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Teachers and sustainability education: exploring the views of Australian preservice and inservice teachers

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Abstract

Sustainability is crucial to the ongoing capability of Earth to sustain life. Although understood in several ways, such as *climate change education*, *education for sustainable development* and education for sustainability, international efforts have promoted sustainability as an important focus for education. In Australia, this focus is reflected in sustainability being embedded in the Australian Curriculum. Australian and international researchers have found that teachers generally understand sustainability and are favourably disposed toward it, but implementation remains an issue. This paper reports findings from an online survey administered to Australian preservice and in-service teachers. Echoing previous research with teachers, participants in this study had a positive attitude towards sustainability but lacked key knowledge and confidence to teach appropriate sustainability ideas within the Australian Curriculum. As such, the implementation of the sustainability cross-curriculum priority area seems inconsistent and there is a need to support teachers through curriculum resources, professional development, and ongoing mentoring.

Keywords Sustainability · Education · In-service teachers · Preservice teachers · School · Australian Curriculum

Introduction

Sustainability is a well-recognised challenge internationally. While noting the contested terminology, sustainability is about 'meeting the human needs of the present and ensuring that future generations can also meet their own needs' (Kidman et al., 2020, p. 2; see also United Nations (UN), 2023). It is about 'sustaining' and cuts 'across timescales' (Kidman et al., 2020, p. 10). The United Nations (UN) views education as an important response to this challenge, evident in its declaring 2005–2014 to be a Decade of Education for Sustainability (DESD) and 2020–2030 to be 'The Decade of Action' (United Nations Education, Scientific

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and Cultural Organization (UNESCO), 2020, p. 1). For the UN (2023) and the Organisation for Economic Co-operation and Development (OECD) (PISA data) (White et al., 2023), Education for Sustainable Development (ESD) entails harnessing the transformational power of education to achieve the 17 Sustainable Development Goals (SDGs). Using this power is essential in this 'Decade of Action to step up progress towards all the SDGs' (UNESCO, 2020, p. 1), especially given the limited progress towards all 17 goals (UN, 2023). ESD derives 'from the need for education to address growing sustainability challenges. ESD employs action-oriented, innovative pedagogy to enable learners to develop knowledge and awareness and take action to transform society into a more sustainable one' (UNESCO, 2020, p. 1). It concerns young people developing agency to address sustainability challenges (White et al., 2023).

UNESCO's (2014) roadmap for a global action program on ESD highlights five priority areas: embedding ESD into education and policy; integrating sustainability principles into education and training; enhancing the capacities of educators to deliver ESD; expanding ESD action among youth; and accelerating local sustainable solutions. Progress has been made as a result of these actions. UNESCO (n.d.) notes that educators from 161 countries have adopted the Berlin Declaration on ESD (UNESCO, 2021). However, almost half of the national curricula UNESCO sampled did not mention climate change, an essential aspect of sustainability. Furthermore, only 40% of teachers were confident about teaching the cognitive dimensions of climate change, and only 20% of teachers could explain well how to act on sustainability (UNESCO, n.d.).

In Australia, the term 'Education for Sustainability (EfS)' is used rather than 'Education for Sustainable Development (ESD)'. From this point in the paper the term EfS will be used unless in a direct quotation where ESD or other terms have been used. EfS relates to:

> interaction between the environment and society; assuming that society encapsulates the social, environment[al], cultur[al] and politic[al]. … the EfS definition should be education that meets these goals for sustainability. … EfS should cut across the domains of formal and informal education and within formal education (across levels of primary, secondary and tertiary education). (Kidman et al., 2020, pp. 9–10)

This definition means that EfS crosses all curriculum areas, a point reinforced by UNESCO (2020) and reflected in the official Australian Curriculum. As the Australian Curriculum, Assessment and Reporting Authority (ACARA) (n.d.) puts it with respect to Version 8.4 of the Australian Curriculum:

> Cross-curriculum priorities are only addressed through learning areas and do not constitute curriculum on their own, as they do not exist outside of learning areas. Instead, the priorities are identified wherever they are developed or have been applied in content descriptions. They are also identified where they offer opportunities to add depth and richness to student learning in content elaborations. They will have a strong but varying presence depending on their relevance to the learning area. (para. 4)

In Version 9 of the curriculum, ACARA (2024) amended this statement to 'Cross-curriculum priorities support and deepen student engagement with learning area content and are best developed within the context of learning areas' (para. 13). These explanations imply that the sustainability Cross-curriculum priorities (CCP) is not graded directly. It could be suggested that EfS includes but goes broader than climate change education.

EfS has been part of Australian education policy discourse for more than 30 years, and in some Australian states and territories part of the curriculum for almost as long. Deriving from the United Nations Decade of Education for Sustainability (2005–2014) and SDG, EfS has been a CCP in the Australian Curriculum for more than a decade (ACARA, 2024; Australian Curriculum, 2023; Almeida et al., 2018; Barnes et al., 2019; Effeney & Davis, 2013; Hill et al., 2020; Larri & Colliver, 2020; Mills & Tomas, 2020). Despite the longevity of sustainability in Australian policy and curricular language, and reviews and research having identified teachers who support the concept of sustainability, its implementation remains an issue.

The research reported in this paper seeks to respond to this challenge by considering a small group of Australian preservice (PST) and in-service (IST) teachers' understanding of sustainability and their confidence in teaching about it in various curriculum areas. Considering both groups of teachers in the one research project distinguishes this research from earlier studies identified in the literature. These studies focused on either PST or IST and school leaders, but not both in the one study. Prior to discussing the research findings, research literature on (1) teachers' understanding of sustainability and its place in the Australian Curriculum and (2) teachers' implementation of the sustainability CCP are considered. Limitations of the study and directions for future research are considered. Attention first turns to sustainability education in Australia.

Sustainability education in Australia

This section details Australia's EfS initiatives, with reference to the responses taken by successive governments to UN initiatives. Attention is directed towards sustainability as a CCP in the Australian Curriculum. Prior to considering sustainability in the Australian Curriculum, we note that understandings of sustainability and education for it differ. We also note recent cross-national research focusing on climate change education, viewing sustainability in this manner (Ben Zvi Assaraf et al., 2024; Dawson et al., 2022).

In Australia, interest in sustainability education developed in the context of environmental education. Two National Action Plans have been developed in this regard. First, a National Action Plan for Environmental Education for a Sustainable Future was outlined in 2000 (Environment Australia, 2000). The UN Decade of Education for Sustainability prompted the Australian government to develop a national strategy to mainstream sustainability via 'education and lifelong learning' (Department of the Environment and Heritage, 2007, p. 4). A second National Action Plan focused on Education for Sustainable Development (Department of the Environment Water Heritage and the Arts, 2009), with the UN understanding of sustainable

development adopted (United Nations, 2023, para.2). This understanding of sustainable development informs how sustainability is conceptualised in the Australian Curriculum. One element of the second national action plan was embedding sustainability in school curricula. ACARA developed sustainability as one of three CCP to be represented across all eight learning areas (ACARA, 2013). These priorities, however, are not assessed.

