of study of those disciplines, formed the basis for all of the negative sentiments expressed. Participants expressed the view that more time should be spent studying more science in order to be qualified as a teacher qualified to teach from year 7-12. An unspoken assumption here is that a bachelor of science, for example, provides graduates with a breadth as well as depth of study in the discipline and the mathematics necessary to teach an integrated STEM.

> *Because there's the Education part here, but the academic bit has been dramatically shortened, and I still think there's much more value in the students doing a three-year degree and then doing their postgraduate Education qualification at the end of that because I don't think they've got enough background to them, because they're not just going to be teaching Chemistry or some Maths. (HODSC0025)*
>
> *Well if we're thinking of high school teaching, actually separating science into chemistry, physics and biology I don't think actually is very insightful because graduates obviously have to teach everything up to Grade 10 and I don't think*

that it's probably going to prepare them for the fundamentals of teaching physics to Grade 7 or biology cells to Grade 7 if they haven't got that background, not doing a uni degree in science, they're just, this is their only actual degree in a way. (SC0031)

While research is not readily available about the extent to which breadth of study across all science understanding sub-strands of the Australian Curriculum, is experienced in a 'typical' undergraduate science degree course, a focussed search of Australian university Bachelor of Science degree structures, indicates that specialisation (e.g. into physics, biology, chemistry or other majors) occurs at the end of first year. Hence Bachelor of Science students do not experience both a breadth and depth of study in all science domains. In comparison, the structure of the BEdSM provides ITE graduates with a credible major in a science discipline in addition to a minor in mathematics. There is also some degree of breadth of science study, as two science electives must also be completed in a discipline other than their chosen major.

Focussed Career Path to Teaching

The second most popular reason the BEdSM was considered positively by the participants was that it offered a career path for a person whose intention was to be a mathematics and/or science teacher from the commencement of tertiary study. This was seen as an advantage by a number of participants in conjunction with the shortened time requirements, as it captures students with a passion for teaching, over and above those who might default into teaching when other career paths falter. It was considered that the two traditional options, particularly the undergraduate degree followed by an education qualification, were not the best options for an individual whose career intention is to be a teacher.

We need to start talking about teaching as a career compared to just something that people fall back on if they can't get jobs in other areas. (SC0031)

As I said this was my, this is the degree I did and I find the people that enrol in the BEd course are the ones that actually want to be teachers. They're not the ones that are looking at possibly going into industry and then thinking oh I'll just do the Dip Ed or whatever the equivalent is, like the M Teach. (SC0035)

It was considered that the two traditional options, particularly the undergraduate degree followed by an education qualification, were not the best options for an individual whose career intention is to be a teacher.

I think it's a great idea in a lot of ways…I see the benefit of this in that it's offering them an actual career pathway to start with; it's not saying, okay, you've demonstrated you've got an interest in science and maths, you know, but here is a pathway that you can do in four years and come out with an actual career pathway already defined for you. (GC0028)

One potential challenge to this approach was described and then rejected by one participant, namely that the BEdSM pathway might limit the options to pursue career paths other than teaching.

I think I'd still encourage people to do an undergraduate degree, a science degree, and then an education degree on top. I think in terms of an experience,

and opening up options for a person, that is perhaps a better pathway, I suspect, than this. (SC0027)

The opportunity to complete mathematics and science units in the program that would provide credit towards a general Science degree was considered by the participant to adequately manage this issue.

Concurrent Study of Education, Science and Mathematics

One of the approaches adopted by the BEdSM course development team was to ensure that there was an integration of mathematics and science content and pedagogy. All students in the program are required to enrol in either a Chemistry, Biology or Physics major and a Mathematics minor, along with two science elective units in a discipline other than their chosen major. The opportunity for students to be able to study science/mathematics content and education concurrently in a program that allows for overlap between subject discipline and education was identified as an advantage for graduates of the program.

I think it's a great idea, in particular actually offering a degree that allows the students to be able to study Education and Science together instead of doing an undergrad and then a postgrad to become a senior secondary teacher. (GC0029)

The requirement to study both science and mathematics was also considered to be a disadvantage. The primary reason offered for this view was that some people do not wish to teach both science and mathematics, but would prefer to teach only one.

