

Identifying Strategies to Cultivate Students' Attitude Towards Circular Economy

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Abstract

Circular economy (CE) in Technical and Vocational Education and Training (TVET) refers to an economic approach that promotes efficient use of resources, material recovery, and waste reduction through vocational education. Despite various activities and programs conducted by TVET instructors to promote the circular economy, reports indicate that students' attitudes towards the environment remain at a moderate level. This paper aims to identify strategies that can be implemented to foster students' interest in practicing the circular economy within the context of TVET. This study uses the Nominal Group Technique (NGT) as an alternative approach to suggest initiatives that can foster students' attitudes towards the circular economy. The process involved silent idea generation, round robin, discussion, two rounds of initial voting, and a final stage survey to determine the priority list. Five content experts participated in the NGT meeting. Initially, 50 strategies were identified. Through the NGT process, 20 important strategies were selected to cultivate students' attitudes towards the circular economy. These strategies include waste management workshops, environmental programs and activities at institutions, conducive public sector ecosystem (EKSA) in institutions, homes and neighborhoods, information boards, simulation outside the classroom, daily routines, campaigns, neighborhood activities, sale of used oil, sale of recycled goods, innovation, waste segregation, cultivating student awareness, application in teaching, motivation, moral support, cleanliness and cheerfulness competitions, environment week, incorporating circular economy in the syllabus, and cross-curricular elements. The identified strategies are expected to assist stakeholders in overseeing the implementation of environmental awareness programs in schools, colleges, and TVET institutions, with the goal of improving student attitudes and transforming TVET education towards greater circular economy awareness.

1. Introduction

The transformation of Technical and Vocational Education and Training (TVET) education refers to the process of renewal or comprehensive change in the approach, curriculum, and delivery of TVET. It involves adapting to the current needs of industry, technology, and the job market, as well as ensuring that TVET students are equipped with relevant skills and knowledge and can make an impact in a changing employment environment (Ekinil et al., 2022; Hu et al., 2022; Zhao, 2021). This transformation also involves the introduction of innovative elements, the development of a sustainability mindset, and coordination with sustainable development aspirations (Kravchuk et al., 2023; Z. Liu et al., 2023; Xu & Stahl, 2023).

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As we face the challenges of the 21st century, aligning with the Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education) and Goal 12 (Responsible Consumption and Production), becomes essential (Amos & Lydgate, 2020; Ekhaton et al., 2021). Recognizing the importance of educational transformation, particularly in Technical and Vocational Education and Training (TVET), becomes essential to effectively address global challenges. The circular economy (CE), as introduced in this study, stands as an alternative economic model. This model emphasizes resource efficiency, waste reduction, and the promotion of sustainable practices (Hegab et al., 2023; Herrador & Van, 2024; Olawumi et al., 2023). The integration of circular economy principles into TVET holds significant promise, offering pathways to equip students with skills that resonate with environmental care and economic efficiency.

The importance of the circular economy in the field of TVET goes beyond theoretical understanding. The circular economy fosters innovation, instills a sense of environmental responsibility, and contributes to economic resilience (Chen & Dagestani, 2023; Kamaruzaman et al., 2021; Mohd Saiful Anuar Zainal & Zakaria Abas, 2018). These attributes are important in preparing TVET students for careers that embrace and champion environmentally friendly practices, in line with the growing demand for a sustainable future.

However, despite the significant benefits, integrating the circular economy into TVET faces formidable challenges. The main obstacle is the limited awareness of circular economy principles among educators, students and stakeholders (Canino et al., 2021; Gillott et al., 2022; Guerra & Leite, 2021; Hull et al., 2021; Keramitsoglou et al., 2023; Manshoven & Gillabel, 2021). Previous studies have found that there are reports that show students' attitudes towards the environment remain at a moderate level (Alzayed et al., 2022; Hicks & Sadler, 2022; Ilakkia et al., 2023; Mehta et al., 2023; Morales-Baños et al., 2023; Natalia et al., 2023; Owojori et al., 2022; Şahin & Gök Demir, 2023; Stewart, 2023). Although their knowledge about sustainability is high, their attitudes towards sustainability are still not satisfactory. This disconnect poses a major challenge in preparing students for careers that champion environmentally friendly practices. Limited awareness of circular economy principles among educators, students, and stakeholders further complicates integrating this concept into the TVET curriculum. Therefore, there is an urgent need to explore and implement strategies that effectively foster positive attitudes towards the circular economy in the TVET education system.

This paper is presented to address the critical gap between sustainability knowledge and attitudes among TVET students. By exploring the views and suggestions of experts, this study aims to identify effective strategies to foster pro-circular economic attitudes. The insights gained will provide a strategic roadmap for educators and policy makers, ensuring that TVET students are not only knowledgeable but also truly committed to sustainable practices. Therefore, this study was made to explore the views and recommendations of experts on the the methods to be used to cultivate students' attitudes towards the circular economy.