In the current Version 9 of the Australian Curriculum, sustainability relates not only to climate change but also to equity and to preserving culture and language. For the writers of the Australian Curriculum:

> The Sustainability cross-curriculum priority explores the knowledge, skills, values and world views necessary for people to act in ways that contribute to a sustainable future. Designing solutions and actions for a sustainable future requires an understanding of the ways environmental, social and economic systems interact, and an ability to make balanced judgements based on present and future impacts. The Sustainability cross-curriculum priority is futures-oriented and encourages students to reflect on how they interpret and engage with the world. It is designed to raise student awareness about informed action to create a more environmentally and socially just world. (ACARA, 2024)

Whereas Version 8.4 of the Australian Curriculum sustainability CPP contained 'three key concepts'—'systems', 'world views and futures' (ACARA, n.d., Line 19), Version 9 of the Australian Curriculum sustainability contains four interconnected elements—'systems', 'world views', 'design' and 'futures' (ACARA, 2024). For the writers of Version 9, sustainability is envisaged to be part of the Arts, English, Health and Physical Education, Humanities and Social Sciences, Languages, Mathematics, Science, and Technologies learning areas. This alteration is significant, given more than a decade of Australian research showing teachers' difficulties with implementing this priority area. As noted by Ben Zvi Assaraf et al. (2024) and Dawson et al. (2022) there can be a gap between the official and the enacted curriculum. Teacher education, political and educational leadership, teacher confidence, and resourcing can influence classroom behaviour. Consequently, attention now turns to how current and future teachers understand sustainability and its place in the Australian Curriculum and classroom. The paper then turns to how confident current and future teachers are of their ability to teach sustainability, as embedded in the Australian Curriculum.

Teachers' understanding of sustainability and its place in the Australian Curriculum

In 2012, the federal Labor government contracted the Australian Conservation Foundation to investigate and recommend ways to improve the integration of EfS across all subject areas. Authors of the report on that project found that, although 92% of surveyed teachers agreed that sustainability should be integrated into the Australian Curriculum, 80% did not comprehensively understand EfS (Australian Education for Sustainability Alliance, 2014). More than half of those who knew what it was were

not teaching it to a standard that would meet the curriculum guidelines. Recommendations focused on teacher professional development and EfS in teacher preparation, encouraging whole-of-school approaches rather than individual teacher efforts, and building support through networks of teachers and community organisations.

In 2013, the federal Coalition government initiated a review of the Australian Curriculum. The reviewers reported broad support for the CCPs, but expressed concern about implementation and found widespread misunderstanding about whether the CCPs were mandatory (Donnelly & Wiltshire, 2014). Consequently, they recommended reconceptualising how the CCPs were to be taught. Subsequent Australian Curriculum revisions retained the CCPs but adjusted the requirements. Yet recent research into climate change education in the Australian Curriculum indicates that the teaching of sustainability remains 'limited' and 'primarily optional' (Ben Zvi Assaraf et al., 2024, p. 9).

Donnelly and Wiltshire's (2014) findings were echoed in a study conducted with principals and curriculum leaders in Tasmanian schools (Dyment et al., 2015; Hill & Dyment, 2016). The researchers' online survey attracted responses from 68 of 279 schools (24%). Researchers found broad support for the sustainability CCP. However, despite a broad understanding of sustainability with an environmental focus, participants reported less knowledge of the CCP, limited capability for teaching it, and a lack of relevant professional development. Similar to Donnelly and Wiltshire (2014), Hill and Dyment (2016) recommended support for teachers and structural changes to the curriculum.

Related, in a Queensland study drawing on surveys and interviews, Nicholls and Thorne (2017) found strong support for the inclusion of sustainability in the Australian Curriculum. Still, translation into practice was limited because only some teachers had the necessary time and support. Moreover, many needed to be made aware of the CCP some years after the introduction of the Australian Curriculum, suggesting a lack of system support with information, resources, and professional development.

Initial teacher education and professional development for IST might be considered important contributors to teachers' confidence with EfS. Several studies have, however, reported that Australian teachers have lacked the necessary preparation and support for addressing EfS (Dyment et al., 2015; Hill & Dyment, 2016; Kennelly et al., 2011; Nicholls & Thorne, 2017). Lack of resources and inadequate teacher preparation are typical of curricular change and have been accompanied by growing research interest in teacher education for EfS, including the emergence of the *Journal of Teacher Education for Sustainability* (JTES) (https://sciendo.com/journal/JTES) and multiple reviews of the related literature. Over the past decade researchers from Australia, Germany, and Sweden have considered pedagogical approaches for EfS in higher education (Brandt et al., 2019; Howlett et al., 2016; Murray et al., 2014; Persson et al., 2023; Tomas et al., 2020).

Collaboration, interdisciplinarity, action, and transformative learning to develop students' creativity, critical thinking and reflection skills are stressed (Brandt et al., 2019; Haim & Aschauer, 2024; Howlett et al., 2016; Murray et al., 2014; Persson et al., 2023; Tomas et al., 2020). In Sweden, Persson et al. (2023) propose 'action-oriented teaching approaches', collaboration across curriculum areas, and interdisciplinarity (p. 201). These action-orientated approaches include guiding students'

'ability to analyse, argue and problematize SD [sustainable development] issues' (p. 203), this action approach is supported by Gorski et al., (2023). These 'action-oriented teaching approaches' (Persson et al., 2023, p. 201) connect with Dewey's experiential learning. Reflection is an important component of Dewey's (2004, 1916) approach and a key element of Mezirow's (2003) transformative learning theory. Internationally, both the UN and the OECD view developing students' skills in critical thinking, communicating, and collaborating as also important here. Indeed, '[g]rounding sustainability education in Dewey's democratic pedagogy underlines its capacity and obligation to develop critical thinking and systems thinking skills, communication skills and collaboration skills in students' (Tarrant & Thiele, 2016, p. 54).

At an Australian university, interdisciplinarity was used to build students' critical thinking and reflection skills, guided by constructivist teaching philosophy and transformative learning theory (Howlett et al., 2016). Similarly, in two sustainability units in a teacher education program in Germany, researchers found the attitudes and beliefs PST brought to the units were important. These PST felt that using lectures, tutorials, and seminars, combined with practical activities and collaboration, was important for their learning (Brandt et al., 2019).

The research reported here indicates that teachers support the inclusion of sustainability in the Australian Curriculum yet have limited knowledge of implementing the CCPs. These studies have not explored how teachers understand sustainability. Australian and international research indicates that teachers consider sustainability in some subjects more relevant than in others.

