Primary Science Pre-Service Teacher (PST) Online Publishing – Is it Recognized as Valuable?

This article presents a case of online publishing in teacher education and explores the status pre-service teachers (PSTs) associate to this act. Publishing as a teacher education strategy is investigated to inform the use of tutorial products that provide learning and teaching advantage. Motivated by Education for Sustainability (EfS), professional vocational publishing provides assistance *to* teachers, *from* PSTs, while PSTs learn teaching. In 2014, PSTs designed teaching tools for primary science teachers published on the ####### Wildlife Sanctuary (##WS) website (##WS, 2015). From 92 PSTs surveyed with an 85% response rate, the value, involvement and quality of tutorial products was attributed to, and raised, when published online. The data suggested that PSTs supported this as a teaching approach and would consider applying it in their future teaching.

Keywords: online publishing, teaching strategy, pre-service teachers, primary science teaching

Introduction

This paper outlines, and spotlights, a case of online publishing. In this investigation pre-service teachers (PSTs) published their tutorial work to establish a teaching resource website for an educational partner (a wildlife sanctuary). The importance lies in how primary PST survey responses support or comment upon this approach. A merger of pedagogy, discipline knowledge and ownership in primary science PST learning provides the background. Meaningful publishing will be highlighted as a

communication medium, where the communicator potentially becomes an empowered author writing for an audience (Irby, 1993; Redmon, 1997). While advantages occur, and are elaborated upon for all stakeholders, PST survey responses provide insights into a different learning experience. This substantiates and indicates some outcomes of tertiary PST online publishing as a learning experience.

The key research question that drives this discussion is:

Do primary PSTs value online publishing as a component of their learning of how to teach science.

This paper will present the findings of quantitatively and qualitatively PST surveys to investigate the student encounter to an online publishing teaching approach. Factors relevant to this project include the imbalance between content and methodology due to current Australian Initial Teacher Education (ITE) policy for undergraduate course design, the development of science teacher identity, PST ownership and empowerment through authorship of science teaching activities and early PST engagement in the teaching community - all will be elaborated upon in conjunction with PST comments. It is recognized that some of these factors interlink, and as such, this article will on occasion mention issues as they overlap. Data collected were in the form of survey questions analysed for correlation firstly only as a pilot analysis (Allen & Seaman, 2007), then the highest percentage rate of positive interest through Likert responses and open-ended comments provide the outcomes of this research. This provided the PST stance and the value they associated to the teaching experience both as data collection and for reflective practice.

Rationale

High quality science teaching that has long lasting impact is an ongoing area of concern. Endeavors to change this for the better, and in a manner that is sustainable, are often on

the educational stage (Danielsson & Warwick, 2014; Jones et al, 2011; Office for Learning and Teaching, 2013; Rubinstein, 2013; Trefil, 1996). The Universal Declaration of Human Rights (UDHR) indicates in Article 27 "Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits" (United Nations, 2016). Access to, and knowledge of science, is more than a requirement; it is a right. For most of us, our first exposure to science understandings comes with formal learning, where teachers take a significant role in our early science. Therefore, science teaching and preparation of those who teach science in the primary sector plays an important role.

School teaching programs are established to enhance the quality and level of science understandings in the next generation. This intends to develop a society competent in science, in a future where science plays an even greater role in the decisions we make, and the interactions with the world around us. The report written by the Chief Scientist in Australia titled *Mathematics, Engineering and Science: in the National Interest* generated the impetus to enhance teacher education with $12 million in grants in the time span of 2014 -2016. This was geared for *Investing in Science and Maths for a Smarter Future* (Office for Learning and Teaching (OLT), 2013). In Australia, there has been federal funding invested from the OLT in the Re-conceptualizing Maths and Science Teacher Education Program (ReMSTEP) (2014-2016). The implication throughout these initiatives was clear. Initial Mathematics and Science teachers have a focus upon them to improve the *status quo*. The teaching experiences within teacher education programs and how they impact PSTs has been identified as a focus area for future quality science teaching. As science teacher educators we recognize this issue and aim for maximum impact on future teaching and learning.

Science has reduced popularity in subject selection for senior secondary Australian schools. In an environment where our media constantly informs us that our science achievement levels are decreasing; a waning interest in formal science learning has been identified as a national and international trend (AAS, 2012; Australian Mathematical Science Institute, 2013). Venille, Hanbury and Longneck (2012) indicate that to pursue a science career is a case of heart and not pocket. If this is the case, we aim for interest to motivate science engagement. In fact, Brian Schmidt 2011 Physics Nobel Prize winner acknowledges his Canadian six-year teacher in his early science learnings (Jones, 2011) when he was asked in an inspired science project to teach his class about a total eclipse of the sun. Given a decline in the numbers who follow higher Education (HE) science disciplines, early experiences of science in schools, and ultimately, all science schooling experiences *can* make a difference to inspire. Desirable science teachers are those who teach to encourage and engage their students; to be generative of a continuing cycle. An ideal resides in teachers who both teach for and are motivated themselves by science. Within this vision the PST perspective counts.

The National Curriculum in Australia (2013) contains science as a compulsory discipline from the foundation/preparatory years. While independent schools in the private sector follow the Melbourne Declaration (MCOEE, 2008) as a curriculum guideline, national curriculum requirements constitute the curriculum of Government and Catholic schools (also private sector) in Australia (ACARA, 2016). The National Curriculum mandates early science experiences for school attendees. The opportunity arises to inspire science engagement in younger children. Yet, the science histories of pre-service primary teachers are often limited (Danielsson & Warwick, 2014). Teaching science with innovation and engagement through ownership and identity building of the primary science PSTs in Australia is a priority.

