

iResilience of science pre-service teachers through digital storytelling

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We live in a multimodal world where communication enabled by digital media supports the expression of ideas, opinions, instructions and experiences in a variety of formats that empower the individual to convey thoughts and emotions persuasively. In education, digital storytelling as a pedagogical strategy can be embedded in student-generated videos of narratives of personal learning experiences or in teacher-constructed stories that inform or instruct. The aim of this qualitative research was to investigate how a group of science pre-service teachers created digital stories to elicit resiliency (risk and protective factors) during their teaching practicum and how their peers responded to the digital stories, uploaded and shared on *VoiceThread*. The results showed that the digital stories were able to convey thinking and emotions successfully at a deeper level. A range of issues (risk factors) and strategies (protective factors) to overcome them could be identified in the digital stories. As reducing the risk of attrition in teachers' early professional careers is important for maintaining teacher numbers and quality in teaching, this research is significant in understanding how pre-service teachers view resiliency in their education. Digital stories are able to provide teacher educators and researchers with richer data for this purpose.

Introduction

In the history of mankind, storytelling has been a means of sharing knowledge and experiences. Through the process of reflection, stories have become part of our attempts to explain, understand and account for events that have happened and the experiences associated with them (Boase, 2008). Storytelling as a form of teaching is a powerful strategy to explain complex matters. When information is shared in an interesting way, people are more engaged and pay more attention to what is being told (van Gils, 2005). Storytelling is compelling, emotionally engaging and provides the opportunity for transformative reflection because when an individual expresses her/himself in narrative forms, it enables the individual to reshape, reassess and reconstruct particular events, creating the possibility for change in themselves and in others (McDrury & Alterio, 2003; Williams, Bedi, & Goldberg, 2006). In education, digital storytelling expands this communicative model of knowledge and experience sharing by integrating rich media into the story telling process.

Digital stories are multimodal expressions that convey an individual's thoughts and emotions. They are short digital narratives captured in video formats and are usually 2-6 minutes long (Kearney, 2011). The creation of digital stories makes use of multimedia technologies and typically combines narrative with digital content such as text, images, sound and video recordings in a short movie. Digital stories can be instructional, persuasive, historical, or reflective (Educause, 2007). With the increasing availability of sophisticated digital tools, the storyteller in education (student or teacher) is provided with expanded creative opportunities and scope to tell his/her story. These richer stories can be shared easily with an audience on Web 2.0's plethora of social networking, video sharing and learning management sites. The web-based social tool used in this study for sharing and collaboration was *VoiceThread*. It allowed the science pre-service teachers to place digital artefacts such as images, videos, documents or multimedia presentations at the centre of an asynchronous conversation. This online collaborative tool, which is also password protected, is safe for students to use. Class members and their teacher were invited to have conversations about the displayed artefact and to make comments that could be either written or voice recorded.

Tools for creating digital stories are audio and video recording devices and software programs, such as *MovieMaker*, *Photostory* or *iMovie*, which can be used to manipulate images and videos on a storyboard. A digital story usually starts with a script or a storyline followed by the assembly of media elements to support the communication of the content in the script. While there is no specific model for creating digital stories, Williams et al. (2006) proposed a number of principles that could be used to enhance the quality of digital stories: (i) purpose – it is necessary for the storyteller to articulate a clear purpose for the story and

to tell the story in first person, if possible, to convey personal values and ownership; (ii) visuals - use visuals with or without texts, ensuring that the quality of the images is clear, text is grammatically correct and that there is no overcrowding of images and text on the screen that could lead to information overload; (iii) sound - use appropriate music and other sounds to suit the context and if a voice over is used for the narration, ensure that it is clear, well-paced and modulated appropriately; and (iv) humour – where possible, inject humour into the narrative or harness digital resources (images, videos or other audio files) to convey a sense of humour that will help to hold the audience’s attention to enable enjoyment and better understanding of the subject matter.

In the context of this study, the purpose and benefits of digital storytelling were clearly conveyed to the science pre-service teachers. They were required to reflect on their experiences in their second teaching practicum to identify one or more difficult situation(s) encountered in their classroom teaching and use the digital story to describe the challenging situation(s) and how they resolved them. They were also required to share their digital stories on *VoiceThread* with four of their peers and the course lecturer co-ordinating the task.

The pre-service teachers were shown how to create an account on *VoiceThread*, upload a digital story, invite their peers to view and comment using either text or the voice recorder (this function also allows for textual and graphic annotations to be made at the same time). A demonstration of how *MovieMaker* works in creating a storyboard and a multimedia artefact was also provided to the students. The ethical and copyright dimensions of using images and music for multimedia product creation were discussed with the pre-service teachers. As further motivation for the students, the task was assessed (contributing 20% of their final mark). There were three main assessment criteria:

1. Ability to work as a member of a group to achieve task objectives including creating and uploading the digital story by the due date and providing constructive, thoughtful feedback to other group members (5 marks)
2. Quality of the final product:
 - a. quality of reflections (4 marks)
 - b. quality of the script including how the story ‘speaks’ to the audience (4 marks), and
 - c. the relevance of texts and images to the story being told (3 marks); and
3. Technical quality, for example clarity of voice and image recording and creativity with the tools used (4 marks)

The aim of the research was to investigate the effectiveness of digital storytelling in assisting the science pre-service teachers to elicit and communicate factors pertaining to resiliency in their teaching practicum. The broad research question was:

- How effective is digital storytelling, as a pedagogical strategy for educators, in assisting science pre-service teachers to learn about and build resiliency in their professional development as teachers?