Consistent with international trends, the most substantial inclusion of sustainability in the Australian Curriculum is in Geography and Science (Ben Zvi Assaraf et al., 2024; Dawson et al., 2022; Maude, 2014; Mills & Tomas, 2020; Zidny et al., 2020). International literature also highlights Mathematics (Li & Tsai, 2022), Physical Education (Baena-Morales & González-Víllora, 2023), the Arts (Simon et al., 2023), and food literacy (Smith et al., 2022) as involving the teaching of sustainability. As a CCP, EfS is expected to be taught across all learning areas in the F-10 Australian Curriculum (Australian Curriculum, 2023).

Implementation

Despite almost two decades of Australian government support for EfS, and almost a decade of inclusion as a CCP, Mills and Tomas (2020) observe that few teachers have the time and support to enact EfS in their classrooms. They offer a lack of explicit guidance as one reason for this finding. A cursory look through the Australian Curriculum teachers' resource, Scootle, for resources connected with Version 9 of the Australian Curriculum suggests sustainability in the F-10 curriculum is evident primarily in Science (Biology and Earth Sciences—21 items), Geography (19 resources), Humanities and Social Sciences (17 items), and Technology and Design (26 items). Six resources were identified for Years 2–12 English and four resources were identified for

Mathematics (https://www.scootle.edu.au/ec/acSubject?filterForm=filter&tablink=&prioritytype=3). A search in Scootle using the word 'sustainability' identified 52 items.

One Year 2 maths resource in Scootle connected to Sustainability through students auditing rubbish in the playground, learning about recycling and combusting, and finally disposing of the rubbish in school bins via auditing bins compared to the rubbish they have audited and classified (reSolve mathematics, 2020). For Year 7 English, the national English teachers' association has contributed a 12-lesson sequence developing students' critical literacy to assist them to make informed and ethical choices in response to consumer advertising. The writer of this unit has included formative and summative assessment tasks (AATE, n.d.). AATE has also contributed English units around waste and life stories for Years 8 and 9. Again, both units include assessment tasks. Twinkle (https://www.twinkl.com.au/resource/au-t2-g-811-environments-sustainability-resource-pack), another resource for teachers, has a 'sustainability resource pack' available for members to download.

This limited evidence of sustainability reinforces prior arguments (Hill et al., 2020; Mills & Tomas, 2020) that there is insufficient understanding and capability to deliver such cross-curricular priorities in Australian schools, which returns us to the necessity of developing teachers' capacity and capability during their initial teacher education. Within schools, the seeming top-down nature of some initiatives further erodes the capacity for success (Mills & Tomas, 2020). Top-down actions, where followers are not involved in developing actions in a meaningful way, generally prevent followers from owning those actions, reducing the likelihood of success. In this case, it might be speculated that teachers and students have not owned actions. Bottom-up actions are also needed (Mills & Tomas, 2020).

Funded by the Australian Government Department of Education and Training, Sustainability in Schools is a portal of 'classroom-ready resources' established by the Australian Education for Sustainability Alliance (AESA). This Alliance was formed from an association of 'organisations in the education, union, youth and environment sectors' seeking to provide Australians with 'access to the skills, practices and values of sustainability, through formal education and throughout life' (Sustainability in Schools. About Us., n.d., Para. 1). The Australian Association for Environmental Education (AAEE)—the peak body for environmental educators in Australia—is a key member of the Alliance. There are 549 Foundation to Year 10 resources in the 'resource portal', which can be searched by year level and curriculum areas. Each resource lists the appropriate curriculum codes. Teachers and organisations can join and share their resources. Organisations that have contributed resources include ABC Splash, the Australian Academy of Science, Australian Association for Environmental Education, Asia Education Foundation, CSIRO, Cool Australia, EarthWatch, LandCare, state government departments and statutory organisations, and the Primary Industries Education Foundation Australia. The portal also enables users to link to Scootle.

Methodology

Evidence from previous research suggests Australian teachers have a positive view of EfS, but are inadequately prepared and resourced (Dyment et al., 2015; Hill & Dyment, 2016; Kennelly et al., 2011; Nicholls & Thorne, 2017). As teacher educators working in the context described, the authors were interested in better understanding the current situation of EfS among current and future teachers. The following research questions guided this study:

1. How do current and future teachers understand sustainability and its place in the Curriculum and classroom?
2. How confident are current and future teachers of their ability to teach sustainability as embedded in the Australian Curriculum?

Participants

Australian preservice teachers (PST) and in-service teachers (IST) were invited to participate in this study via a snowballing technique that used e-mail and social media for recruitment. Ultimately, 99 responses were received, of which 37 were identified as PSTs and 38 as ISTs. Twenty-four respondents did not identify if they were PSTs or ISTs. After discarding incomplete responses, 38 responses remained. Of these, 20 (17 female, three male) were from ISTs and 18 (15 female, three male) were from PSTs. The researchers speculate that the limited responses were due to people being in survey fatigue because many organisations now ask 'how well did we do?' through a survey.

Data collection

The survey questions were developed based on statements from the Australian Curriculum and additional questions were derived from the literature (See Table 1). Data were collected via an online survey using a university-operated instance of LimeSurvey (https://www.limesurvey.org). Survey distribution used a snowballing technique to attract diverse responses. The survey had a brief introduction about the project, details of ethics approval, and contacts for questions or perceived issues. Questions were presented in two groups. The first five questions covered demographics, including gender, age, career stage (teacher or preservice), year level(s) taught, and postal code of most recent school experience. The second set of 19 questions comprised a mix of closed and open-ended items about sustainability education. There were 14 closed-item questions. These questions asked about the value (Likert scale 1 to 5) respondents placed on teaching about sustainability, curriculum areas in which sustainability appears and/or is taught, confidence levels (Likert scale 1 to 5) for each of nine organising ideas from the sustainability CCP, and perceived attitudes of school and curriculum to sustainability. The 5 open-ended items asked respondents to define sustainability in their own words, suggest how their students

Table 1 Teachers' confidence in their ability to teach organising ideas from the sustainability CCP

		PSTs						Teachers					
		1	2	3	4	5	Mean	1	2	3	4	5	Mean
	Systems												
1	The biosphere is a dynamic system providing conditions that sustain life on Earth		4	6	6	2	3.33	2	3	5	9	1	3.20
2	All life forms, including human life, are connected through ecosystems on which they depend for wellbeing and survival		2	1	10	5	4.00	2	1	6	10	1	3.35
3	Sustainable patterns of living rely on the interdependence of healthy social, economic, and ecological systems		3	5	7	3	3.56	1	1	3	6	8	4.00
	World views												
4	World views that recognise the dependence of living things on healthy ecosystems, and value diversity and social justice, are essential for achieving sustainability		4	2	9	3	3.61	2		4	4	9	3.95
5	World views are formed by experiences at personal, local, national and global levels, and are linked to individual and community actions for sustainability		2	6	7	3	3.61	2		4	4	9	3.95
	Futures												
6	The sustainability of ecological, social and economic systems is achieved through informed individual and community action that values local and global equity and fairness across generations into the future		1	8	5	3	3.59	2		4	5	8	3.89
7	Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments		1	4	10	2	3.76	1		6	5	7	3.89
8	Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgements based on projected future economic, social and environmental impacts		3	7	4	3	3.41	1	2	4	3	9	3.89
9	Sustainable futures result from actions designed to preserve and/or restore the quality and uniqueness of environments		3	3	9	2	3.59	1	1	4	4	9	4.00

describe sustainability, describe pedagogical approaches they use to teach sustainability, indicate sustainability topics in which they would like professional development, and describe an activity that would enhance students' knowledge and skills.

