Article

Teaching and Learning Approaches: Curriculum Framework for Sustainability Literacy for Technical and Vocational Teacher Training Programmes in Malaysia

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Abstract: Given the impact of unsustainable practices, work, and living patterns, it has become increasingly important to raise global citizens as stewards of the earth's life support system. Thus, developing sustainability literacy has become very crucial. A sustainability-literate professional can make sound decisions and act in environmentally friendly, socially acceptable, and economically viable ways. Technical and vocational education and training (TVET) arguably has the potential to educate workers, graduates, and citizens alike in developing sustainability literacy since it is regarded in many nations as the supplier of skilled labour. TVET teacher training programmes in Malaysia have been vastly proficient in developing vocationally competent teachers and workers. Still, there remains uncertainty regarding the extent to which these vocational teaching professionals have been trained to develop sustainability competencies and literacies. The implication is that, when technical and vocational teachers responsible for training workers do not possess the requisite competencies to engage in sustainability education, the potential for TVET to become a viable tool for ESD diminishes. Given this backdrop, this study was undertaken to propose a curriculum framework for sustainability literacy for technical and vocational teacher training programmes. Using a modified Delphi method (MDM) consisting of 15 expert participants from Asian-Pacific countries, four important curricular elements for sustainability literacy were identified and defined. These include the learning outcomes for sustainability literacy, teaching competencies for sustainability literacy, pedagogical approaches to foster effective teaching and learning for sustainability, as well as ESD integration strategies. The specific indicators within this curriculum framework were also defined. The paper concludes with vivid implications for practice within TVET teacher training programmes in realising Goal 4 of the United Nations Sustainable Development Goals (SDGs).

Keywords: approaches of teaching and learning; learning outcomes; teaching competencies; sustainability literacy; education for sustainable development; curriculum framework; technical and vocational education

1. Introduction

Sustainable development has been a long-term goal globally. Its realisation depends on several actors and stakeholders, including higher education institutions, governmental and non-governmental organisations, policymakers, educators, individuals, and so on [1,2]. There is also the growing understanding that to secure our collective futures and create sustainable societies, people must make the right decisions and adjust their behaviour to be in harmony with nature and the environment rather than exacerbate living conditions which invariably affects the balance and sustainability of the earth's life resources [3]. Achieving this desired behaviour would require individuals to possess the awareness, knowledge, skills, and values that support sustainable development. Hence, educating people to develop these capabilities for sustainable development becomes an indispensable

task that institutions of learning must undertake. The concept of Education for Sustainable Development (ESD) has continued to gain importance in educational policies, research, and practice, and rightfully so; it must continue to be promoted so we can move closer towards the attainment of the Sustainable Development Goals (SDGs) [3].

Higher education institutions (HEIs) arguably have the most influence in developing sustainability literate graduates across disciplines [1,4–8]. Sadly, learning for sustainability in higher education has become so intangible that HEIs embrace only a minute depiction of the concept. Some HEIs have adopted green practices and campus-wide initiatives as their sustainability agenda while neglecting the importance of reorienting their programmes to incorporate ESD holistically into the curriculum they provide students. Gadotti [9] argues that HEIs are mostly approaching sustainability in terms of being green and not educating students on how to become sustainable, lead sustainable activities in society and workplaces, and educate them on how they can become self-sufficient members of society. Similarly, Sydow [10] argues that the hype of going green has become a trendy way for HEIs to view sustainability, and sustainability has often become a buzzword for going green. Hence, Sydow [10] argues that those green practices and initiatives across HEIs are not the solution to problem of HEIs not educating for sustainable development, howbeit its importance and that sustainability is much more profound than going green. Hence, a much more impactful resolution would be for HEIs to ensure that their programmes are designed to develop sustainability literate graduates across disciplines. This they can achieve by reorienting their programme curriculum for sustainability literacy.

Technical and vocational education and training (TVET) is an important field of study given its potential in preparing and training workers and graduates to meet the skills demands of nations. TVET has also been termed the supplier of a skilled workforce for nations [11]. It is worth noting that TVET and TVE will be used interchangeably for the rest of this paper.

Given the unique role, TVET plays in developing nations, its potential in developing sustainability-competent vocational professionals should not be underestimated. However, achieving success in developing a sustainability literate and competent workforce depends on how well vocational teacher training institutions address sustainability in their programmes. Kennelly et al. [12] and Owens [13] assert that graduates can only develop the necessary capabilities for sustainable work and living if the teachers responsible for facilitating and coordinating their learning understand sustainability principles, contents, and pedagogies. This thus reinforces the need for technical and vocational education (TVE) teacher training programmes to holistically incorporate ESD into their programmes, both at the undergraduate and postgraduate levels to train sustainability literate vocational teachers who can, in turn, develop sustainability-competent vocational professionals. Consequently, this calls for the reorientation of TVET teacher training programmes, especially with regard to the integration of sustainability education across the length and breadth of the curriculum.

In the early 1970s, the resolution reached at the Tbilisi Conference was that "the curricula for those undertaking vocational and technical education should include information about the environmental changes that result from the sort of work they will do" and "that emphasis should be given in vocational and technical education to the environmental applications for workers in each vocational area, and the collective effect of related vocations upon the environment" [14]. Since the first resolution, several forums have been held to advance ESD in TVET. However, Gough [15] reports that ESD in TVET has become so indefinable that progress cannot be exactly specified. Some of the challenges reported in the literature for the slow-paced and sometimes non-existent progress in terms of embedding ESD into TVET programmes include: the perception that the TVET curriculum is overcrowded, as held by some vocational educators; some educators viewing sustainability education as a burden rather than a solution to societal challenges; the lack of a sustainability mandate at the national level requiring teacher education institutions to integrate ESD into their programmes; the absence of teacher certification guidelines defining sustainability

as a benchmark for the assessment and evaluation of quality in TVET programmes; the unavailability of professionally trained vocational educators equipped with adequate ESD knowledge; and TVET educators not knowing how to approach ESD [1,15–19].

These issues and challenges further reiterate one major problem, i.e., the need for a curriculum framework that accounts for important ESD elements that TVET teacher training institutions must embed into their curriculum to train pre-service vocational teachers at the undergraduate level. Regardless of the many frameworks and models of sustainability, these frameworks need to define specific ESD standards and elements that must be embedded into the curriculum of TVET teacher training programmes across HEIs. Cebrián and Junyent [20] argue that existing ESD frameworks must become alive and integrated into the existing teacher training curriculum to facilitate the development of ESD competencies among pre-service teachers. Given the absence of such a holistic curriculum framework for sustainability literacy in technical and vocational teacher education, we proposed an exemplary curriculum framework for sustainability literacy that reflects the viewpoints of sustainability experts in the Asian-Pacific region. We do this by consolidating the viewpoints of sustainability experts into important ESD elements that must be accounted for in the curriculum of TVET teacher training programmes to develop sustainability-literate vocational teachers who would, in turn, contribute to the training of more sustainability-literate workers and graduates, thereby enabling the development of a sustainability-literate citizenry and workforce. This research contributes to the existing literature by providing an exemplary curriculum framework that defines key elements of ESD, reflecting the key competencies that vocational pre-service teachers must develop to successfully design lessons within their subjects.

The following section thus presents a summary of the theoretical foundations of our study, first presenting an overview of the concept of sustainable development and education for sustainable development. We then discuss sustainability literacy from a technical and vocational teaching perspective. Then we restate the study aims before charting the methodological procedures used to obtain and analyse the data. Next, we discuss the study's findings and implications before concluding and discussing the study's limitations, making recommendations, and proposing directions for future research.

1.1. The Concept of Sustainable Development

The concept of sustainable development has been described in so many ways. The most common definition to date remains that which was reported in the 1987 Brundtland's commission report at the United Nations World Conference on Environment and Development: Our Common Future, wherein sustainable development was defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" [21].

