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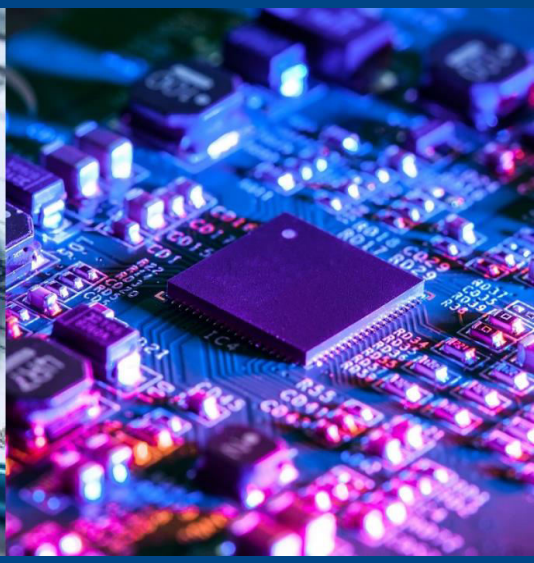

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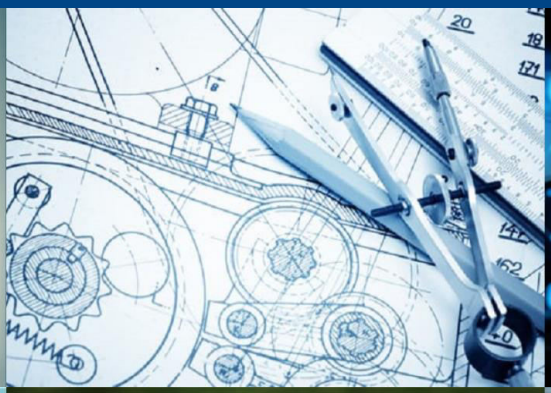

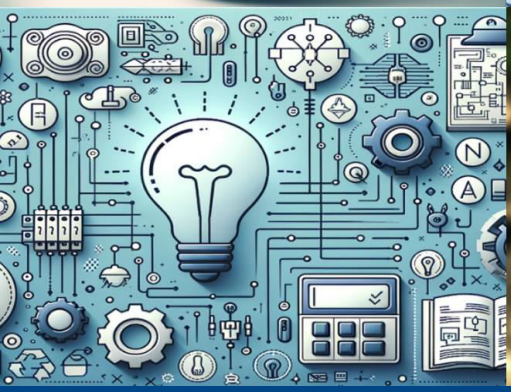

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From Scientific Understanding to Green Behaviour: A Conceptual Framework for Environmental Sustainability among Secondary School Students in Papum Pare District of Arunachal Pradesh

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ABSTRACT: Among secondary school students, the gap between scientific understanding and green behaviour persists. Scientific education helps students understand environmental processes and the consequences of human activities. However, environmental awareness does not assure environmental responsibility. A student might know about the importance of conserving biodiversity, reducing waste and managing resources. However, they might seldom remain committed to these responsibilities. This paper is based on a conceptual framework relevant to secondary school students in the Papum Pare district of Arunachal Pradesh. This framework draws on literature about environmental education, science learning and theories of behaviour. influences of family practices, school culture, community expectations, access to resources, etc. Environmental education research studies indicate that it improves knowledge, attitudes, intentions, and behaviour, but with significant variations in outcomes across studies and measurement approaches. The paper claims that environmental learning should go beyond factual knowledge to include inquiry, evidence-based decision-making, and repeated opportunities to take environmental action. It provides a scientific basis for connecting science teaching with environmental practices in the community and guiding future research on Green Culture and environmental sustainability in Arunachal Pradesh.

KEYWORDS: science education, Green Culture, environmental sustainability, green behaviour, secondary school students, Papum Pare, Arunachal Pradesh

I. INTRODUCTION

Educators care about environmental sustainability because many problems relate to human behaviors toward resources and environmental concerns such as pollution, waste, loss of biodiversity, and the excessive use of natural resources. Addressing these issues requires greater scientific understanding and more responsible individual and collective actions. Students can also develop an understanding of these problems and make decisions about how their everyday choices affect the environment.