Data analysis

Data were exported from LimeSurvey to Excel which was used to analyse responses to the demographic questions by simple tabulation. This technique was used to create an overview of respondents as presented in Fig. 1. Because the small number of complete responses did not support extensive statistical analysis, Excel was used to analyse the closed questions by counting frequencies, calculating means of responses, and applying t-tests where relevant. Open coding was used to analyse the open-ended questions.

Results

Considering the first research question, we report on participants' understanding of sustainability. Continuity and recycling were two of the main ways sustainability was viewed. We also consider where participants saw sustainability fitting within the Australian Curriculum including eight learning areas and as a cross-curriculum priority. Turning to the second research question, participants' responses about the curriculum areas where they taught sustainability and the pedagogies they used were

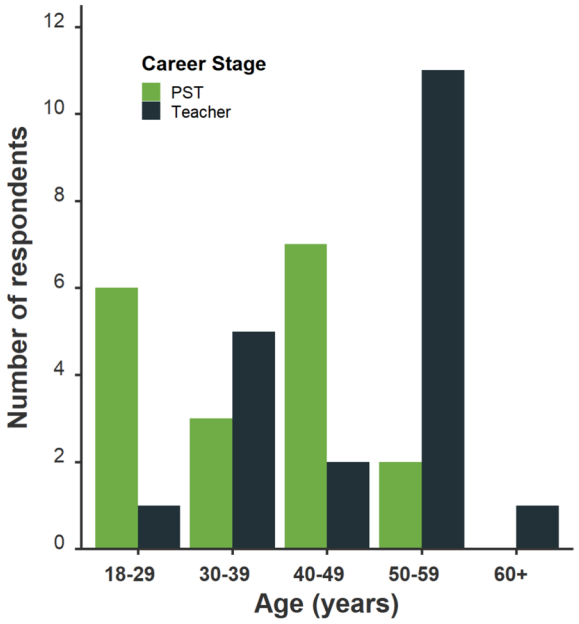

Fig. 1 Distribution of respondents by age and career stage

less positive. Prior to discussing these results, participants' demographics are briefly reported.

Of the 38 complete responses, 12 reported teaching primary school classes, 25 reported teaching secondary classes, and 2 recorded no response for that item. One respondent taught into both primary and secondary classes. Figure 1 presents the distributions of age ranges. As expected, teachers are typically older than PSTs. Most respondents provided a Queensland postal code for their most recent school (16 PSTs, 14 teachers). Among the PSTs, one each indicated Western Australia and Tasmania. Among the teachers, three were from New South Wales, one each from Western Australia and overseas, and one with no response.

Attention now turns to the research findings. This discussion is organised using the two research questions that guided the study.

How do current and future teachers understand sustainability and its place in the Curriculum and classroom?

In the discussion below, we first delve into participants' understandings of sustainability and then report on how they saw sustainability within the Australian Curriculum. Three key points were evident in the data. First, a high number of participants did not define sustainability. Second, the comments provided by participants who did respond to this question emphasised continuity and preserving the environment. Third, science, the humanities, and social sciences were viewed as the main locations for sustainability within the curriculum.

Understandings of sustainability

Participants were asked for a definition of sustainability. Prior to identifying participants' definitions, it is of interest that 32 participants did not respond to this item. It is possible that these participants perceived the question to be 'difficult' or that the ordering of questions was problematic for these participants. It is of concern for enhancing sustainability if teachers experience difficulty in defining an important element within the Curriculum.

Understandings of the concept of sustainability among respondents mostly centred on a theme of 'continuity', as in maintaining a way of life over long periods. Definitions included 'For how long can I keep doing this?', 'Being able to continue over the long term with no need for external support', and 'An ability to maintain or sustain something over a long period of time'. Other notable themes related to an enhanced, or undiminished, 'future' and preservation or restoration of the 'environment'. These ideas are consistent with the Australian Curriculum's description of sustainability as addressing 'the ongoing capacity of Earth to maintain all life' and meeting 'the needs of the present without compromising the ability of future generations to meet their needs' (ACARA, n.d.). Interestingly, PSTs were more likely than their in-service colleagues to use the word 'negative' in defining sustainability in the context of preventing 'negative impacts'. In-service teachers were more likely to use

the word 'good' in the context of 'making good use of resources', 'leaving the world as good as it was when we arrived', and 'bringing the most good for us all'.

Respondents' thoughts about how students might understand sustainability focused on 'recycling' and 'frugality' in reducing waste or profligate use of resources, with mentions of 'environment', 'continuity', and 'future'. These ideas are consistent with their understandings of sustainability as they might be transformed for teaching, with the curriculum idea that EfS 'develops the knowledge, skills, values and world views necessary for people to act in ways that contribute to more sustainable patterns of living' (ACARA, n.d.), and with the willingness of schools to take action on sustainability through such practical measures. The most mentioned keyword was 'recycling', with 11 mentions. Other common responses were 'energy' (e.g., 'renewable energy') and 'reducing' (e.g., 'reducing landfill' or 'natural resources use'). These responses also contributed to the second most common theme of 'frugality' or 'restraint', which was represented in 10 entries. Examples included 'Not using too much', 'Using less and recycling more', 'Making things last and renewing resources', and 'Not using up all the resources and destroying the environment'.

Figure 2 illustrates responses to the question, 'What value do you see in teaching about sustainability? (1 = little or no value, 3 = not sure, 5 = very great value)'. Although no respondent selected 1, there were three blank responses. As is visible in Fig. 2, almost all respondents saw teaching about sustainability as having great value, with mean scores of 4.4 (PSTs) and 4.8 (teachers). Given the near-universal selection of the highest value, no apparent differences in value were attributed to sustainability by age, gender, or year level taught.

Both PSTs and ISTs almost universally accorded the teaching of sustainability great value. Moreover, they saw this value embedded in the Curriculum, recording

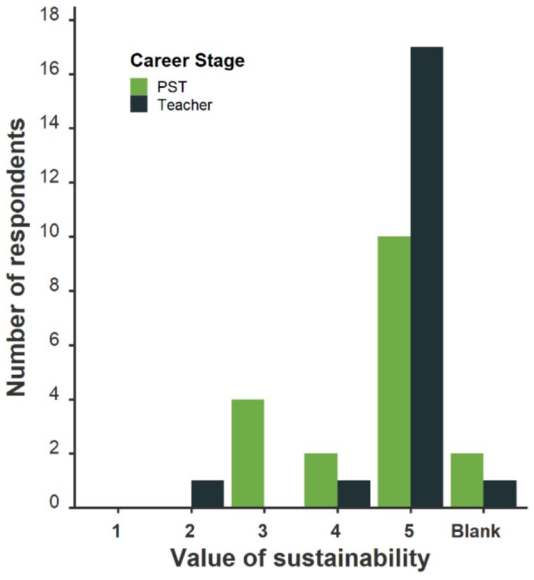

Fig. 2 Value of teaching about sustainability

both schools and the Curriculum as concerned about sustainability. Schools were perceived as willing to act on sustainability but the curriculum was seen as challenged by taking action, most likely because any action must rely on schools and teachers implementing it.