The maths and science seems to naturally go together but we have people in our maths faculty that don't teach science and are not interested in science and we also have that people that are teaching science that have no interest or background in mathematics and I was just wondering is it, is the degree you're looking at, must it have a mathematics component or is it possible to do the B Ed in straight science rather than specifically science and maths? (SC0035)

At the time of interviews, course design was ongoing and hence while the intention of the course developers is to expand the program to include a mathematics major and a science minor, this was not shared with the participants.

Mode of Program Delivery

The Faculty of Education within which the BEdSM is housed has been teaching in blended mode for at least ten years; students are able to choose whether to study their units in either face-to-face mode or online. In the BEdSM, staff teaching the science and mathematics discipline units also offer their units in blended mode, with laboratory and/or field activities, undertaken in residential schools. Details of blended delivery were not shared to any great extent with interview participants, and hence one aspect of the program that raised negative sentiment was the notion of online learning. It was suggested by some that the on-campus experience was important for some students and that online learning is inherently more difficult.

I love the sound of the four-year degree, but I really wish it was structured, and an on-campus offer as well. I would have difficulty in recommending it as the

career person to our grade twelve leavers, because that's what I find now: they don't have the life experience to be good online self-directed learners, so when any of them ever talk to me about, you know, courses, can they do them online, I kind of go, ah, you have to be really dedicated, you really have to understand that it's much more difficult to learn by yourself and to be really structured, and kind of I think that they miss out on that university life too. (GC0028)
My daughter did an online bridging chemistry course and she hated it. And I think that could well be an issue too. Young people I think still need some element of face to face even if, like there were different people involved in my course who were good or had strengths in areas that others obviously didn't have and there has to be a talking face somewhere along the line. (SC0032)

Limited Scope of Science Subjects

A second aspect of the program that raised negative sentiment was the focus on only a limited scope of science subjects. While students would complete a major in one science discipline e.g. Biology and a number of units from a second e.g. Chemistry, the lack of a capacity to include other sciences, such as Physics, Geology, Astronomy was considered by participants to limit the science background of the graduates.

So probably what concerns me then is that, okay your chemistry is great but how much other stuff have you got, to equip you to teach seven to ten right across all those areas of science? (HODSC0020)

While this is certainly a legitimate concern, as noted earlier, such limited breadth of science study is also experienced by teacher graduates who have completed a science degree. Few science graduates have experienced a breadth of study across the science disciplines, as study in Bachelors of Science require students to specialise in a discipline quite early in the degree. It is also the case the number of units included in a major in the BEdSM is comparable to that completed by a substantial number of ITE students enrolled in postgraduate science education programs at the institution where the study was conducted. Considering the range of different science disciplines, it is considered that this issue is one that would be difficult to resolve irrespective of the approach taken.

Program Marketing

All of the interview participants were asked their views about who target groups are for marketing the BEdSM program. The common view was that, while marketing would include Years 11 and 12 students and their teachers, it was important to commence the process at year 10 when students are considering their career prior to the senior school period.

Talking to them first up, and then from there, getting it out to our maths and chem teachers, because they also talk to the students very much about career pathways, especially when they're doing subject selections with grade 10s going into grade 11 and 12. (GC0028)
I think I would be starting an awful lot earlier than year 11 and 12 students. First of all, I think I would be starting with probably year 9 to ten 10. (MT0033)

A second target audience for the BEdSM was identified as mature age people who did not hold tertiary maths/science qualifications. Traditionally, people of mature age who change careers in order to become a mathematics and/or science teacher already possess a tertiary mathematics/science undergraduate degree and only require to complete an education qualification. This option does not exist for a mature age person without the appropriate undergraduate qualifications. The BEdSM offers such a person a viable pathway to a teaching career.

