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Research Article

Methodological Approach to Study the Factors of Adolescents' Pro-environmental Behavior: Emerging Need of Mixed Methods Research

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Abstract
Identifying the factors influencing pro-environmental behavior among adolescents is crucial. Several studies have explored these factors using various methodologies, but the research designs used in those studies have not been systematically examined. To address this gap, a systematic review of previous studies was conducted using PRISMA. The peer-reviewed articles were searched in three databases; Scopus, Web of Science, and Pro-Quest. With selected inclusion and exclusion criteria, 29 articles were reviewed. The results reveal that most past research has relied on quantitative methods. Given the complexity of pro-environmental behavior, a deeper exploration necessitates mixed methods research. Mixed methods research offers a more comprehensive understanding, broadens the scope of the study, provides complementary insights, and enhances validity through triangulation if explicitly integrated the result of two strands. This article is vital for guiding future researchers in examining the determinants of pro-environmental behavior using mixed methods research.

Keywords: *pro-environmental behavior; mixed methods; quantitative; qualitative*

Methodological Approach to Study the Factors of Adolescents' Pro-environmental Behavior: Emerging Need of Mixed Methods Research

Introduction

Sustainable development is highly talked term in present-day society. In order to achieve sustainable development, social, economic, and environmental factors must be balanced (Bezrukova et al., 2019). In line with this perspective, the environment must be taken into account across various aspects of life. Presently, the environment is confronted with numerous issues, such as pollution, water scarcity, species depletion, and global warming (Pielke Jr, 2004), resulting in climate change. Climate change refers to the change in climate directly or indirectly by human activities like deforestation and overconsumption (Pielke Jr, 2004). Thus, United Nations (2023) claimed that it is a severe issue around the world as it has caused adverse environmental consequences like floods, drought, cyclones, landslides, and global warming. Climate change affects people from many generations and geographic regions. Among them, adolescents or youths are the most affected stakeholders (Chan et al., 2021). Therefore, it is essential to have a discourse on PEB among adolescents (Chan et al., 2021).

United Nation Children's Fund [UNICEF] (2023) has defined teenagers between 10-19 years as adolescents. During the adolescent phase of life, they are influenced by different social issues like climate change on their social and cognitive development (Eisenberg et al., 1995). As

explained earlier, climate change affects adolescents, and they must be appropriately guided to engage in environment-friendly behavior (Krettenauer, 2017). This environmentally friendly behavior that protects the environment is termed pro-environmental behavior (PEB) (Palupi & Sawitri, 2018). In order to motivate the adolescents to behave environment appropriate manner, the factor determining the environment friendly behavior of adolescent must be identified.

There have been many studies on factors influencing adolescents' PEB. For example, Uitto et al. (2015) claimed that environment-related attitudes, values, norms and self-efficacies are major factors. Likewise, Pickering et al. (2021) showed climate knowledge, belief, religiosity, and socio-demographic factors determine environment-friendly behavior. In line with this, Stevenson et al. (2018) suggested environmental education can influence adolescents' behavior towards the environment. In like manner, Balundė et al. (2020) put forward personal norms, self-identity, and biospheric values as the determinants of PEB. In this connection, research design carried out to explore the factors is essential to understand.

Researchers can implement quantitative, qualitative, or mixed methods research designs to identify the factors. However, all three research methods have both pros and cons (Kaushik & Walsch, 2019). The quantitative method is guided by post-positivism philosophy, which claims knowledge as an objective reality and standardization (Creswell, 2013). With the quantitative method, the answer to the *what* question can be explored; however, it is difficult to understand the specific setting (Sharma & Bhattrai, 2022). The answer to *how* and *why* is hard to be synthesized by quantitative method. To synthesize the explanation of how and why, qualitative research may be used, which is often guided by constructivist philosophy (Creswell & Plano Clark, 2011). This method is suitable for developing subjective phenomena. However, qualitative research lacks generalizability (Zikmund et al., 2014). Thus, for the situation when an answer to both *what* and *how* or *why* is required, mixed methods research can be performed (Sharma & Bhattarai, 2022). The mixed methods research may provide both objective and subjective reality guided by pragmatism philosophy (Kaushik & Walsh, 2019), which is comprehensive. Many researchers utilized quantitative method for studying PEB (Hosany et al., 2022). For example, the relationship between environmental consideration and PEB among adolescents was investigated using correlation and confirmatory factor analysis (Balundė et al., 2020). Similarly, the recent study using systematic review (Bhattarai et al., 2024) found that many research in the area used quantitative research design (20 out of 21 articles) to determine the factors influencing PEB. In the review, only one study, Dąbrowski et al. (2022), utilized qualitative research design like focus group discussion in their study. The knowledge production on factors influencing PEB among adolescents is increasing (Hosany et al., 2022). However, there have been limited studies on the different aspects of research design, like the data analysis process. The proper research design is essential to understand the complex phenomena of PEB, as highlighted by Chen et al. (2019). The complexity inherent in analyzing the factors influencing PEB necessitates a comprehensive analytical approach such as mixed methods research design which should be monitored continuously for longer period of time (Janakiraman et al., 2021). The research design implemented by previous studies has not been consolidated. Thus, the primary objective of this study is to examine and synthesize the research design employed in existing studies that investigate the factors influencing pro-environment behavior of adolescents. Furthermore, this study aims to explore the extent to which mixed methods research approaches have been utilized in this area and to analyze how these methods have been applied to study the factors affecting PEB of adolescents. In doing so, this article also synthesizes the different data analysis processes. In this way, this study contributes to consolidating the research design used in the study of factors influencing the PEB of

adolescents.