Science education helps students learn about many subjects, such as ecosystems, food chains, biodiversity, pollution and resource conservation, and helps them understand how natural systems function. It also teaches students how human activities can change or harm the environment. Scientific inquiry encourages questioning and observation. It also helps students interpret evidence and evaluate options; skills they need to make appropriate decisions when assessing environmental claims or reporting solutions.

However, interpreting something scientifically and behaving in an environmentally responsible way are rather different. For instance, a student may explain how plastic waste harms the ecosystem while continuing to use single-use plastics. Another student may know the importance of conserving water without actually doing so at home. These are examples of the knowledge-action gap—understanding something but not acting differently. Globalization and environmental behavior are two of the many interesting topics being studied by environmental science students.

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Van de Wetering et al. (2022) conducted a meta-analysis of 169 studies involving 176,007 participants from 43 different countries. The studies showed increases in environmental knowledge, attitudes, intentions and behaviour after environmental education. However, the effects varied considerably, and most behavioural outcomes were self-reported. Environmental education can contribute to positive outcomes, but the relationship between learning and sustained action requires closer attention.

This subject is important in secondary education in Arunachal Pradesh. The teaching and learning of science should take into account not only what is taught but also the environmental problems of the local area. Children should be actively involved in their learning. In Papum Pare district, this subject is easier to study and research.

The current study examines how a scientific understanding can be used to promote environmentally friendly behaviors, and what educational and social factors can facilitate students translating knowledge gained through education into long-term environmentally friendly practices. It integrates research from environmental education, science education, and behavioral influences to create a theoretical model applicable to secondary education in Papum Pare District.

II. REVIEW OF LITERATURE

2.1 Environmental education and student outcomes

The goal of environmental education is to provide individuals with the ability to acquire knowledge, attitudes, skills and capacities needed to deal with environmental challenges. Each of these five components cannot be used interchangeably. An individual's knowledge of pollution, their expression of concern regarding pollution and their continuous effort to reduce waste are each a unique accomplishment.

Van de Wetering et al. (2022) documented that environmental education has led to improved knowledge, attitude, intention, and action in children and teenagers; however, there is great variability among studies. Their findings support the value of environmental education while cautioning against assuming that improvements in knowledge will automatically produce equivalent improvements in behaviour.

Ardoin et al. (2020), in their systematic review of 105 environmental education studies focused on conservation outcomes, argue that contextual issues, partnerships, and opportunities for involvement, are often integral to understanding the impact of such programs. Their review revealed that outside the realm of academic studies, EE has the potential to go beyond simply providing students with knowledge about their local environment. However, it is difficult to track the changes in conservation measures.

Steg and Vlek (2009), in their work concerned with promoting behaviour change, argue that successful interventions require an insight into the influential predictors of a given behaviour and possible barriers to change. Their analysis showed that environmental efforts are more effective when they focus on specific behaviours and encourage the people around us to change them.

Overall, the articles discussed above suggest that EE should be evaluated in terms of individual knowledge, attitudes, and behaviour. Understanding the former two areas is relatively specific, while assessing the latter requires more in-depth analysis of processes and possible follow up work. In addition, it may be important to distinguish between changes in attitudes and behaviour and analyse whether the observed changes are enduring.

2.2 Science education and environmental decision-making

Science education helps students to investigate the environmental issues on the basis of evidence, evaluate possible causes behind them and their consequences, and also compare alternative solutions. These are crucial skills for making decisions on contested issues, where there is more than one explanation, conflicting social interests and practical limitations.

Högström et al. (2025) in their systematic review of 157 studies about teaching socio-scientific issues, identified that science education research frequently focused on developing higher-order thinking and scientific content knowledge. Environmental and sustainable-development issues were common areas of instruction, and group discussion was a

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prevalent teaching strategy. Review highlighted the value of using environmental issues as contexts for scientific reasoning and discussion in the classroom.