2. Literature Review

2.1 Attitude Towards Circular Economy

The literature on students' attitudes towards the circular economy is still limited, but some studies have touched on this aspect. A study conducted by Rahmatika, (2022) found that students' awareness of the circular economy is higher in terms of knowledge (85.5%) than attitude (55.5%) and behavior (68.2%). The results of attitude and behavior show that students tend to buy new items rather than reuse/rent or repair them. Another study conducted by Rahmatika, (2022) found that female students' knowledge of the circular economy was higher than male students', while their attitudes and behaviors showed similar results. The study also found correlations between knowledge and attitude, attitude and behavior, and knowledge and behavior, indicating that these variables influence each other. Rahman, (2023) suggests that university students exhibit a high level of behavior and an intermediate level of attitude. This provides an opportunity to enhance their awareness and understanding of issues associated with the circular economy.

Some previous researchers argue that the concept of circular economy is too broad and vague, making its measurement and implementation difficult (Corvellec et al., 2022). Criticism also states that the circular economy tends to depoliticize industrial and environmental policy, emphasizing market-based solutions without addressing structural barriers. A study by Tsalidis (2023) discusses the potential of universities to contribute to the circular economy through teaching, research, and collaboration with industry. However, some observers criticize that the circular economy overemphasizes market forces without addressing industrial and environmental policies holistically.

Drawing from Ajzen's Theory of Planned Behaviour and Fishbein's Attitude Theory provide valuable insights into understanding attitudes towards the circular economy. Fishbein and Ajzen's Theory of Planned Behavior, thoroughly supported by their seminal 1975 work, elucidates the critical relationships between attitudes, subjective norms, and perceived behavioral control in shaping behavioral intentions. This model demonstrates that the more positive the attitudes and norms, coupled with greater perceived control, the stronger an individual's intention to engage in a specific behavior (Fishbein & Ajzen, 1975). In this context, a positive attitude

can significantly encourage individuals to adopt circular economy practices, as it enhances their motivation and the likelihood of committing to sustainable behaviors. This understanding informs strategies to increase positive attitudes and foster acceptance by emphasizing the value and benefits that individuals perceive. This theory can be clearly illustrated in the Fig. 1 below.

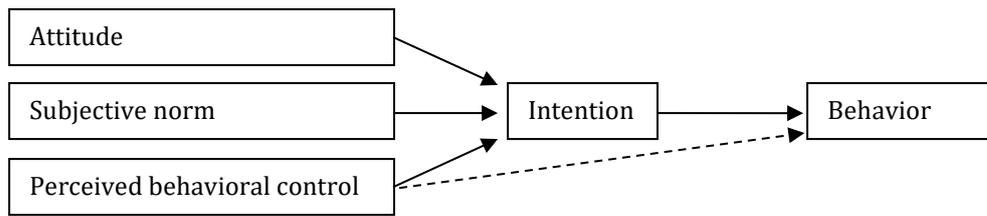


Fig. 1 *The theory of planned behavior* (Fishbein & Ajzen, 1975)

Building on the insights gained from Fishbein & Ajzen Theory of Planned Behavior, it becomes clear that although the literature on student attitudes towards the circular economy is still limited, there is a great opportunity for TVET educational institutions to increase understanding and drive behavioral change. Although challenges in defining and implementing the circular economy persist, as critics suggest, TVET educational institutions are well positioned to foster its adoption through educational initiatives, research and industry collaboration. This strategic approach can take advantage of positive attitudes, norms, and perception control highlighted by Fishbein and Ajzen, (1975) to strengthen students' intentions and actions towards sustainable practices.

2.2 Circular Economy Strategies in TVET

The literature on circular economy strategies in technical and vocational education and training (TVET) is growing, with a focus on raising awareness and integrating circular economy concepts into educational approaches. A study from Khan et al., (2022) provide a holistic view of the implementation of the circular economy by identifying several obstacles that hinder this process. Among the identified barriers are technological, market, institutional, and cultural factors. The study also revealed that from an economic point of view, the concept of linear resource use and the Circular Economy business model are similar.

The study by Keramitsoglou et al., (2023) emphasizes the need for an educational approach to support the concept of a circular economy for secondary level students, highlighting research gaps in this field. This study suggests the formulation of practical educational strategies to encourage teachers to practice circular economy principles and increase student understanding and engagement. However, the literature also presents criticisms of the circular economy, with some arguing that the concept is diffuse and broad, making it challenging to measure and implement (Corvellec et al., 2022). The literature underlines the importance of integrating circular economy principles into educational frameworks, especially at the secondary level, to foster a deeper understanding and practical application of sustainable practices. The available literature provides valuable insights into the need for an educational approach to support the circular economy concept in TVET.