The sub-questions were:

1. What are the risk and protective factors elicited by the pre-service teachers in their digital stories on resilience?
2. How do the pre-service teachers communicate these factors in their digital stories?
3. How do the pre-service teachers respond to their peers’ digital stories on resilience posted on *VoiceThread*?
4. What are the pre-service teachers’ perceptions of the use of digital stories for reflection of their professional teaching experiences to identify and share elements of their resiliency?

Theoretical framework underpinning research

Digital storytelling as a pedagogical strategy for instruction

Digital stories as a pedagogical tool engage students to learn either through the consumption of information from other digital stories or through creating their own digital stories. In teacher education, the process of

digital storytelling can be used as a strategy to enhance personal and professional development, for example in relation to resiliency. The pedagogy encourages pre-service teachers to reflect on their professional teaching experiences to identify moments when things did not work out as planned and how they overcame the challenges presented by those moments. Reflective actions such as these are means of engaging in productive inquiry (Dewey, Boydston, Baysinger, & Murphey, 1988), which is the deliberate seeking of what the individual needs in order to do what (s)he wants to do. Brown (2005) describes digital storytelling as a tool that can be used pedagogically for engaging in productive inquiry. For example Brown, Collins, and Duguid (1989) used *story problems* for teaching mathematics and suggested that “learning environments must allow narratives to circulate and ‘war stories’ to be added to the collective wisdom of the community” (p. 40). Inherent in productive inquiry and digital story creation are the involvement of critical thinking skills (Alterio, 2003; Boase, 2008). Boase (2008) indicated that storytelling requires numerous cognitive strategies and a degree of critical awareness. In reflecting on past experiences, the pre-service teacher is required to select information and/or experiences, evaluate, arrange and revise the information for the final product to reflect a meaningful account of the experience or event. Tendero (2006) asserted that too often pre-service teachers are provided with idealised examples in their teacher education programs, examples that often seem unattainable. Digital storytelling enables pre-service teachers to face, narrate and share less idealised situations related to their own teaching selves.

Other pedagogical benefits of digital storytelling include promoting the development of critical media skills (Ohler, 2006), motivating learning that leads to improved academic performance (Sadik, 2008; Tay, Lim, Lim, & Koh, 2012; Yang & Wu, 2012), encouraging divergent thinking (Kim, Choi, Han, & So, 2012) as well as self-review and cooperative learning that enable students to value emotional realities and encompass holistic means of constructing new knowledge (Alterio, 2003; Nicholas & Starks, 2014). In addition, storytelling requires students to make sense of experiences by acknowledging and integrating cultural, contextual and emotional realities into the storytelling processes (Bishop & Glynn, 1999). Alterio (2003; p. 4) further stated that:

Students who learn through telling and reflectively processing their stories develop skills that enable them to link subjective and objective perspectives, capture the complexity of experience and bring about thoughtful change to self and practice. When storytelling is used as a robust mode of inquiry, student learning is enhanced in multiple ways.

These pedagogical strategies and benefits are equally applicable to future students who the pre-service teachers will be teaching. In consequence, teaching pre-service teachers how to use digital stories for teaching by getting them immersed in the creation of digital stories is modelling a way of embracing digital stories as a pedagogy for their future teaching.

A secondary but important pedagogical benefit for students engaged in creating digital stories is the development of their digital literacy skills associated with the use of digital devices and software, for example *MovieMaker*, to create short multimedia artefacts to demonstrate their understanding of subject matter, an experience, a phenomenon or an event. Digital literacy is a central tenet of twenty-first century skills (Chinién & Boutin, 2011; Dede, 2010; Partnership for 21st Century Skills, 2006) that include communication, collaboration, problem-solving, critical and creative thinking skills as well as those “needed to make the best use of rapidly changing technologies” (Walser, 2008; p.1). In the context of this research, the development of these skills is fostered in the creation and sharing of digital stories related to resilience. The digital literacy skills and competencies that are enhanced encompass dimensions that are technical, cognitive and social-emotional (Ng, 2012). Technically, the pre-service teachers would develop operational skills to use the features of the movie-making software, for example, creating the storyboard, uploading images and editing the movie. Cognitively, they would need to create the content for the digital story where the use of critical, visual and audio literacies would be developed in the choice of text, images and sound to convey the meanings of the story creatively. Furthermore, the pre-service teachers would require knowledge of the ethical and copyright issues pertaining to multimedia product creation and the use of images, music and videos for their digital stories. Social-emotionally, the choice of words, images and music, the intonation of the voice and video-captured gestures would transmit moods that the pre-service teachers would wish to convey. In addition, when providing feedback on *VoiceThread* to their peers’ digital stories on resilience, the pre-service teachers would need to observe ‘netiquette’ by being respectful and using appropriate language to reduce or minimise misinterpretation and misunderstanding. These are digital

literacy skills that the pre-service teachers would develop in constructing digital stories to share with their peers.