For example, students could investigate waste-disposal practices in their school, by classifying the types of waste, recording how they are disposed of, considering the environmental consequences and suggesting improvements. This activity would provide students with the opportunity to apply scientific ideas to a real-world decision, and to test if their recommendations are supported by evidence and realistic within their school community.

While evidence-based decision-making is an important skill, the application of such decisions are not always possible. Students might discover an appropriate solution to a local environmental issue, but do not have the facilities to implement their idea. Science education gives student the foundational knowledge to make well-polished decisions about their environment, but motivation and opportunities also depend on social and institutional factors for every action.

2.3 Explaining the knowledge–action gap

Theory of Planned Behavior allows us to analyze how knowledge influences the way individuals think and act. Ajzen (1991) stated that an intention to perform an action develops from a personal attitude, perceived social expectations and the level of command a student has over that action. According to the theory, the combination of a specific intention and the perceived capacity to influence a situation are the two factors that determine if an action occurs.

The data gathered from secondary school students provide evidence that this theory is applicable to educational settings. De Leeuw et al. (2015) tested the Theory of Planned Behavior regarding pro environmental actions and found that perceived control and behavioral patterns within a family are significant predictors of an intention. Researchers concluded that the intentions of high school students develop based on factual information, the examples set by parents or siblings and the degree to which students believe they can influence their own choices.

The conclusions that researchers reached help to improve the design of programs within schools. Since students sometimes express a desire to change specific habits, like the amount of water they consume but lack the resources to modify their actual conduct, those programs must establish the necessary circumstances for a positive shift. To achieve this the programs need to consider the motivations of students and remove physical or social obstacles that prevent action. It is reported that students who want to separate materials for recycling at school are often unable to do so because the facilities do not provide specific containers for different types of waste (De Leeuw et al., 2015). Similar problems exist in other areas, including the consumption of water, the disposal of uneaten food and the conservation of electricity.

2.4 Green Culture and the Indian context

Green Culture is interpreted in this paper as a pattern of environmental values and practices that incorporates responsibility towards the natural environment. It comprises reduction of waste, conservation of resources, biodiversity protection plus responsible consumption. It goes beyond awareness and looks at how people care for the environment through their daily actions.

Shimray and Dwivedi (2025) undertook an exploratory study of the levels of environmental knowledge amongst 1,779 Indian school students. Differences were found across states and educational stages, but none between rural and urban students. These findings demonstrate variations of environmental knowledge between educational and regional factors. However, the study does not explore the extent to which knowledge translates into students' environment-friendly practices.

Regional data offers the opportunity to investigate the issue further. Baral and Tok (2025) asked questions about secondary school students' attitude towards Green Culture in the Papum Pare district. Generally positive attitudes were found towards Green Culture, along with differences between government and private school students. This is useful data in terms of exploring attitudes in a local context. Yet positive attitudes do not equate to ongoing environmental practices.

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The present paper takes an alternative approach by investigating how scientific understanding may link with environmental responsibility, opportunities and repeated behaviour. Local environmental concerns and knowledge provide valuable contexts for science learning. Their educational value is maximised when students can explore relevant claims, compare explanations and apply evidence to understanding environmental processes.

III. RESEARCH GAP

The literature establishes that environmental education can improve several learning outcomes, that science teaching can support evidence-based environmental decision-making, and that behavioural influences extend beyond knowledge alone. However, these strands are not always considered together when explaining how environmental learning may translate into sustained practice.

The regional evidence identified for this paper includes research on students' attitudes towards Green Culture in Papum Pare district. The present paper extends that discussion by examining the possible relationship between scientific understanding, behavioural intentions, practical opportunities and sustained environmental action. The literature reviewed here does not establish that no similar framework exists; rather, it identifies a need to bring these connected dimensions together in a framework relevant to secondary science education in the district.

