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Where Western Australian Graduate Diploma of Education Primary Students Source their Information on Sustainability

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Abstract: Sustainability has recently been made a cross-curriculum priority in Australia, through the development and implementation of the Australian Curriculum. Subsequently, primary and secondary teachers across all subject areas are required to integrate Education for Sustainability (EfS) into formal education. A recent research case study was undertaken to determine Western Australian (WA) Graduate Diploma of Education (Primary) students' perceptions of sustainability on entering their teacher education course. This paper reports on part of the findings from this study, specifically the sources of information these pre-service teachers used to inform their perceptions of sustainability. The case study emphasised the need for reliable scientific information in mass media and pre-service teachers' mistrust of commercial media. It also underscored the need to provide specific sustainability content in pre-service primary teacher education courses.

Introduction

The researchers maintain that if WA Graduate Diploma of Education pre-service primary teachers are not critically supported by appropriate sustainability pedagogical content knowledge at the pre-service level, or as part of an ongoing professional development program, sustainability as a cross curriculum priority in the Australian Curriculum (ACARA, 2011) could become marginalised (Birdsall, 2014). In addition, it is suggested that the personal perceptions of sustainability that pre-service primary teachers hold will shape the way they interpret sustainability as a cross-curriculum priority.

Education for Sustainability (EfS) is a relatively new initiative, and many pre-service primary teacher education institutions are yet to engage integrated sustainability themes in both courses and units (Stevenson, Davis, Ferreira & Evans 2014). Therefore, without formal EfS at the researchers' university it was decided to investigate where pre-service primary teachers access information about sustainability, given that information sources will influence sustainability literacy (Nisbet, Cooper & Garrett, 2015), or in respect to some information sources, have the potential to create alternative conceptions that can misinform their teaching (Boon, 2010, 2011). The data from this WA case study of 18 participants suggests that pre-service teachers' perceptions of sustainability are informed by: family and friends, mass media, online information, and importantly the subject content presented to them in through their education journey such as university teacher education courses (Dyment & Hill, 2015; Martin & Carter, 2015; Mills & Tomas, 2013). Therefore, pre-service primary teachers must be sustainability-literate so they can integrate its themes across all learning areas (Mills & Tomas, 2013; Nolet, 2009).

Sustainability has also received considerable investment from international bodies through research and education initiatives: for example, through the United Nations Education, Scientific and Cultural Organisation's (UNESCO, 2005) development of the three pillars of sustainability for education; economic, environmental, and socio-cultural sustainability. The Intergovernmental Panel for Climate Change (IPCC) supports these pillars through publishing climate change science, such as their 2014 summary report that warns policy makers about the danger of greenhouse emissions that are causing planetary stresses, and damaging human and natural environments (IPCC, 2014). If teachers are to genuinely integrate sustainability themes in their classrooms, they need to be able to source and critique information on sustainability. This paper provides insight into a WA case study of how a group of 18 pre-service primary teachers' source information relating to sustainability. It emphasises the need for teacher educators to develop sustainability literacies with their pre-service primary teachers, so they can take an educated stance in the ongoing public debate of sustainability, especially with respect to climate change (Boon, 2011) and renewable energy (Australian Academy of Science, 2015; Lewandowsky Ecker, Seifert, Schwarz, & Cook, 2012).

Primary school teachers are particularly important in developing sustainability awareness in students, as they have an opportunity to apply sustainability themes across several learning and teaching contexts (e.g., Science, Humanities and Social Sciences, and Health Education) through their role as generalist teachers. However, research conducted by Angus, Olney and Ainley (2007) suggests that most primary teacher have a nature study-centred view of primary science, which restricts the development of other conceptual understandings that links science to other human contexts. The Angus et al. (2007) finding is similar to the narrow biophysical view of sustainability that is shared by many pre-service teachers (Birdsall, 2014; Dymont & Hill, 2015; Nolet, 2009).