Teacher resilience and digital storytelling

Research has shown that the teacher attrition rate in the first 5 years of their teaching could be as high as 40% (Australian House of Representatives, 2007; Ewing & Smith, 2003; Milburn, 2011; Rinke, 2007). As a first step to reducing the risk of attrition in early career teachers, it is important for teacher educators to understand the issues that pre-service teachers face during their professional experience and how they adapt to reframe things and persist in challenging times (Ng, Nicholas, & Williams, 2010). Through this understanding, teacher educators would be able to equip their students with resilience-enabling strategies to take into their first years of teaching. While most research studies on teacher resilience make use of interviews and survey instruments to capture the factors contributing to teacher resilience (Beltman, Mansfield, & Price, 2011), this study made use of digital storytelling as a pedagogy integrated into the science teachers' education program, to assist the pre-service teachers to elicit these factors. The rationale is that issues and coping strategies are manifested differently by different individuals and for different audiences and by explicitly expressing their specific issues to an audience of peers, the individual pre-service teacher could target their own personal problems and solutions, rather than having to be involved in general class discussion of issues which may not affect them at all. In digital storytelling, individuals have the freedom to choose from a much wider choice of resources (Nicholas & Starks, 2014) to express their views and emotions, hence conveying more powerful messages that are not guided or constrained by a single modality such as in written essays, statements in a questionnaire or questions and dialogue in an interview or class discussion. They express what matters to them most and in planning and constructing a digital story, they have time to plan, reflect and choose the modes of representations that best convey their views, knowledge and feelings. Hence there is rich data embedded in the individual's digital story which may not have been expressed in a written essay, an interview or a questionnaire.

The science pre-service teachers in the study created digital stories on resilience with *iMovie*, *MovieMaker* or *Photostory* programs, tools that facilitated the use of voice, images, videos, sound/music and text to convey more compellingly and persuasively their professional teaching experiences (in comparison to previous reflective essays that had been descriptive and text-based). In order to evaluate the effectiveness of digital stories in eliciting teacher resiliency issues, they need to be analysed for explicit meanings pertaining to resilience-associated factors (risk and protective factors) in the narrative (i.e., the spoken narrative and written texts) and the implicit meanings in the images, sounds, text, animations and/or videos accompanying the narrative. The risk and protective factors in the digital stories were identified in relation to Beltman et al.'s (2011) framework of resilience (see Table 1) derived from their studies on teacher resilience. These factors are elaborated in the next section.

Risk and protective factors in teacher resilience

Resilience is a construct commonly understood as bouncing back despite adversity (Price, Mansfield, & McConney, 2012). Schubert (2012) cites psychologist Michael Carr-Gregg in describing resilient people as those who have the capacity to reframe things when they go bad. The demanding nature of teaching, particularly in the initial years of a teacher's career has been emphasised by researchers (e.g., Beltman et al., 2011; Castro, Kelly, & Shih, 2009; Le Cornu, 2009). In their review of the literature, Beltman et al. (2011) identified the risk factors associated with this demand as individual risk factors and contextual risk factors. As shown in Table 1, individual risk factors include having negative self-beliefs or confidence, difficulty seeking help and a perceived conflict between personal beliefs and practices. Research (e.g., Ng et al., 2010) has shown that teachers with high personal self-efficacy are less concerned about survival and are able to bring about more effective teaching and learning with their students. The two types of contextual risk factors identified by Beltman et al. (2011), are classroom teaching and professional contextual risk factors. Managing student behaviour in the classroom and catering to the needs of disadvantaged students ranked as the most challenging classroom teaching contextual risk factors. Other classroom and school-based risk factors include the lack of support from leadership staff, inadequate resources, geographical and/or social isolation and relationships with colleagues and parents. Professional contextual risk factors related largely to difficult schools, low salary, curriculum/classroom knowledge, unsupportive/no mentor and heavy workloads and extra-curricular activities, resulting in time pressures in their teaching routines.

Table 1
 Personal and contextual risk factors and protective factors in teacher resilience identified by Beltman et al. (2011; pp.189-191)