IV. OBJECTIVES

1. To examine the relationship between scientific understanding and green behaviour in environmental education literature.
2. To identify personal, educational and social conditions that may influence the translation of environmental knowledge into practice.
3. To develop a conceptual framework relevant to secondary school students in Papum Pare district, Arunachal Pradesh.
4. To suggest implications for science teaching and further research on environmental sustainability.

V. REVIEW APPROACH

This paper adopts a critical conceptual review of selected literature on environmental education, science learning, environmental behaviour and behavioural theory. Its purpose is to bring together relevant findings and concepts, examine their limitations and develop a framework for the relationship between scientific understanding and sustained green behaviour.

Relevant literature was identified using targeted internet searches with terms including "environmental education," "science education," "environmental knowledge," "green behaviour," "pro-environmental behaviour," "secondary school students," "India," "Arunachal Pradesh" and "Papum Pare." Preference was given to studies containing substantial discussion of identified themes, as well as recognized reviews, and foundational research papers addressing the issues raised in this paper. In addition, bibliographic references and publication details of cited works were used to identify relevant literature.

The literature was categorized according to themes of outcomes of environmental education, scientific literacy and decision-making, influencing factors, and the regional context of Green Culture. Comparing these results highlighted key trends, methodological limitations, and remaining research gaps. This review was critical and conceptual in nature.

VI. CONCEPTUAL FRAMEWORK: FROM SCIENCE LEARNING TO SUSTAINED GREEN BEHAVIOUR

The framework connects science learning with environmental responsibility, willingness to act and opportunities for practical engagement. It also recognises that social and institutional conditions can influence the process at different stages.

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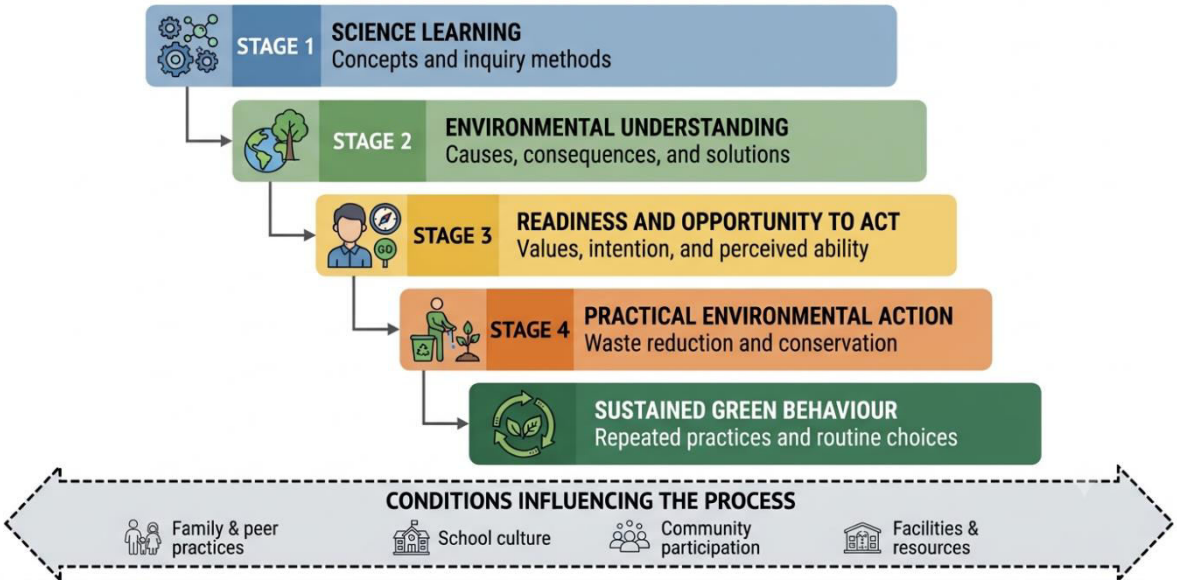

Fig 1: Relationship Between Science Learning, Environmental Action and Sustained Green Behaviour.

Note. The framework integrates insights from the Theory of Planned Behavior (Ajzen, 1991), research on adolescent pro-environmental behaviour (de Leeuw et al., 2015), and environmental education outcomes (Ardoin et al., 2020; van de Wetering et al., 2022).