Method

To fulfill the objectives, the researchers of this study implemented a systematic literature review method. As suggested by Nor et al. (2023) and Pradana et al. (2023), a systematic literature review helps to synthesize the knowledge from the existing literature review. It reduces biases, improves dependability, and fosters effective communication of findings. Thus, it is recognized as a desirable approach to review (Liberati et al., 2009). It provides a scientific and reproducible approach (Tranfield et al., 2003). Researchers can follow the procedure more effectively by using the well-explained steps and inclusion and exclusion criteria that a systematic review offers. For performing a systematic literature review, the authors utilize the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA), which is an established reporting mechanism in the systematic literature review (Hosany et al., 2022).

To perform PRISMA method, a search strategy is vital. The search strategy includes different stages, such as identification, screening, eligibility, and inclusion (Hosany et al., 2022). For identification, the four factors- database, keywords, source types, and language- were considered. The three databases- SCOPUS, ProQuest, and Web of Science (WoS)- were selected for the literature search. The search was performed on April 15, 2025.

The Boolean combinations of keywords for PEB were "environmental behavio*r" OR "pro-sustainability behavio*r" OR "pro-ecological behavio*r" OR "green behavio*r" OR "sustainable behavio*r" OR "ecological behavio*r" OR "eco-friendly behavio*r". Similarly, keywords for adolescents were “adolescen*" OR "youth*" and keywords for methodology were "research method*" OR "Research design*" OR method* OR quantitative OR qualitative OR "mixed methods".

The keywords were searched in the titles, abstract, and keywords of the articles. The search was limited to document-type, openly accessed and available in English articles. For Scopus, the code used for search is TITLE-ABS-KEY (("environmental behavio*r" OR "pro-sustainability behavio*r" OR "pro-ecological behavio*r" OR "green behavio*r" OR "sustainable behavio*r" OR "ecological behavio*r" OR "eco-friendly behavio*r") AND ("adolescen*" OR "youth*") AND ("factor*" OR "determinant*") AND ("research method*" OR "Research design*" OR method* OR quantitative OR qualitative OR "mixed methods")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (OA , "all")). For WoS, the code is TS=(("environmental behavio*r" OR "pro-sustainability behavio*r" OR "pro-ecological behavio*r" OR "green behavio*r" OR "sustainable behavio*r" OR "ecological behavio*r" OR "eco-friendly behavio*r") AND ("adolescent*" OR "youth*") AND ("factor*" OR "determinant*") AND (“research method*” OR “Research design*” OR method* OR quantitative OR qualitative OR “mixed methods”)). The other criteria set to search were open access articles in English language. Finally, the code used for search in ProQuest is ("environmental behavio*r" OR "pro-sustainability behavio*r" OR "pro-ecological behavio*r" OR "green behavio*r" OR "sustainable behavio*r" OR "ecological behavio*r" OR "eco-friendly behavio*r") AND ("adolescen*" OR "youth*") AND ("factor*" OR "determinant*") AND ("research method*" OR "Research design*" OR method* OR quantitative OR qualitative OR "mixed methods") and field selected was Abstract and Document Title and was limited to full-text (open access) and peer reviewed English language scholarly journals. The open access articles were used in all databases as this provides barrier free access which is