UNESCO's definition of sustainability through the three interconnected pillars demonstrates how sustainability is not only linked to the environment, but a part of economic and socio-cultural discourse (UNESCO, 2005) and this broad definition frames sustainability as a cross-curriculum priority (ACARA, 2011). These human interactions construct sustainability themes as broader than the conservationist component of nature study (biophysical), traditionally taught in primary science (Angus et al, (2007); Australian Academy of Science, 2005; Dymont & Hill, 2015; Lummis, 2001, 2009; Skamp, 2012). If teachers do not understand this complexity they may limit their students' understandings of sustainability to a preferred pillar, thus neglecting the deeper interconnectedness of human economic and socio-cultural settings in this cross-curriculum priority (Dymont & Hill, 2015; Lummis, 2001).

Pre-service Teachers' Sustainability Literacy

Recent national and international debates have underscored sustainability as an important global issue: for example, the planetary stresses created by expanding human populations as they consume, pollute and compete for resources (A. D. Brown, 2003; L. R. Brown, 2006, 2011; Garnaut, 2008, 2011; Gore, 1993; IPCC, 2014; Stern, 2006). However, the evidence of unsustainable practices and ecological devastation is often complex and overwhelming for pre-service teachers (Dymont & Hill, 2015).

The literature suggests that often teachers and students develop their understandings about sustainability through their lived experiences (e.g., family, friends and mass media), including through pre-service teacher education courses (Odgaard, 2014). Evans, Whitehouse, and Hickey (2012) found that pre-service teachers often have a one-dimensional

view of sustainability that is grounded in ecology and environmental awareness, with limited awareness about social, economic, and political issues linked to sustainability. The perception of sustainability as only linked to the environmental pillar is common among pre-service teachers, both in Australia and internationally (Birdsall, 2014; Dymont & Hill, 2015; Nolet, 2009). Birdsall's (2014) research provides an example of pre-service teachers' limited understanding of sustainability. Not only does Birdsall argue that pre-service teachers have an environmentally-centred definition of sustainability, but also that less than 50% have an accurate self-awareness regarding the depth and breadth of their knowledge related to sustainability themes. Dymont and Hill (2015) found similar results, where pre-service teachers had only 'limited-moderate' knowledge of sustainability when tested through an instrument that considered all interrelated pillars of sustainability.

In addition to content knowledge acquisition for developing sustainability-literate teachers, there is also an issue with the translation of teachers' knowledge into their practice. Kagawa's (2007) research determined that many pre-service teachers are pro-sustainability in terms of support for the general concept of sustainability, but lack support for action to combat global sustainability issues (i.e., inclusive of the three pillars). This was supported in recent Australian research, where systemic factors acted as a barrier for teachers who wanted to integrate sustainability (Mills & Tomas, 2013; Steele, 2010). As expected, engaging in specific education related to sustainability and EfS improved teachers' self-efficacy to embed this learning in their practice. Kennelly, Taylor, and Serow (2011) commented on the success of EfS in teacher education, as explicit EfS at university supported teachers' ability to integrate sustainability in primary learning despite other challenges arising within some primary schools. Effenev and Davis (2013) found that pre-service teachers who engaged in a specific Education for Sustainability (EfS) unit at university had more general knowledge across the interrelated pillars of sustainability, and higher self-efficacy to teach sustainability. Mills and Tomas (2013) reported that the majority of pre-service teacher education courses that include EfS do so as a stand-alone unit of study. Yet, Nolet (2009) suggested that creating new courses or units around EfS does not model an integrated approach to teachers, which is necessary for transformative education. Mills and Tomas (2013) assert that enabling integration of sustainability at a wider university level could also have a positive impact on pre-service teachers, which is consistent with comments made by Ferreira, Ryan and Tilbury (2006) and Nolet (2009).