Risk factors	Protective factors
<p>1. Individual/personal risk factors:</p> <ul style="list-style-type: none"> • Negative self-beliefs or confidence • Difficulty seeking help • Conflict between personal beliefs and practices <p>2. School/classroom and professional contextual challenges:</p> <ul style="list-style-type: none"> • Classroom management & disruptive students • Meeting needs of disadvantaged students • Unsupportive/disorganised leadership staff • Lack of resources/equipment • Relationships with students' parents • Geographical/social isolation • Relationships with colleagues • Scrutiny of peers, parents, principal • Using material prepared by others <p>3. Professional work challenges</p> <ul style="list-style-type: none"> • Heavy workload, lack of time, non-teaching activities • Difficult schools, courses or classes • Externally imposed regulations • Poor hiring practices; insecurity • Curriculum/classroom knowledge • Unsupportive/no mentor • Low salary/poor funding 	<p>1. Personal attributes</p> <ul style="list-style-type: none"> • Altruism; moral purpose; influence of faith • Strong intrinsic motivation – sense of vocation • Tenacity; perseverance; persistence • Positive attitude; enthusiasm; optimism • Not primarily motivated by extrinsic rewards • Sense of humour • Emotional intelligence; emotional stability • Gender – females use more active coping strategies • Patience • Flexibility • Willingness to take risks/accept failure <p>2. Self-efficacy</p> <ul style="list-style-type: none"> • Sense of competence, pride, confidence • Internal locus of control; belief in ability to make a difference • Self-efficacy increases with experience <p>3. Coping skills</p> <ul style="list-style-type: none"> • Proactive problem-solving skills including help-seeking • Able to let go, accept failure, learn + move on • Use of active coping skills • High levels of interpersonal skills, strong networks; socially competent <p>4. Teaching skills</p> <ul style="list-style-type: none"> • Know students; help them succeed; high expectations • Skilled in range of instructional practices • Confidence in teaching abilities • Creative + explore new ideas <p>5. Professional reflection and growth</p> <ul style="list-style-type: none"> • Self-insight, self-evaluation, reflection • Professional aspirations • Professionally proactive - act as mentors, role models, leaders • Committed to ongoing professional learning <p>6. Self-care</p> <ul style="list-style-type: none"> • Take active responsibility for own wellbeing • Significant supportive relationships • Type of qualification

Protective factors are the things that sustain individuals when difficulties arise, enabling them to reframe the challenges to create more favourable situations (Schubert, 2012). The protective factors, as shown in Table 1, that are identified by Beltman et al. (2011) in teacher resilience studies are categorised as (i) *personal attributes*, for example positive attitudes, enthusiasm, optimism, patience, flexibility, altruism and

influence of faith, intrinsic motivation, tenacity, perseverance and willingness to accept risks and failures, (ii) *self-efficacy*, for example confidence, sense of competence and belief in one's own ability to make a difference (iii) *general coping*, for example use of coping skills such as seeking help from colleagues or networks, possessing good social and interpersonal skills and the ability to accept failure, let go, learn and move on (iv) *teaching skills*, for example having good knowledge of students and a range of instructional strategies, being innovative and confident in teaching and the ability to help students achieve (v) *professional reflection and growth*, for example being able to reflect and self-evaluate, possessing professional aspirations and commitment to ongoing professional learning and (vi) *self-care* – taking care of one's wellbeing and having a significant supportive network of people.

The personal and contextual challenges that are risk factors and the protective factors that enhance the capacity to reframe things under adverse conditions provide a framework for analysing the pre-service teachers' digital stories on resiliency. The study fills a gap in the literature with respect to researching the use of digital stories to capture the psychological (cognitive and emotional) accounts of pre-service teachers' experiences and practice during their professional teaching placements.

Learning theories underpinning learning through digital storytelling

Theories underpinning the learning associated with digital storytelling that incorporates reflection and the production of a digital artefact are constructivism (Piaget, 1955; Bruner, 1966) and constructionism (Papert, 1991). Constructivist learning theory posits that people learn by actively interacting with the learning materials where their prior knowledge and past experiences will influence that learning. By getting the science pre-service teachers to reflect on their teaching and tell a story about how they overcame an adverse situation, they engage in actively reviewing their practice and thinking through the classroom events thoroughly in order to put together a coherent story. Improvements are only possible when individuals are able to identify their weaknesses. The construction of a digital story to share with their peers is underpinned by Papert's (1991) constructionism learning theory that focuses not only on the mental construction of knowledge but also on a physical construction of a tangible product or artefact. Students are more motivated and become more engaged with the learning if they are constructing an artefact that others will see, critique and/or use (Papert, 1991). The social aspect of constructing knowledge is advocated in Vygotsky's (1962) social-constructivist learning theory where the role of others (e.g., peers and parents) is important in mediating the learner's access to new experiences and scaffolding the acquisition of new knowledge. Asynchronous collaborative learning environments such as *VoiceThread* are more conducive to deep learning as students have the time to self-reflect and think critically about the different perspectives offered by their peers to make judgements that value, support or oppose the different views (Ng & Nicholas, 2010; Fung 2004). When a group of people share a concern or a passion for something and have the desire to learn how to do it better, regular interaction leads them to form a community of practice (Lave & Wenger, 1991). In sharing their digital stories about their professional teaching experiences with their peers on *VoiceThread*, the pre-service teachers in this study created their own communities of practice. Within their communities of practice, they shared similar or different experiences with the storyteller, and offered encouragement and ideas to enhance the cognitive and emotional experiences of the storyteller. Communities of practice are able to grow over time and have the capacity to promote lifelong learning if the pre-service teachers maintain regular interaction with members of their community as they enter teaching and develop their professionalism as teachers. The opportunity to relate an experience in a digital story format caters to students who may not be linguistically sophisticated in expressing opinions and emotions in a written form (as in traditional reflective essay writing) but who may be able to use a combination of modes of representations afforded by digital technology to convey and share their stories.