Although the concept of the circular economy has received criticism, particularly regarding its implementation, the focus on integrating circular economy principles into education remains a key area of interest. This study highlights the ongoing discourse on the role of TVET in promoting sustainable practices and the need for practical educational strategies to effectively engage students in circular economy principles. The integration of circular economy practices into technical and vocational education and training (TVET) is essential to prepare the workforce for the transition to a circular economy (2023; L. Liu & Ramakrishna, 2020; Medgyes et al., 2021; Pradhananga & Elzomor, 2023; Ziegler et al., 2023). The concept of a circular economy, which emphasizes the principles of reduction, reuse and recycling, is closely related to issues such as food waste management and sustainable resource use. Research by Hamid et al., (2023) emphasized the need to explore the integration of circular economy concepts in TVET, particularly through sustainable practices, resource management, waste reduction and closed-loop production processes.

Furthermore, organizations such as UNESCO-UNEVOC have collaborated to develop training programs and learning modules for TVET institutions, aiming to raise awareness of the skills and jobs needed to drive climate action and to outline the role that TVET institutions can play in closing skills gap for a circular economy (Friedrich, 2020; UNESCO-UNEVOC, 2017). The role of education, from preschool to university, is highlighted as the best way to enable the transition from a linear economy to a circular economy (Haase et al., 2024; Papamichael et al., 2023; Tiippana-Usvasalo et al., 2023). Therefore, the literature supports the importance of integrating circular economy practices into TVET to foster sustainable development and equip individuals with the skills needed for a circular economy. These circular economy strategies can be summarized as shown in Fig. 2 below.

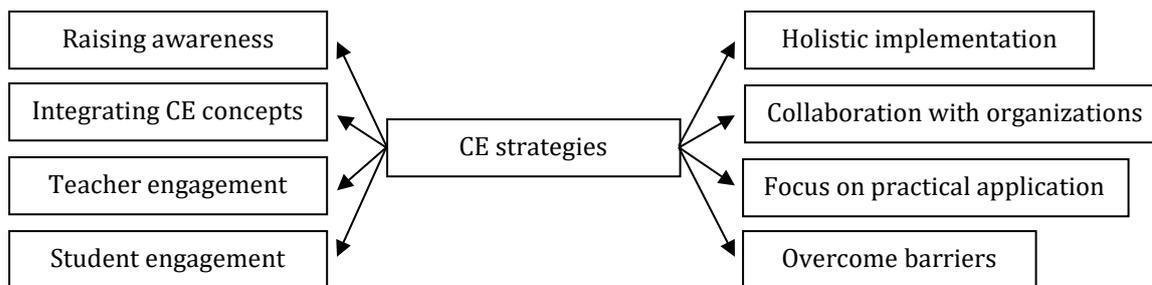


Fig. 2 *The circular economy strategies in TVET education*

The above strategies align with the Theory of Planned Behavior by Fishbein and Ajzen. Attitudes towards CE in TVET education can be shaped by raising awareness and integrating CE into the curriculum, leading to sustainable practices. Subjective norms, influenced by teacher involvement and organizational support, create a social obligation for students to engage in CE practices. Perceived behavioral control, enhanced by addressing barriers, providing resources, and focusing on practical application, increases students' confidence in managing resources and reducing waste. Student engagement also plays a crucial role in shaping these perceptions. Intentions are strengthened when students have positive attitudes, supportive norms, and believe in their ability to implement CE strategies. Consequently, strong intentions lead to behaviors such as waste reduction, effective resource management, and sustainable practices in TVET. This literature review can be summarized in the conceptual framework shown in Fig. 3 below.

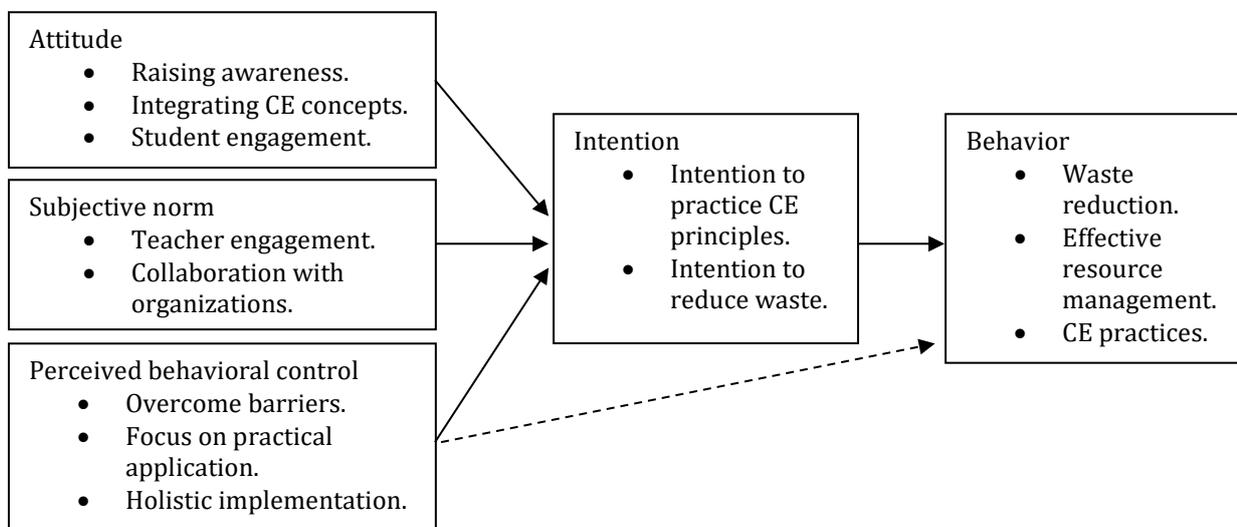


Fig. 3 *The conceptual framework to cultivate students' attitudes and strategies to foster circular economy in TVET education*