The Role of Mass Media in Forming Perceptions of Sustainability

Experiences in compulsory and tertiary education, as well as information in the media are two common sources that develop pre-service teachers' understandings of sustainability (Effenev & Davis, 2013; Evans et al., 2012; Martin & Carter, 2015). As an alternative source of information, in addition to education, it is important to investigate teachers' exposure to public information (e.g., commercial and government media) sources on sustainability, as well as their credibility. The Nielsen (2011) Global Online Environment and Sustainability Survey determined the general decline of public support for climate change issues could be a reflection on the media's coverage of increasing financial and economic concerns during the Global Financial Crisis, as opposed to ongoing reporting about climate change issues. The 2011 Nielsen's findings contrast similar research from the beginning of the 2000s. Fien (2001) noted a high level of public awareness around environmental issues reported in the media: for example, "the greenhouse effect, ozone layer, renewable resources and ecology" (p. 11). While public support for sustainability issues has decreased between these two studies, both limited the definition of sustainability to the largely ecological/environmental

definition reported by Evans, Whitehouse and Hickey (2012). This public presentation of sustainability could limit the complexity of individuals' perceptions of EfS, such as the competing narrative of "sustainable development discourse promoting both social and economic benefits, as well as environmental protection" (Kopnina, 2013, p. 59). Kortenkamp and Basten (2015) stated that a lack of scientific literacy by journalists is problematic where:

Media reports of environmental science often give equal weight to opposing viewpoints, which can make the science seem more controversial than it actually is ... how journalists portray environmental science can have a large impact on public understanding of environmental risks and responses to these risks. (pp. 1-2)

The reliance on public information could be changed through active participation in sustainability education: for example, Wall (2007) found that undertaking environmental journalism projects influenced individuals' sense of environmental citizenship. Appropriate education in EfS could influence pre-service primary teachers' capacity to critically analyse public information on sustainability, and benefit their integration of EfS in primary classrooms (i.e., sustainability as a cross-curriculum priority). One step towards this aim could be exposing primary teachers to broader groups of stakeholders in sustainability and EfS: for example, "invite guest lecturers (such as classroom teachers, principals and scientists) in ... to speak to preservice teachers about EfS initiatives ... to provide applied examples of sustainability principles" (Mills & Tomas, 2013, p. 158).

The Research Context

The research project occurred during a period where sustainability and environmental issues were at the forefront of the Australian media and education. The media was reporting many issues around climate change and natural disasters, including the Queensland floods of 2010-2011 and the Fukushima nuclear disaster in 2011.

The Queensland floods occurred in Australia due to the strongest La Nina effect on record, exaggerated by an above average sea surface temperature (Phillips, 2012). Three-quarters of Queensland (1.3 million square kilometres) was flooded with some areas receiving 400 millimetres in one day, 100 millimetres above the average (Phillips, 2012). The Queensland floods saw 35 deaths and billions of dollars of damage all covered by the Australia and international media on a daily basis (Phillips, 2012). The Fukushima disaster occurred after a 15 metre high tsunami hit the north east coast of Japan on the 11th March 2011 (World Nuclear Association, 2015). The international media provided live television and online coverage of the event (Imtihani & Mariko, 2013). The Fukushima nuclear reactors were disabled by the impact of the tsunami, which resulted in a meltdown in the radioactive core (World Nuclear Association, 2015) with over 100,000 people being evacuated (World Nuclear Association, 2015). The international media reported a sequence of explosions in real time, showing the serious radioactive contamination to the surrounding land and ocean (Imtihani & Mariko, 2013).

Leading up to the tsunami there had been reports to suggest that Australia should invest in nuclear energy (O'Keefe, 2011). The media coverage of the incident at Fukushima created a great deal of discussion covering the safety of the nuclear industry, as well as the potential for weapons proliferation (O'Keefe, 2011). In addition, in May 2011 the media was reporting that the Gillard Labor Government was to phase out its successful solar panel

rebate (i.e., an earlier initiative to help restrain carbon emissions) (Arup & Coorey, 2011). The media emphasised that the government was under increasing political pressure from powerful corporations with interests in gas, coal and petroleum (Arup & Coorey, 2011). The media also reported that the Australian taxpayer was subsidising coal and other non-renewable energy at a cost of circa four billion dollars per year (Lannin, 2011). In 2011, Australia and the United States were identified as the two highest G20 countries subsidising fossil fuel exploration (Lannin, 2011).