Similarly, Opoku and Ahmed [22], redefined sustainable development as the adjustment of human behaviour to address the needs of the present without compromising the ability of future generations to meet their own needs. They argued that human behaviour and the concept of needs are pertinent to achieving sustainability. Furthermore, Griggs, et al. [23] defines sustainable development as "the development that meets the needs of the present while supporting Earth's life support systems, upon which the welfare of current and future generations depends". They explained that the life support systems were essential elements and resources present on the earth that ensured the survival of all living organisms. Sustainable development aims to ensure quality of life for all, now and for future generations, through environmental protection, ethics, values, and dispositions that promote sustainability and equip individuals with the capability to maximise earth's life support system to meet our needs and develop sustainable economies [3].

1.2. The Concept of Education for Sustainable Development

To develop sustainability literate graduates, workers, and citizens, Education for Sustainable Development must become an important component of the teacher training cur-

riculum [24,25]. Education for Sustainable Development (ESD) is concerned with teaching and learning needed to develop the individual's capabilities to contribute to the long-term future of the environment, society, and economy of nations and the world at large [2,3]. Furthermore, Longhurst et al. [26] defines Education for Sustainable Development as "the process of equipping students with the knowledge and understanding, skills and attributes needed to work and live in a way that safeguards environmental, social and economic well-being, both in the present and for future generations alike" (p. 5). The Cloud Institute for Sustainable Education [27] also describes education for sustainable development as learning to think and act in ways that will safeguard the future and well-being of people and our planet. These definitions suggest that ESD promotes the kind of learning needed to develop the capabilities that are also necessary to safeguard earth's life support systems now and in the future. However, the challenge with ESD at the tertiary level is that higher education institutions (HEIs), despite recognising its importance, have not been able to holistically integrate it across their programmes including technical and vocational teacher training programmes. Addressing this has become increasingly important.

1.3. Sustainability Literacy in Technical and Vocational Education

Sustainability literacy is focused on applying sustainable development capabilities to addressing the environmental, social, and economic issues that threaten earth's life support systems. Parkin et al. [28] as cited in Opoku and Egbu [3] describe "sustainability literacy as the knowledge and understanding to make decisions and act more sustainably as part of the individual and collective change by rewarding decisions towards sustainable development". Hence, a person is said to be sustainability literate if they:

- Understand the need to change and transform into sustainable ways of doing things individually and collectively.
- Have adequate knowledge and skills to make decisions and act in ways that promote sustainable development.
- Be capable of recognising and rewarding other people's actions that promotes sustainable development [29,30].

A person is considered sustainability literate if that person understands the fundamental principles of sustainable development and can apply this knowledge and understanding in making environmentally friendly decisions that promote social well-being and contribute to sustainable economies. Therefore, sustainability literacy in technical and vocational education can be achieved if vocational educators develop the requisite competencies to educate for sustainable development. To develop these competencies, technical and vocational teacher education programmes must reorient their curricula to holistically integrate ESD principles to enable the training and development of sustainability-literate vocational teachers. The challenge, however, is that there are no curriculum frameworks for sustainability literacy to guide TVET educators and relevant stakeholders regarding the important ESD elements that a curriculum for developing sustainability literacy should model. We elucidate our approach to filling this gap by discussing the theoretical foundations of this study in the following section.

1.4. Theoretical Underpinnings

Educational stakeholders and theorists have adopted diverse perspectives and paradigms in shaping how we view the world [31]. Education is considered to be possibly the greatest change agent with regard to sustainable development [32]. In the early 1980s, the concept of SD was introduced by the World Conference on Environment and Development (WCED) as an approach to balancing the needs of the environment with those of economic and social development in such a way that we do not compromise the ability of future generations to do the same [14]. In achieving this goal, education became increasingly paramount [20]. This crucial role of educating for sustainable development calls for teachers and educators at all levels to act as change agents, capable of preparing their students to develop the capacities for sustainable living. Goal 4.7 of the SDGs reiterates the need for "all learners to acquire the knowledge and

skills needed to promote sustainable development by 2030". Asikainen and Tapani [32] state that pursuance of this goal should manifest as actions by both teachers and students.

Developing teachers' capacities and competencies in education for sustainable development (ESD) is an endeavour that has been regarded by many as the priority of priorities [32–34]. To develop these ESD competencies, TVET teacher training programmes must be consciously designed to reflect substantial knowledge about the SD concept, issues, or phenomena, as well as the pedagogical competencies required to implement innovative teaching strategies on SD. Several labels, such as holism, pluralism [35], and action orientation [36], have been mentioned as approaches to ESD implementation. According to Saleem et al. [37], connections between the three areas of social, economic, and environmental knowledge make up "holism" in teaching and learning, whereas "pluralism" refers to a variety of viewpoints and beliefs about transformative and innovative teaching traditions, as well as learner-centred teaching techniques that incorporate critical evaluation, including social learning, participatory decision-making, critical thinking and value-based learning. These reflect learning that is transformative. According to Asikainen and Tapani [32], the transformative role of ESD can be summed up as follows: ESD leverages learners' experiences and generates possibilities for engagement as well as the development of creativity, innovation, and the capacity to consider other modes of living. It challenges students to consider how their daily decisions affect living systems. Therefore, it can be summed up that the goal of ESD is to promote transformative learning to equip individuals to act sustainably in complex situations. To achieve the desired competency required to engage learners to reflect and change their behaviours, teachers must learn about the contents of SD and ESD, develop critical sustainability competencies, and learn how to facilitate all of these as educators [32].

Transformative learning (TL) refers to a qualitative shift in the learner's view or perception, particularly when the learner reframes or examines their assumptions or thought patterns and develops a critical awareness of those beliefs and practices that become problematic [18]. Many ESD scholars have chosen transformative learning (TL) as a theoretical foundation because of its broad definition and general goal: to contribute to a more significant societal change (or transformation) through education. For instance, Ratnavadivel et al. [38] argued the need for a transformative teacher-education model to develop teachers who can meet the learning demands of future generations. Ratnavadivel et al. [38] posit that this transformative teacher education model must be research-based, relevant to current and future needs, meet new stakeholders' expectations, be internationally recognised, build the needed human capital, and be able to address the needs of the nation sustainably. Similarly, Harun et al. [39] proposed that a good teacher education curriculum structure for developing ESD-competent teachers is one that is integrated and emergent in nature with thinking as its core, specifically in the following aspects: (i) facilitating the development of the intellect, (ii) learning to learn, (iii) knowledge production, (iv) metacognition, (v) decision making, (vi) creativity, (vii) problem solving, and (viii) problem-based learning.

Although TL has been used extensively as a background theory in ESD [40], there are still some issues with this relationship [41]. First, in ESD, the definition of transformation is often ambiguous because any change can qualify as transformation. Second, in transformational ESD, it is never entirely apparent what has to be maintained and what needs to be transformed [41]. Hence, we refer to the stringent definition of transformative learning only as learning that entails a significant change in the prevailing modes of knowing and thinking that underlie people's perceptions of the world and interactions with it—i.e., an epistemic transformation—can be considered transformative. With this, we recognise that for learning to be transformational and bring about the desired change, the learning structures also need to be transformed. Yet, clear learning goals are needed, and the teacher's role in guiding, facilitating, and participating in the learning process needs to be clarified and modelled [32]. Technical and vocational teachers are an important group of teachers whose immense role and contribution to sustainable development have been profoundly discussed in the background of this study and hence should not be minimised. Recognising

the importance of a transformative model of teacher education in preparing pre-service vocational teachers for teaching and learning for sustainable development, we will propose an exemplary curriculum framework for sustainability literacy in technical and vocational teacher training programmes representing the perspectives of sustainability experts. In doing so, we posed this central question to guide the investigation through three rounds of a modified Delphi.

RQ1. What are ESD experts' perspectives on important elements that must be embedded into the TVET teacher training curriculum to develop sustainability-literate vocational teachers?