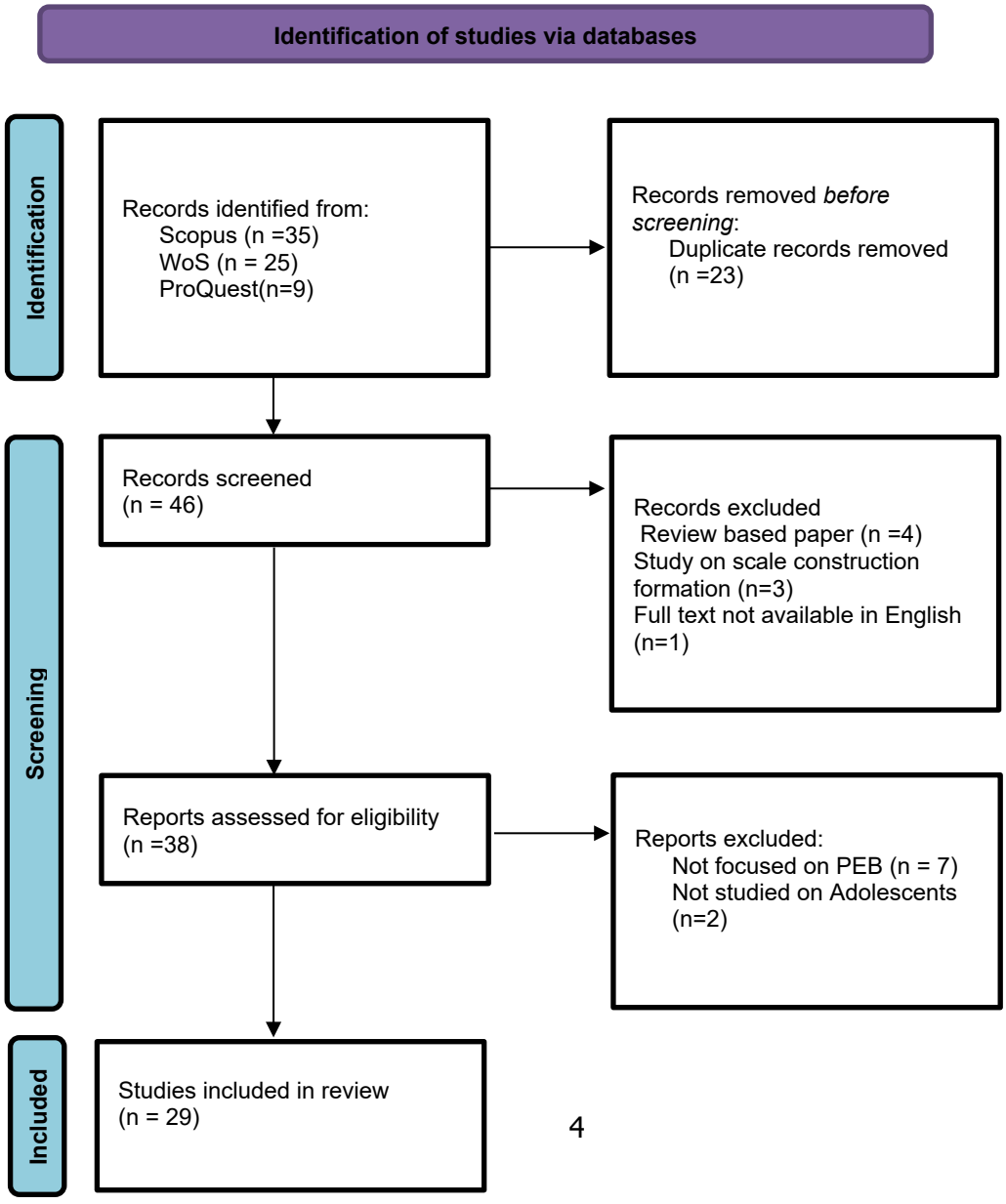
beneficial for the reviewers with limited access to expensive databases and provides transparency in review process (Gusenbauer & Haddaway, 2020). The time limitation was not set for the search in all databases. After the search, 35 articles were identified in SCOPUS, 25 articles were identified in WoS, and 9 articles were identified in ProQuest. Thus, 69 articles were exported to Microsoft Excel for screening and eligibility. 23 duplicates were identified in three databases. After removing duplicates, 46 articles were selected for abstract screening.

Inclusion and Exclusion Criteria

After abstract screening, exclusion criteria were determined. Review based article, study done for scale construction, and full text not available in English were excluded. This resulted in 38 articles for further process. At the end, articles focused on study of pro-environment behavior among adolescents were included for final review. This resulted in 29 articles. Two reviewers (RS and PCB) extracted articles independently to ensure validity. Apart from that all the PRISMA checklist 2020 (Page et al., 2021) were completed. The complete process of PRISMA is shown in Figure 1.