Sustainability issues were also prominent in education, due to the development of the cross-curriculum priorities in the Australian Curriculum (ACARA, 2011). A cross-curriculum priority is a required focus area that is integrated across all compulsory education from Kindergarten to Year 12, and all subject areas (ACARA, 2011). As a priority, sustainability "... will allow all young Australians to develop an appreciation of the need for more sustainable patterns of living, and to build the capacities for thinking and acting that are necessary to create a more sustainable future" (ACARA, 2011, para. 5). Therefore, students were (and are) required to learn about the environment, economic and socio-political aspects of sustainability through the Australian Curriculum (ACARA, 2011).

The integration of sustainability within the Australian Curriculum occurred during the Decade of Education for Sustainable Development (DESD) (UNESCO, 2005). The DESD promoted the interrelationship of teaching and learning linked with climate change, disaster risk reduction, biodiversity, poverty reduction, and sustainable consumption (Odgaard, 2014; UNESCO, 2005). In addition, UNESCO (2005) supported teacher education that engaged and facilitated students to, "change their behaviour and take action for sustainable development. [Through] ... competencies like critical thinking, imagining future scenarios and making decisions in a collaborative way" (para. 1).

International initiatives are often translated into Commonwealth policies, and the DESD contributed to ongoing support of the Australian Research Institute in Education for Sustainability¹ (ARIES) at Macquarie University (ARIES, 2003, 2015; Steele, 2010). The funding of ARIES to facilitate, "research into how to move beyond simply raising awareness to achieve the attitudinal and behavioural changes necessary to live sustainably" (Departments of Sustainability, 2011, para. 1) demonstrated a politicised commitment to sustainability during this research period.

However, it is important to note that in spite of the media, education and funding for sustainability research, EfS was still reported as being 'hit and miss' in most pre-service teacher courses (Ferreira et al., 2006). In this study, no formal EfS units were taught in the primary teacher education course (although it has been subsequently introduced into the Science Education unit at the university).

Methods

This research sought to determine Graduate Diploma of Education (Primary) pre-service teachers' perceptions on sustainability, and to explore implications for pre-service teacher education in EfS. Part of this research included investigating where pre-service teachers sourced their information on sustainability. The credibility and breadth of sources influencing pre-service teachers' knowledge may affect their future teaching and learning (Boon, 2011; Effeney & Davis, 2013; Kennelly, Taylor, Maxwell, & Serow, 2012): for

¹ ARIES was formally known as the Australian Research Institute for Education and Sustainability to coincide with the Decade of Education for Sustainability.

example, misinformation could lead to the development of alternative conceptions regarding the science of sustainability and climate change (Boon, 2010).

The research employed a case study approach, utilising a qualitative interpretivist methodology (Stake, 2000). The research was grounded in interpretivism and constructivism as they are ontologically linked to the lifeworld experience (Habermas, 1984; Husserl, 1999); that is, a social construction of sustainability awareness as a result of popular media, social networks (i.e., family and friends), as well as their education. A case study usually reports on the understanding of an event or process related to a group of individuals within a system (Creswell, 2014). In this case, the cohort of pre-service teachers enrolled in the Graduate Diploma of Education (Primary) bounded the case study.

The students enrolled in this course had two key similarities: they had completed at least a Bachelor degree prior to entry in the course, and they had not engaged in any specific EfS learning. The participants held a range of Bachelor Degrees, with five in Science². The remaining pre-service teachers (n=13) had degrees in the Humanities/Arts. Four participants held Higher Degrees by Research (Masters or PhD).

A total of 18 self-selecting Graduate Diploma of Education (Primary) pre-service teachers participated in this research, out of a possible 113. The 18 pre-service teachers interviewed included six males and 12 females; 13 Australian students and five overseas students, inclusive of three females and two males, all of who had permanent residency.

The objective was to determine the perceptions of these pre-service teachers within these parameters, which could then be used to explain potential areas for intervention in Graduate Diploma of Education (Primary) teacher education course at the university, with an intended focus on the Primary Science unit.