2. Materials and Methods

2.1. Research Paradigm and Design

This study adopts a pragmatic research paradigm. Pragmatism is described as the philosophical paradigm for most mixed-method research [42]. It advocates for a more pluralistic and compatibilist approach to research by integrating quantitative and qualitative methods in a single study. According to Creswell [43], pragmatism focuses on the outcomes of research, that is, the actions, situations, and consequence of the inquiry rather than the antecedent conditions as in post-positivism. The foundations of pragmatism according to [31] focus on "what works" and an emphasis on finding solutions to real-world problems. Consequently, rather than focusing on the philosophical underpinnings for how truth is uncovered, pragmatism allows for adopting appropriate and suitable methods for solving a problem. The emphasis is usually on the problem being investigated and the questions asked about the problem. Therefore, a modified Delphi method that consolidates qualitative and quantitative research methods was used. Adler and Ziglio [44] describe the Delphi method as a "group communication process that is structured to produce a detailed examination of a topic/problem and includes discussion from the participating group but not one that forces a quick compromise". The modified variant of the Delphi method was utilised in the study as it provided a means to solicit feedback from expert participants selected from Malaysia and Asian-Pacific countries without these experts being physically present, as in face-to-face interviews. Stitt-Gohdes and Crews [45] and Linstone and Turoff [46] explain that the Delphi approach is particularly suited when the following is apparent: (a) when the problem does not lend itself to precise analytical techniques, but can benefit from subjective judgments on a collective basis; (b) when more individuals are needed than can adequately interact in a face-to-face exchange; and (c) when time, cost, and geography make frequent group meetings infeasible. Therefore, the modified Delphi method was used because this study reflects these characteristics. In our use of the modified Delphi method for this study, three consecutive rounds were used, and instruments were distributed to expert participants via emails as these experts were geographically distributed.

2.2. Selection Criteria for Expert Participants

The quality of data from a Delphi study will only be as good as the quality of the expert panellist [47,48]. Hence, we first considered how other scholars had defined the term "expert" in the past. Linstone and Turoff [46] describe an expert as one who has mastered a specific field and can effectively respond to matters or issues without thinking critically. They explained that such a response might emerge from the subconscious as the individual is well-grounded in the discussed subject. Similarly, Taylor et al. [49] describe an expert as one knowledgeable in a particular field. Therefore, in the context of this study an expert is described as an academician or a practitioner in the field of Education for Sustainable Development who is actively engaged in teaching and research projects involving one or more dimensions of sustainability and engaged in disseminating research outputs in the form of scholarly, empirical, opinion, and conceptual papers. Expert participants were selected based on the following criteria: (a) the expert is knowledgeable about ESD concepts and issues; (b) the expert is within the field of TVET and particularly from an Asian–Pacific country, including Malaysia; (c) the expert participant has a minimum of five years of experience working on Education for Sustainable Development projects and

has consolidated research reported through scholarly publications; and (d) the selected expert has a Ph.D. with ESD as an area of specialisation. The selection of experts was carried out through purposeful sampling and snowball sampling. The initial identification of experts was based on purposeful sampling, where experts meeting the selection criteria were contacted and invited to participate in the study. Snowball sampling was also used, as expert participants were asked to recommend their colleagues who may be interested in the study and meet the requirements for participation. Each expert invited to participate in the study recommended at least one professional colleague to whom invitations were also sent. At least five experts who later constituted the final expert panellist for this study were recommended by other experts.

2.3. Size of the Expert Panel and Number of Rounds

The size of the expert panel for a Delphi study usually consists of as few as 7 participants to as many as 100 participants [46,50,51]. While the specific and allowable size is still an issue of contention across fields, consensus builds around utilising between 10 to 20 participants. Hence, for this study, 15 expert participants were selected. However, only 14 expert participants completed all three rounds of the study. The number of rounds adopted for a modified Delphi study is somewhat arbitrary, i.e., it is not based upon a defined system of operation. Instead, it is based on random choice, usually determined by the researcher after giving due diligence to specific factors. Delphi studies have commonly utilised three and four rounds [52–54]. Linstone and Turoff [47] consented to the use of three rounds to attain stability in participants' responses They further argued that the use of more than three rounds tends to show very few changes to previous rounds and may lead to excessive repetition which may be unacceptable to expert participants. Therefore, considering these factors, the number of Delphi rounds was set a priori at three. However, the researchers were open to extending the rounds if stability of response and consensus were not achieved at the end of the third round.

2.4. Instrumentation and Data Analysis

Data from round one was collected using an open-ended questionnaire that sought to determine experts' perspectives on important elements that must be embedded into the TVET teacher training curriculum to develop sustainability-literate vocational teachers. Data for round two and three of the modified Delphi was collected using a structured questionnaire designed from expert participants' responses from round one. The questionnaire required expert participants to indicate the extent to which they agreed to items produced from round one responses.

Data from the first round was analysed qualitatively using thematic content analysis. Four key themes emerged from the analysis, which formed the basis for the second-round questionnaire. Experts were asked to give vivid descriptions of the identified themes which reflect important curriculum elements for developing ESD competencies in TVET teacher training programmes in Malaysia. The researchers sent a copy of the analysis from round one to each expert for review and verification. This was done to eliminate researchers' bias and ensure that the analysis adequately reflected the experts' perspectives.

In rounds two and three of the modified method, the goal was to obtain group consensus on each identified curriculum element. The response from round one of the MDM was translated into a 5-point Likert scale instrument. Expert participants were asked to rate their level of agreement or disagreement after considering the group's summaries of the items for each identified curriculum element. Agreement was reached using the median, while consensus was reached using the interquartile range (IQR). Agreement in the context of a Delphi study is used to show the group's response to the individual statement, whereas consensus is used to measure the extent to which the group members agree with each other regarding the issues discussed [55]. Hsu and Sandford [56] state that the criteria upon which agreement and consensus are based are subjective, making the issue of consensus one of the most controversial aspects of the Delphi process. As much as a universally agreed upon standard for assessing agreement and consensus in

a Delphi study does not exist, several studies in the literature recommend parameters between 51% to 100% [56–59]. Hence, in this study the level of agreement for each item was determined using the median. This practice is consistent with the literature on Delphi studies, as the median is less influenced by extreme scores with small groups than the mean and standard deviation [60]. The threshold for agreement was set according to the Peck and Devore [61] benchmark. Median scores greater than or equal to ($\geq$) 3 were considered as items that expert participants agreed to. The level of consensus (i.e., the extent to which expert participants agree with each other) relative to an item was estimated using the interquartile range (IQR). A threshold of ≤ 1 on a five-point scale was set as a benchmark for determining consensus. This practice is consistent with the research literature on Delphi studies [61–65].

3. Results

The study sought to describe ESD experts' perspectives on important elements that must be embedded into the TVET teacher training curriculum to develop sustainability-literate vocational teachers. In round one of the MDM, data from the open-ended questionnaire was analysed thematically, and four main themes emerged. The themes include the learning outcomes for sustainability literacy, teaching competencies for sustainability literacy expressed as knowledge, skills and specific attributes, pedagogical approaches for sustainability teaching and learning, and ESD integration strategies. We mapped out these emerging themes as the missing link in Malaysia's TVET teacher training curriculum. Expert participants in round one was also asked to express what these components constitute clearly. In rounds 2 and 3, the researcher sought to ascertain the extent to which experts agreed to the components and the indicators generated from round one (i.e., agreement) and the extent to which experts agreed with each other regarding the components and indicators described (i.e., consensus). The median and interquartile range were used to establish agreement and consensus in this modified Delphi. The following headings present the study findings according to the four emergent themes representing four curriculum components.

3.1. Learning Outcomes for Sustainability Literacy

The first component of the curriculum framework identified was the learning outcomes for sustainability literacy. These outcomes were classified into general and specific learning outcomes for sustainability literacy for TVET teacher training programmes. Tables 1 and 2 show the general and specific learning outcomes for sustainability literacy in TVE. In round 1, experts identified 8 general learning outcomes for sustainability literacy in TVE, out of which one (item 8) was discarded at the end of round three because median values < 3 and IQR values > 1 were obtained. Hence, items 1 to items 7 from the general learning outcomes achieved consensus.

Table 2 also shows the identified specific learning outcomes for sustainability literacy for TVET teacher training programmes. All items were greater than or equal to the median values ≥ 3 and IQR ≤ 1, indicating that consensus was achieved and that expert participants agreed to the items reflecting the specific learning outcomes.

3.2. Teaching Competencies for Sustainability Literacy

Expert participants also identified and outlined the teaching competencies for sustainability literacy for TVET teacher training programmes. These competencies were expressed as sustainability knowledge areas, specific skills, and attributes. These are discussed in the following subheadings.