Authentic learning in science education for increased engagement is an international phenomenon. Engagement is enhanced when learning is integrated in a context (Caldwell, 2014; Ljunggren, 2009; Jones et al., 2011; Rubenstein, 2013). A pathway has developed for creative authentic endeavors in science learning as an organic experience (Tyler, 2007). Examples exist within science special entry schools, such as the John Monash in Victoria, Australia, which is a Science, Technology, Engineer and Mathematics (STEM) school for Science, Mathematics and Associated Technologies and the New York Academy of Sciences (Science Education Event Monash University, RISE, 2013). Learning with, and within industry, has given rise to partnerships in the field.

Partnerships often capitalize upon networks. Partnerships exist between schools and organizations, and between HE and organizations (###### & Author, 2015; Author 1 & ######, 2013). Traditionally, partnerships in science are Government funded industry-university collaborations for product development. Caldwell (2014) mentions schools as outward looking when cognition exists of collaboration in community organizations for engagement. If as Cook (2008) states partnership development through networking is a new generational act, then the experience of a partnership involvement as professional learning (###### & Author 1, 2015) sets the scene for PSTs, once teaching, to endeavor beyond their classroom into collaboration with education providers and organizations in their vicinity, as part of their pedagogy.

This partnership project was established between tertiary teacher education and a local education provider; ##WS. It encouraged primary PSTs to produce science teaching tools designed for online publication by the sanctuary. It aimed to build PST ownership and agency in science understandings, and a new history of active experience in primary science teaching. This was the third year of the project and the second year

when PSTs had created teaching tools for publishing. With this background the collective and individual impact that PST recognized will be identified to support the case of undergraduate online publishing.

Methodology

The pilot project occurred in 2012 when PSTs identified an absence of authentically created teaching tools based on the ##WS experiences available for teachers. The first publication of student work with the sanctuary occurred the following year (##WS, 2014). This article is based on the second year, 2014, of the partnership collaboration (##WS, 2015).

The tutorial tasks for publication had a dual purpose. Firstly, the resources developed supplemented a folio of activities for teaching primary years as part of the PSTs' major assessment. Each tutorial and lecture during the semester when collated by PSTs built a teaching resource of F-6 folio Australian Victorian Education Learning Standards (AusVELS) (ACARA, 2016) ready-to-use science teaching artefacts - each critiqued from literature for best teaching. F in the Australian Curriculum is the Foundation or preparatory year. Two goals were being achieved by PSTs in this project; firstly in a component of assessment, and secondly, to communicate and share with an audience.

In 2014 the Primary PSTs cohort had a gender mix of 22% males and 78% females who attended the ##WS adjacent to their university, and actively participated in all the primary activities the sanctuary offered - designed in an excursion format. The first tutorial/excursion in the Biological science section was presented by the sanctuary where students were encouraged to record written and audiovisual information. Activities included Woodlands Walk, Frog Calling, Dip Netting, Nesting Boxes and Wildlife CSI (##WS, 2015). Experiential Biological Science content was covered for

the Science Methodology section of the Primary Teacher education course. The theoretical content was presented in a series of one-hour lectures. Each area of science throughout the semester was supported and scaffolded with weekly lectures and readings that covered the theory, curriculum and teaching strategies – the discipline content and the pedagogy. Lectures alternated with, and were supported by, experiential tutorial encounters.

The second Biological Science tutorial occurred at the university in class where PSTs formed collaborative teams. Each team selected one of the activities from the sanctuary, such that all the activities encountered were distributed and each activity had sole attention of one team. The AusVELS sustainability curriculum components were identified in conjunction with background information of sustainability resources. PSTs developed ways to highlight sustainability through projects designed for Years F-6. This aligned to their assessment requirements. Projects were created that focused on environmental sustainability issues for junior, intermediate and senior primary school levels within the F-6 curriculum. All activities development were applicable to the PSTs' assessment requirements. Whatever PSTs either created for the sanctuary or sourced as material already published by the 2013 Science Methodology class, could be referenced and included in folios. The project contributed to the Biological section of the assessment that covered the science understanding areas of: Physical, Chemical, Biological, Earth and Space Science understandings.

Students submitted sustainability projects they authored at the conclusion, or shortly after, the second tutorial. Author names were added if PSTs decided to contribute to the ##WS website. The teaching tools generated were given to the sanctuary and a volunteer PST editor developed the material in a publishable form alongside the sanctuary leader and the lecturer for quality assurance. Therefore, there

was a three-person quality control of PST content: the volunteer editor, ##WS leader and lecturer; each a checkpoint. PSTs were acknowledged online for their endeavors (##WS, 2015). Anecdotally, folio tasks proved to be such a useful resource for the new curriculum that they were shared within PST networks – to practicing primary teachers. Practicing primary teachers had contacted the lecturer for suggestions of activities when this curriculum first began, and PSTs had their folio artefact resource ready to assist.

The survey conducted at the end of the second tutorial ensured that the response captured directly followed participation for a lived experience of social reality (Ejimabo, 2015; Langenhove & Harré, 1999). The survey reflection added to the praxis (Anderson & Freebody, 2012) process in learning. The survey, had ethical approval granted by the ######## University Ethics committee, and contained two parts for a mixed methodology approach to give depth, synergy and voice to the lived experiences (Gill, 1996; Mertens, 2013). This was categorized as quantitative analysis, with a qualitative contribution.

Quantitative survey questions (Appendix A), were asked in themes to determine the value PSTs associated to authentic tasks, group work design in tutorial teaching, working with industry partners and the culture when resources were shared. The first question which requested interest in the study of science had options of: very interested, interested, neutral, not very interested and not at all interested while the following 15 questions had the options of: very much, somewhat, undecided, not really and not at all. A total of 16 questions were administered all other questions with a five-point Likert scale used to detect the extent PSTs agreed with the questions as a confirmatory factor model, which adhered to equally opposite status either side of the central neutral/undecided option. This common Likert format provided a measure of attitude (Albaum, 1997). The survey questions where analyzed by SPSS software.