> *If you could market it in such a way that people who have been in the workforce, and many jobs over the years that have been soul destroyingly boring and not very rewarding. And the thought of doing something that could have a significant impact on someone's life can be quite an allure…Marketing to them, I think that's a key point, marketing to someone who needs a career change. (HODSC0022)*
>
> *You'll probably find that this will appeal to a lot more mature aged students too, that are considering coming back to uni or getting into teaching, or whatever it may be, because it is online and they can do it around other things. (GC0029)*

Implications for Practice

Our results indicate that there is an opportunity for a program such as the BEdSM to offer an alternative pathway to traditional ITE programs for students wishing to pursue a career as a mathematics and science teacher as perceived by stakeholders. The educators who were interviewed expressed the view that a market existed in two distinct groups, namely school students who viewed teaching as a career option and wished to take the shortest route to achieving that goal, and mature age people looking to change careers to be a science and mathematics teacher, but who lacked the formal academic qualifications to gain direct entry to a postgraduate teacher education program. There appear to be two major challenges to the attractiveness of the program, firstly the perception that graduates of the BEdSM would not be sufficiently prepared in the science and mathematics content to be successful teachers and secondly that the program incorporates online teaching and residential schools into its structure.

The primary source of negative sentiment in relation to the BEdSM was the perception that graduates would be underprepared in the science content, particularly when compared with teachers who graduate with an undergraduate degree in science and/or mathematics. However, in the current educational context, this is not considered a substantial challenge. The number and breadth of units completed in the science major is comparable to that completed by students enrolled in postgraduate ITE programs. The study in the mathematics minor is considered sufficient for teaching up to year 10 and an added bonus of this program, when compared with bachelors of science which might include a unit of mathematics only rather than a coherent minor. If it is considered that teaching is a profession, then graduation from any ITE is only the point of commencement of a long journey of professional learning. This view is now articulated in Standard 6 – Engage in professional learning of the AITSL standards (see http://www.aitsl.edu.au/australian-professional-standards-for-teachers/standards/list), which requires teachers to undertake ongoing professional learning throughout their career. It must also be remembered that there

are also specific requirements by the accrediting bodies for initial teacher education programs, such as the BEdSM and the program cannot be accredited without meeting these standards.

The second primary argument against the BEdSM is the inclusion of units that are studied online. As discussed earlier, interview participants were not engaged in an in-depth discussion of program delivery or what blended delivery in the context of such a degree means, hence their perceptions were not fully informed. In actuality, students living near one of the hosting university's campuses have the option to study all units in either face-to-face, online or blended mode. Science and mathematics units studied in blended mode, that is using both online and face-to-face pedagogies, incorporate a mandated residential school if they include practical components. Such flexibility and choice offers advantages to mature age students and those in rural and remote locations.

The benefits that ensue to students studying STEM subjects in an integrated way (Kennedy & Odell, 2014; Tytler et al., 2008), were identified by only one of the interview participants. Considering that nine of the interviewees were either mathematics and/or science teachers or heads of department, this is considered of particular interest. The lack of STEM subject integration that currently exists within Australian schools, described by Blackley and Howell (2015), is considered a likely reason for this. The integrated nature of the study of mathematics, science and education was one of the primary foci behind the development of the BEdSM and represents the principle innovation of the program. Equally surprising was the lack of attention paid to units that enhance ITE students' understandings of what it means to think scientifically and mathematically and engage in authentic practice related to these disciplines. The Australian Curriculum: Science requires teachers to teach more than just content, rather they need to engage students in science inquiry, the nature of science and its benefits to society. Such understandings do not develop automatically through the study of a discipline, they need to be taught explicitly and where possible experienced authentically. The inclusion of specific units with this focus in the program is another innovation that remained unremarked.

The development of the units included in the integrated STEM ITE program, the BEdSM, is expected to continue through cross-curriculum collaboration until 2018. The BEdSM was accredited by the Tasmanian Teacher Registration Board in late 2016 and now provides a viable alternative to the traditional teacher education pathways currently available to students whose career goal is science and mathematics secondary school teaching. For course developers, however, recognising that secondary science and mathematics teachers and careers counsellors, have their own beliefs about what constitutes a valid teaching degree (i.e. an undergraduate degree (BSc for example) followed by a post-graduate degree (MTeach)) is important when the program is marketed widely. Future employment of the BEdSM graduates will also rely upon course information and marketing ventures to address such beliefs through explicit course philosophy statements and narratives around course structures. It will be necessary to specifically concentrate on the benefits of the BEdSM described above, when comparisons are made with traditional undergraduate/post graduate or dual degree course offerings, which generally lack any integration of STEM disciplines (Blackley & Howell, 2015) or indeed, any integration with education theory and pedagogies.

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