3.2.1. Knowledge Areas for Sustainability Literacy in TVET (Factor 3)

Table 3 shows the results obtained in rounds 1, 2 and 3 regarding the teaching competencies for sustainability literacy in TVET expressed as sustainability knowledge areas. These identified areas represent important sustainability knowledge domains that can be embedded into the TVET teacher training curriculum to develop sustainability-competent vocational

teachers. Twenty-three (23) items reflecting various sustainability knowledge areas were identified. After round three, consensus was achieved for all items in this category.

Table 1. General learning outcomes for sustainability literacy (Factor 1).

Factor 1	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
1. To identify the principles of sustainable development	2	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
2. To discuss the theoretical underpinnings of education for sustainable development (ESD)	2	15	4.00	1.00	14	4.00	0.50	13	A	Consensus
3. To discuss the historical underpinnings of education for sustainable development (ESD)	2	15	4.50	1.00	14	5.00	1.00	13	A	Consensus
4. To explain the key principles of SD such as equity, ecological balance and protection, education, responsible citizenship, responsible production and consumption, peace, conflict resolution, human security, social justice, and so on	4	15	4.00	0.00	14	4.00	0.00	13	A	Consensus
5. To apply pedagogies for education for sustainable development in their lessons	5	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
6. To demonstrate competency in delivering lessons on sustainability within TVET programmes	6	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
7. To explain ethics in sustainability	5	15	4.00	0.25	14	4.00	0.50	13	A	Consensus
8. To evaluate activities from TVET organisations that contribute to environmental, social, and economic issues	3	15	2.00	1.25	14	2.00	2.00	13	D	No Consensus

f: Number of times mentioned. MED: Median; IQR: Interquartile Range; n: Sample; A: Accepted; D: Discarded; Shaded cells indicate consensus was not achieved. R1: Round 1, R2: Round 2, R3: Round 3.

Table 2. Specific learning outcomes for sustainability literacy (Factor 2).

Factor 2	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
1. Discuss practices within TVET occupational areas that threaten the attainment of a sustainable future.	2	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
2. Demonstrate responsible use of materials and resources in workshops/laboratories.	8	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
3. Demonstrate sustainable behaviour for responsible citizenship.	3	15	5.00	1.50	14	Z	1.00	13	A	Consensus
4. Demonstrate the capacity to reflect on actions that contribute to economic, social, and environmental issues.	3	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
5. Apply appropriate pedagogies in teaching sustainability concepts.	4	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
6. Use historical knowledge and evidence to identify unsustainable practices.	2	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
7. Analyse emerging industrial processes and activities that affect living conditions.	1	15	4.50	1.00	14	5.00	1.00	13	A	Consensus
8. Analyse how industrial activities contribute to environmental issues.	1	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
9. Distinguish between environmental, economic, and social aspects of sustainability.	3	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
10. Discuss nature and environmental conservation.	2	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
11. Discuss wealth distribution as an important element of economic sustainability for TVET organisations.	1	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
12. Develop critical thinking abilities to resolve issues resulting from unsustainable practices.	4	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
13. Discuss climate change and its impact on the ecosystem.	3	15	5.00	1.00	14	5.00	1.00	13	A	Consensus
14. Evaluate the causes of climate change and its implication for living conditions.	2	15	5.00	1.00	14	5.00	1.00	13	A	Consensus
15. Explain the role of students in sustainability through participation in civic learning.	1	15	4.50	1.00	14	4.00	1.00	13	A	Consensus

Table 2. *Cont.*

Factor 2	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
16. Explain the place of ethics in educating students for a sustainable future.	2	15	5.00	0.25	14	5.00	0.50	13	A	Consensus
17. Explain the concepts of ethical behaviour and attitude.	3	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
18. Explain the role of fairness and justice in building an equitable society.	1	15	4.00	1.00	14	4.00	1.00	13	A	Consensus
19. Explain how industrial processes are impacted by social, environmental, economic and political interventions.	4	15	4.00	1.00	14	4.00	1.00	13	A	Consensus

f: Number of times mentioned. MED: Median; IQR: Interquartile Range; n: Sample; A: Accepted; D: Discarded; Shaded cells indicate consensus was not achieved. R1: Round 1, R2: Round 2, R3: Round 3.

Table 3. Sustainability knowledge areas for sustainability literacy in TVET (Factor 3).

Factor 3	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
1. TVET teacher trainees must be able to explain the concept of sustainable development.	7	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
2. TVET teacher trainees must be able to discuss the principles of sustainable development.	7	10	4.00	2.00	14	4.00	1.00	13	A	Consensus
3. TVET teacher trainees must be able to analyse the relationships between environmental, social, and economic systems.	2	10	4.50	1.25	14	5.00	1.00	13	A	Consensus
4. TVET teacher trainees must be able to explain the relationships between environmental, social, and economic systems.	4	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
5. TVET teacher trainees can use scientific evidence to analyse how human activities impact the ecosystem.	1	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
6. TVET teacher trainees can use technological tools to appraise how human activities impact the ecosystem.	2	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
7. TVET teacher trainees must be able to explain the important elements that make a sustainable community.	2	10	5.00	1.00	14	5.00	0.50	13	A	Consensus
8. TVET teacher trainees must be able to explain the concept of sustainable development.	2	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
9. TVET teacher trainees must be able to discuss the principles of sustainable development.	2	10	5.00	1.00	14	5.00	0.50	13	A	Consensus
10. TVET teacher trainees must be able to analyse the relationships between environmental, social, and economic systems.	1	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
11. TVET teacher trainees must be able to explain the relationships between environmental, social, and economic systems.	1	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
12. TVET teacher trainees can use scientific evidence to analyse how human activities impact the ecosystem.	3	10	4.50	1.00	14	5.00	1.00	13	A	Consensus
13. TVET teacher trainees can use technological tools to appraise how human activities impact the ecosystem.	2	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
14. TVET teacher trainees must be able to explain the important elements that make a sustainable community.	3	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
15. TVET teacher trainees must be able to explain the concept of sustainable development.	1	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
16. TVET teacher trainees must be able to discuss the principles of sustainable development.	2	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
17. TVET teacher trainees must be able to analyse the relationships between environmental, social, and economic systems.	2	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
18. TVET teacher trainees must be able to explain the relationships between environmental, social, and economic systems.	3	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
19. TVET teacher trainees must have knowledge in designing teaching aids to explain complex sustainability concepts.	2	10	5.00	1.00	14	5.00	1.00	13	A	Consensus

Table 3. *Cont.*

Factor 3	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
20. TVET teacher trainees must have knowledge in utilising teaching aids to simplify complex sustainability concepts.	1	10	5.00	0.00	14	5.00	0.00	13	A	Consensus
21. TVET teacher trainees must develop the knowledge needed to demonstrate effective teaching strategies when delivering lessons about sustainability.	2	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
22. TVET teacher trainees must have knowledge of effective teaching methods to deliver lessons about sustainability.	4	10	4.50	1.00	14	5.00	1.00	13	A	Consensus
23. TVET teacher trainees can apply various teaching and learning theories in teaching and learning for sustainability.	2	10	5.00	1.00	14	5.00	1.00	13	A	Consensus

f: Number of times mentioned. MED: Median; IQR: Interquartile Range; n: Sample; A: Accepted; D: Discarded. Shaded cells indicate consensus was not achieved. R1: Round 1, R2: Round 2, R3: Round 3.

3.2.2. Specific Skills (Factor 4)

Expert participants from the modified Delphi also expressed the teaching competencies in terms of the specific skills that TVET teacher trainees should possess in ESD teaching and learning. Table 4 shows the identified specific skills for sustainability literacy in technical and vocational education. All identified teaching skills for sustainability literacy achieved consensus at the end of round three and, as a result, no item was discarded in this category.

Table 4. Specific skills for sustainability literacy in TVET (Factor 4).