A written qualitative component followed where PSTs participants added a snapshot vignette of comments. Respondents were asked how they felt and to provide positive advice for the project's development within each theme. The opportunity to contribute an opinion served to elicit longer personal responses (Myklebust & Bjøkrlund, 2010) as a guide for project improvement. The advice contribution was thematically analyzed by NVivo software (Attride-Stirling, 2001). The mixture of quantitative and qualitative techniques was geared to evoke PST stance directly after the project experience as an immediate reflection and provide data of both the collective view and the personal encounter.

The survey response rate was 85% of the 108 students in recorded attendance for the two-tutorial sequence. Five tutorials groups were delivered in 2014. From the PSTs who participated in the tutorial sequence, 92 surveys were collected. While survey recruitment was optional, and completed anonymously, only PSTs who attended the sanctuary were asked to complete the survey. PSTs either chose to participate or left the tutorial when the learning tasks were completed. Ultimately 63 PSTs, 68% of the students who responded to the survey chose to add their names to the content submitted for publication (##WS, 2015). Publication occurred in 2015.

Results and Data Analysis

The survey was located as a reflective endpoint to the two-tutorial sequence. While the positive associations in the data provided insight into the key aspects pertinent to the PST, the qualitative responses emphasized the meaning making that occurred. Both quantitative and qualitative data provide support for the research question of whether students attributed value to this teaching and learning strategy.

Correlation coefficient data was generated as a pilot analysis data (Allen & Seaman, 2007) as presented in Tab. 1 using SPSS software and summarized for positive associations (Laerd, 2013). All data generated can be viewed in Appendix B.

Table 1

Correlations Between Measures

	4. Tutorial adds value when published	*5. Rate of involvement in activity*	*7. Publish your developed task online (share)*	*13. Gives more quality to the task*
4. Tutorial adds value when published	1	0.524** .000	0.521** .000	0.584** .000
5. Rate of involvement in activity	0.524** .000	1	0.597** .000	1
7. Publish your developed task online (share)	0.521** .000	0.597** .000	1	0.645** .000
13. Gives more quality to the task	0.584** .000	1	0.645** .000	1

Note. Data in the table represents N=80 where correlation** is significant at the 0.01 level (2-tailed). Only data that was fairly highly correlated is shown. The numbers indicated identify the survey question.

From this starting point the percentage response rate collectively for each question is presented in Tab. 2. The complete table of data is available in Appendix C.

Table 2

Likert PST Percentage Responses

Questions	*Not at all*	*Not really*	*Undecided*	*Somewhat*	*Very Much*
3. Two tutorials advantageous	1.3%	1.3%	7.5%	45.0%	45.0%
4. Tutorial adds value when published	3.8%	5.0%	16.3%	38.8%	36.3%
5. Rate involvement in activity	2.5%	2.5%	10.0%	40.0%	45.0%
6. Helped sustainability re AusVELS	1.3%	5.1%	7.6%	34.2%	51.9%
7. Publish your developed tasks online	1.3%	11.3%	15.0%	38.8%	33.8%
8. Consider students publishing	0.0%	5.0%	8.8%	30.0%	56.3%
9R. Two tutorials necessary	5.1%	6.3%	19.0%	27.8%	41.8%
10. Interest contribute wildlife sanctuary	3.8%	15.0%	37.5%	33.8%	10.0%
11R. Engaged by publishing	5.1%	5.1%	34.2%	31.6%	24.1%
12. Link with out of school partner	1.3%	6.3%	24.1%	39.2%	29.1%
13. Gives more quality to task	1.3%	10.0%	6.3%	43.8%	38.8%

PSTs indicated that they would consider using this approach as a teaching strategy in the future where their own students would publish (56%). Of the questions asked this generated the highest level of agreement. Followed by the two-tutorial sequence being advantageous and online publishing created tasks increased the rate of involvement (45%). Then 39% of students selected "very much" that online publishing increased the quality of the task. Next, but to only to a marginally lesser extent, 36% of PSTs indicated that there was value-added to the tutorial, when published online. The data suggests that developed tutorial tasks, which were to be published online, were recognized to have more value and that this project process increased the rate of involvement because the product would be published online. There was indication that PSTs saw online publishing as a worthwhile way to share their tutorial work (34%).

NVivo qualitative analysis has been condensed into a table for data where more than ten PSTs responded consistently.

Table 3

Qualitative Survey Results

Theme	How PSTs felt?
Sustainability *"Highlighting sustainability in primary education"*	Important (20) Enjoyed (15) Greater understanding (12) Better equipped to teach it (12) Relevant/Necessary (10)
Publishing *"Publishing in teaching and learning (both for you and for your students in the future)"*	Good that it will be used (11) Puts more value on it (10) It will be useful (10)
Sharing *"Sharing when developing content for teaching"*	Sharing (22) Forming ideas/Broadens knowledge (13)

Note. Results table indicates survey responses at or above ten.

The request for positive project improvements yielded no consistent data with similar representative numbers, and as such, the focus will be predominantly on how

PSTs felt. Whereas, the largest data in this field was when PSTs suggested more time was required in each theme: sustainability (8), publishing (5) and sharing (2). The highest number PST responses for project improvement was in the sustainability theme where seven PSTs suggested a need for more information and direction.

Qualitative response statements supported the project design except in one area. Limited time to complete the task was not appreciated. The session was designed to represent a staff meeting when a task was collaboratively required in a time frame and submitted later if desired. Time pressure was evident and an issue that PSTs objected to - like the objections of practicing teachers. This will be further addressed.

