



Innovative Pedagogies For Sustainability: A Review Of Strategies In Secondary Education

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Abstract

In today's day to day life the inculcation of sustainability concepts in school curriculum is essential for preparing pupils with the knowledge and skills that needs to be address in the present global challenges such as climate change, resource depletion, and biodiversity loss intensify, in the aspects of environmental, social and economic. The objective of this study is to examines innovative pedagogical approaches such as project-based learning, experiential learning, and the use of digital tools that effectively promote sustainability awareness and student engagement. Drawing on literature from databases like Google Scholar, Scopus, and ERIC, the study underscores the value of interdisciplinary and hands-on learning in enhancing sustainability literacy among students.

Regardless of their potential, these innovative pedagogies face challenges during implementation process such as having rigid curriculum, insufficient teacher training, and limited resources. The Indian educational policy frameworks provided solid evidence to embedded sustainability into education especially at school level. The National Education Policy (NEP,2020) & National Curriculum Framework for School Education (NCFSE, 2023). However, to implement successfully, the systematics reforms are essential.

The study results conclude that, the innovative teaching strategies have ample scope to inculcate and foster sustainability in school level education but their effectiveness relay on strong teacher preparation, allocating resources equally and active pupil participation beyond the classroom. The study highlights the ongoing discussion on sustainability education by identifying and offering various pedagogical methods to inculcate sustainability at school level education.

Key words: Sustainability Education, Innovative Pedagogies, Sustainability literacy, Secondary Education.

I. Introduction

The 21st century has seen a significant rise in the environmental problems so, the need for sustainability education has been more crucial. As global concerns such as climate change, resource depletion, and biodiversity loss intensify, educators are entrusted with equipping students with the knowledge, skills, and values necessary to foster a sustainable future (UNESCO, 2017). Though the fundamental traditional teaching methods frequently struggle to inspire students to undertake a meaningful action or engage in significant learning process. (Sterling, 2001). Therefore, the demand for innovative approaches to teaching sustainability that impart on theoretical information that promote knowledge, encourage critical thinking, problem-solving, and real-world application (Wals & Jickling, 2002).

The innovative pedagogical strategies like experiential learning, project-based learning, gamification, and ICT-integrated learning made sustainability education more feasible (Tilbury & Wortman, 2004). It supports transformative learning, which defines the importance of the deep connection between the student and the subject matter he or she learns. (Mezirow, 2000). For example, project-based learning allows students to address the real-world sustainability issues, through which developing a sense of accountability in students (Thomas, 2000). Similarly, gamification manipulates the motivational power of games to make learning about sustainability interactive and enjoyable (Deterding et al., 2011).

Whereas experiential learning motivates the students to learn through hands-on experiences and helps to bridge the gap between real-world application and theoretical concepts (Kolb, 1984). This method can be used to enhance the understanding of students in complex concepts of sustainability and its practical application (Eyler, 2009). The use of virtual reality and online platforms are examples of ICT integration in education which offer novel opportunities for interactive and cooperative learning experiences (Selwyn, 2011). It facilitates the simulation of real-world situations, allowing students to investigate the implications of their choices in an appropriate environment (Huang et al., 2020). In addition to enhancing their understanding of sustainability, this immersive method develops their critical thinking and problem-solving abilities, thereby equipping them to address actual environmental issues. Teachers are constantly coming up with innovative ways to use technology as it develops further in order to improve student learning outcomes.

Despite these strategies, the implementation of sustainability in classroom faces lots of challenges. Obstacles such as limited resources, lack of teacher training, and resistance to change are hindering the adoption. (Henderson et al., 2017). Even though, the studies have shown that with proper support and professional development, educators can surmount these obstacles and successfully implement innovative methods into their teaching practices (Evans et al., 2017). Moreover, transdisciplinary collaboration and community involvement have been identified as key factors in enhancing the effectiveness of sustainability education (Brundiers et al., 2010).

II. Review of Literature

This paper explores the capacity of innovative teaching methods to nurture sustainability education in classroom scenarios. Relying on contemporary research and case studies, it examines how these approaches help in bridging the gap between theory and practice, developing a group of environmentally conscious and socially responsible citizens (Tilbury, 2012).