Factor 4	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
1. Able to use frameworks to analyse the impact of human activities on the ecosystem.	7	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
2. Analyse complex sustainability issues that can be addressed within TVE.	7	10	4.50	1.00	14	5.00	1.00	13	A	Consensus
3. Use innovative pedagogies in communicating the concept of sustainability to learners.	2	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
4. Integrate SD concepts within the scope of each vocational subject.	4	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
5. Apply sustainability knowledge in solving real-life problems.	1	10	5.00	1.00	14	5.00	0.50	13	A	Consensus
6. Apply sustainability knowledge in proposing workplace practices that align with SD principles.	2	10	5.00	1.00	14	5.00	0.50	13	A	Consensus
7. Able to integrate various teaching methods in teaching SD concepts.	2	10	5.00	1.00	14	5.00	0.50	13	A	Consensus
8. Demonstrate leadership skills for mitigating sustainability challenges.	2	10	4.50	1.00	14	4.00	1.00	13	A	Consensus
9. Analyse sustainability issues using technical and vocational education approaches.	2	10	4.50	1.00	14	4.00	1.00	13	A	Consensus
10. Apply holistic approaches to solving real-life sustainability problems.	1	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
11. Develop learning activities that show how sustainability can be achieved in global communities.	1	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
12. Develop learning activities that show how sustainability can be achieved in local communities.	3	10	5.00	0.00	14	5.00	0.00	13	A	Consensus
13. Investigate practices that result in sustainability issues and challenges in local communities.	2	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
14. Investigate unfamiliar problems resulting from human practices and activities.	3	10	4.50	1.00	14	5.00	1.00	13	A	Consensus
15. Propose solutions to unfamiliar problems by applying sustainability knowledge.	1	10	5.00	1.00	14	5.00	1.00	13	A	Consensus

<div align="center">Table 4. <i>Cont.</i></div>

Factor 4	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
16. Criticise information about environmental, social, cultural and economic issues.	2	10	5.00	0.25	14	5.00	0.00	13	A	Consensus
17. Able to select information for investigations about sustainability issues.	2	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
18. Able to organise data for learning activities about sustainability.	3	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
19. Evaluate the accuracy of data for investigation purposes.	2	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
20. Analyse existing models to explain the social aspects of SD.	1	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
21. Analyse existing models to explain the environmental aspects of SD.	2	10	5.00	1.00	14	5.00	1.00	13	A	Consensus
22. Analyse existing models to explain the economic aspects of SD.	4	10	5.00	1.00	14	5.00	0.50	13	A	Consensus
23. Analyse existing models to explain the cultural aspects of SD.	2	10	5.00	0.25	14	5.00	0.00	13	A	Consensus

f: Number of times mentioned. MED: Median; IQR: Interquartile Range; n: Sample; A: Accepted; D: Discarded. R1: Round 1, R2: Round 2, R3: Round 3.

3.2.3. Attributes for Sustainability Literacy in TVE

The modified Delphi identified attributes for sustainability literacy for TVET teacher training programmes. Expert participants identified 16 attributes required for sustainability literacy that pre-service TVET teachers ought to develop. Table 5 shows the identified attributes. All 16 items for this component were agreed upon, and consensus was achieved.

<div align="center">Table 5. Attributes for sustainability literacy in TVET (Factor 5).</div>

Factor 5	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
1. Reflection	7		4.00	1.00	14	4.00	1.00	13	A	Consensus
2. Care	5		5.00	1.00	14	5.00	0.50	13	A	Consensus
3. Charity	1		5.00	1.00	14	5.00	0.50	13	A	Consensus
4. Respect	8		4.00	1.00	14	4.00	1.00	13	A	Consensus
5. Compassion	5		4.00	1.00	14	4.00	1.00	13	A	Consensus
6. Cooperation	3		4.00	1.00	14	4.00	1.00	13	A	Consensus
7. Self-determination (i.e., one's ability to control one's own life)	1		4.00	1.00	14	4.00	1.00	13	A	Consensus
8. Self-reliance (i.e., reliance on one's powers and resources rather than others)	2		4.00	1.00	14	4.00	1.00	13	A	Consensus
9. Empathy (i.e., one's ability to understand and share the feelings of others)	8		4.00	1.00	14	4.00	1.00	13	A	Consensus
10. Emotional intelligence (being sensitive to the needs of others)	6		4.00	1.00	14	4.00	1.00	13	A	Consensus
11. Ethics (behave in ways that conform to the principles of SD)	9		4.50	1.00	14	4.00	1.00	13	A	Consensus
12. Assertiveness (one's ability to express their feelings, opinions, beliefs and needs, directly, openly, and honestly, while not violating the personal rights of others).	2		4.00	1.00	14	4.00	1.00	13	A	Consensus
13. Appreciates all living entities	3		4.00	1.00	14	4.00	1.00	13	A	Consensus
14. Appreciates cultural, social, economic, and environmental development and biodiversity.	2		4.00	1.00	14	4.00	1.00	13	A	Consensus

Table 5. *Cont.*

Factor 5	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
15. Appreciates that current actions can impact the quality of life for future generations.	1		4.00	1.00	14	4.00	1.00	13	A	Consensus
16. Expresses the view that technology alone cannot solve all human problems.	3		4.00	1.00	14	4.00	1.00	13	A	Consensus

f: Number of times mentioned. MED: Median; IQR: Interquartile Range; n: Sample; A: Accepted; D: Discarded. R1: Round 1, R2: Round 2, R3: Round 3.

3.3. ESD Pedagogical Approaches

The third component of the curricular framework for sustainability literacy identified is the pedagogical approaches to foster effective teaching and learning for sustainability. Expert participants identified and reached consensus on 11 pedagogical approaches. Table 6 shows the results obtained from each round of the modified Delphi.

Table 6. Identified ESD pedagogical approaches (Factor 6).

Factor 6	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
1. Case studies	2		5.00	1.00	14	5.00	1.00	13	A	Consensus
2. Stimulus activities	3		4.00	1.00	14	4.00	1.00	13	A	Consensus
3. Place-based learning	2		5.00	0.25	14	5.00	0.00	13	A	Consensus
4. Problem-based learning	9		4.50	1.00	14	5.00	1.00	13	A	Consensus
5. Simulation	2		4.50	1.00	14	5.00	1.00	13	A	Consensus
6. Transformative pedagogy	8		5.00	1.00	14	5.00	1.00	13	A	Consensus
7. Collaborative learning	5		4.50	1.00	14	4.00	1.00	13	A	Consensus
8. Pedagogy of work	1		4.00	1.00	14	4.00	1.00	13	A	Consensus
9. Enquiry-based learning	4		4.00	0.25	14	4.00	0.50	13	A	Consensus
10. Heutagogical approaches	1		5.00	1.00	14	5.00	1.00	13	A	Consensus
Lecture or exposition	4		5.00	1.00	14	4.00	0.00	13	A	Consensus

f: Number of times mentioned. MED: Median; IQR: Interquartile Range; n: Sample; A: Accepted; D: Discarded. R1: Round 1, R2: Round 2, R3: Round 3.

3.4. ESD Integration Strategies

The fourth component of the proposed curriculum framework for sustainability literacy is the integration strategies that TVET faculties can utilise in embedding ESD holistically into their programme curriculum, research, and practice. After three rounds of the modified Delphi, expert participants identified 10 integration strategies as part of the curricular framework for sustainability literacy. Table 7 shows the identified ESD integration strategies. Consensus was achieved for all 10 strategies after round 3.

Table 7. ESD integration strategies (Factor 7).

Factor 7	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
1. Integrating sustainability in the TVET curriculum should begin with universities adopting a sustainability philosophy, vision and mission statements.	2	10	3.00	1.00	14	4.00	1.00	13	A	Consensus
2. Each university should formulate specific sustainability goals which a person may direct within the institution by a team whose role would be to liaise with faculties to embed ESD within their formal curriculum.	1	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
3. TVET faculties should identify specific competencies for education for sustainability for which the TVET programme should prepare students.	1	10	4.00	1.00	14	4.00	1.00	13	A	Consensus

Table 7. *Cont.*

Factor 7	R1		R2			R3			A	Remarks
	f	n	MED	IQR	n	MED	IQR	n		
4. TVET faculty members should integrate sustainability themes into their research and practice as this would reinforce the importance of teaching sustainability in the courses they teach.	2	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
5. TVET programmes should integrate sustainability into their co-curricular activities so that students can develop skills for sustainability while participating in these activities.	2	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
6. TVET faculties should facilitate staff development in education for sustainable development.	2	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
7. Each TVET educator should identify areas where ESD concepts can be integrated successfully in their courses.	1	10	4.50	1.00	14	5.00	1.00	13	A	Consensus
8. Sustainability should be designed for all students in all programmes within the university to enrol in.	1	10	3.00	1.00	14	4.00	1.00	13	A	Consensus
9. The TVET programme can integrate ESD into all core courses to ensure that all students participate in these learning opportunities for sustainability.	2	10	4.00	1.00	14	4.00	1.00	13	A	Consensus
10. TVET faculties should practice sustainability practically, so students develop attributes and values that reflect these practices. For example, TVET faculty buildings and environment can integrate sustainable designs, and work carried out in workshops can be modelled after sustainability.	1	10	4.00	1.00	14	4.00	1.00	13	A	Consensus

f: Number of times mentioned. MED: Median; IQR: Interquartile Range; n: Sample; A: Accepted; D: Discarded. R1: Round 1, R2: Round 2, R3: Round 3.