Overall, the respondents in this study, both PSTs and teachers, demonstrated positive attitudes toward sustainability and some understanding of the topic as it appears in the Curriculum. These findings are consistent with those of previous studies in Australia (Dyment et al., 2015; Hill & Dyment, 2016) and elsewhere (Goller & Rieckmann, 2022; Pegalajar-Palomino et al., 2021) that reported PSTs or teachers had some understanding of sustainability and positive dispositions toward its place in the classroom.

The place of sustainability in the Curriculum and the classroom

Respondents were asked, 'Where do you see sustainability in the Australian Curriculum?'. To assist their response, they were presented a list of learning areas with the general capabilities and CCPs appended. Figure 3 summarises the responses. All eight learning areas, the general capabilities, and CCPs were selected as locations for sustainability in the Australian Curriculum; but there was a concentration of selections in the Science, HASS (Humanities and Social Sciences), and Technologies learning areas and the general capabilities and CCP. That indicates that respondents understand how and where sustainability is placed in the Australian Curriculum.

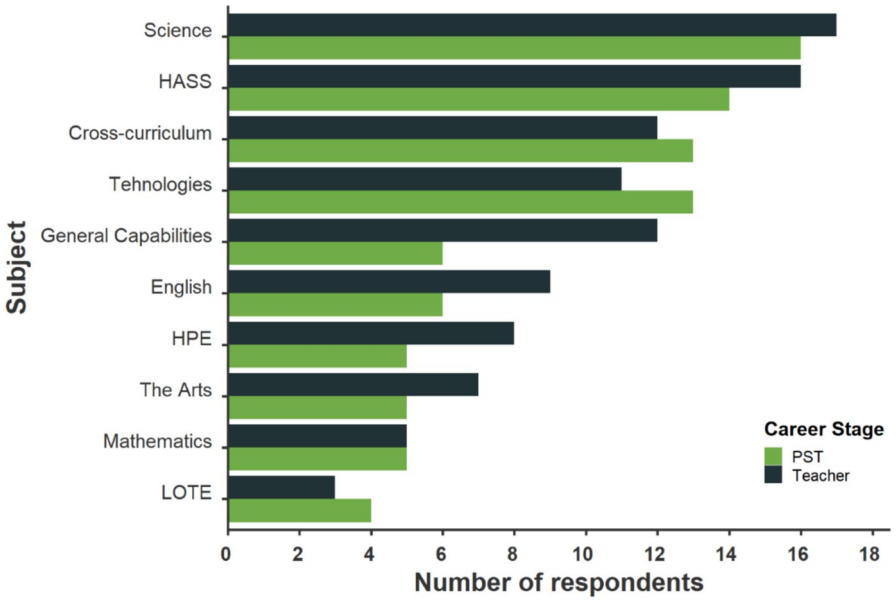

Fig. 3 Perceived presence of sustainability in the Australian Curriculum by career stage

Seven or more respondents selected each of the learning areas. The seven respondents (4 PSTs and 3 teachers) who saw sustainability in LOTE (Languages other than English) selected all 10 options, raising suspicions about the selectivity of their responses. The remaining responses appear to be genuine representations of how the respondents see sustainability in the Curriculum. Science, HASS, Technologies, general capabilities, and CCPs attracted stronger responses, in accord with the curricula for those learning areas, suggesting that the respondents generally have a sound appreciation of how sustainability is embedded in the Australian Curriculum.

The subsequent survey item asked, 'In which curriculum areas do you teach sustainability? Select "None" if you do NOT teach sustainability', and presented the same list of learning areas with the addition of 'None' as an option. Figure 4 summarises the responses. The single selection for each of Mathematics, LOTE, and HPE (Health and Physical Education) was made by a PST who had selected all 10 options in the previous item and selected all options other than 'None' for this item. Those selections may be spurious, but the remaining responses appear more deliberate. The next highest number of selections was four, with the three teachers recording that number selecting Science (2) or The Arts (1) in addition to Technologies, general capabilities, and CCPs. The evidence suggests that the respondents are considered in choosing the learning areas in which they can embed sustainability.

Although survey respondents were favourably disposed to EfS, understood the concepts expressed in the Australian Curriculum, and knew where it fitted in the Curriculum, their responses about the curriculum areas where they taught sustainability offered a less positive picture. Consistent with the Curriculum, the most selected learning areas were Science and HASS, with Technologies and the

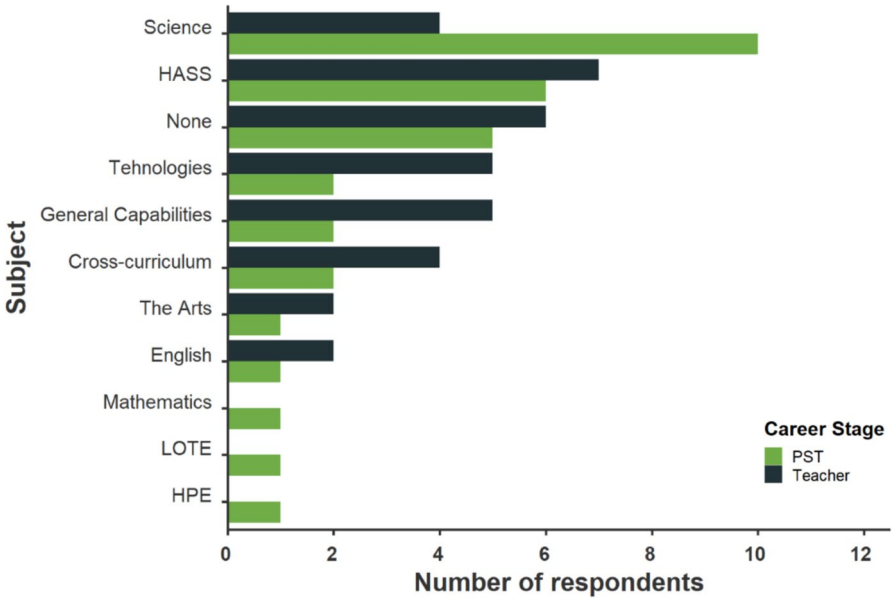

Fig. 4 Reported teaching of sustainability in the Australian Curriculum by career stage

cross-curriculum elements also attracting support. However, almost one-third of respondents (11 of 38) reported not teaching sustainability. That might be of limited concern for the PSTs, among whom one indicated that there had yet to be an opportunity, and others may have been similarly prevented. However, teachers should be implementing the Australian Curriculum and there is cause for concern that 30% selected 'None' for the curriculum areas in which they taught sustainability almost a decade into Curriculum implementation.