The results indicated that creation of science teaching tools for online publication increased the quality of the task. The publishing destination and purpose of the task, engendered involvement and assigned value to the HE tutorials. The data indicated that the PSTs saw the links between involvement, value and quality to online publication. Online publication of science teaching tools increased the meaning, authenticity and participation. In teacher education online publishing opens opportunities for PSTs to engage with science in a new manner, but also, unlocks an audience, where skills and ideas are pro-actively encouraged and are provided with a showcase. A means is sighted of tutorial teaching which needs further investigation into impact beyond the inspiration. This data indicates that this was a strategy that increased the value to PST of tutorials in tertiary primary science learning.

Discussion

Statements generated in the qualitative component of the survey will be highlighted to shed light on the individual PST response in relation to areas pertinent to PST primary science online publishing as a reflection of the lived learning experience.

No area of discussion stands alone, there are intersections that overlap which is conveyed in this section.

Project design intentions in conjunction with PST responses

The discussion will outline the intentions of the project and the related responses from PSTs. The intentions cannot be explicitly said to be realised however the comments from the PSTs indicated that steps to meet the aims did occur.

Policy versus Pedagogy

Beyond a student's prior science experience, it is within teacher education courses where the negotiation of science teacher identity occurs and is constructed (Danielsson & Warwick, 2014). In the Netherlands an initial difference existed between PSTs who had greater science subject course content, compared to, method of science subjects. This difference dissipated as learning continued (Velthuis, et al., 2014). When ITE courses have few dedicated science subjects, the minimum national requirements set by the Australian Institute for Teachers and School Leadership (AITSL, 2017) is an eighth of a year, it is essential to balance content and methodology. Innovation and creativity nested in experiential learning can assist inquiry and divergent thinking - valued science classroom teaching attributes (Liu & Lin, 2014), however such authentic learning approaches are not always identified as comfortable.

Stakeholder advantage resides within the ideology of participatory projects as 21st Century learning models for increased ownership, early engagement in professional life and science learning. Ultimately, I speak to sustainability for future primary science teaching professionals, through early awareness and contribution to professional behaviour when outward looking (Caldwell, 2014) projects reside in HE learning. Implicitly graduate standards of community engagement and involvement are within this philosophy. Soft skills are included in tertiary courses to advantage PSTs and their

future students (Lucas, 2016) as expectations of future careers. The challenges of entering early career experiences while beneficial are not always comfortable. This was recognised when PSTs commented on the discomfort in conjunction with the reward felt while participating in the project.

> "Good. Scared of criticism though!", "There is a lot more pressure, but also motivational knowing that our work would be seen by others", "Was not that comfortable with publishing work but though the process I can now see real benefit in teaching" and "Felt a bit nervous but knowing that we would have recognition made me feel better", "A bit nervous, but once we started discussing the project we got the ball rolling", "Working in a group was a little confronting, but the ideas developed helps to improve our learning".

There is focus on PST science teaching to encourage understandings due to a pressure-point in primary science teaching in Australia. A gap resides between the limited history of primary teachers' science experiences (Danielsson & Warwick, 2014) and the requirement for explicit science teaching within the Australian Curriculum documents (ACARA, 2016). Such disparity requires a bridge when the science learning time for primary PSTs in programs is often limited. This project aimed to develop science discipline ownership, engagement in a worthwhile project and empowerment/ownership for primary PSTs through authorship. The bridge was intended when PSTs became authors of science teaching tools for a client - the ######## Wildlife Sanctuary (##WS) – *and* for the community of primary teachers who access the ##WS online resources - the audience. This is also where PSTs shared their work, and as such, the process established as a teaching approach. Some of these ideas were sighted in the PST survey responses.

> "I liked sharing resources. Make[s] you feel part of the teaching community", "I feel good to be able to support fellow teachers and make a public contribution", "I think it is a great idea! Gives me a sense of professionalism, plus it is very exciting", "It is exciting to be able to share ideas with other people and to know that you are helping others learn from your knowledge", "I felt this

would be beneficial to others", "I felt like it could help future teachers and students", "It's very helpful when sharing resources because everyone had different ideas that develop as a group".

Authorship for Ownership

Writing is a creative act of powerful personal ownership. When one reflects upon the product generated, and the involvement in development, authorship contains the stamp of individual cognition and voice. I suggest that given authorship enhances ownership (Irby, 1993; Redmon, 1997), when PSTs publish in a science teaching context, the connection between primary PSTs and science discipline content increases and generates experiential learning; a core attribute of learning (Dewey, 1961).

When students publish for an audience there is purposeful communication in the writing. The intent of publishing is to communicate (Dodd, 1986; Irby, 1993; Nadelson, 1997; Redmon, 1997), and intrinsically binds the author to the audience. Students become empowered with confidence, and a voice, when they write to communicate. Documented instances of student publishing are largely based in secondary (elementary) school contexts; an approach indicated to encourage and motivate students. In HE within doctoral studies, research domains and academic careers, publishing skills are built via mentoring (Author 1, 2014; Beattie, 1992; Boyd & Horstmanshof, 2013; Johnson, 2011). The ability to communicate through publication contains authority, a source of power and provides an ownership and agency - transformative to expert status (Hattie, 2003). An applied deep learning experience occurs for individuals when writing for a meaningful purpose. With negligible documented research about undergraduate publishing, this act is potentially an uncapitalised opportunity.

Case studies provide insight into the student authoring experiences where audiences are important. In elementary English classes in America, students were

motivated to write of the student world vision and the faults in the school system (Irby, 1993). The audience were key stakeholders - the school board. Similarly, underground newspapers (Redmon, 1997) or mainstream publishing opportunities (Dodd, 1986) develop student authors. Online publication increases the audience when students' science research projects otherwise only reach the assessor (Nadelson, 1997). The audience provides the common element that instills meaningfully purpose and writing inspiration. Examples provided are not new however the connection between authorship and the medium of publication in undergraduate learning is different.