4. Discussion

The researchers sought to propose a curriculum framework for sustainability literacy for TVET teacher training programmes in Malaysia. Findings will be discussed in line with the results presented in the proceeding section.

4.1. Learning Outcomes for Sustainability Literacy for TVET Teacher Training Programmes

Two major categories of learning outcomes were identified. The first category was the general learning outcomes for sustainability. In this category, experts used broad statements to convey the general aspects of ESD that they considered important for developing pre-service teachers' capabilities for sustainability in technical and vocational education. Findings show that experts identified outcomes representing learning about (a) the concept and principles of sustainability, (b) the theoretical and historical underpinnings of education for sustainable development, (c) outcomes to develop pedagogical knowledge and expertise in ESD, and (d) outcomes to develop an appreciation for ethics in sustainable development. Similarly, experts identified specific learning outcomes for sustainability literacy for TVET teacher training programmes. These outcomes reflect specific knowledge, values, and dispositions that students should learn. Experts identified 19 specific learning outcomes for sustainability which were later regrouped into five major learning outcome categories. These categories include outcomes to develop a reflective and ethical practice for sustainability, outcomes to develop ESD teaching professionalism, outcomes to develop an appreciation of the need for sustainability, outcomes for the comprehension, expression and demonstration of sustainability knowledge, and outcomes to develop community-based problem resolution.

The first specific learning outcome category, i.e., outcomes to develop a reflective and ethical practice for sustainability, is centred on learning based on developing pre-service teachers' knowledge, skills, and attributes to foster reflection. This learning outcome category consists of four specific learning outcomes which include: discussing practices within TVET occupational areas that threaten the attainment of a sustainable future, demonstrat-

ing responsible use of materials in workshops/laboratories, demonstrating sustainable behaviour for responsible citizenship and demonstrating the capability to reflect about actions that contribute to economic, social, and environmental issues.

The second learning outcome category is the outcomes to develop ESD teaching professionalism. This outcome is focused on developing the ethos and professionalism of the teaching profession in line with those of ESD. Here, pre-service teachers are taught to efficiently design teaching and learning activities about sustainability issues and concepts that reflect the capabilities students are expected to demonstrate.

Furthermore, the third learning outcome category identified was developing an appreciation of the need for sustainability. In this category, experts emphasised the importance of pre-service teachers in developing capabilities to use historical knowledge and evidence to identify unsustainable practices and analyse emerging industrial processes and activities that affect living systems. Developing adequate knowledge of these issues would better prepare pre-service teachers to appreciate the need for sustainable development.

The fourth learning outcome category, i.e., outcomes for the comprehension, expression, and demonstration of sustainability knowledge, is focused on developing pre-service teachers' knowledge and capacities on the various aspects of sustainability as it relates to TVET occupational areas. Experts emphasised the importance of preparing pre-service teachers to develop adequate knowledge on the environmental, economic, and social aspects of sustainability, nature, and environmental conservation; wealth distribution as an important element of economic sustainability for TVET organisations; climate change, its causes and impact; as well as an appreciation for ethics as important aspects of sustainable development. These outcomes reflect systematic and holistic thinking as they present pre-service teachers opportunities for analysing and synthesising trends and patterns within larger systems, thereby enabling them to understand cause-effect relationships and conceptual models of a system and create the desired changes within such systems [66]. For instance, in taking a systemic view of nature and conservation within the ecosystem, students can learn the cause-effect relationship of biodiversity and resource depletion, its consequential impact on climate change and global warming, and the long-term implications for the sustainability of future generations.

Finally, the fifth category of learning outcomes identified are outcomes to develop community-based problem resolution. This would prepare pre-service teachers to develop the capabilities for identifying problems and issues resulting from unsustainable practices and activities within communities and using such opportunities as case studies to propose solutions that reflect sustainability principles. Experts highlight that this outcome category consists of specific learning outcomes that should aim to develop pre-service teachers' critical thinking abilities to resolve issues resulting from unsustainable practices; explain the role of citizenship in sustainable development through participation in civic learning; explain the concepts of ethical behaviour and attributes; explain the role of fairness and justice in building an equitable society; and explain how industrial processes are impacted by social, environmental, economic and political interventions.

4.2. Teaching Competencies for Sustainability Literacy for TVET Teacher Training

Teaching competencies for sustainability literacy were described. These competencies were expressed as sustainability knowledge domains, specific skills, and attributes. Hence, discussions regarding the teaching competencies identified are presented in these three areas.

a.   Teaching competencies expressed as knowledge areas for developing sustainability literacy.

Experts identified and reached a consensus on 23 sustainability knowledge areas. These sustainability knowledge areas identified include: sustainable development, concept, principles, dimensions and interrelationship between the dimensions; assessing the impact of (un)sustainability using scientific evidence, technological evidence, historical evidence and research skills; sustainable communities, features, and elements; climate change, causes, impacts, consequence and mitigation strategies; economic sustainability

of business enterprises; humans and the environment, the impact of human activities on the environment and on living systems; the concept of resource management; problem identification and resolution within local communities; knowledge and application of effective pedagogical approaches and tools for ESD.

These identified knowledge domains are congruent with the ESD concepts identified by Simmons [67], McClanahan [68], and UNESCO [69]. However, the difference lies in their specificity for TVET teacher training programmes. Interestingly, the identified knowledge domains do not just identify specific knowledge domains for sustainability; rather, within these knowledge domains are expressions of specific capabilities pre-service teachers should develop upon participating in TVET programmes incorporating these knowledge competencies.

b.   Teaching competencies expressed as specific skills for sustainability literacy.

ESD experts in the modified Delphi method identified and reached a consensus on 23 specific teaching skills for sustainability, which were later regrouped into 7 skill categories following the recommendations of expert panellists and Hair et al. [70]. These categories include interpretative skills, questioning and analytical skills, communication skills, learning development and pedagogical skills, problem identification and resolution skills, and leadership and investigative skills. These skill categories are further discussed in the following subheadings.

The interpretative skill category highlights the capacity of pre-service teachers to use frameworks and models (examples) to explain various aspects of sustainability to learners. Various models convey diverse depictions of what sustainability should entail. Some proponents of these models [71–73] use models and frameworks to describe ways sustainable development could be achieved. The questioning and analytical skill category emphasise pre-service teachers' capacities in questioning practices that contribute to (un)sustainability. More specifically, this skill category should develop pre-service teachers' capabilities for analysing complex sustainability issues that can be addressed within TVET and develop pre-service teachers' capacities for analysing sustainability issues using TVET approaches. According to Simmons [67], sustainability literacy depends on "the willingness and ability to ask questions about the surrounding world, speculate and hypothesise, seek and evaluate information and develop answers to questions". To develop this skill, pre-service teachers must master the art of inquiry and analyse and synthesise information to develop and communicate diverse perspectives.