Learning science is the focus of the first phase. Pupils are gaining an understanding of environmental processes and the impacts of different behaviors. Environmental values and a sense of duty may be influenced by this comprehension. The next step is to evaluate the pupils' abilities and willingness to perform. Subsequently, practical engagement provides an opportunity to apply their learning and repeated action can lead to more consistent behavior. The framework does not assume that these phases always take place in a certain order. Some students may already engage in conservational practices due to their family traditions, while others may be aware of environmental issues but do not have the opportunity to take action in real world. Hence, Social expectations, school facilities and household practices can affect several stages at the same time.

Component	Illustrative indicators	Educational relevance
Scientific understanding	Knowledge of ecosystems, pollution, biodiversity and resource use	Supports informed environmental decisions
Environmental values	Concern about environmental consequences and personal responsibility	Connects learning with reasons for acting
Intention and perceived ability	Willingness to conserve resources and confidence in taking action	Helps explain readiness to act
Practical engagement	Waste audits, water-use observations and conservation activities	Provides opportunities to apply knowledge
Social and institutional conditions	Family practices, school expectations and available facilities	Influences whether action is feasible
Sustained green behaviour	Repeated waste reduction, resource conservation and responsible consumption	Indicates whether practices continue over time

Table 1. Components of the conceptual framework

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VII. IMPLICATIONS FOR SCIENCE EDUCATION

The framework implies that the ideas which are being taught need to be linked to observable issues. Instead of just explaining waste management, teachers could be taking students through a documentation process of the wastes in their school, looking at how these are disposed of and suggesting alternative practices based on what they observe. Similar projects could explore water use, electricity consumption and biodiversity in the school.

Environmental education should also include a component of recurring activities. A one off awareness programme is great, but it's better for learners to be repeatedly going through processes where they test their understanding and see for themselves if the actions they perform have an effect. The school could be monitoring the results of such activities to both evaluate scientific content understanding and engagement in the given practice. The school also needs to look inward to ensure that it is not contradicting the practice it asks of others. Learners might be asked to segregate certain wastes, but not provided with the required facilities. Environmental responsibility requires the school's support and involvement beyond advising students on their individual actions.

In Papum Pare district, science teaching can be informed by the relevant environmental issues and their understanding within the communities from where the school's students originate. Learners can explore their own issues and compare them with those of their peers. This process would allow them to assess various arguments and research the most plausible causes and solutions. Indigenous and community knowledge can be used, but the students should be aware of any unscientific reasoning that might be involved and thus not automatically accept a statement's validity.

VIII. LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH

The research provided in the paper is based only on published works, and there are no primary data from Papum Pare district. Further experimentation and research might be needed to fully comprehend the relationship between student science and their attitudes toward the creation of a sustainable environment. The experiments could include questionnaires to determine students' behavior toward the subject and observe their actions, for instance, segregation of garbage or saving energy. Additionally, multiple observations would be necessary to monitor if students maintain the proper behavior throughout a certain period of time. It might also be valuable to experiment with the role of school facilities, family, friends, and practical activities in developing the Green Culture and students' attitudes towards ecological sustainability.

IX. CONCLUSION

Science education plays an important role in helping students to comprehend environmental matters, analyze information and make the right choices. However, scientific information per se may not be sufficient to encourage lasting environmentally friendly behaviours. Instead, learners need to be aware of their own impact on the environment, feel empowered to make a difference and be provided with the relevant opportunities to do so. Family involvement, peer group interaction as well as school culture and infrastructure can also play a role in influencing students' conduct. For instance, in schools in the Papum Pare district, science teachers can integrate issues affecting their community, such as waste disposal, conservation and biodiversity, into science classes through practical activities and discussions based on evidence. The framework can help to demonstrate how scientific knowledge may be applied in everyday life and provide guidance for further improvements in science education, as well as research into environmental issues in Arunachal Pradesh.

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