Further "Publication [provides an] avenue for publication in the life of a community" (Irby, 1993, p. 53) - a school newspaper or an organization. PSTs who publish within teaching contexts engage early as communicators in the teaching community. Service to professional teaching enables representation of the profession (Richardson, 1999). Cases documented within secondary/elementary teaching, rather than HE, discuss publication to build ownership. Communication skills can be developed and quality enhanced when a peer reviewing audience engages with the text.

Greater commitment occurs when writing is teamed with an issue of personal importance. Redmon's (1997) Year 9s voiced their concerns publicly, learnt the value of a formal expression of student opinion and recognised a future outlet for what was heartfelt. Whereas, PSTs developed teaching tools for a client and professionally shared. Publication success may even springboard a further writing cycle (Dodd, 1986).

Redmon (1997) states "Learning that actively involves the student in doing something, producing something, or creating something is more effective than learning for learning's sake" (p.79). These ideas married together, acknowledge authentic learning experiences (Dewey, 1961; Tyler, 2007), support publishing within primary science PST programs and show some validation in PST survey responses.

> "It's good to know your planning and learning can go to good use; it made me feel valued", "Students will be more engaged if they know their work will be used in a really practical way", "Publishing the projects is very motivating as it means we, and others, can use it as a resource for the future", "I put more value into work I know other people will see", "Publishing your work is a good incentive to do better work", " I don't mind having my work published it makes me feel special!" "I felt it was great to be putting my name to a properly published piece of work".

The advantages of authorship identified in PST survey responses support the project's significance (Dodd, 1986; Irby, 1993; Nadelson, 1997; Redmon, 1997). When 56.3% of the PSTs indicated strong support of using this approach in their own future teaching, value was associated to this act.

Stakeholders Who Win

The crux of this teaching tool creation resides in its enterprise pedagogical approach (Jones & Iredale, 2010). Originally developed for an English economic crisis to capitalise upon learning experiences, value exists in a win-win situation (Fullan, 2009). The project intended to capacity built when the learning encourages growth in the future educator as a contributor to their professional community (Crow, 2009; White, 2002).

Products developed by HE students in tutorial workshops often used for assessment contain authentic learning particularly in vocational courses such as teacher education. Rarely do tutorial products go beyond the classroom, advantageous to the community where PSTs become acknowledged authors (Dodd, 1986; Nadelson, 1997). Yet, in my experience quality tutorial content has significant potential. This article highlights publishing tutorial products in a community partnership arrangement. Given that primary teachers access the ##WS online teaching tools; context, meaningful purpose and an audience were involved. The content generated by PSTs had win-win stakeholder advantage (Fullan, 2009), provided an example of enterprise pedagogy (Jones & Iredale, 2010; ###### & Author 1, 2015) and assisted the ##WS to build their

website. A resource for primary teachers was generated, PSTs benefited when working on an assessment when they took control of the science content with recognized author status and it was noted as a worthy teaching approach that PSTs would use in their future teaching.

> "I think it is great for both parties to have published work", "Really good! It's good to think that I have 'published' before I finish my course", "Happy to help future teachers", "Positive. It is beneficial to help other teachers", "Useful for teachers and teaching when planning lessons following excursions."

A 21st Century Teaching Model

The 'how' of this project not only presents a scenario of active involvement but emphasizes a future teaching model.

Various machinations of 21st Century skills (Fullan; 2013; Kivunja, 2014; White, 2002) exist. White (2002) uses the words: creative, innovative, inventive, entrepreneurial, adaptable and resilient. White's (2002) version sets the scene of the Partnerships for 21st Century Skills (P21) movement that emerged for advantage in the digital technological age. Kivunja (2014) presents a case of skills required for a successful future workforce in Learning and Innovation Skills, Career and Life Skills and Digital Literacy Skills. And Fullan (2013) subscribes to a six C educational model. The six Cs being character, citizenship, communication, critical thinking and problem solving, collaboration and teamwork, and creativity and imagination. The advantages of enterprise education in the UK experience for the students were listed as increased ownership, creativity development, experiential learning, enhancement of employability skills and insight into entrepreneurial approaches (Jones & Ireland, 2010).

The various 21st Century lenses apply equally to the approach outlined here. All look to successfully manage a time of change. Specific definitions aside, a melting-pot of 21st Century skills arise in multi-faceted projects. In the 2013 project iteration PSTs

were surveyed (###### & Author 1, 2015) and a student pin-pointed a merit of the project as a 21st Century exemplar.

Tutorials designed for learning and authentic purposes build and set an approach for professional involvement. A 21st Century ideology (Fullan; 2013; Kivunja, 2014; White, 2002) can be recognized within the project design, which promotes teacher communication and online sharing.

> "I feel that this is a great way of creating opportunities for both myself and students. It encourages a more accurate frame of mind", "Really like this concept. In the workplace this is how the workforce works." "I feel this is a great way to document experience, share knowledge, build on experience", "I felt it was a good way of sharing everybody's ideas on the topic and introduce you to more efficient ways of teaching", "Collaborative approach to teaching helps to get the benefit of both partners' knowledge".

Early Professional Authentic Acts

Science learning through authentic endeavors builds contextual understanding – active science. The creation of teaching artefacts when learning the art/science/pedagogy (Churchill, 2011) of teaching represents a *bona fide* act. There is symmetry of professional development, ownership and membership of the teaching profession when PSTs develop products published in the public domain for professional teachers. Learning occurs through tangible experience (Dewey, 1961; Tyler, 2007). PSTs are participatory in the teaching profession when teaching tools are created for the profession. This act goes beyond professional sufficiency and into sustenance (Collin, Van der Heijden & Lewis, 2012; Murphy & Calway, 2008) and sustainability. A strong discipline knowledge emphasis exists in professional associations (Murphy & Calway, 2008), however it is the participants, who enable forward movement who promote the profession (Richardson, 1999). When action is added to the profession the individuals involved in change can become agents of change.