Furthermore, communication skills in this context focus on developing pre-service teachers' capacity to use innovative pedagogies, teaching methods, and strategies effective in communicating sustainability and its multi-faceted dimensions to learners. The task here is for pre-service teachers to learn how to align appropriate pedagogies in the delivery of lessons on various aspects of sustainability to learners. To achieve this, they must first be conversant with the various pedagogical approaches best suited for fostering meaningful learning experiences on sustainability for learners. Learning development and pedagogical skills develop pre-service teachers' capacities to design, develop, and facilitate teaching and learning activities on sustainability issues. The skill category specifically entails pre-service teachers being able to integrate SD concepts into the vocational subjects they teach, integrate and apply various teaching methods in teaching sustainability issues, and develop learning activities that show how sustainability can be achieved. Problem identification and resolution skills, on the other hand, reflect the ability to apply sustainability knowledge in solving real-life problems, the ability to apply sustainability knowledge in proposing workplace practices that align with SD principles, the ability to apply holistic approaches in solving real-life sustainability problems, the ability to investigate unfamiliar problems resulting from human practices and activities, and the ability to propose solutions to unfamiliar problems by applying sustainability knowledge.

Pre-service teachers must also develop capabilities to lead and manage teaching and learning activities for sustainability using a variety of active learning approaches such as place-based learning or games. Teachers need to be able to lead their students towards

meaningful, consequential, and impactful learning and lead them to form real perspectives of the issues surrounding our world and the need for collective actions geared toward sustainable development.

Pre-service teachers need also to develop capabilities for selecting, organising, and critiquing information about sustainability issues. Expert participants emphasised that pre-service teachers need to develop investigative skills that allow them to first select needed information from the chunk of data available, organise that information into a useful dataset in relation to the issue being investigated, and then critique and evaluate the accuracy of such information to support findings and conclusions reached. Simmons [3] states that learners must be able to design investigations to answer specific questions about the environment (i.e., the social, economic, political, cultural, and physical aspects of the environment). Simmons [3] further reiterates that learners (pre-service teachers) need to be able to develop approaches for investigating unfamiliar types of problems and phenomena.

c.   Teaching competencies expressed as attributes for sustainability literacy.

Experts identified sixteen attributes required of pre-service teachers for sustainability literacy. These attributes were categorised into distinct categories following the recommendations of expert panellists and those of Hair, Ringle, and Sarstedt [70]. Hence, four attribute categories emerged. These attributes include relationship, personal responsibility, social-emotional, and future-thinking attributes.

Relationship attributes reflect the values and behaviours required to foster healthy relationships with humans and nature irrespective of their cultural backgrounds, views, or personal disposition. This category reflects attributes such as care, charity, respect, compassion and cooperation. Experts suggest that these attributes are required for sustainability literacy, especially in fostering healthy relationships, which is necessary for sustainable development. Wiek et al. [74] explained that fostering healthy relationships helps to establish the needed cooperation and collaboration among people working for the shared benefit of solving real-life sustainability problems.

Personal responsibility emphasises the development of pre-service teachers' attributes in critically examining actions before they are acted on while making responsible and ethical decisions. More specifically, pre-service teachers ought to develop reflective practices where they can examine actions and the consequences of actions in relation to how this action affects other people, systems, places and events. Furthermore, experts agree that self-determination is an attribute that is crucial to realising personal responsibility. It is one's ability to control one's own life. Furthermore, within the personal responsibility attributes lies the quality of self-reliance (i.e., reliance on one's own powers and resources, rather than others) and ethics (i.e., one behaving in line with the principles of sustainable development). Similarly, the personal responsibility attribute also shows an appreciation for cultural, social, economic, and environmental development and biodiversity. Lambrechts et al. [75] also identified responsibility as an important competence for sustainable development. They explained that in taking personal responsibility, teachers need to become accountable to society and evaluate their actions.

Pre-service teachers must also develop and nurture social-emotional attributes. Here, the focus is to nurture the values of empathy, nurture pre-service teachers to become sensitive to the feelings of others, express opinions and beliefs directly and honestly, listen and respect the views of others, as well as distinguish between facts, presumptions, and opinions. The authors [75] also identified a similar ESD competence. They alluded that emotional intelligence is an important competence for sustainable development. Social-emotional attributes in this context constitute the development of social-emotional values such as empathy (i.e., one's ability to understand and share the feelings of others), emotional intelligence (i.e., being sensitive to the needs of others), assertiveness (one's ability to express their feelings, opinions, beliefs and needs, directly, openly and honestly, while not violating the personal rights of others), as well as appreciating all living entities. With social-emotional attributes, students can learn to show concern, care, and value towards people and the ecosystem.

Future-thinking attributes prepare pre-service teachers to be future-oriented and anticipate how present actions may impact both present and future generations. It also prepares pre-service teachers to approach social, economic, and environmental decision-making from a sustainability perspective. More specifically, this attribute category will focus on preparing future TVET teachers to appreciate the view that technology alone cannot solve all human problems and that actions towards a sustainable future should be approached by exploring multiple alternatives. The authors [75], in their study on competencies for sustainable development in higher education, identified a similar competency which they referred to as future orientation. They defined future orientation as the ability of a sustainable professional to think and work from a future-oriented perspective by anticipating and thinking in varying timescales, as well as distinguishing between short and long-term approaches.

4.3. Pedagogical Approaches for Facilitating the Teaching of Sustainability Concepts and Issues

Eleven (11) pedagogical approaches were identified as effective for teaching sustainability concepts. Experts agreed on all pedagogical approaches identified from the three rounds of the modified Delphi method. These pedagogical approaches include case study, stimulus activities, place-based learning, problem-based learning, simulation, transformative pedagogy, collaborative learning, the pedagogy of work, enquiry-based learning, heutagogical approaches and lecture method.

Case studies provide context-rich opportunities for students to explore real-life problems, analyse the problem from varying perspectives, evaluate potential solutions, and create solutions that best address the problems. This is possible because students are exposed to real problems, where they experience first-hand the issues that manifest. Segalàs et al. [76] and Sprain and Timpson [77] corroborate this by stating that case studies enable students to consider real-world issues and examine them from diverse perspectives. Stimulus is also another useful pedagogical approach for ESD. This involves using prompts such as artwork, images, animation, or quotations to stimulate discussions and reflections about a sustainability issue [78]. These activities spur students into thinking about an issue they are familiar with. Place-based learning as a pedagogical approach for ESD is a teaching and learning (T&L) approach used to provide learners with experience and knowledge to care for our environment [79]. It focuses on connecting scientific understanding and emotional attachments with the specific geography under investigation, thereby cultivating a sense of place in learners [80]. This approach is based on outdoor experiential learning and is mostly multidisciplinary.

Similarly, problem-based learning was identified as another pedagogical approach for sustainability teaching and learning. This approach often overlaps with project-based learning and case studies. However, it is specifically used to facilitate the development of knowledge, skills, and competencies from inquiries based on real-life investigations facilitated through an interdisciplinary medium [76]. Furthermore, simulations as a pedagogical approach for ESD mimic real-life learning experiences by presenting learners with similar elements and characteristics of real-life experiences. In the words of Bell et al. [81] as cited in [82], simulation is described as a learning environment designed to enhance a learner's engagement with real experiences, which can develop skills and learning objectives. In a TVET context, one expert (P03) notes that simulation can be facilitated with activities such as role plays, mock trials, games, and so on.

In transformative pedagogy, students are trained to ask critical questions about issues and develop information literacy (i.e., the skills in searching for relevant and additional information to identify problems and critically evaluate that information and use it to solve problems) [83]. Collaborative learning, on the other hand, is a pedagogical approach that is used to foster the development of active knowledge construction in students. Here, students are made to work in a group, with each group member contributing towards a specific goal. Students brainstorm and contribute ideas towards the overall goal of the task, thereby learning and developing skills that are important for sustainability. This can be used to foster the development of good practices for sustainability.

With the pedagogy of work, students learn by making useful products or providing useful services that are solutions to identified issues or problems. While designing these products or services, students are taught to apply the knowledge of sustainability principles. In addition, enquiry-based learning also can be used to facilitate effective T&L for sustainability. Here, students work in groups to solve an identified problem by applying prior knowledge of the fact. In this approach, students utilise trial and error to determine which solution works best for an identified problem [84,85]. Furthermore, the heutagogical approach is learner-centred and emphasises building capability over competence. Capability is the learner's ability to reproduce skills and knowledge in unfamiliar situations, whereas competency is the learner's ability to repeat skills and retrieve knowledge. Students can be given a novel problem to solve, and by reproducing skills in such unfamiliar situations, they develop capability over competence [86]. Finally, the lecture method is described as best suited for introducing students to new sustainability concepts and issues. Its style is based on traditional or classic academic teaching, where the teacher is the source of information. Experts argue that this approach is still fundamental, especially as it aids teachers with in-depth knowledge about a subject to introduce new concepts to learners—the keyword here being "to introduce". Although its use in the teaching and learning process is recommended, especially with the integration of more innovative pedagogies [87], in terms of its application to ESD, expert participants recommend that it is used to introduce students to new sustainability concepts.