How confident are current and future teachers of their ability to teach sustainability as embedded in the Australian Curriculum?

Respondents were asked to rate their confidence in their ability to teach the nine organisational ideas from the sustainability CCP, as per Version 8.4 of the Australian Curriculum (ACARA, n.d.). Table 1 presents the distributions of Likert scale responses and means for each idea. Although teachers recorded higher means than PSTs for all but the first two organising ideas, no significant differences were found using t-tests. The mean values are all greater than 3.0, suggesting both PSTs and teachers, on average, have some confidence in teaching sustainability.

The distribution of responses varied considerably from one item to another, indicating that respondents have considered each item before responding. Among teachers the highest confidence ratings were recorded for items 3 and 9 (mean = 4.00), and 4 and 5 (mean = 3.95) whereas for PSTs the highest ratings were for items 2 (mean = 4.00), 4 and 5 (mean = 3.61). There were 12 respondents (9 teachers, 3 PSTs, 32% overall) who recorded personal means greater than 4.0 across the nine items. Of those teachers, eight reported being over 30, suggesting that experience likely contributed to their higher confidence levels. Conversely, seven respondents (18%) recorded personal means less than 3.0 across the nine items. Four of these respondents were PSTs and three were teachers who reported ages indicating some experience. One of those teachers recorded 1 for all nine items.

None of the PSTs recorded 1 for any of the items. However, there were numerous responses below 4 for both PSTs and teachers. For the teachers, only the first item had half of the responses less than 4, but, for the PSTs, items 1, 6, and 8 had more than half of the responses less than 4, suggesting a substantial lack of confidence in teaching those organising ideas.

One possible explanation for the limited implementation of EfS (Table 1) is that teachers lack confidence in teaching the concepts. Fewer than one-third of respondents recorded mean confidence greater than 4.0 on a 1 to 5 scale across the nine organising ideas, and almost one-fifth recorded means less than the midpoint, 3.0. Many respondents recorded 1 or 2, indicating a lack of confidence, or a 3, indicating 'not sure' on one or more of the nine organising ideas. Selecting 'not sure' may or may not have indicated a lack of understanding of the organising idea but certainly implied a lack of confidence to teach it.

Lower confidence aligned with not teaching sustainability and not suggesting appropriate pedagogical approaches. The most suggested pedagogical approaches were those mentioned in that survey item, but there were some additional

suggestions, including integration into learning areas, which indicated some teachers were working with sustainability as a CCP. Of the eight blank responses to the question about school or class-based activities for EfS, five were from respondents who recorded means of less than 3.5 on the confidence item, confirming the link between low confidence and experience or ideas for EfS. The recorded suggestions focused on practical activities, such as recycling, that seemed consistent with their students' practical understandings of sustainability.

Although survey respondents were favourably disposed to EfS, understood the concepts expressed in the Australian Curriculum, and knew where it fitted in the Curriculum, their responses about the curriculum areas where they taught sustainability offered a less positive picture. Almost one-third of respondents (11 of 38) reported not teaching sustainability. That might be of limited concern for the PSTs, among whom one indicated that there had not yet been an opportunity, and others may have been similarly prevented. However, teachers should be implementing the Australian Curriculum and there is cause for concern that 30% selected 'None' for the curriculum areas in which they taught sustainability almost a decade into Curriculum implementation.

A question about pedagogy for sustainability asked 'What pedagogical approaches do you use to teach sustainability? (For example, Problem-Based Learning (PBL), 5Es (Engage, Explore, Explain, Elaborate, and Evaluate., commonly used in science), Action learning, etc.)'. It attracted various responses, with some respondents recording two or more approaches. The most mentioned pedagogical approaches, possibly echoing the prompt, were PBL and 5Es. Other responses included integration in learning areas, action learning, inquiry learning, resource selection, modelling, and case study. Figure 5 summarises the recorded approaches.

The final open item had the prompt, 'Please briefly describe a school or class-based activity that would enhance students' knowledge of, and skills for, sustainability'. Although it attracted eight blank responses, three from PSTs and five from

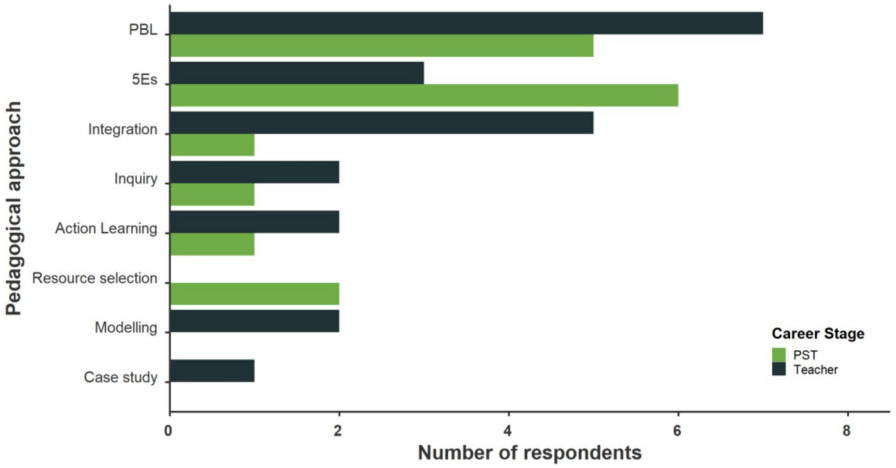

Fig. 5 Pedagogical approaches to education for sustainability

teachers, and some very brief responses such as 'composting', '10c recycling of cans/bottles', and 'sustainability audits and trips to nature', most responses were substantial with a mean length of 21 words. There were multiple suggestions for activities to engage students on sustainability projects relevant to their own lives or local community, including personal consumption and activity audits. Several suggestions were related to growing, consuming, and composting food or recycling other materials. One teacher wrote, 'I am located in a rural area: link in with local elders and do field trip on country about Indigenous sustainability resource management, link in with local farmers and do field trip to a working farm that practises sustainable resource management, school audit and recommendations for recycling/sustainability options'. A PST wrote, 'Sustainable living challenge: Students track their energy use, water use, waste production, and transportation habits for a week. They can then reflect on their habits and identify areas to make changes to live a more sustainable lifestyle'.