3. Methodology

Using the Nominal Group Technique (NGT) as the main research method, this study involved five experts who have expertise in the field of TVET education and the environment. The face-to-face NGT sessions last for two hours, where experts gather and participate in brainstorming sessions to generate ideas and propose solutions based on their expertise. After the session, the researcher carried out specific calculations using the NGT method to obtain results that answered the objectives of the study.

3.1 Nominal Group Technique

NGT represents a systematic approach to looking at a group's collective perspective on a particular issue. Originally conceptualized as a "participatory approach to social planning scenarios" (Delbecq & Van De Ven, 1970), social planning situations include activities such as exploratory research, citizen engagement, interdisciplinary expert collaboration, and proposal evaluation (Kennedy & Clinton, 2009). Over time, this method has found application in various group contexts, including empirical research in the social sciences. Although it has seen some use in educational research (Lomax & McLeman, 1984; O'Neil & Jackson, 1983), its more prevalent use appears to be in social science research, particularly in environmental studies (Bakus et al., 1982; Hugé & Mukherjee, 2018; Kirsch et al., 2020; Lakhani et al., 2018; Manca et al., 2019).

This technique facilitates problem identification, solution exploration, and priority setting. It is particularly effective in "groups of strangers", where maintaining a balance of status and verbal influence among members is important. NGT usually includes four different steps (Algeo et al., 2022; Ramavhoya et al., 2022; Stoffelen et al., 2019):

- Generating ideas through brainstorming (silent generation in writing): Participants freely and silently write down their answers to prompt questions.
- Round robin session: Each participant, when prompted, contributes an idea, which is then documented on a large flip chart. Debating ideas is not allowed. The finished sheet is attached to the wall for everyone to see. The group facilitator continues to call participants until all ideas are recorded or the group decides that they have generated a satisfactory number of ideas.
- Discussion on the list of ideas: Participants discuss each idea on the list to ensure mutual understanding.
- Voting: Participants determine the most important ideas, prioritize them in an optional way, vote on a flip chart, and engage in discussion about voting patterns.

It encourages genuine results and dedication to them by combining anonymous voting along with defined allocations. Finally, the NGT ensures a permanent record of the group's processes and decisions by documenting all inputs and authorized modifications on a flip chart page. When presented, these sheets allow groups to seamlessly resume discussions from previous meetings, and they also serve as an effective way to update those who were absent for all or part of the meeting (Boddy, 2012). The steps in the NGT used in this study are listed as Fig. 4 below.



Fig. 4 The steps in the NGT used in this study

The NGT meeting lasted two hours, held face-to-face in a meeting room with five participants and a moderator present. The moderator begins by outlining the purpose of the study and the research question. After that, the participants individually silently generate ideas about strategies to improve students' attitude to practice the circular economy. A round-robin technique is then used, with each participant sharing their ideas in turn. The moderator prompts each participant to contribute one item until all ideas are exhausted, fostering common pooling of ideas, encouraging clarifying questions, and facilitating categorization of ideas.

An assistant transcribed the items for participants to view, resulting in the creation of an initial list of 50 strategies. After this, during the group discussion phase, the moderator presents the literature review to the group, allowing them to decide whether to include additional items. Each item underwent a thorough review and explanation through a moderator-led discussion. Items have been merged or removed as deemed appropriate. This iterative process led to a reduction in the number of lists, as similar items were consolidated. Similar items have been deleted. Finally, a total of 20 lists were generated as a strategy to improve students' attitudes towards the circular economy.

3.2 Research Sample

There is ongoing discussion about the optimal sample size for conducting studies using the NGT technique. Some scholars argue that NGT can be used for a single cohort or large group (Davies et al., 2023; Dobbie et al., 2004; Lomax & McLeman, 1984; Maclachlan, 1996; Muqsith et al., 2017). However, it can also be divided into smaller groups to facilitate effective communication based on the needs of the study. To address this, previous researchers have used various sample sizes, as outlined in detail in Table 1.

The researcher opted for the involvement of 5 experts in the Nominal Group Technique (NGT) process for this study, a number considered suitable for capturing diverse perspectives and facilitating effective discussions. The selection criteria for participants were guided by recommendations from Delbecq and Van De Ven, (1970); Steward, (2001) emphasizing the importance of including individuals with extensive knowledge from various backgrounds. This approach allows participants to contribute diverse viewpoints and ideas, fostering a comprehensive discussion. Thor, (1987) viewpoint discourages the inclusion of individuals prone to criticizing and evaluating others' ideas in discussion sessions. In contrast, criteria suggested by Aziz, S. F., and Siraj, (2015) for expert participants in group discussions include possessing extensive knowledge, a willingness to participate, good communication skills, and over five years of experience.