Figure 1

PRISMA Flowchart



Result and Findings

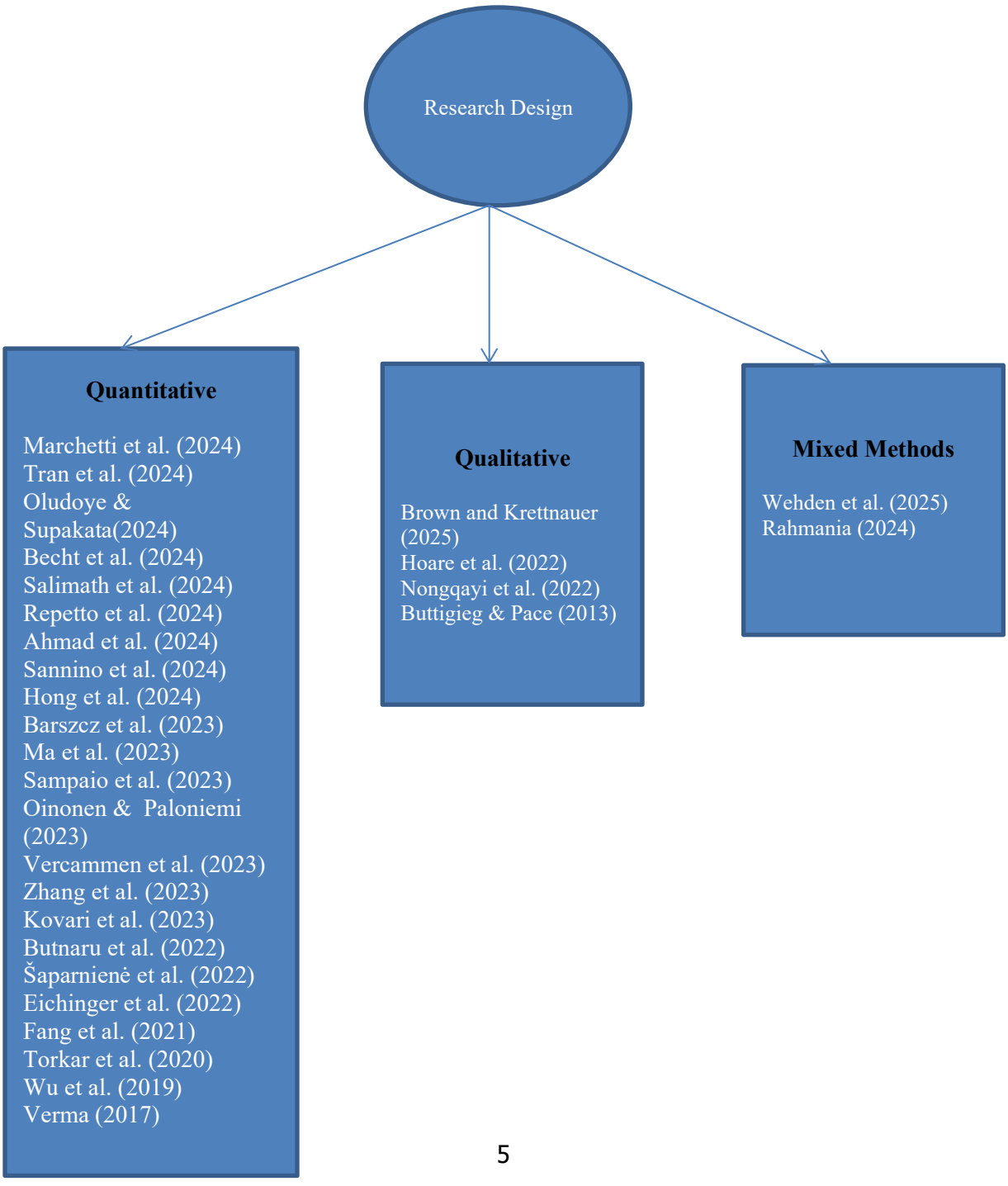
After the in-depth review of 29 articles, researchers here present the findings on methodology of factors influencing PEB among adolescents.

Research Design

Majority of the literatures (*n=23*) have implemented the quantitative research design followed by qualitative research design (*n=4*). Very few literatures (*n=2*) have used mixed methods research design. Figure 2 summarizes the articles and their specific research design.

Figure 2

Research Design



Data Analysis Techniques

Many papers have utilizes the quantitative research design as shown in Figure 2. They have utilized different data analysis techniques like post-hoc, macro process, pearson correlation and regression, factor analysis and structural equation modeling for analyzing the relationship between independent and dependent variables.

Post-Hoc Analysis

Verma (2017) used quantitative research design for understanding green behavior of adolescents. They found out demographic factor like age is important in developing green behavior among adolescents of different era using post-hoc analysis.

Macro Process

Marchetti et al. (2024) utilizes the Pearson correlation to check the association between the variables and process macro for analyzing the mediation effect between independent variables and dependent variables. Likewise, Sannino et al. (2024) analyzed the moderating role of sex of the youth on relationship between environment friendly behavior and divergent thinking using macro process utilizing quantitative research design. They found sex of the youth moderates the association between divergent thinking and environment friendly behavior.