The prompt, 'I would like further professional development in these sustainability related topics', attracted only a small number of informative responses. Almost half of the respondents (8 PSTs and 10 teachers) offered no response, and a further 11 (7 PSTs and 4 teachers) offered a single word or short phrase indicating 'Yes' (9) or 'No' (2). Among the substantive responses, PSTs suggested 'ideas to kick start our ability to teach sustainability throughout any subject', 'in a way that is 'child friendly' so that it is easier to explain to the students', and 'Technological advances to improve sustainability practices in science [and] economic sustainability, rather than merely Corporate Social Responsibility'. Teachers suggested 'sustainable communities', 'sustainability practices are constantly developing meaning there are opportunities for teachers to develop their knowledge', and 'this is an area that needs regularly updating in latest developments … teachers not in geography & probably science may not have expert knowledge or understanding in these areas', and 'renewable energy and biodiversity'.

The lack of suggestions for professional development seems at odds with what might be assumed to be a need among teachers lacking confidence and ideas for teaching EfS. However, it might also indicate that in some cases the lack of confidence or knowledge is deep enough that there is no basis for suggesting where to begin with professional development. These PSTs and teachers have a fair understanding of sustainability and its place in the Curriculum, and some have the knowledge and confidence to proceed. In contrast, others lack the knowledge and confidence to know where and how to begin.

Discussion

Sustainability is under theorised in schools, perhaps because data are difficult to obtain from individual classrooms. Although, Barnes et al. (2021) offer new ideas around theorising teachers' experiences with EfS they also indicate that EfS is not a priority in schools. Previous Australian research into sustainability within the classroom has focused on either preservice teachers or on teachers and school leaders. This study investigated preservice and in-service teachers' knowledge and

understanding. Although teaching experience appeared to aid confidence, other findings, as considered below, suggest that teachers' capacities for EfS need to be increased. As in earlier sections, the discussion in this section is organised by the two research questions.

Understanding of sustainability and its place in Curriculum and schools

The words used by PSTs and ISTs identified in Figs. 2 and 3 suggest that participants who responded to this question understand sustainability in terms similar to those promoted by the UN, with a focus on sustaining or continuing life now and into the future. That recycling and being frugal were viewed as a means of achieving sustainability is interesting, as these accord with some of the sustainability activities in Scootle. As approximately one-third of participants reported not teaching sustainability, there is potentially a gap between their reported understandings of sustainability and its place in the Curriculum and their actual understanding of sustainability and its implementation of it in their classrooms.

If this gap does exist, then there has been little change since Effeney and Davis's (2013) work with primary pre-service teachers and Hill et al.'s (2020) research with teachers and school leaders. Effeney and Davis (2013) found 'no relationship … between [PSTs'] perceived knowledge and [PSTs'] actual knowledge …' (p. 32). Hill et al. (2020) noted teachers and school leaders saw cross-curricular priorities as valuable, yet did not understand sustainability and how it might be implemented across the curriculum. Yet approximately two-thirds of the study participants reported that they taught sustainability.

It might be argued that, after more than a decade of sustainability within the Australian Curriculum, PSTs and ISTs who defined sustainability have a higher understanding of sustainability than that reported in earlier studies. The fact that multiple potential participants did not offer a definition but exited the survey at that point raises concerns that they either needed help framing a response to the question or that survey questions need to be reorganised. If these participants did not understand sustainability, then further work might be needed at the teacher education, school, and policy levels to enhance teachers' capacity for sustainability.

Confidence in teaching sustainability

Similar to earlier studies such as that undertaken by UNESCO (2021), participants in this study appeared to have low confidence in teaching sustainability. Reasons for this finding might be, as noted close to a decade ago, that Australian teachers have been inadequately prepared and supported for teaching sustainability (Dyment et al., 2015; Hill & Dyment, 2016; Kennelly et al., 2011; Nicholls & Thorne, 2017). Returning to UNESCO's (2014b) five priority areas, it could be suggested that both current and future teachers' capacities to teach sustainability could be improved, with an eye to ways to increase their self-efficacy in teaching sustainability. While noting that teaching experience appears to increase confidence in teaching sustainability, the need to increase teachers' capacities is further enhanced by the finding

that few participants articulated their professional learning needs. It might be speculated that more attention to education for sustainability within initial teacher education might assist teachers' capacities and confidence rather than relying on experience alone.

Increasing EfS within initial teacher education is, however, dependent not only on teacher education program accreditation guidelines, but also on university policies and teacher educators' knowledge of and confidence with EfS. As noted by Davis and Davis (2021) in their audit of Australian universities with early childhood education programs, there is a gap between university sustainability and teacher educator EfS. Such work connects with UNESCO's (2014b) priority areas of embedding sustainability into education and policy; integrating sustainability principles into education and training; and enhancing the capacities of educators to deliver EfS.

There appears to be a solid basis for this work within teacher education, with multiple participants in this study identifying pedagogies such as PBL and the 5Es as appropriate for teaching about sustainability. A pedagogy that did not seem to be mentioned by participants is transformative learning (Mezirow, 2003). Although more common in higher education, it has also been reported as being used in upper secondary classrooms to teach sustainability (Tomas et al., 2020). According to Mezirow (2003), transformative learning 'transforms' 'sets of fixed assumptions and expectations (habits of mind, meaning perspectives, mindsets)' so they are 'more inclusive, discriminating, open, reflective, and emotionally able to change. Such frames of reference … are more likely to generate beliefs and opinions that will prove more true or justified to guide action' (pp. 58–59). Haim and Aschauer (2024) promote pedagogical approaches which support creativity and innovation as a way forward for educators. Whereas Simon et al., (2023) suggest an Arts based approach. Conceptually, practitioners and researchers have found many ways to make links between current curriculum and pedagogical approaches to assist teachers with embedding sustainability education into their classroom, but it appears that teacher's skill and will (confidence and proficiency) are a large part of the problem.

Examining pedagogies for sustainability in university education, Murray et al. (2014) found that using transformative learning within EfS was more likely to shift university students' values relating to the environment. Across research from Australia, Germany, and Sweden, it was evident EfS in higher education entailed collaboration, interdisciplinarity, action, and transformative learning to develop students' critical thinking and reflection skills (Brandt et al., 2019; Howlett et al., 2016; Murray et al., 2014; Persson et al., 2023; Tomas et al., 2020). 'Action-oriented approaches' (Persson et al., 2023, p. 201) connect with Dewey's experiential learning. Reflection is an important component of Dewey's approach and is also a key element of Mezirow's transformative learning theory (Dewey, 2004, 1916; Mezirow, 2003). Developing students' critical thinking, communication, and collaboration skills are also important here. Indeed, '[g]rounding sustainability education in Dewey's democratic pedagogy underlines its capacity and obligation to develop critical thinking and systems thinking skills, communication skills and collaboration skills in students' (Tarrant & Thiele, 2016, p. 54). Transformative learning entails changing one's thinking, attitudes, and beliefs. It requires action and ongoing critical reflection.