The 18 participants registered interest for the interview during the research quantitative pilot phase, and each of the participants subsequently completed a semi-structured interview of approximately 60 minutes with a researcher, conducted on the campus at a mutually arranged time. The interview transcripts were then transcribed, and inductive coding was used to determine key themes (four themes were identified). Inductive coding was used as the aim was to uncover the perceptions of pre-service teachers, which were previously unknown within this WA context (Auerbach & Silverstein, 2003), by organising the raw data (i.e., the recording from the semi-structured questions) into key sustainability themes. Repeated open coding continued until the data were saturated.

It was apparent in the interview process that all of the participants had a personal interest in sustainability that is likely to positively skew these findings. This was probably caused by their self-selection, through which it is assumed that they all held reasonable self-efficacy in sustainability awareness. The findings are subsequently linked to the context of this case; however, they may be of relevance to others beyond this specific WA context.

Findings

The following findings represent four key themes about the types and quality of sustainability information sourced by the pre-service teachers. The four key themes were identified as:

- Mistrust of commercial media.
- Trust of non-commercial media.
- Trust in the scientific community and research.

² The actual degrees completed by the participants have been broadly defined as either Science or Humanities/Arts to maintain their confidentiality.

- The importance of education.

Pseudonyms have been used to protect the participants' confidentiality.

Mistrust of Commercial Media

All the pre-service teachers (n=18) claimed an emphatic distrust of commercial media's reports on sustainability issues. Alan said 'I would not trust commercial news for anything' and Barbara said that commercial media 'provides no [reliable] information'. Colin and Des both mistrusted newspapers, with Des claiming that newspapers are 'partial ... they are politicised'. Brian also extended the politicised nature of sustainability reporting to include radio, asserting how 'the shock jocks on the radio ... a lot of the media is distorted ... [they have] agendas ... a lot of shared and pooled ignorance'. Some pre-service teachers expressed concern over the level of government's manipulation of sustainability themes through commercial media. Brian explained, 'leaders in government, community leaders ... could do well to take a look at themselves'. Helen said 'I would not say [the] government [is] at all' a reliable source of information. These participants expressed a critical awareness about bias and the political nature of commercial media.

The pre-service teachers identified factors contributing to climate change and tipping points as covered in the media. For several pre-service teachers the technical details were buried in the partisan economic debate conducted by Australia's commercial media, which they interpreted as a continual attack on the legitimacy of peer-reviewed science. The pre-service teachers noted the forceful rhetoric covering the partisan approach presented in some commercial radio. Some participants provided insight into the pro-economic position held by then Federal Opposition (Abbott), as well as the sustainability/economic model argued by Labor (Rudd and Gillard) governments at the time. Fred discussed the implementation of the carbon tax to reduce greenhouse targets, saying 'there is no way to implement a climate change model without ... effect on the economy ... it [is] unwise to implement any ... measures that ... effect the economy'. Fred was concerned about the short-term impact on the economy during the post-GFC climate, in contrast to the long-term economic outcomes if emissions were not significantly reduced or maintained (Stern, 2006). In contrast, Helen was concerned about making polluters 'pay' by 'stop giving the big carbon emission ... companies ... [with] massive profits ... [a] let off ... they need to start making ... carbon producers ... pay ... or be given the incentive [to use alternatives]'.

Trust of Non-Commercial Media

Despite their mistrust in commercial media, 16 primary pre-service teachers trusted information disseminated by Australia's non-commercial media: for example, the Australian Broadcasting Corporation's (ABC) television programs, documentaries or related radio programs. In sourcing reliable information about sustainability, Alan said: 'It would definitely be non-commercial news, I ... trust in that'. Caddy identified 'ABC, radio, [and] documentaries' as her non-commercial sources of information, saying 'I would say I have more faith in documentary style shows ... aired on ABC rather than commercial programs'. Mary also trusted non-commercial media sources, specifically due to their inclusion of local sources of information. Sources were deemed as suspect if they were supported by commercial sponsorship or linked to a political platform that was not independently verified by an external body. The pre-service teachers' trust in non-commercial media supported their approach to acquiring reliable scientific information.