Method of study

Participants

The participants in this study were 21 secondary science pre-service teachers enrolled in the 1 year Graduate Diploma in Education course at a university in Australia. There were 7 males and 14 females, among whom 3 of the females were international students from Asia. Five of the pre-service teachers were over the age of 35 while the others were under 30 years of age. The pre-service teachers were studying to be generalist science teachers and/or specialist teachers in biology, chemistry and/or physics. They were taught by three methods lecturers, each specialising in one of biology, chemistry or physics as a teaching method. One of

the lecturers, the coordinator of the digital storytelling task, was also a researcher in the study. Ethics approval and consent were obtained prior to the commencement of the study. Only data from students who volunteered were used in this study. The 21 pre-service teachers in the study represented 60% of the total cohort studying in the program. The participants are provided with pseudonyms in this paper with the female students named F1 to F14 and the male students M1 to M7.

Data collection and analysis

The digital stories generated by the science pre-service teachers were analysed for risk and protective factors according to the themes identified in Beltman et al.'s (2011) framework (see Table 1). The pre-service teachers' responses (either written or voice recorded) to their peers' digital stories on *VoiceThread* were analysed for themes that emerged. To evaluate the usefulness of the digital storytelling task in helping the pre-service teachers understand issues associated with resilience, post-project semi-structured interviews were conducted with the pre-service teachers in five small focus groups of 3-4 students. The interviews sought to reaffirm the risk and protective factors identified in the digital stories and elicit the pre-service teachers' perceptions of the usefulness of digital storytelling as a pedagogical strategy in assisting them to become more resilient as a teacher. Sixteen of the pre-service teachers participated in the interviews.

A research assistant and one of the other method lecturers also participated in the data collection and analysis phase of the research. The research assistant conducted the interviews and transcribed them. The analysis of three of the digital stories was benchmarked with the method lecturer and co-researcher to ascertain that the interpretation of the messages conveyed and identification of risk and protective factors were categorised according to Beltman et al.'s (2011) framework. Each digital story was watched at least twice, pausing and rewinding where necessary to identify the messages conveyed. The first time focused on the identification of the format of the story presentation (e.g., multimedia, audio and/or visual) and to document in a table next to each participant's name the types of visuals (e.g., picture of school or frustrated students) in the digital story. The second and third time focused on the identification of risk and protective factors. A table as shown in Table 2 was created and perceived meanings in the digital stories were ticked against the themes representing risk and protective factors. These meanings were either explicitly displayed through audio or text (e.g., "I had trouble engaging the students") or implicitly displayed through visuals (e.g., picture of a rowdy classroom depicting a classroom management issue).

Table 2
Partial example of risk factor analysis in relation to Beltman et al.'s (2011) framework

St.	Individual/personal risk factors			School/classroom and professional contextual challenges			
	Neg. beliefs	Diff. seeking help	Conflict between beliefs and practices	Classroom management	Catering to disadvantaged students	Unsupportive leadership	Etc
M1	✓			✓			
M2				✓	✓		
F1	✓			✓			
etc							

Results and Discussion

How the science pre-service teachers chose to display their digital stories

One of the male students (M1) chose to speak to the camera and video recorded himself telling his story, which was edited to include the minimum number of images permitted. Unlike the other digital stories that had more visual and audio features to convey the moods of their thinking, M1 spoke directly about some of the things that went wrong and how he had dealt with them. Another digital story by student F11 was largely an interview with the principal of the school – this pre-service teacher had identified her inability

to cater for an autistic student with behaviour problems in her class and sought to find expert advice in her attempt to overcome the problem. She was a confident and knowledgeable teacher but special needs students posed a risk to her teaching.


The other 19 digital stories incorporated various combinations of images, texts, music, videos and PowerPoints. Half the stories had images of their schools as introductory and context-setting components for their stories. The pre-service teachers were careful not to use real students' images, showing only the backs of students or representing them by cartoon/drawn pictures. The images depicted in the digital stories conveyed the sense of frustrations (e.g., an image of person tearing her hair out) when faced with a classroom management problem, the sense of joy (e.g., smiley faces) when the pre-service teachers felt that they had engaged the students and the sense of uncertainty (e.g., image of person with lots of question marks around him). Seventeen of the digital stories had voice-over narration, synchronised with images or videos. The voice-overs in the digital stories sounded mostly controlled, indicating that they were read from scripted texts, often masking the emotional aspects of the story. Other digital stories (by students M6 and M7) had no voice-overs but texts written next to or over the images in each frame of their digital stories to convey the messages. While M7's series of images and text was self-explanatory, M6 made additional written comments on *VoiceThread* to expand on the issue of classroom management in dealing with an autistic student with major behavioural problems (e.g., banging fists on the table and lying on the floor of the classroom) and how he coped with them. The different communicative formats used in telling their digital stories reflected on the one hand, the students' frame of mind when creating the story and on the other, their technical skills in using multimedia materials to convey the meanings.

Risk factors elicited from the science pre-service teachers' digital stories

Table 3 shows the categories of risk factors identified from the pre-service teachers' digital stories. The specific categories are ordered from top to bottom according to the frequency with which they occurred. All three major categories of Beltman et al.'s (2011) risk factors were identified. However, not all sub-categories were identified as they were not explicitly demonstrated by the digital stories. For example sub-categories such as *difficulty seeking help* or *relationships with students' parents* were not explicitly mentioned by the students in their digital stories. As Beltman et al.'s (2011) framework for risk and protective factors was identified from research with in-service teachers, it is not expected that the pre-service teachers would experience all the sub-categories identified in that framework.