Table 1 *Sample size*

Author	Sample
Delbecq, (1970)	5-9 & 9-200 experts/participants
Horton, (1980)	7-10 experts/participants
Steward, (2001)	5-8 experts/participants
Harvey, (2012)	6-12 experts/participants
Odu, (2017)	9-12 experts/participants
Carney et al., (1996)	Minimum 6 experts/participants
Dang, (2015)	6 experts/participants
Tseng et al., (2006)	13 experts/participants
Muqsith, (2017)	21 experts/participants
Madi, (2011)	7-10 experts/participants

In this study, purposive sampling was employed to invite content experts who are TVET instructors from diverse agencies such as the Technical and Vocational Education and Training Division, the Malaysian Ministry of Education, the Ministry of Youth and Sports, and Community College under the Ministry of Higher Education. Specifically, the selected experts consist of three females and two males, with more than eight years of experience in environmental education within the field of TVET, indicating a level of maturity and expertise in TVET education. This careful selection process ensures that the NGT sessions are enriched by the insights of experienced individuals with diverse backgrounds, contributing to a robust exploration of circular economy awareness in TVET.

3.3 Research Instrument

In the implementation of the Nominal Group Technique (NGT) to conduct this study, several key instruments ensured the effectiveness of the discussion session. First, the research question has been carefully formulated and serves as the main tool to obtain detailed responses from NGT participants (Onwujekwe et al., 2023; Osmond et al., 2023; Pagnamenta et al., 2022). This allows participants to respond creatively and give their views on the issues discussed. In addition, individual worksheets were also introduced as a tool that provides space for each participant to record ideas or answers personally before sharing with the group. This step ensures that each individual can contribute their views without being influenced by the opinions of others, resulting in a variety of valuable input.

The moderator guide is the main guide that includes the instructions and steps required to ensure the smooth running of the NGT session. This includes instructions on the introduction of the study, the implementation of the session, and the overall management of the discussion process (Rafi et al., 2022; Zamzuri et al., 2022). Moderators play an important role in ensuring that all aspects of the session run smoothly (Dueckers et al., 2012; Levine et al., 2006; Tran et al., 2020). The use of the flip chart as a visual medium plays an important role in recording and organizing the ideas shared by the participants during the group discussion. This facilitates the visualization process and allows participants to see the progress of the discussion directly.

Marker pens and pens provided for participants allow them to write their ideas or answers on paper or flip chart. This gives freedom to participants to present their views creatively and easily understood by the group. Overall, the use of instruments such as research questions, individual papers, moderator guides, flip chart, and pen markers, has contributed positively in making the Nominal Group sessions a success, ensuring active participation and comprehensive discussion results.

3.4 Analysis of Data

Quantitative data collected through the Nominal Group Technique (NGT) can be analyzed using various statistical methods to identify patterns, trends, and relationships between data. Quantitative analysis can be used to prioritize ideas generated by participants. For example, ideas can be ranked based on their frequency, centrality or importance, and the process of consensus building can involve discussing and refining these positions until a final decision is reached (Dueckers et al., 2012; Giannouchos et al., 2021; Rachel et al., 2012; Rossler et al., 2021; Schmit et al., 2023; Tran et al., 2020). Data analysis involves prioritizing the recorded ideas in relation to the original question using techniques such as multiple voting or priority lists. In this study, participants were given 3-point Likert scale, namely disagree (1), not sure (2) and agree (3). Participants voted on the list (n=20) given after the discussion session. The solution with the highest total ranking is often chosen as the final decision. This

structured approach allows for a combination of quantitative and qualitative data collection, making it a valuable research instrument for generating consensus and understanding group dynamics (Hugé & Mukherjee, 2018; Maguire et al., 2022).

4. Result

Circular economy is a relatively new concept, and many students may not be familiar with it. However, educating students about the circular economy is important to enable them to understand the importance of sustainability and encourage them to make more environmentally conscious decisions. After conducting the NGT session, as a result of the expert's suggestions and views, the researcher formulated alternatives or methods that could be used to cultivate students' attitudes towards the circular economy.

Table 2 shows the total score for the component of efforts that can be taken to foster students' attitudes towards the circular economy obtained from an expert's point of view. The findings of this study briefly show that all the percentages of the evaluated elements are at a suitable level for use. This is because the percentage value has exceeded 70% as required based on studies (Dobbie et al., 2004; Ferreira et al., 2010). The conclusion that the researcher can make is that all study participants agree that all the elements developed are acceptable and can be used. The NGT technique allows researchers to obtain information quickly because it does not involve rounds of evaluation sessions between experts. Just by implementing 4 steps in NGT, results can be produced easily.