Trust in the Scientific Community and Research

Three pre-service teachers spoke specifically of the scientific community and research as the most reliable source of information. Brian sought the scientific community's consensus on climate change: 'I think ... everything is political but ... [scientists] have fewer agendas (sic) ... they use ... sound methodology, scientific practices ... we need to listen to them and I think we ignore them to our peril'. Kerry also trusted science, but with caution: 'I guess [I trust] agencies like CSIRO and academic research, although you do tend to wonder if it is not skewed a certain way because of ideology'. Des, who had a background in Science, stated: 'When I was at university I had a couple of my professors working on research ... the evidence is there, it [is] pretty strong'.

In addition to published science articles, 10 pre-service teachers stated selective Internet websites were their best source of information on sustainability. Helen stated: 'I look ... on the Internet ... [for] a reliable source', which was qualified by Lorna as '... not a dot com or blog'. Only two pre-service teachers cited blogs as a source. Ann mentioned using blogs as a broadly reliable source: 'The Internet is a good ... news, opinion blogs, you name it'. However, Colin used blogs as a starting point to investigate science: '[I go]... onto the climate deniers' site and when I go "hey, what's going on here? [This seems unreliable]", I go onto a scientific one [website] and ask a question'.

Importance of Education

Seven pre-service teachers spoke of the importance of education across a variety of contexts. Caddy stated: 'I get information ... from what comes home with my kids from school ... at a university ... I didn't have much of an understanding before'. Pre-service teachers also discussed educational influences from their personal experiences, noting: 'It depends on the lecturer [some] have very strong views on sustainability. ... I'm ... happy to listen ... but I think I ... want to go and find things out for myself' (Irene). Mary identified, 'general discussion with [university] peers', as an important source. Others said their family and friends educated them; however, they often presented polarised views. In response to these polarised views, the interviewed pre-service teachers preferred to source family or friends who they viewed as specialists: for example, scientists or farmers, or those with relevant tertiary qualifications. Barbara noted, 'both my parents work in science ... so I get a lot of my information from them'. A common perception from the pre-service teachers was a view that society lacked Science and sustainability literacies

In other sections of the interview, many of the pre-service teachers claimed they lacked technical knowledge and several inferred misconceptions covering climate change science that required more education. Barbara said that more funding was needed to educate the public about sustainability and climate change: 'People are not taking it very seriously ... a lot of people ... cannot be bothered to think about it ... I certainly am not as informed as I could be'. Kerry said: 'I would like more information ... a better handle on it ... evidence to support ...'. Colin saw a lack of scientific literacy in education with people not being able to combat 'false propaganda being put out that climate change isn't happening'. Des linked ignorance to poor science education, where 'research obviously [needs to counter] ... a lot of misinformation ... education ... [to] look into the science behind it [climate change]'. Joy claimed 'a lot of people are ... not taking a stance' ... [because of] poor education'. She also said 'people are not willing to pay ... to change ... [they] are not convinced of the science behind it'. Importantly, education and scientific literacy were highly valued by the pre-

service teachers interviewed, be it by direct reference (n =7) or the many more indirect references that were for EfS.

Discussion

This research aimed to investigate the Graduate Diploma of Education (Primary) pre-service teachers' perceptions on sustainability, and to explore implications for pre-service teacher education in EfS. The primary concern of the majority of pre-service teachers was an issue of trust in securing reliable information regarding sustainability, as well as a need for bipartisan leadership from the Commonwealth government (Lummis, 2009; Steele, 2010) to support sustainability as cross-curriculum priority. Consistent with the Steele (2010) and UNESCO (2002, 2005) definitions of sustainability, the pre-service teachers' were very aware of socio-cultural themes, socio-economic motives, and the need for scientific literacy.

The 18 pre-service teachers were also aware of the influence of the media in shaping their knowledge of sustainability. Their links between sustainability knowledge and the media issues present during the research context was consistent with Hawkins (2005), who identified that media narratives influenced the public's interest in a particular environmental issue. Nielsen (2011) and Wall (2007) reinforced the power of the media to influence attitudes towards sustainability awareness. Hamilton (2012) claimed that people who are well briefed on sustainability issues could be influenced by a lack of intensity and frequency media presentations on these themes. Memories of disastrous events shown through the media shape people's estimates of risk, and in addition the media's focus on such events is likely to alert people to the increasing risks of climate change (Lewandowsky Ecker, Seifert, Schwarz, & Cook, 2012). These attitudes were evident during the interviews, when pre-service teachers who had previously held pro-nuclear energy options as a preferred option for carbon emissions, started to consider the nuclear risks too high as a result of the graphic media coverage of the Fukushima power plant. This example demonstrated how journalism has an essential role in perception formulation (Wall, 2007).