This article depicts the multi-faceted aspects of project design, where benefits are diverse, and motivation arises from meaningful products – authorship and adaptability skills alike. To identify if this paradigm is meaningful and adds to a new PST science experience history requires investigation of the PSTs standpoint, which is the focus of this research. If ownership is required, it is the owner, their feelings and their confidence that must be investigated.

> "I feel confident about sharing and think this is a great idea", "It gave everyone a sense of achievement and confidence"

PST Voice

The key driver in this project design was the value of PSTs becoming authors, and the place of authorship for science teaching empowerment through ownership (Irby, 1993; Redmon, 1997). There were multiple stakeholders and the win-win Fullan (2009) paradigm was evident between the PSTs, the ##WS and the lecturer, seen in 21st Century skills, described as soft skills required for professional intellect (Murphy & Calway, 2008) of contemporary teachers. Authentic science teaching tasks established an important early professional participatory exemplar. Each of these aspects have been unpacked in this article. Yet it is the participants of the project are who will ultimately need to address the area of concern in early science learning. For this reason, the focus of data collection and analysis was based on PSTs as it is they who have the greatest influence on this future.

A common thread of community exists in this paper - a community organization and the practicing teachers community - both provided incentive for PSTs to undertake this project as a professional teacher act (Crow, 2009; Dyson, 2010; Martin & Johnston, 2013; Richardson, 1999; White, 2002). PSTs mention this project as a professional act engaged in sharing with the teaching and learning community. The community theme

also has importance in the graduate teacher standards required by Australian graduates of how to engage professionally with the community (AISTL, 2015).

This project was collaborative and advantaged stakeholders – a step that PST recognized and valued, because it assisted/helped others. It was product development for an education provider and primary teachers. The ##WS partner gained through the development of the website, and the publicity of hundreds of primary teachers who graduated from ##### University, would have the experience of the sanctuary as an excursion site (###### & Author 1, 2015). The project pilot commenced in 2012, and PSTs have since returned to the sanctuary as practicing teachers.

This project was designed as a mutualism scenario – to be mutually beneficial. Fullan (2009) discusses teacher involvement in creative and productive enterprises as a win-win situation – the future new generational leadership (Cook, 2008). PSTs identified the positive features that they associated with content published before they completed their course to become authors, whose knowledge was appreciated for its authority, in a sense, science education co-leaders (Crow, 2009; Martin & Johnston, 2013; White, 2002). While it cannot be stated that capacity was built, there was authorship, and therefore, some control of the medium – science – noted through mention of increased confidence. PSTs provided the ideas and inspiration for teaching strategies, worked actively with science *not* a passive or transmission learning experience; to establish a new pattern. Not all appreciated this approach of active engagement to develop products promptly.

After a pilot project in 2012, 2013 saw the project titled as “Tutorial Tasks that Multi-task”. The design continued into 2014 for skill development through a learning experience in-built with time limitations to be authentic to teacher deadlines. PSTs in their teams were required to be rapidly participatory, to develop a purposeful teaching

product, which was problem solving. Limited time for tasks represented teacher practice. PSTs aligned equivalently with teachers in the workplace (Author 1, 2009; Murphy & Calway, 2008; Richardson, 1999) with time concerns, and indicated a desire for additional time. While PSTs commented appreciatively of the teacher role experience, simultaneously there was antipathy towards pressure and time constraints. Authenticity was evident, and with it, both advantages and disadvantages were recognized.

> "I felt that we had insufficient time to prepare ideas for a specific task. We were under pressure to come up with something", "We all felt a bit frustrated with our progress", "[We needed] more time to brainstorm and think of ideas before having to work in groups", "Again more time, but it was great. Lots of information, websites, etc.".

The product created assisted assessment, while it developed the ##WS's website. PSTs feedback appreciated the self-generated, and shared approach of teaching tools that had ongoing value. On the website author status was acknowledged, enterprise statements (Jones & Iredale, 2010) were possible, and *curriculum vitae* could reference the product as employment ready marketable tools. PSTs recognized they had "properly published" and would "receive recognition". Through the project, PSTs developed awareness and evidence of what they "have done" and "could do". In times when providers of all courses are mindful of developing employment ready skills such opportunities can be indicated as a step apart from other tutorial learning.

The project aim was to build the experiences of PSTs to become active in teaching tool development and communication of that product. This career voice typifies teacher professional associations, those who undertake professional sharing and maintenance in journal publications (Collin, Van der Heijden & Lewis, 2012; Murphy & Calway, 2008). As graduate standards involve such acts (AITSL, 2015) this project indicates how steps can be taken towards developing professional involvement.

To sustainably promote a profession, we require a new generation of active voices. The active voices expression arises from Education for Sustainability (EfS), which goes beyond environmental education and into active involvement (Littledyke, Taylor & Eames, 2009). EfS is participatory; individuals aim to make a difference *to* the environment and in the context of this project *to* the teaching profession. Publishing indicates a level of expertise, professional ownership/empowerment and contains implicit awareness of peer review. The model presented in this project, steps future teachers into new generational acts when publishing tutorial products. It scaffolds, and signposts elements of professional behaviour, while HE students. The project arose from the identification of the quality products created by PSTs in tutorials for assessment, which had a limited audience unless a strategic design was developed (Cook, 2008; Nadelson, 1997).

Given that PSTs recognised online publishing of science teaching tools as engendering involvement, quality and value, (ordered specifically based on survey response) that they would use themselves in teaching, this stands as a powerful process. The positive response of future use of online publishing as a teaching strategy was generated by PST data, however, whether this eventuates as an endeavor requires longitudinal tracking to note if PSTs use this approach in teaching when their students publish online.