Table 2 NGT analysis result on methods to be used to cultivate students' attitudes towards the circular economy

List of Strategies	Voter1	Voter2	Voter3	Voter4	Voter5	Total item score	Percentage	Rank Priority	Voter Consensus
1 Waste management workshop: The waste management workshop includes lectures and hands-on guidance to students.	3	3	3	3	3	15	100	1	Suitable
2 Environmental programs and activities at institutions: Environmental programs and activities in institutions that are educational and entertaining.	3	3	3	3	3	15	100	1	Suitable
3 Daily routine: Daily routines involving sustainable practices and environmental awareness form the student's lifestyle.	3	2	3	3	3	14	93.3	2	Suitable
4 Cultivate student awareness: Cultivating students' awareness of the environment builds a foundation for positive action and participation in environmental issues.	3	3	3	3	3	15	100	1	Suitable
5 Environment week: Environment week includes various activities to increase awareness and participation in environmental issues.	3	3	3	3	3	15	100	1	Suitable
6 Conducive Public Sector Ecosystem (EKSA) in institutions, homes, and neighborhoods: EKSA in surrounding areas involves a holistic approach to foster environmental awareness in daily life.	3	2	3	3	3	14	93.3	2	Suitable
7 Information board: Information includes briefings during the weekly assembly and during the implementation of co-curricular activities.	3	2	3	3	3	14	93.3	2	Suitable
8 Campaign: The campaign supports comprehensive efforts to spread awareness and positive action on environmental issues.	3	3	3	3	3	15	100	1	Suitable
9 Neighborhood activities: Activities in the area around the school such as gotong royong can improve environmental sustainability.	3	2	1	3	3	12	80	4	Suitable

10	Simulation outside the classroom: Simulation outside the classroom gives students the opportunity to apply knowledge in practical situations outside the academic environment.	3	2	3	3	3	14	93.3 3	2	Suitable
11	Innovation: Innovation includes efforts to create creative solutions to environmental challenges.	3	3	3	3	3	15	100	1	Suitable
12	Application in teaching: Application in teaching integrates environmental concepts in the curriculum to improve student understanding.	3	2	3	3	3	14	93.3 3	2	Suitable
13	Moral support: Moral support gives confidence to students to continue efforts in developing environmental awareness.	3	3	3	3	3	15	100	1	Suitable
14	Put circular economy in syllabus: Coordination with the syllabus ensures that environmental knowledge is integrated in the formal curriculum.	3	3	1	3	3	13	86.6 7	3	Suitable
15	Cross-curricular elements: Cross-curricular elements link environmental concepts with other disciplines, promoting comprehensive understanding.	3	3	3	3	3	15	100	1	Suitable
16	Motivation: Motivation plays an important role in stimulating students to engage in environmental efforts and sustainable practices.	3	3	3	3	3	15	100	1	Suitable
17	Cleanliness and cheerfulness competition: The competition based on the 10R principle fosters the spirit of environmental awareness.	3	3	3	3	3	15	100	1	Suitable
18	Sale of used oil: The sale of used oil involves the collection and recycling of oil to reduce the negative impact on the environment.	3	2	2	3	3	13	86.6 7	3	Suitable
19	Sale of recycled goods: The sale of recycled goods helps promote environmentally friendly attitudes and build awareness about reuse.	3	2	3	3	3	14	93.3 3	2	Suitable
20	Waste segregation: Waste segregation helps reduce pollution and increase the effectiveness of recycling.	3	3	3	3	3	15	100	1	Suitable

Table 3 below is a list of recommendations derived from expert opinion, categorized according to the variables in the conceptual framework that have been described in the literature review.

Table 3 *List of recommendations derived from expert opinion on methods to cultivate students' attitudes towards the circular economy*

Variable	Expert Opinion	Source
Attitudes	1. Waste management workshop: The waste management workshop includes lectures and hands-on guidance to students.	Expert1
	2. Environmental programs and activities at institutions: Environmental programs and activities in institutions that are educational and entertaining.	Expert1
	3. Daily routine: Daily routines involving sustainable practices and environmental awareness form the student's lifestyle.	Expert2
	4. Cultivate student awareness: Cultivating students' awareness of the environment builds a foundation for positive action and participation in environmental issues.	Expert4
	5. Environment week: Environment week includes various activities to increase awareness and participation in environmental issues.	Expert5
Subjective Norm	1. Conducive Public Sector Ecosystem (EKSA) in institutions, homes, and neighborhoods: EKSA in surrounding areas involves a holistic approach to foster environmental awareness in daily life.	Expert1
	2. Information board: Information includes briefings during the weekly assembly and during the implementation of co-curricular activities.	Expert1
	3. Campaign: The campaign supports comprehensive efforts to spread awareness and positive action on environmental issues.	Expert2
	4. Neighborhood activities: Activities in the area around the school such as gotong royong can improve environmental sustainability.	Expert2
Perceived Behavioral Control	1. Simulation outside the classroom: Simulation outside the classroom gives students the opportunity to apply knowledge in practical situations outside the academic environment.	Expert1
	2. Innovation: Innovation includes efforts to create creative solutions to environmental challenges.	Expert3
	3. Application in teaching: Application in teaching integrates environmental concepts in the curriculum to improve student understanding.	Expert4
	4. Moral support: Moral support gives confidence to students to continue efforts in developing environmental awareness.	Expert4
	5. Put circular economy in syllabus: Coordination with the syllabus ensures that environmental knowledge is integrated in the formal curriculum.	Expert5
	6. Cross-curricular elements: Cross-curricular elements link environmental concepts with other disciplines, promoting comprehensive understanding.	Expert5
Intention	1. Motivation: Motivation plays an important role in stimulating students to engage in environmental efforts and sustainable practices.	Expert4
	2. Cleanliness and cheerfulness competition: The competition based on the 10R principle fosters the spirit of environmental awareness.	Expert4
Behavior	1. Sale of used oil: The sale of used oil involves the collection and recycling of oil to reduce the negative impact on the environment.	Expert2
	2. Sale of recycled goods: The sale of recycled goods helps promote environmentally friendly attitudes and build awareness about reuse.	Expert3
	3. Waste segregation: Waste segregation helps reduce pollution and increase the effectiveness of recycling.	Expert3