Pearson Correlation and Regression Model

Marchetti et al. (2024) utilizes the Pearson correlation to check the association between the variables. The study of Tran et al. (2024) implemented Baynesian regression analysis with the help of R-programming. Likewise, Becht et al. (2024) also implemented Baynesian regression analysis. Costa et al. (2023) utilizes linear regression to study the relationship between independent variables and dependent variables. Vercammen et al. (2023) utilizes logistic regression and Pearson correlation. Zhang et al. (2023) used regression with two-stage least square methods. Likewise, Barszcz et al. (2023) utilized quantitative survey to determine the factors of pro-environment behavior. They found out intrinsic and extrinsic life goal as important factors determining pro-environment behavior utilizing correlation and regression analysis. Similarly, Salimath et al. (2024) implemented quantitative research design using multiple regression analysis to analyze the factors influencing forest conserving behavior among youths. They found knowledge, age, gender, and information available are some of the major factors influencing forest conserving behavior of youths. In the same line, Repetto et al. (2024) utilized quantitative research design implementing correlation analysis to see the influence of digital learning in climate self-efficacy. With their analysis they claimed that digital learning have more influence on climate self-efficacy among male compared to female adolescents. Similarly, Kővári et al. (2023) used quantitative research design utilizing descriptive statistics and relationship analysis to understand the green attitude of youth of four different European countries. With their analysis, they claimed that difference exist in green attitude among youths based on countries. Furthermore, Eichinger et al., (2022) made cluster controlled pilot study utilizing survey and found out public climate school raises the climate awareness and practice among students implementing logistic regression model. Finally, Fang et al. (2021) utilized multiple regression analysis for analyzing the relationship between independent variables and dependent variables.

Factor Analysis and Structural Equation Modeling (SEM)

Many reviewed papers utilize confirmatory factor analysis (CFA), exploratory factor analysis (EFA), and SEM for data analysis. The study of Torkar et al. (2020) uses CFA for exploring the relationship between students'' dog care and PEB. Likewise, Oludoye and Supakata (2024) used CFA to study the factors influencing the plastic reduction among students and found attitude of students as major factor reducing the use of plastic. Similarly, the study of Šaparnienė et al. (2022) carried out by EFA to study the influence of attitude and behavior on sustainable tourism among youths. Moreover, the study of Ma et al. (2023) utilizes SEM to analyze the relationship between environmental knowledge, environment attitudes, and climate change awareness with their PEB. Likewise, Oinonen & Paloniemi (2023) implemented EFA and CFA for data analysis. Whereas many papers have utilised factor analysis, regression, and SEM separately, the study of Butnaru et al. (2022) utilizes EFA, CFA, and SEM to find out factors influencing environmental behavior. Likewise, Ahmad et al. (2024) made a study on factors influencing curtailment behavior among adolescent. They used quantitative research design utilizing SEM and found government policy moderate the relationship between curtailment behavior and economic concern. Furthermore, Hong et al. (2024) studied green consumption behavior among Chinese youth utilizing quantitative research design. They implemented SEM and found attitude and subjective norms positively influenced green consumption behavior. Likewise, Wu et al. (2019) explored influence of internet use on the formation of environmental attitude among adolescents utilizing quantitative research design using SEM. They claimed level of internet usage influence positively on environmental attitude formation.

Figure 2 shows four papers that have a qualitative research design. They have implemented case studies using focus group discussion (FGD), thematic analysis, and narrative inquiry as data analysis techniques. The study of Hoare et al. (2022) utilizes a case study with FGD as an instrument for interviews to see the influence of conservation education on the coexistence of humans and wildlife. Likewise, Nongqayi et al. (2022) use thematic analysis to understand the knowledge and awareness among youths on human contribution on climate change. Furthermore, Buttigieg & Pace (2013) implement narrative inquiry with in-person interview to understand the youths' role in mitigating climate change. Likewise, Brown and Krettnauer (2025) used qualitative research design using semi-structured interview among adolescents to understand adolescents' pro-environmentalism. They found out nature experience and availability of information is crucial for development of pro-environment behavior.

Two papers in the review applied a mixed methods research design. The study of Wehden et al. (2025) used mixed methods research design integrating case study followed by online survey. They found out occupational choice like photovoltaics installation among German adolescents are key components of pro-environment behavior. However, integration is not purposeful. The connection of integration of results of two research design can be further explained with the techniques like join display. Likewise, Rahmania (2024) explored the influence of environmental and psychological factors on sustainable behavior among students. They utilized the mixed methods research design integrating surveys, interview, and observations, and secondary literature review and found school environment is important in shaping the sustainable behavior among students. This study also could not explicitly discuss the integration of results of two strands.

Discussion: Untapped Potentials of Mixed Methods Research in PEB

The above results show quantitative method dominates the methodological implementation of

the study of factors influencing the PEB of adolescents. However, exploring the determinants of PEB is a multifaceted undertaking, given the intricate nature of individual decision-making processes, as highlighted by Chen et al. (2019). The complexity inherent in analyzing the factors influencing PEB necessitates a comprehensive analytical approach. Singular methodologies may not fully justify the psychological aspects involved in decision-making, potentially limiting the depth of understanding regarding the determinants of PEB. Such a reductionist approach could, in turn, compromise the practical and research implications derived from the study. Thus, assessing pro-environmental behaviors necessitates continuous monitoring and measurement of daily routines over extended periods (Janakiraman et al., 2021), which requires mixed methods for the research.