The approach of publishing assessments within HE subjects has moved to being enacted in secondary teacher education subjects at the same university. Mathematics Methodology PSTs have published in their state association – the Mathematics Association of Victoria (MAV). In a Science Method subject PSTs develop an excursion, visit an education site, generate a meaningful teaching tool and contribute it

to the education provider. All acts that have generated in assessments from this project's initial concept.

Conclusion

Survey feedback derived from responses of 92 PSTs with an 85% response rate strongly captured the PST viewpoint. PSTs indicated that when they online published authentic science teaching tools for a meaningful purpose involvement increased, quality was associated to the task and it was valued. An intentional interplay of purpose was integral to the design of the project, yet the findings were based on PST perception. This sets groundwork for impact as a teaching strategy given that the highest data response from PSTs indicated this as a practice worthy of applying in their future teaching practice.

The advantages of authentic learning are well known. This project presents undergraduate PSTs collaboration with a local education provider in their community who published PST created excursion suitable primary science teaching resources. Authentic teaching tasks generated tangible tools with a future life –noted by PSTs as "work that is used in practical way". The product assisted assessment while it developed the ##WS's website and generated teaching tools practicing teachers could use.

Online publication of teaching artefacts aims to build ownership, confidence and generate PST voice within the science. When PSTs generated tools through writing, products were shared with a primary teaching professional audience in the public domain, author status was acknowledged, and enterprise statements were possible as evidence of skill. There was immediacy, which some may say lacks regulation, however, inherent peer-review was recognised by PSTs when their work would be scrutinized, and subsequently, an increase of quality was motivated.

This tutorial design enabled PSTs to indicate a confidence and ownership in their comments and to step into their professions with a publication from their courses. To use authorship and becoming a communicator stands as teaching approach for teachers and teacher educators alike. Compared to other tutorial experiences this strategy contained a timeline for creative endeavors which is discomforting; a constant professional teaching challenge. While PST involvement builds within this approach, the nature of the feedback from the PSTs presents discomfort with valued reward when PSTs enact teacher requirements of quality science teaching products being promptly developed for an audience of peers.

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Appendix A - Quantitative Survey Questions

1. How would you describe your feelings about the study of science?

2. Has your attitude towards teaching science altered as a consequence of the course to date?

3. Would you say that the sequence of 2 tutorials in Biological Science was advantageous?

4. Do you think that this tutorial task adds more value given that it will be published?

5. How would you rate your involvement in the group work design of this activity?

6. Did this task help highlight the sustainability components of AusVELS?

7. Would you publish your developed teaching tasks online in some form as a consequence of this task?

8. When teaching would you consider your students publishing their work in the future?

9. (R) Would you say that the 2 tutorials of this task were unnecessary?

10. If this task did not contribute to the Wildlife Sanctuary's website would you feel as interested?

11. (R) Are you disengaged by publishing content that you have produced as teaching tools in the future?

12. With the experience in mind would you link with an out of school partner as part of your teaching approach?

13. Does this give more quality to the task because it was going to be seen by other Primary teachers in the future?

14. Would the content of sustainability have been as clear without this task?

15. Would you take note and use information such as that created today online when attending an excursion?

16. (R) Do you prefer to work on such tasks as the 2 tutorial sequence individually?