5. Discussion

The list of strategies produced plays an important role in fostering a positive attitude towards the circular economy in the context of Technical and Vocational Education and Training (TVET). Experts chose top strategies (rank priority = 1) including waste management workshops, environmental programs and activities in schools, campaign, innovation, waste segregation, cultivate student awareness, motivation, moral support, cleanliness and cheer competition, environment week, and cross-curricular elements. This strategy aims to engage students in

practical experience related to waste management, environmental activities and campaigns, creating a holistic learning environment.

The second stage (rank priority = 2) consists of strategies such as a Conducive Public Sector Ecosystem (EKSA) in school, home and neighborhood, information board, simulations outside the classroom, daily routine, sales of recycled goods, and applications in teaching. Although not in the highest position as the first group, this strategy still makes a great contribution to the consolidation of the circular economy concept by integrating it in various aspects of students' lives both inside and outside the school environment. The third stage (priority rank = 3) includes the strategy of placing the circular economy in the syllabus and the sale of used oil. The strategy highlights the importance of formalizing circular economy principles in the educational curriculum and incorporating real-world practices, such as the sale of used oil, to enhance practical understanding. At the fourth level (priority rank = 4), neighborhood activities are mentioned, indicating that although they are beneficial, they may not have the same impact as strategies at higher levels.

Strategies identified to foster attitudes towards a circular economy, according to experts, include waste management workshops, environmental programs, and activities aimed at routine practice. According to the Theory of Planned Behavior, this educational and participatory approach effectively forms positive attitudes by providing interesting knowledge and experiences. Subjective norms are influenced by perceived social pressure or expectations of others regarding the use of sustainable behavior. Strategies such as the implementation of a Conducive Public Sector Ecosystem (EKSA), information boards, campaigns, and neighborhood activities directly address this norm. By integrating these strategies in institutions, homes and neighborhoods, they collectively foster a community-oriented mindset towards sustainability, which is essential in creating a supportive social environment.

Perceived behavioral control reflects the ease or difficulty of performing a behavior, which is influenced by personal efficacy and resource availability. Strategies such as simulations outside the classroom, innovative projects and the integration of circular economy principles into the curriculum increase students' confidence and ability to engage in environmental behavior. The inclusion of moral support and cross-curricular elements further supports students' belief in their ability to effect change. This strategy aligns with the theoretical assertion that higher perceived control increases the likelihood of engaging in certain behaviors, which is a finding supported by many studies on environmental education.

The intention to engage in a behavior is considered a direct antecedent of the behavior itself in the Theory of Planned Behavior. Strategies such as fostering motivation through competitions and applying circular economy principles in the curriculum directly aim to strengthen students' intentions to practice sustainable behaviour. The focus on cultivating a strong motivational foundation is important for actual behavioral outcomes and is consistent with a theoretical framework in which intentions mediate the relationship between attitudes, subjective norms, and perceived behavioral and behavioral control.

Behavioral strategies identified in the expert opinion include the sale of used oil, recycled goods and waste separation. These practical actions not only allow students to use their knowledge and intentions but also contribute in a real way to environmental sustainability. This behavior is a critical endpoint in the Theory of Planned Behaviour, where the actual use of sustainable practices is the primary goal. By providing opportunities for these behaviors, the strategy reinforces the theoretical path proposed by Fishbein and Ajzen and contributes to the growing body of evidence supporting the effectiveness of direct environmental education.

The NGT analysis results and expert recommendations provide strategic insights into fostering a positive attitude towards the circular economy within TVET education. These strategies directly address findings from previous studies like those by Rahmatika, (2022) and Rahman, (2023), which highlighted a gap between students' knowledge and their attitudes and behaviors regarding sustainability. Specifically, targeted strategies such as waste management workshops and environmental programs aim to enhance students' daily engagement and practical understanding of environmental issues, potentially improving both attitudes and behaviors.