In all the digital stories, student management and engagement, that is managing behaviour, the diversity of learning needs and being able to engage them in learning were conveyed by the pre-service teachers as challenges they had encountered. The lack of confidence in teaching, lack of content knowledge and pedagogy and being unprepared for unforeseen situations were challenges, each of which was identified in about a third of the digital stories. The category *class teaching management* is an additional category to Beltman et al.'s (2011) framework. This category related to unforeseen or unplanned events that threw the planned teaching out of sequence. For example student M5 was flustered because a chemical for the practical that he had planned for his class was wrongly prepared and the practical lesson was a failure. He became more positive later as he checked through everything before the next practical lesson. This sub-category of class teaching management where unforeseen circumstances arise is particularly significant for pre-service teachers due to a lack of teaching experience.

Table 3
Risk factors identified from the science pre-service teachers' digital stories. (N=21)

Beltman et al.'s (2011) risk factors: Category and subcategory	Examples elicited from the digital stories	No. of students	% students
Category 2: School/classroom and professional contextual challenges Sub-categories: Management of disruptive students Meeting needs of disadvantaged students	F4: It's been a relatively a long time since I have thought about science in simplistic terms for the year 7s. M6: The student began to get distressed and disrupt other students, bang his fists on the table, throw his books on the ground and lay down on the floor in the middle of the room. F1: Challenges of weak students and lack of attendance	21	100%
Category 1: Individual/personal risk factors Sub-category: Negative self-beliefs or confidence	F5: I felt lost and I was praying for the class to finish F6: Being a new starter as a part of Australian education system and the culture, I was scared of my placement. F13: Sometimes during teaching rounds I felt like  this ...ill equipped and out of my depth.	7	33%
New category identified by this study: Class teaching management Sub-categories: Time management Unplanned and unforeseen circumstances	M5: The prac went so badly my level of enthusiasm has gone right down. As a result I have lost my trend of thought...and because i was disengaged, the kids were disengaged....I lost them. F2: A problem I encountered was that time disappeared during my lesson like a distortion in the flow of time, like a time warp.	7	33%
Category 3: Professional work challenges Sub-category: Curriculum knowledge and pedagogy	M3: As someone veering into a new career in teaching I did my undergrad. studies over 12 years ago so I'm rusty on some science and biology material. I'm studying hard to come up to scratch. F14: They were asking questions that told me that they didn't know what I was talking about. F9: Need to talk less, show more and use ICT where possible.	6	29%
Category 3: Professional work challenges. Sub-category: Unsupportive/no mentor	M6: One of my biggest challenge was related to my mentor or lack of.	3	14%
Category 3: Professional work challenges Sub-category: Heavy workload, lack of time, non-teaching activities	F13: There was so much work to do so the students both learn and enjoy during lessons.	1	5%

Protective factors elicited from the science pre-service teachers' digital stories

Beltman et al. (2011) listed six major categories of protective factors. These are: (1) personal attributes; (2) self-efficacy; (3) coping skills; (4) teaching skills; (5) professional reflection and growth and (6) self-care. For the same reason as in the preceding section, not all sub-categories were identifiable in the digital stories.

Within the major categories, sub-categories of persistence/perseverance, positive attitude, willingness to take risks, sense of competence and confidence, self-efficacy increasing with experience, use of active coping skills, know the students, self-evaluation and reflection, and significant supportive relationships were identified in the digital stories.

Table 4

Protective factors identified from the science pre-service teachers' digital stories (N=21)

Beltman et al.'s (2011) protective factors: Category and subcategory	Examples elicited from the digital stories	No. of students	% students
Category 4: Teaching skills Sub-category: Know students; help them succeed; high expectations	F6: I tried to learn about what the children liked and disliked. F7: I noticed most students like the one on one teaching better. F1: I came up with a list of activities for the students to do. I searched the Net and found an awesome interactive program about how the nephrons work within the urinary system. F2: When I used ICT during lessons, it added an extra dimension which students really enjoyed especially when it was in context of their world.	21	100%
Category 1: Personal attributes Sub-category: Positive attitude enthusiasm; optimism	M6: It also encouraged me to put more work into preparation, so that I would have a few alternative activities up my sleeve, for if/when things went awry. F14: Teaching is a mixture of frustrations, disappointment and enjoyment. F13: Having a bad lesson is not a bad thing, you learn from it ... take the criticism, pick yourself up and have another go. M3: Not to take things personally.	9	43%
Category 3: Self-efficacy Sub-category: Sense of competence, pride and confidence	M6: ... forced me to work independently and deal with problems myself, as they arose. F14: By the end of the class, the students were totally engaged in the activity and were asking questions about the activity. Because my class was fully involved, I felt better about myself and my ability to fulfil my role as a teacher.	8	38%
Category 5: Professional reflection and growth Sub-category: Self-insight, self-evaluation and reflection	M5: In the future if something goes wrong, I should not have lost my attitude. F7: I wanted to find out what the students thought of my teaching.	8	38%
Category 6: Self-care Sub-category: Significant supportive relationships	M2: My mentor was excellent in providing positive and constructive feedback. F13: But being with other student teachers at rounds was a way to share experiences, to cope as well as to offer tips and share resources.	8	38%
Category 1: Personal attributes Sub-category: Tenacity, perseverance, persistence	F5: If you are in rut explaining something and you are confusing yourself. Get them to write something for the board while you give yourself time to compose and salvage the situation!! F1: ... so the next lesson, I rectified it.	5	24%