Appendix B – Raw Quantitative Analysis Data

		1. Feelings about science	2. Attitude towards science changed	3. Two tutorials advantageous	4. Tutorial adds value when published	5. Rate involvement in activity	6. Helped sustainability re AusVELS	7. Publish your developed tasks online	8. Consider students publishing	9R. Two tutorials necessary	10. Interest contribute wildlife sanctuary	11R. Engaged by publishing	12. Link with out of school partner	13. Gives more quality to task	14. Sustainability clearer with this task	15. Take note and use info when on excursion	16R. Prefer not to work on own
1. Feelings about science	Pearson Correlation	1	-.081	.185	.016	-.137	.011	-.035	.073	.274*	.470**	.020	.049	-.166	-.004	-.087	-.012
	Sig. (2-tailed)		.473	.100	.891	.225	.922	.760	.517	.015	.000	.859	.669	.142	.971	.445	.914
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
2. Attitude towards science changed	Pearson Correlation	-.081	1	.413**	.361**	.372**	.324**	.445**	.340**	.186	-.055	.250*	.148	.437**	.259*	.371**	.091
	Sig. (2-tailed)	.473		.000	.001	.001	.004	.000	.002	.100	.626	.026	.194	.000	.020	.001	.421
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
3. Two tutorials advantageous	Pearson Correlation	.185	.413**	1	.384**	.419**	.333**	.396**	.244*	.252*	.087	.335**	.135	.347**	.269*	.422**	-.003
	Sig. (2-tailed)	.100	.000		.000	.000	.003	.000	.029	.025	.442	.003	.235	.002	.016	.000	.976
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
4. Tutorial adds value when published	Pearson Correlation	.016	.361**	.384**	1	.524**	.287*	.521**	.250*	.080	-.196	.209	.196	.584**	.125	.354**	.070
	Sig. (2-tailed)	.891	.001	.000		.000	.010	.000	.025	.484	.081	.064	.084	.000	.268	.001	.535
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
5. Rate involvement in activity	Pearson Correlation	-.137	.372**	.419**	.524**	1	.360**	.597**	.445**	.195	-.122	.262*	.181	.485**	.305**	.466**	.012
	Sig. (2-tailed)	.225	.001	.000	.000		.001	.000	.000	.085	.279	.020	.110	.000	.006	.000	.913
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
6. Helped sustainability re AusVELS	Pearson Correlation	.011	.324**	.333**	.287*	.360**	1	.419**	.283*	-.092	-.052	.154	-.014	.325**	.252*	.283*	.238*
	Sig. (2-tailed)	.922	.004	.003	.010	.001		.000	.011	.424	.652	.178	.904	.003	.025	.011	.035
	N	79	79	79	79	79	79	79	79	78	79	78	78	79	79	79	79
7. Publish your developed tasks online	Pearson Correlation	-.035	.445**	.396**	.521**	.597**	.419**	1	.396**	.020	.087	.198	.181	.645**	.271*	.313**	.084
	Sig. (2-tailed)	.760	.000	.000	.000	.000	.000		.000	.863	.444	.081	.110	.000	.015	.005	.461
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
8. Consider students publishing	Pearson Correlation	.073	.340**	.244*	.250*	.445**	.283*	.396**	1	.187	.132	.103	.387**	.340**	.188	.356**	.043
	Sig. (2-tailed)	.517	.002	.029	.025	.000	.011	.000		.099	.243	.365	.000	.002	.094	.001	.706
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
9R. Two tutorials necessary	Pearson Correlation	.274*	.186	.252*	.080	.195	-.092	.020	.187	1	-.032	.363**	.243*	.052	-.082	.277*	-.192
	Sig. (2-tailed)	.015	.100	.025	.484	.085	.424	.863	.099		.782	.001	.032	.652	.474	.013	.090
	N	79	79	79	79	79	78	79	79	79	79	78	78	79	79	79	79
10. Interest contribute wildlife sanctuary	Pearson Correlation	.470**	-.055	.087	-.196	-.122	-.052	.087	.132	-.032	1	-.285*	.136	-.042	.265*	.004	.167
	Sig. (2-tailed)	.000	.626	.442	.081	.279	.652	.444	.243	.782		.011	.233	.711	.018	.975	.138
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
11R. Engaged by publishing	Pearson Correlation	.020	.250*	.335**	.209	.262*	.154	.198	.103	.363**	-.285*	1	-.028	.254*	-.060	.159	-.200
	Sig. (2-tailed)	.859	.026	.003	.064	.020	.178	.081	.365	.001	.011		.807	.024	.598	.161	.078
	N	79	79	79	79	79	78	79	79	78	79	79	79	79	79	79	79
12. Link with out of school partner	Pearson Correlation	.049	.148	.135	.196	.181	-.014	.181	.387**	.243*	.136	-.028	1	.296**	.128	.154	.073
	Sig. (2-tailed)	.669	.194	.235	.084	.110	.904	.110	.000	.032	.233	.807		.008	.260	.176	.524
	N	79	79	79	79	79	78	79	79	78	79	79	79	79	79	79	79
13. Gives more quality to task	Pearson Correlation	-.166	.437**	.347**	.584**	.485**	.325**	.645**	.340**	.052	-.042	.254*	.296**	1	.234*	.442**	.133
	Sig. (2-tailed)	.142	.000	.002	.000	.000	.003	.000	.002	.652	.711	.024	.008		.037	.000	.238
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
14. Sustainability clearer with this task	Pearson Correlation	-.004	.259*	.269*	.125	.305**	.252*	.271*	.188	-.082	.265*	-.060	.128	.234*	1	.243*	.241*
	Sig. (2-tailed)	.971	.020	.016	.268	.006	.025	.015	.094	.474	.018	.598	.260	.037		.030	.031
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
15. Take note and use info when on excursion	Pearson Correlation	-.087	.371**	.422**	.354**	.466**	.283*	.313**	.356**	.277*	.004	.159	.154	.442**	.243*	1	.097
	Sig. (2-tailed)	.445	.001	.000	.001	.000	.011	.005	.001	.013	.975	.161	.176	.000	.030		.394
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80
16R. Prefer not to work on own	Pearson Correlation	-.012	.091	-.003	.070	.012	.238*	.084	.043	-.192	.167	-.200	.073	.133	.241*	.097	1
	Sig. (2-tailed)	.914	.421	.976	.535	.913	.035	.461	.706	.090	.138	.078	.524	.238	.031	.394	
	N	80	80	80	80	80	79	80	80	79	80	79	79	80	80	80	80

Appendix C – Complete Likert PST Percentage Responses

	Not at all interested	Not very interested	Neutral	Interested	Very interested
	Row N %	Row N %	Row N %	Row N %	Row N %
1. Feelings about science	0.0%	2.5%	22.5%	50.0%	25.0%
2. Attitude towards science changed	3.8%	3.8%	10.0%	45.0%	37.5%
3. Two tutorials advantageous	1.3%	1.3%	7.5%	45.0%	45.0%
4. Tutorial adds value when published	3.8%	5.0%	16.3%	38.8%	36.3%
5. Rate involvement in activity	2.5%	2.5%	10.0%	40.0%	45.0%
6. Helped sustainability re AusVELS	1.3%	5.1%	7.6%	34.2%	51.9%
7. Publish your developed tasks online	1.3%	11.3%	15.0%	38.8%	33.8%
8. Consider students publishing	0.0%	5.0%	8.8%	30.0%	56.3%
9R. Two tutorials necessary	5.1%	6.3%	19.0%	27.8%	41.8%
10. Interest contribute wildlife sanctuary	3.8%	15.0%	37.5%	33.8%	10.0%
11R. Engaged by publishing	5.1%	5.1%	34.2%	31.6%	24.1%
12. Link with out of school partner	1.3%	6.3%	24.1%	39.2%	29.1%
13. Gives more quality to task	1.3%	10.0%	6.3%	43.8%	38.8%
14. Sustainability clearer with this task	1.3%	23.8%	22.5%	41.3%	11.3%
15. Take note and use info when on excursion	1.3%	3.8%	15.0%	38.8%	41.3%
16. Prefer to work on own	15.0%	20.0%	31.3%	22.5%	11.3%