This study also aligns with the critiques of Corvellec et al., (2022) and Tsalidis, (2023) regarding the vague nature of the circular economy concept and its implementation challenges. By outlining specific strategies and their effectiveness, this research clarifies how circular economy principles can be integrated into TVET curricula, addressing educational gaps identified by Keramitsoglou et al., (2023) and aligning with UNESCO-UNEVOC's, (2017) recommendations for enhancing environmental awareness and skills. Moreover, the findings support Fishbein and Ajzen's Theory of Planned Behavior by demonstrating how structured educational strategies can enhance students perceived behavioral control and subjective norms, thereby strengthening their intentions and behaviors towards sustainable practices. Overall, this research contributes to the literature by providing structured approaches to implementing circular economy principles in educational settings, thereby equipping students with the necessary skills and attitudes for sustainable practices.

6. Conclusion

Analysis of experts' opinions reveals a strong emphasis on strategies designed to shape students' attitudes towards the circular economy. Workshops, awareness programs, and environmental campaigns were consistently highlighted as important in shaping positive attitudes. This approach is consistent with findings from Ajzen and Fishbein's Theory of Planned Behaviour, where attitudes play an important role in motivating behavior towards sustainability. The unanimous endorsement of such strategies by experts underscores their potential effectiveness in fostering an environmental mindset among students.

The results of the NGT analysis further outline a consensus among stakeholders on priority strategies for integrating the circular economy into TVET. High-ranking strategies such as waste management workshops and campaigns are not only in line with expert opinion but also reflect broad agreement on their applicability and impact. This alignment shows that the recommended strategies are not only theoretically sound but also practically accepted by those involved in educational settings, providing a solid foundation for curriculum development focused on sustainability.

The findings from both the expert recommendations and the NGT analysis offer significant implications for educational practice and policymaking. They highlight the need to embed circular economy concepts into the curriculum and students' daily routines, which supports the hypothesis that exposure and engagement are key drivers of behavioral change. This research reinforces the view that strategic educational interventions can effectively increase students' understanding and acceptance of circular economy principles, as suggested by previous studies such as Rahmatika, (2022) and Rahman, (2023). In conclusion, this study outlines the important role of educational strategies in fostering student attitudes towards the circular economy (CE) and is represented in the conceptual framework shown in Fig. 5 below.

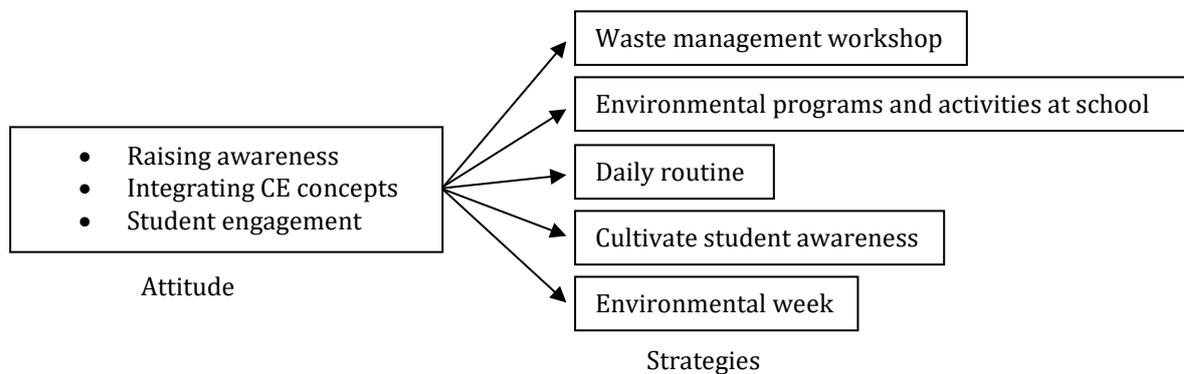


Fig. 5 The conceptual framework of attitudes and strategies to foster circular economy in TVET education

This study can be used as a reference and alternative for teachers, instructors or lecturers to diversify the approach in cultivating a circular economy. Future studies should evaluate the long-term effects of these strategies on student behavior and attitudes through longitudinal studies. Comparative studies across different cultural and educational contexts are also necessary to understand the adaptability and scalability of these strategies globally, ensuring they are culturally sensitive and applicable. Educational institutions should aggressively integrate these strategies into their curriculum and training programs, focusing on practical applications such as waste management workshops and cross-curricular elements. Policymakers should incorporate these strategies into education policies to support the transition to a circular economy, ensuring future generations are aware and skilled in sustainable practices. Overall, this research extends previous findings by offering actionable strategies and emphasizes the importance of educational initiatives in promoting sustainability within the TVET framework, fostering a capable workforce ready to address sustainability challenges.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Norzaharah, Fathiyah; **data collection:** Norzaharah; **analysis and interpretation of results:** Norzaharah, Mohamad Sattar; **draft manuscript preparation:** All authors reviewed the results and approved the final version of the manuscript.

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