Educators at all levels, teachers, teacher educators, tertiary educators should promote student engagement with the concepts of EfS to assist in stimulating interest and motivating action of their students (Gorski et al., 2023). They recommend hands on, practical and authentic activities for students. Sass et al. (2024) also promote an action-orientation approach for effective teaching of sustainability. Technologies available in modern classrooms should assist with this endeavour. For example, gaming, simulations, immersive environments (García-Hernández et al., 2023) and mobile devices (Krouska et al., 2023). However, building students' moral and social responsibility towards sustainability is very difficult in the cluttered Australian Curriculum, other curriculum areas such as history (Filatov, 2024) and digital technology (Redmond et al., 2021) are having similar issues finding space for curriculum development in the business of a school day.

Twenty-four participants in this study suggested sustainability activities that connected with students' lives and interests. It might be argued that, after more than a decade of sustainability within the Australian Curriculum, PST and IST have increased their understanding of sustainability and how to teach it in their classrooms. The findings reported from this study are consistent with previous research that found teachers typically had limited capability for teaching sustainability (Dyment et al., 2015; Hill & Dyment, 2016). When sustainability is taught, pedagogical approaches appear to favour engaging students in practical activities, which is consistent with previous research findings (Cutter-Mackenzie & Rousell, 2019; Verlie & Flynn, 2022; Yli-Panula et al., 2020). The apparent focus on engaging students in activities like recycling, composting, and growing food suggests teachers mostly align with the first typologies identified by Timm and Barth (2021), functioning as change agents within their classrooms rather than seeking broader institutional change.

Implications

Ongoing teacher development is required to provide educators with the knowledge and skills to teach sustainability education effectively. This development could include joining relevant professional associations or professional learning communities, attendance at conferences, professional reading or coaching.

A popular way of enhancing teachers' confidence and capacity is through more experienced teachers mentoring less experienced teachers (Ehrich, 2022; Ehrich & Kimber, 2016; Gimma-Farrell, 2015). Such developmental mentoring—both informal and formal—is where mentoring can be viewed as 'a learning activity'. While recognising the impact of the quality of the relationships between mentors and mentees and the formality of the program on the success of mentoring, developmental mentoring provides the mentee with both 'career development and psychosocial support' (Ehrich, 2022, p. 4). Such mentoring might occur one-on-one, through a network, or through a professional learning community, for instance.

This data indicate that Australia has a long way to go to achieve UNESCO's (2014) roadmap for Education for Sustainability including enhancing capacity of educators to deliver sustainability education, and the ripple effect of this is likely

to impact the goal to expand EfS action among youth who are the students of these teachers. However, empowering teachers through environmental and sustainability education could create meaningful change in educational settings, where the newly graduated teachers were unable to implement EfS due to the limited support from school administration and a school culture which does not support EfS (Barnes et al., 2021).

Limitations and future research

There are several limitations to this study that need to be kept in mind when interpreting the results. The first of these limitations is the small number of valid responses which could be a function of survey fatigue. Low response rates might also be a function of the teachers' lack of understanding of the Australia curriculum given the wording of the questions was based on the wording of the curriculum. The curriculum wording may not just be an issue for survey responses but also an issue for curriculum implementation. Additionally, while pedagogical content knowledge was explored, teacher self-efficacy for sustainability was not. It is also important to note that the survey was based on Version 8.4 of the Australian Curriculum (ACARA, 2023). This version has now been replaced with Version 9.0. Future research might be based on Version 9 of the Curriculum, with the four areas of —'systems', 'world views', 'design', and 'futures' (ACARA, 2024). Questions relating to self-efficacy for teaching sustainability might be included. Survey items might also be reorganised to increase valid responses. Further research could also probe reasons limiting teachers' capacity to act more strongly on their clearly expressed beliefs in the value and importance of education for sustainability. Finally, the context where the PSTs and ISTs' attempts to teach EfS were occurring could be something to explore in detail, particularly if data were available on contexts where sustainability is well taught. Further research is needed to probe more deeply into what might be limiting teachers' capacity to act more strongly on their clearly expressed beliefs in the value and importance of education for sustainability. A survey is unlikely to reveal sufficient detail and an alternative data collection such as interviews is suggested.

Although this research did not ask participants about possible barriers to effective teaching of sustainability perhaps the barriers identified by technology integration and STEM researchers parallel this study. For example, there has been a lot of research about teacher's slow uptake of technology integration, as early as Ertmer in 1999. Others have found similar outcomes (Bowman et al., 2022; Brantley-Dias & Ertmer, 2013). The authors of this paper are also researchers in technology integration and STEM and believe that Ertmer's (1999) barriers for technology integration are similar for all STEM related disciplines. First order barriers are situational or issues which are largely out of the teacher control such as access to tools and materials, access to effective professional development, and school policy and culture. The second order barriers identified by Ertmer (1999) are dispositional and often more difficult to address because they are directly related to teachers' beliefs,

confidence and perceived value of the curriculum within their classroom—in this case sustainability.

Conclusion

Sustainability has been an international and Australian priority for over two decades (National Sustainability Council, 2013). It has been promoted as Education for Sustainable Development (UNESCO, 2013) and Education for Sustainability (Australian Education for Sustainability Alliance, 2014). Sustainability is embedded in the Australian Curriculum within selected learning areas and as a cross-curriculum priority (ACARA, 2024). Research has been undertaken from a variety of perspectives (Yli-Panula et al., 2020) including the role of teacher education in preparing teachers for that work (Goller & Rieckmann, 2022; Pegalajar-Palomino et al., 2021). An Australian project working across multiple universities to embed change for sustainability education reported some success (Ferreira et al., 2019).

Findings from this study suggest that these efforts have built basic knowledge of sustainability and positive attitudes among teachers. Respondents almost universally agreed that education for sustainability was of great value and perceived their schools as concerned about sustainability and willing to act. Their expressed understandings of sustainability were consistent with its representation in the Australian Curriculum, and their perceptions of their students' understandings aligned with the curriculum's emphasis on building knowledge and skills to support a sustainable future.

Nevertheless, respondents' confidence in teaching the organising ideas from the sustainability CCP in the Australian Curriculum could have been stronger. A substantial proportion needed more confidence in one or more of those organising ideas and were unable or unwilling to suggest appropriate approaches to teaching sustainability. There may have been very limited development in the teaching of sustainability in Australian schools since previous studies reported similar findings (Hill & Dyment, 2016; Mills & Tomas, 2020; Nicholls & Thorne, 2017).

Conventionally, professional learning and additional resources have been recommended to increase teachers' confidence and enhance their pedagogical approaches (Hill & Dyment, 2016; Mills & Tomas, 2020; Nicholls & Thorne, 2017). Similarly, recommendations have been for further attention to sustainability in preservice teacher education. Given the limited responses to the question about professional development, an alternative approach is to provide teachers (and preservice teachers) with access to mentoring—both formal programs and informal networks, including professional learning communities. Mentoring and professional learning communities could provide valuable guidance and foster a collaborative network. A challenge for this approach is that the respondents in this study were mostly unable or unwilling to suggest what professional development might be appropriate.

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Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose. The authors have no competing interests to declare that are relevant to the content of this article.

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