Worldview of Mixed Methods Research

Researchers using mixed methods research follow the pragmatic worldview. According to Creswell (2009), researchers follow multiple approaches and perspectives for in-depth understanding of the research issues. They integrate a plurality of methods. Researchers implement philosophy and methodology that suits the research problem with a focus on research questions and consequences of research rather than methods (Creswell & Plano Clark, 2011). Pragmatists believe in single or multiple realities open for inquiring empirically and are grounded in the environment and can be realized using human experience (Tashakkori & Teddlie, 2008). According to pragmatist researchers, knowledge is based on each individual's experience gain from their socially shared experience (Kaushik & Walsh, 2019). Pragmatist focuses on practical consequences of human action and beliefs (Morgan, 2014). Thus, researchers following pragmatism implement mixed methods research which has blended characteristics of both quantitative and qualitative research designs providing diverse perspectives in the research issues. The characteristics of mixed methods research has been discussed in next section.

Characteristics of Mixed Methods Research

According to Denzin and Lincoln (2011), mixed methods research poses eight contemporary characteristics that provide diverse perspectives while conducting the research. The eight contemporary characteristics, as stated in Denzin and Lincoln (2011) are as i) methodological eclecticism, ii) paradigm pluralism, iii) emphasis on diversity at all levels of research enterprise, iv) emphasis on continua rather than set of dichotomies, v) iterative and cyclic approach to research, vi) focus on research questions in determining method, vii) set of basic "signature research designs and analytical processes, and viii) tendency towards balance and compromise (p. 287). Methodological eclecticism refers to freedom to combine methods in research for delving into research problems and answer research questions (Tashakori & Teddlie, 2008). Likewise, paradigm pluralism refers to the possible use of multiple epistemologies, theoretical frameworks, and research methodologies in a research (Ghiara, 2020). In the same line, mixed methods research values the perspectives of researchers, participants, and other stakeholders of the research, integrating diversity in the research at all level (Denzin & Lincoln, 2011). Similarly, mixed methods emphasize the interconnectedness of various research methodologies and data integration instead of just focusing on either quantitative or qualitative research design (Teddlie & Tashakkori, 2011). With mixed methods research, researchers can move forth and back for data collection and analysis as guided by the research questions, thus giving flexibility to the researchers (Ivankova & Wingo, 2018). Likewise, mixed methods research provides flexibility to balance and compromise quantitative and qualitative research design and provides

flexibility in the integration of strengths of both qualitative and quantitative research (Benz & Newman, 2008). Finally, mixed methods researchers can implement different signature research designs and approaches like sequential design, embedded design, convergent design, and transformative design (Leavy, 2022). The various approaches are explained in the next section.

Strategies

Many different types of strategies for mixed methods research have been proposed. Among them, the six strategies have been proposed by Creswell and Plano Clark (2011). They are convergent parallel design, explanatory sequential design, exploratory sequential design, embedded design, transformative design, and multiphase design. In convergent parallel design both qualitative and quantitative research are performed separately, and their results are combined to interpret the result. Likewise, in explanatory sequential design, quantitative research is performed first, and the result is explained with the help of qualitative research. Similarly, exploratory research design, at first qualitative research is performed which is followed by quantitative research to generalize the result obtained from qualitative research. In embedded design, researchers add strand of qualitative research to quantitative or vice-versa to improve the interpretation of the result. However, in transformative design, a transformative framework like feminism is considered for prioritizing quantitative or qualitative research design. Finally, in multi-phase design, more than two designs like sequential design and convergent design are implemented over the period to get an in-depth understanding of the research.

In line with Creswell and Plano Clark (2011), the Teddlie and Tashakkori (2011) have suggested five different types of mixed methods research design. The first one is parallel mixed methods design, where both quantitative and qualitative data are collected and analyzed at same time and results are integrated to address the same research question. The second one is a sequential mixed methods design, where one research design is followed by other to answer the research question related to the first design, and other research questions evolved during the process or after the analysis of the first research design. The next one is conversion mixed designs, where one type of data is converted to other types for mixing purposes to answer the same research question. Likewise, the fourth design is multilevel mixed design, where mixing can occur in the sequential or parallel design and in multiple levels to answer the same question. Finally, the fifth design is a fully integrated mixed design where mixing can occur at any stage of research. It is not necessary that mixing occurs only in the findings or results section. It might happen in the conceptualization stage or methodological stage.

Likewise, Morse and Niehaus (2009) suggested eight different types of mixed methods design. The first one is inductive-simultaneous methods (QUAL+quan), where the main research design is qualitative, which is supplemented by a quantitative research design. The second one is inductive sequential design (QUAL->quan), where the core component is qualitative research design, which is supplemented by quantitative research design. Likewise, the third one is deductive-simultaneous design (QUAN+qual), where the main research designs is quantitative and supplemented by qualitative research design. The fourth one is deductive sequential design (QUAN->qual), where the core component is quantitative research design, which is supplemented by qualitative research design. These four designs are mixed methods research design. They have suggested the other four designs as multi-methods designs. For example, the fifth design is inductive simultaneous design (QUAL+qual), where both research designs are

qualitative. Furthermore, the sixth design is inductive sequential design (QUAL->qual) where both are qualitative research designs. Similarly, the seventh design is a deductive simultaneous design (QUAN+quan), where both research designs are quantitative. Finally, the sixth design is deductive sequential design (QUAN->quan), where both are quantitative research designs. The mixed methods research design proposed by Morse and Niehaus has both mixed methods design and multilevel design.