The interviewed pre-service teachers emphasised a need to secure independent knowledge on a range of interrelated sustainability themes that relied on specialised science outside invested interest groups, including politicians and the media. The pre-service teachers were aware of competition for media space and of the role of commercial and non-commercial television and radio, and their role in the process of political discourse and when seeking information from targeted independent sources. However, an important finding was the metacognitive disclosure that the pre-service teachers felt they did not have sufficient technical knowledge about sustainability. This limited knowledge affected their self-efficacy to engage in critical discourse about sustainability, consistent with the findings of Effney and Davis' (2013) study. However, they showed metacognitive capacity that is beyond the recognition of teachers in other research (Birdsall, 2014), perhaps indicating a move towards growing awareness due to the implementation and expectations of the Australian Curriculum (ACARA, 2011).

Part of the pre-service teachers' discussion centred on an understanding of risk management linked to practical applications to support sustainability. They reinforced how future independent research needs to investigate sustainability education options based on information that is deemed independent and reliable, and with incentive based outcomes that are perceived as authentic and tangible (Steele, 2010; UNESCO, 2002, 2005). In addition, a greater investment in both pre-service teacher education and intervention in WA primary schools is required (Angus et al., 2007). As Steele (2010) suggests, sustainability in the primary school context should be developed using a whole school approach that engages

partnership networks associated with major scientific and sustainability focused organisations. In Australia, ARIES had been one source of funding to encourage research in this area; however, this was subject to government backing (ARIES, 2015). Other universities have independently tried to integrate EfS and EfS research to support teachers (Dyment & Hill, 2015; Kennelly et al., 2011; Mills & Tomas, 2013). These researchers have found varying degrees of pre-service teacher knowledge on sustainability (Dyment & Hill, 2015; Kennelly et al., 2011), and teacher educators' integration of EfS within teacher education courses (Mills & Tomas, 2013). Given the pre-service teachers' desire and reliance on education as quality source of information regarding sustainability, it is imperative that teacher education addresses the issue sustainability literacy. Education provides an opportunity to critically discuss issues about sustainability through evidence as opposed to sensationalism, given that "an individual's prior beliefs and political ideology strongly bias how he or she responds to these arguments through selective exposure, attention, comprehension, and recall" (Nisbet et al., 2015, p. 38).

Conclusions

This research reinforced the complexity that is associated with EfS (Steele, 2010; Lummis, 2001; UNESCO, 2005). This WA case study provided an interpretivist insight into 18 Graduate Diploma of Education Primary students' perceptions of sustainability as defined by UNESCO (2005), incorporating three interdependent pillars (economic, environmental and socio-cultural). This paper specifically reported on where these pre-service teachers sourced their information on sustainability, as the credibility and breadth of these sources influence pre-service teachers' knowledge may affect their future teaching and learning (Boon, 2011; Effeney & Davis, 2013; Kennelly, Taylor, Maxwell, & Serow, 2012). In addition, the interpretivist approach of qualitative research developed opportunities for grounded theory and the need for further research, and this research demonstrates the need for further investigation to link sources of information to content knowledge about EfS, including possible misconceptions by pre-service teachers, well as the need to redesign existing pre-service teacher units to include sustainability themes.