Category 1: Personal attributes Sub-category: Willingness to take risks/accept failure	e.g., acting – F8: The Jester represents acting to engage students by capturing their attention with interesting educational material. M6: I began the next lesson by talking to the class about I wasn't really happy with how the previous class had gone ... We came up with an agreement of class expectations, and of the consequences of breaking that agreement.	4	19%
Category 2: Self-efficacy Self-efficacy will increase with experience	M1: Teaching is difficult but I will get there. F10: ... have another go because you are not an expert yet.	3	14%
Category 3: Coping skills Sub-category: Use of active coping skills	M2: The end of the prac was in sight	2	10%

As shown in Table 4 above, the focus on the students that the pre-service teachers were teaching was evident as 100% of the pre-service teachers acknowledged in their stories one or more of the following: the need to get to know their students, the need to tailor the lessons according to their students' learning needs, the need to ensure that their students were engaged, that lessons are fun and the need to use a variety of strategies in their teaching. The most commonly mentioned strategy to engage the school students was the use of technology in the lessons. In terms of getting to know their students, a resilience strategy adopted by pre-service teacher F7 was to get regular written feedback from her students on how her teaching went, so that she could improve on it. Hence F7 was both persistent and had positive attitudes. Pre-service teacher F9 (an international student) was comfortable using her ethnicity to build rapport with the students, instructing them to let her know if she had mispronounced any words so that she could improve on her communication with them. This was a protective factor even though it was a risk-taking action of humility that helped her to get through her teaching round. Being humble was also a strategy that pre-service teacher M1 used as identified in his digital story:

I don't think I am ready to become a professional teacher. I think it will come once I start becoming a teacher, the professionalism will come because it is different running your own classes.

Other protective factors that were reflected in the science pre-service teachers' digital stories included being positive (43% of the students indicated this), possessing a sense of competency and believing in oneself (38%), being able to self-evaluate and reflect (38%) and seeking support from their mentors and/or peers (38%).

The interview data demonstrated further how the science pre-service teachers reframed their thinking to demonstrate resilience. From a cultural perspective, two of the international students adopted a philosophical view of teaching and living, akin to Beltman et al.'s (2011) *influence of faith*, that the harder life is, the more you learn, as shown below:

I tried but it was really stressful. It was really hard, I couldn't sleep for the first two weeks. It was a nightmare ... the culture was different, I never saw this type of kids before. Like in my country kids are so different. Like here they used to call me names as well ... I have to finish this course, I have to get the qualifications ... yes, I told myself that, you know, I go through a lot of hardship in life and the more hard life is, the more you learn. (F6, interview data)

I have to keep thinking positively, at the end of the day, the good things come along out of the hardships. (F14, interview data)

The need to look after oneself was elicited from the interviews as being a resilience strategy that was not conveyed in the digital stories:

... getting enough sleep, eating properly and not being too run down. Be able to switch off. (F4, interview data)

These more personal beliefs were not displayed in the digital stories as the stories appeared to focus on the students and the mentors rather than on self. Better guidelines for digital story creation could encourage the pre-service teachers to focus explicitly on self, their students and other environmental factors, but this would also require careful group work to build trust between the pre-service teachers.

Communities of practice: Pre-service teachers' responses to their peers' digital stories on resilience posted on *VoiceThread*

Each digital story was randomly assigned to four pre-service teachers to view and provide feedback. The pre-service teachers could also invite other peers (e.g., in their friendship group) to view their digital stories if they wished. Thematic features identified from the responses of peers to the digital stories on *VoiceThread* were:

1. All the responses were polite and respectful
2. They were always encouraging, often relating their own, similar experiences but sometimes other ones. Examples of comments by F4 and F7 are:

Hey M5, what a great learning experience! Although chem is not my specialty, I could relate with you on a lot of levels in this situation. I too found out the hard way that it is best to go through the prac in detail with the students before setting them off on their own. And I hate the feeling of losing momentum with the students. On a brighter note, I caught myself smiling while listening to your reflection. Obviously you have learned how to handle things better next time, but hopefully you are able to look back and smile at your mistakes too. After all, we all make them, and it usually isn't anything too major. It seems like you have a good sense of humour about it all though, and, as (instructor) said, that helps with your resilience. So, with practice, you'll be able to bounce back quicker and maybe get/maintain the students' interests better next time. Best of luck! (F4)

Yes F5 I agree with you about trying to implement new ways of teaching is not easy, but in time once we get the hang of it we will have an increase in confidence to experiment new ways. It was a little difficult trying to change but the students noticed me trying and taking their feedback into consideration this led to a better relationship with students. (F7)

3. Noticing the technique in constructing the digital stories, for example:

Your storyboard looks fantastic and I could still get the idea even without narration!!! (F5)

Wow F6! A really tranquil account of your first placement. It was really relaxing listening to the background music. (F10)

Quite frankly I'm in awe! Another creative Digital Story. I'm going to have to get some tips as to how to access/modify images etc. (M2)

4. Obtaining new ideas on teaching and resources. Examples of comments are:

I love your resources, F1. Will have to write them down (F12).