Johnson and Christensen (2017) further provided nine types of mixed methods design integrating equal status or interactive design, which was missing on other designs (Schoonenboom & Johnson, 2017). They are as follows QUAL+ QUAN (equal-status concurrent design), QUAL+quan (qualitatively driven concurrent design), QUAN+qual (quantitatively driven concurrent design), QUAL->QUAN (equal-status sequential design), QUAN->QUAL (equal-status sequential design), QUAL->quan (qualitatively driven sequential design), qual->QUAN (quantitatively driven sequential design), QUAN->qual (quantitatively driven sequential design), and quan->QUAL (qualitatively driven sequential design).

Apart from these designs, another mixed methods research design follows the interactive approach suggested by Loomis and Maxwell (2003). This approach considers design as a process which fits together objectives, conceptual framework, research questions, methods, and validity of the research issues. Thus, the researcher must continuously compare and adapt the components. In this way, researchers have multiple options from various designs to implement in their research. This provides flexibility to the researchers in their study. As per the requirement, researchers can choose specific designs for their issues. Because of flexibility and diverse characteristics, the use of mixed methods design provides an in-depth understanding of the issues. The next section of this study discusses some of the prominent reasons for using mixed methods research design in the study of PEB.

Why is Mixed Methods Research Needed in PEB?

In-depth understanding of phenomena. PEB is complex phenomena with various behaviors like waste management, reducing, recycling, and reusing (Chen et al., 2019). In addition to that, adolescent go through various physical and mental change and sensitive to different societal issues like climate change (UNICEF, 2023). In such condition, it is necessary to have in-depth understanding of PEB phenomenon among adolescents. The mixed methods in the research are used for an in-depth understanding of the phenomena and are becoming popular as both quantitative and qualitative data can be integrated into one single study, providing more robust inference for the research (Creswell, 2013). For example, the importance of mixed methods research stems from its dual approach, merging quantitative surveys with qualitative interviews in the study of Janakiraman et al. (2021). Surveys offer quantifiable insights into level of PEB and attitudinal learning, while interviews explore the intricate experiences of adolescents, revealing how these encounters contribute to the cultivation of PEB among them. Furthermore, different factors influence PEB (Balkenberg & Alhusen, 2019). The utilization of mixed methods, as suggested by Creswell and Plano Clark (2017), allows for a holistic understanding of influence of diverse factors on the issue. Only one method cannot provide such in-depth understanding. For example, in the study of Li et al. (2022), a quantitative survey yielded limited insights into eco-paralysis experiences; the integration of qualitative method facilitated the inclusion of narratives that elucidated the meaning of the quantitative results in a way that a singular method could not achieve.

Expansion of study. Various phenomenon like waste management and recycling indicate PEB and multiple factors like psychological, external, and internal factors influence the PEB among adolescents (Bhattarai et al., 2024). This requires multiple data source which single method cannot provide. However, in mixed methods research, the multiple data sources can be integrated and synergized for assisting complex problems (Poth & Munce, 2020). This provides the wider view or research lens in complex phenomena (Shorter & Smith, 2021) like PEB among adolescents. The justification for opting for a mixed-method approach over a mono-method is twofold (Li et al., 2022). This helps in the expansion of the study. Li et al. (2022) implemented quantitative research in the first phase, which identified the broader spectrum of tourists with diverse environmental profiles. However, to ensure a more comprehensive understanding and validate the quantitative findings, additional context and reality checks were carried out by incorporating qualitative techniques. Thus, mixed methods research can expand study of measuring PEB and identifying factors influencing PEB among adolescents.

Complementary value add-on. The use of two methods in one study acts as complementary, which will add value to the research (Dawadi et al., 2021) like PEB among adolescents. The two methods are used to answer the same research questions. This ensures greater certainty and helps to enrich the understanding of the issue (Morgan, 2014). In line with this, mixed methods incorporate diverse perspectives by combining two methods. It is important to have quantitative and qualitative aspect in the study of PEB among adolescents. While surveys provide measurable information about the degree of PEB and attitudinal learning, interviews delve into the complex lives of teenagers and show how these interactions help them develop PEB. This will ensure the newer research avenues with the enriched comprehension of the phenomena. This approach, as emphasized by Teddlie and Tashakkori (2011), adds value to the research process by offering a more comprehensive and holistic view. Furthermore, the insights gained from mixed-methods research contribute to a better understanding of various components within a phenomenon, facilitating the development of substantial theories, as highlighted by Venkatesh et al. (2013). The findings of quantitative research must be complementary to the findings of qualitative research or vice versa (Li et al., 2022).