This study is important because sustainability is a cross-curriculum priority in the Australian Curriculum (ACARA, 2011). The Australian Curriculum explains that: 'Sustainability will allow all young Australians to develop an appreciation of the need for more sustainable patterns of living, and to build the capacities for thinking and acting that are necessary to create a more sustainable future' (ACARA, 2011 para. 5). Therefore, given the expectations from the Australian Curriculum, how pre-service teacher source information on sustainability has important considerations for pre-service teacher education across the Australian primary education sector. Australian State Education Departments, Catholic Education and Independent School systems will assume graduating primary school teachers will be able to implement appropriate pedagogical content knowledge to support ACARA (n.d.) and EfS (Angus et al., 2007). Therefore, it is imperative that university pre-service primary school teacher education courses accommodate appropriate sustainability pedagogical content knowledge for long-term active citizenship across diverse economic, environmental and socio-cultural contexts (ACARA, 2011; Australian Academy of Science, 2015; Steele, 2010; UNESCO, 2005).

This research suggested that pre-service teachers demonstrated positive levels of critical thinking when accessing information, primarily from reliable sources, communicated across a variety of contexts, especially non-commercial media. One of the major themes to emerge was an open mistrust of commercial media and commentators without any formal

expertise (e.g., bias rhetoric pushing anti-climate change narratives). Several pre-service teachers also expressed mistrust in some government agencies, especially when partisan political rhetoric was linked to commercial media interests or lobbyists. Selective Internet use was valued as an important source of information, but pre-service teachers applied a caveat when discussing unreliable scientific material, especially on blogs or commercial websites. The pre-service teachers also endorsed colleagues and friends with specialised credentials.

The pre-service teachers saw education and research as central to EfS, but accommodated through independent authorities as particularly important in building knowledge about sustainability through authentic scientific knowledge. They expressed cynicism towards political rhetoric linked to corporate interests or lobbyists. Despite an emphasis of reliable sources, some pre-service teachers interacted with Internet sites that were generated for a non-specialist audience. In addition, the interviews suggested that many of the pre-service teachers required a more astute scientific literacy to share reliable information that can lead to active participation from primary children.

The issue of developing primary teacher scientific literacy is not isolated to teacher education courses, but also requires major teacher employer groups' support of on going profession development in EfS (Steele, 2010) and Science (Australian Academy of Science, 2005) for all primary teachers. Importantly, it was the pre-service teachers who perceived conceptual gaps in their EfS content knowledge. The complexity associated with any understanding sustainability suggests a dilemma for pre-service teacher education consistent with other research (Angus et al., 2007; Steele, 2010). Further research needs to assess how much content covering the integrated themes of sustainability can be practically embedded in a pre-service teacher education four-year degree; including both the Bachelor of Education in Primary, and the one-year Graduate Diploma of Education (Primary) course (Steele, 2010; Odgaard, 2014).

This research identified several EfS considerations that require further investigation. Firstly, if there a potential lack of sustainability content knowledge and Scientific literacy as identified by Angus et al. (2007), then specialist teachers should be considered as part of an intervention. Kagawa (2007) states the investment in specialised content was deemed important, and the pre-service teachers in this study agreed sustainability was important, but their positive attitudes were not matched by critical understandings of concepts regarding sustainability (Odgaard, 2014). A second consideration could include a compact between the Government, teacher employer groups and universities to ensure pre-service teacher receive meaningful pedagogical content knowledge to support EfS as required by the Australian Curriculum and supported by Steele (2010). Thirdly, given the complexity of sustainability as a cross-curriculum priority, State and Federal governments need to provide a bipartisan approach to the rhetoric associated with EfS, and appropriate funding to accommodate professional learning to develop specialist teachers to assist the generalist primary classroom teacher.

Finally, the research suggested that the pre-service primary teachers' knowledge was influenced by the media and respected colleagues and selected family members. Although global warming dominated the discourse, many students had limited conceptualisation regarding the interconnected themes associated with sustainability and climate change science. Therefore, like Leiserowitz et al. (2011), the researchers conclude that many of the self-selected 18 participants would be making ad-hoc, uninformed decisions regarding sustainability and climate change when entering primary school as teachers without specialist support. These research findings question the pre-service teachers' readiness to fully accommodate EfS in the Australian Curriculum. Given that in this case study the participants were self-selected (including some with postgraduate qualifications) and disclosed limited

content knowledge, there is concern that pre-service teachers without a personal interest in sustainability could have a potential for reproducing misconceptions with primary children.

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