F5. I thought it was great! It has given me some ideas for mine because I don't have any pictures from where I taught. (M4)

That is a new idea (to do a digital story) in making the students interested towards science. Thanks for sharing. I think it was a good use of ICT. (F13)

Pedagogically, the sharing of the digital stories eased the feeling of isolation for the science pre-service teachers, knowing that their peers shared similar challenges and gaining ideas for teaching strategies in both classroom and content management. Their ability to use technology in creating digital stories was enhanced as they viewed how different modes of representations were used to communicate messages by

their peers. By telling their stories on *VoiceThread*, the community of practice that emerged offered a useful model for adoption in their future professional careers.

The themes elicited from the sharing of digital stories on resilience were reaffirmed in the interviews with the pre-service teachers. The interviews enabled the pre-service teachers to reflect on the digital storytelling experience and about teacher resilience at this stage of their career. The majority (75%) of the students interviewed agreed that the digital storytelling task was useful in (i) helping them reflect on individual challenges, (ii) obtaining feedback that affirmed that they were not alone in experiencing the challenge narrated, (iii) getting to know about a range of challenges their peers faced as well as coping strategies that had been tried, and (iv) enhancing their digital literacy in having to create a digital artefact that was new to all of them. The comments below summarise what most of the pre-service teachers thought:

The issue of resilience interest me. I need constant self-review particularly in the formative years of a teaching career, constantly refining your approach with the wisdom from others helps build a resilient teacher. (M3)

Talking to other students definitely helped and was comforting. (F8)

The main concern raised by the four students who disagreed with digital storytelling as a practice was the time-consuming nature of creating the digital stories where planning the story and learning to use the software took a considerable amount of time. However, they all agreed that the sharing of their stories and getting feedback from their peers were beneficial for their professional growth and development.

Implications of digital storytelling for teacher education

The task of creating the digital stories reported in this study was situated in authentic learning that was relevant and motivating to the pre-service teachers. The results indicated that the digital stories were able to convey deeper levels of thinking using multimodal means of representations. Most of the science pre-service teachers were positive about the learning experience. The results of the study are, however, not generalisable due to the small sample size of the investigation. Nevertheless, the study showed that digital storytelling is a useful pedagogical strategy to engage students in demonstrating their own ability to identify adverse situations in their own teaching and means to overcome them. It was beneficial in engaging pre-service teachers in deeper critical reflections to raise self-awareness of the challenges that confront them in teaching and to assess their ability to handle them. The promotion of deep learning in teacher education and other courses through the use of digital storytelling has also been reported by other researchers (e.g., Barrett, 2005; Jenkins & Lonsdale, 2007; Kearney, 2009). As resilience is a multi-dimensional construct (Oswald, Johnson, & Howard, 2003), the multimodal affordances of technology foster the conveyance of the cognitive and emotional dimensions of resilience more effectively. Hence digital stories provide a way for educators and researchers to better understand individual challenges and to design programs that target these challenges to assist with resilience-building of the pre-service teachers. For the pre-service teachers, the sharing of their individual stories with a group of peers is beneficial through meaningful, assistive and therapeutic discussions.

An implication of using digital storytelling as a reflective tool is that both educators and the pre-service teachers need to have adequate levels of multiliteracies (New London Group, 1996), for example visual and audio literacies for interpretation and the technical skills to create the multimedia artefacts to communicate the reflections. These are digital competencies that educators should introduce to pre-service teachers in their programs and digital storytelling offers a means to develop them.

Gu and Day (2007) stated that teacher resilience is a necessary condition for teaching effectiveness and that its manifestation varies from person to person and could fluctuate over time depending on the situations they are in and their capacities to manage them successfully. Hence resilience and resilience-building are very individualistic constructs and require the individual to be able to identify the challenges within the environment that they are experiencing and reframe the unfavourable situations to something more favourable. Resilience is not a quality that is innate (Gu & Day, 2007) and resilience-building can be developed if the right opportunities in teacher education are provided (Le Cornu, 2009). Hence the cultivation of resilience in teachers should begin at the pre-service level. Through digital storytelling that involves sharing with peers, pre-service teachers will be able to do this.

Further research with larger numbers of pre-service teachers in both science and other disciplines creating digital stories to help them reflect on their teaching practices would provide a more nuanced picture of the role of storytelling in building resiliency, including how issues of personal style, culture, gender or teaching discipline contribute to its manifestation and negotiations. Using the same framework for analysis, comparisons between the use of text-based descriptions (i.e., essay writing) about resilience and digital storytelling could be investigated to determine the richness and depth in thinking of each form of reflection, as well as how peer viewing and feedback can be made most constructive and productive. Longitudinal studies could investigate how (specific) pre-service teachers are able to make use of the feedback of peers and the strategies they have employed in adverse times to develop into better teachers. More studies would potentially lead to a reframing of the theory of teachers' resilience to one that is more appropriate for understanding pre-service teachers' resilience.

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