All the identified pedagogies seem to connote some essential similarities, including meaningful social interaction, reflection, real-life problem solving, and a broad view of knowledge. These were all identified for their penchant for bringing learners to terms with themselves and the world they live in.

4.4. Strategies for Integrating ESD into TVET Teacher Training Programme

Findings revealed that a starting point for integrating ESD into TVET teacher training programmes should begin with HEIs adopting a sustainability philosophy, vision, and mission. They emphasised that doing this would specifically embrace sustainability in all aspects of the institution's operation, teaching, learning, research, etc. Other strategies endorsed by experts for ESD integration include teacher training institutions, and HEIs must formulate sustainability goals across all areas of the institutions' operation. Such initiative should be directed by a team within the institution who will be responsible for consolidating all efforts towards implementing sustainability initiatives. Furthermore, another strategy for ESD integration is that TVET faculties should identify and develop specific ESD competencies for which the TVET programmes should prepare pre-service teachers. Doing this would enable educators to act. Experts also agreed that TVET educators should integrate sustainability themes into their research and practice as this would reinforce the importance of teaching sustainability in their courses. In addition, experts also emphasised the need for TVET programmes to integrate sustainability into their co-curricular activities so that students can develop skills for sustainability while participating in these activities. Another important strategy to embed ESD into TVET teacher training programmes is to prepare TVET educators for ESD through professional training and staff development programmes. This can be accomplished through workshops, professional development forums, seminars, or by making several in-service training mediums available. Experts also recommended that sustainability be integrated into a compulsory university course and through dedicated core courses at the faculty level. This initiative would allow students across TVET programmes, irrespective of their areas of specialisation, to be afforded the opportunities to participate in learning about sustainability.

These integration strategies identified from the modified Delphi phase of this study reflect some of the approaches reported by [88]. These strategies do not represent a one-size-fits-all approach; rather, they reflect exemplary approaches that can be adopted or adapted to suit specific contexts and scenarios.

4.5. The Proposed Curriculum Framework for Sustainability Literacy for TVET Teacher Training Programmes

The proposed curriculum framework for sustainability literacy consolidates four main themes from this study. These themes represent the important curriculum components, i.e., ESD learning outcomes, teaching competencies for sustainability literacy expressed as knowledge, skills, and attributes, pedagogical approaches used to foster effective teaching and learning on sustainability, and some strategies for ESD integration across the TVET curriculum. The following section discusses the proposed curriculum framework for the study. Figure 1 shows the curriculum framework for sustainability literacy for TVET teacher training programmes.
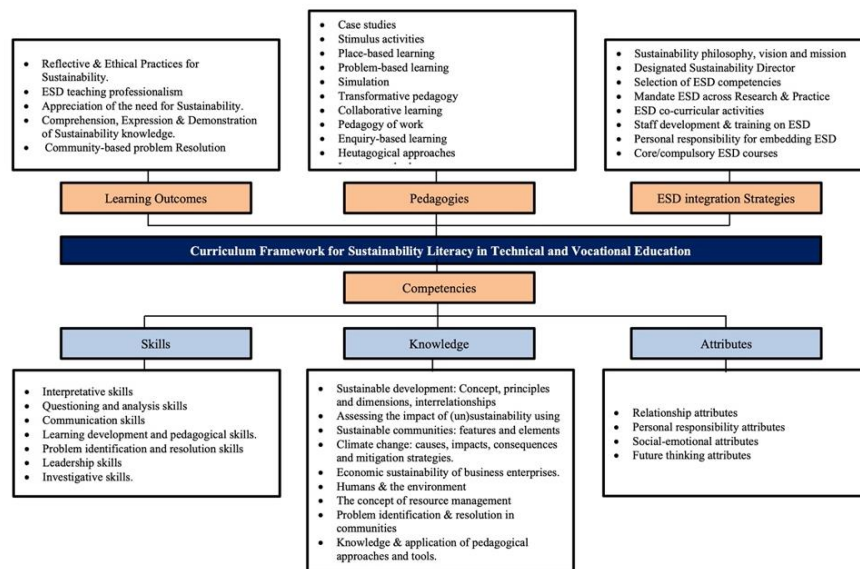
Figure 1. A TVET curriculum framework for sustainability literacy.

The proposed curricular framework for sustainability literacy is an exemplary tool for researchers, educators, and teacher training institutions seeking to develop programmes to prepare pre-service teachers for sustainability T&L in vocational education. However, this framework can be applied to other teacher training specialisations. This framework has vivid implications for TVET institutions, the ministry of education, and the Malaysian Qualification Agency (MQA). The framework may assist universities with TVET faculties/departments seeking to prepare pre-service teachers for ESD, as important curricula offerings for sustainability literacy have been defined. All four components of the curricular framework are indicative of strategies and approaches that are proven perspectives from the experiences of ESD experts. Thus, they can help reorient teaching practice as it relates to how vocational education is taught and how the latter helps drive the sustainability agenda by contributing to the development of teaching professionals who have developed the ethos and competencies of sustainability literacy. ESD is not commonly identified as a part of TVET teachers' work [17,89–91]; therefore, the MQA may use this framework to incorporate standards and benchmarks for sustainability literacy. These criteria may be adapted from the proposed curriculum framework for sustainability literacy. When the MQA defines qualification standards for a programme, teacher training institutes are mandated to incorporate them in TVET programmes, because fulfilling these standards becomes a criterion for getting accreditations for the TVET programme. We conclude by stating that this study is not without limitations. As with most Delphi studies, findings may only be interpreted within the study's context, as findings reflect only the views of the expert panellist [92], and the quality of the findings may only be as quality as the expert panellists. However, expert panellists were carefully selected using well-defined criteria and recruiting experts from Asian-Pacific countries to diversify perspectives and enhance the quality of the research outcomes. Our recommendation for further study is to examine

the perspectives of TVET educators concerning the relevance of these identified curricular elements to TVET teacher education. A future study could also explore how these curriculum elements are implemented by TVET educators using a case study. Third, a future study could also assess the effectiveness of these curriculum elements in transforming pre-service teachers' sustainability consciousness and behaviour.

5. Conclusions

We argued the need for a curriculum framework for sustainability literacy for TVET teacher training programmes, given the potential of TVET in educating and training skilled and semi-skilled workers. We argued that to draw closer to the SD agenda, workers must be equally trained in their specialised vocations and develop sustainability competence. To achieve this, technical and vocational teachers must be trained to become vocationally competent and ESD competent. Our discussions and analysis showed that ESD is not commonly associated with the work of technical and vocational teachers. As a result, a conscious effort had to be taken to ensure that vocational teachers develop competencies in ESD. Therefore, we established the need for a curriculum framework to reorient TVET teacher training programmes. We argued that such a curricular framework must be transformational and capable of transforming people's attitudes and behaviour to act sustainably in complex situations. We also emphasised that in transformational ESD, consensus on what is to be transformed and maintained is often left ambiguous due to the absence of holistic contents and pluralistic pedagogies in most ESD frameworks. Hence, in this study, we attempted to clarify the ambiguities left by most transformational ESD models. The result of this study hence emerged from four themes representing four distinct curriculum elements for sustainability literacy. These curriculum elements include the learning outcomes, teaching competencies, pedagogical approaches for sustainability T&L, and ESD integration strategies. We defined specific categories that reflect the study's findings within these four curriculum components, as shown in Figure 1. We recognise that these elements do not represent a one-size-fits-all approach to ESD; rather, we proposed these elements as contributions to a more transformative model of ESD for teacher education. The model can serve as a template for curriculum reorientation in teacher education, especially in technical and vocational education.

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