Validity through triangulation. One of the values added by mixed methods in research is triangulation of data. This will increase the validity of the research (Dawadi et al., 2021). This is important in the study of PEB among adolescents. The level of PEB might be quantifiable, however, how they practice in different community is difficult to measure as contextual social factor influences the PEB among adolescents (Dąbrowski et al. 2022). This can be achieved by qualitative research. The result of one method cannot provide insights into the issue. Hence, the result of one method can be validated by the result of other methods by comparing two results (Plano Clark & Ivankova, 2016). For example, the study of Janakiraman et al. (2021) validated the quantitative result using the qualitative result to offer enhanced insights into the experience of gameplay. This shows the benefit of employing mixed methods studies. Using mixed methods, a researcher can achieve greater insights using both quantitative and qualitative data (Teddlie & Tashakkori, 2011), which results in the validated conclusion with greater credibility (Venkatesh et al., 2013).

Why is Mixed Methods Research Not Prioritized in Pro-environmental Behavior?

Although mixed methods research provides both qualitative and quantitative perspectives, researchers are reluctant to use mixed methods in research. This is because researchers fear for not achieving goals by using mixed methods in research because of threats associated (Dawadi

et al., 2021). The mixed methods research is lengthy and costly. Studying various indicators of PEB like waste management, recycling, reducing, and reusing (Chen et al., 2019) among adolescents demand prolonged time period. Thus, researchers may not able to finish the research using mixed methods in an estimated budget and time (Hauken et al., 2019).. The PEB of adolescents is influenced by psychological, internal, and external factors (Bhattarai et al., 2024). In mixed methods, there is always difficulty in providing higher priority between the two methods as quantitative and qualitative research design may provide different factors. It is amplified when the findings of one method contradict the findings of other methods (Salehi & Golafshani, 2010). Assessing pro-environmental behaviors among adolescents necessitates continuous monitoring and measurement of daily routines over extended periods (Janakiraman et al., 2021) which is challenge for researchers. Thus, researchers need a broader set of skills for mixed methods research (Dawadi et al., 2021). Hence, with these sorts of challenges, researchers are reluctant to use mixed methods in research like adolescents' PEB.

A Contribution to Mixed Methods Research

As Chen et al. (2019) have highlighted, PEB (Pro-environmental Behavior) has a complex nature. Therefore, relying solely on either qualitative or quantitative research methods may not fully capture the complex psychological factors influencing these behaviors, potentially limiting our understanding of PEB. The reviews of articles in this study also indicate that mixed methods research is crucial for a comprehensive understanding of adolescents' PEB. Additionally, mixed methods research with explicit integration of results from two strands allows for the investigation of environmental behaviors from multiple strategies and perspectives.

Limitations of the Study

Even though this paper has highlighted the research design implemented in the study of factors influencing adolescents' PEB, this study has certain limitations. First, this study only synthesizes the research designs used in studies rather than describing the complete process of methodology. Second, arguments for mixed methods research design is not based on systematic review. Third, the keywords used in the study could have been more for better results. Fourth, only the open access articles have been reviewed. This has limited the implications and conclusion of this study. Fifth, this study did not include ancestral search of articles. This has reduced the opportunity of in-depth synthesis of the research design utilized in the issue. Finally, this study utilized a search from two databases. The inclusion of more databases could have provided different results.

Conclusion

Most of the previous studies implemented quantitative methods for analyzing the factors of PEB among adolescents. However, PEB is a complex phenomenon that requires both objective and subjective perspectives for analysis. Thus, this study highlights the importance of mixed methods in the study of factors influencing the PEB of adolescents and, therefore proposes for implementation of mixed methods research in the study.

This study suggests the benefits of mixed methods research in studying the issue of adolescents' PEB. This method provides an in-depth understanding of PEB, expands the study, validates the result with triangulation, and offers complementary value add-on by implementing both

quantitative and qualitative studies on the issue of PEB. The utilization of mixed methods allows for a holistic comprehension of the diverse influence of factors of PEB. Also, to ensure a more comprehensive understanding of factors influencing adolescents' PEB, both quantitative and qualitative methods need to be integrated. Combining the two methods (mixed methods) provides a more comprehensive understanding of the diverse outcomes found in the current body of literature. However, it is important to explicitly integrate the results of two strands while using the mixed methods research design.

The finding of this study is essential for future researchers to conduct research on the issue of determinants of PEB among adolescents in mixed methods for a holistic comprehension of the diverse influence of factors. Despite posing strengths and benefits, mixed methods research has not been implemented much in the study of PEB among adolescents. The researchers must be trained to conduct and disseminate mixed methods research in a range of pro-environmental behavior research.

Author's Contribution
Conceptualization, R.S. and P.C.B; methodology, R.S. ; validation, R.S and P.C.B,; formal analysis, R.S. and PCB; investigation, R.S.; writing – original draft preparation, R. S.; writing – review and editing, R.S. and P.C.B ; visualization, R.S. and P.C.B, supervision, P.C. B.

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