The study also highlights the potential and difficulties encountered when putting these strategies into practice, providing guidance for curriculum designers, educators, and legislators (Wiek et al., 2011). A critical examination of the literature on fostering sustainability in secondary school reveals both noteworthy advancements and significant obstacles. When innovative pedagogies such as transdisciplinary, experiential learning, digital tools, and community-based approaches have showcased the importance of fostering students' understanding and engagement with sustainability, its execution often faces major challenges.

For instance, the integration of sustainability across subjects, as proposed by Wals (2014) and Sterling (2016), needs considerable curricular reforming and teacher cooperation, which many schools struggle to achieve due to non-flexible educational frameworks and limited resources.

Similar to that, project-based and experiential learning frequently requires a large amount of time, money, and logistical support all of which are not always available in schools having little resources despite proving successful in developing real-world problem-solving abilities (Brundiers et al., 2020; Eilam & Trop, 2012). Additionally, although gamification and digital technologies provide engaging methods of teaching difficult sustainability ideas (Huang et al., 2019; Kavanagh et al., 2021), their efficacy is dependent on teacher preparation and technological access, underscoring inequalities in educational equality. Studies by Ferreira et al. (2007) and Evans et al. (2017) highlight the necessity of comprehensive professional development programs to give teachers the abilities and self-assurance to adopt cutting-edge pedagogies, demonstrating that teacher readiness continues to be a significant obstacle. Although real learning experiences are offered by community-based approaches (Wals & Benavot, 2017; Krasny & Tidball, 2015), their effectiveness hinges on how easily local partnerships can be accessed and how willing stakeholders are to interact with schools. A major gap in the literature is the lack of prolonged studies measuring the long-term impact of these pedagogies on students' attitudes, behaviors, and contributions to sustainability. Without these evidences, it is difficult to determine whether these innovative approaches transfer into meaningful, everlasting changes. Overall, while the literature offers valuable insights into nurturing sustainability in secondary education, addressing systemic barriers, certify equitable access, and organizing long-term impact studies are essential for advancing this field.

III. Need and significance

The need for this study rises from the crucial role of secondary education in handling global sustainability challenges. While innovative pedagogies like interdisciplinary curricula, experiential learning, digital tools, and community-based approaches show promise, their execution faces barriers such as limited resources, insufficient teacher training, and systemic inequities. This study is remarkable as it discovers how these pedagogies can be efficiently blended into classrooms, providing implementable insights for educators and

policymakers. It also reinforces the need of teacher training and fare access to resources, ensuring inclusivity and impact. By identifying best practices, the study contributes to promoting education for sustainable development (ESD) and empowering students to deal sustainability challenges, making it essential for shaping a sustainable future.

IV.Statement of the Problem:

Innovative Pedagogies for Sustainability: A Review of Strategies in Secondary Education

V. Research Questions

- 1.Which innovative pedagogy is most effective in nurturing sustainability awareness and action within secondary school students?
- 2.How interdisciplinary approach and experiential learning methods can be blended into secondary education to enhance environmental literacy?
- 3.What are the key obstacles and factors in executing innovative pedagogies for sustainability in secondary classroom scenario?

VI. Objectives

- 1.To identify and assess the innovative pedagogies that promote sustainability awareness and engagement in secondary education.
- 2.To explore approaches for integrating interdisciplinary and experiential learning methods into secondary curricula to enhance sustainability literacy.
- 3.To analyze the difficulties and enabling factors in adopting innovative pedagogies for sustainability and propose actionable solutions.

VII. Methodology

The methodology for this review paper involves on innovative instructional strategies for sustainability in secondary school was gathered and synthesized for this review using a structured methodology. Using specific keywords like "sustainability education," "innovative pedagogies," and "secondary education," pertinent studies were found in scholarly databases like Google Scholar, Scopus, ERIC, and ResearchGate. Peer-reviewed journal articles that particularly addressed educational practices in the context of secondary school and were published within the last ten years were the main focus of the selection criteria. The chosen papers were then thematically grouped into themes such multidisciplinary methods, experiential learning, digital tools, and implementation issues after titles and abstracts were screened for relevancy. After that, a thematic synthesis was carried out to find recurrent themes, point out areas that needed more investigation, and create a cohesive conceptual framework for improving sustainable teaching methods

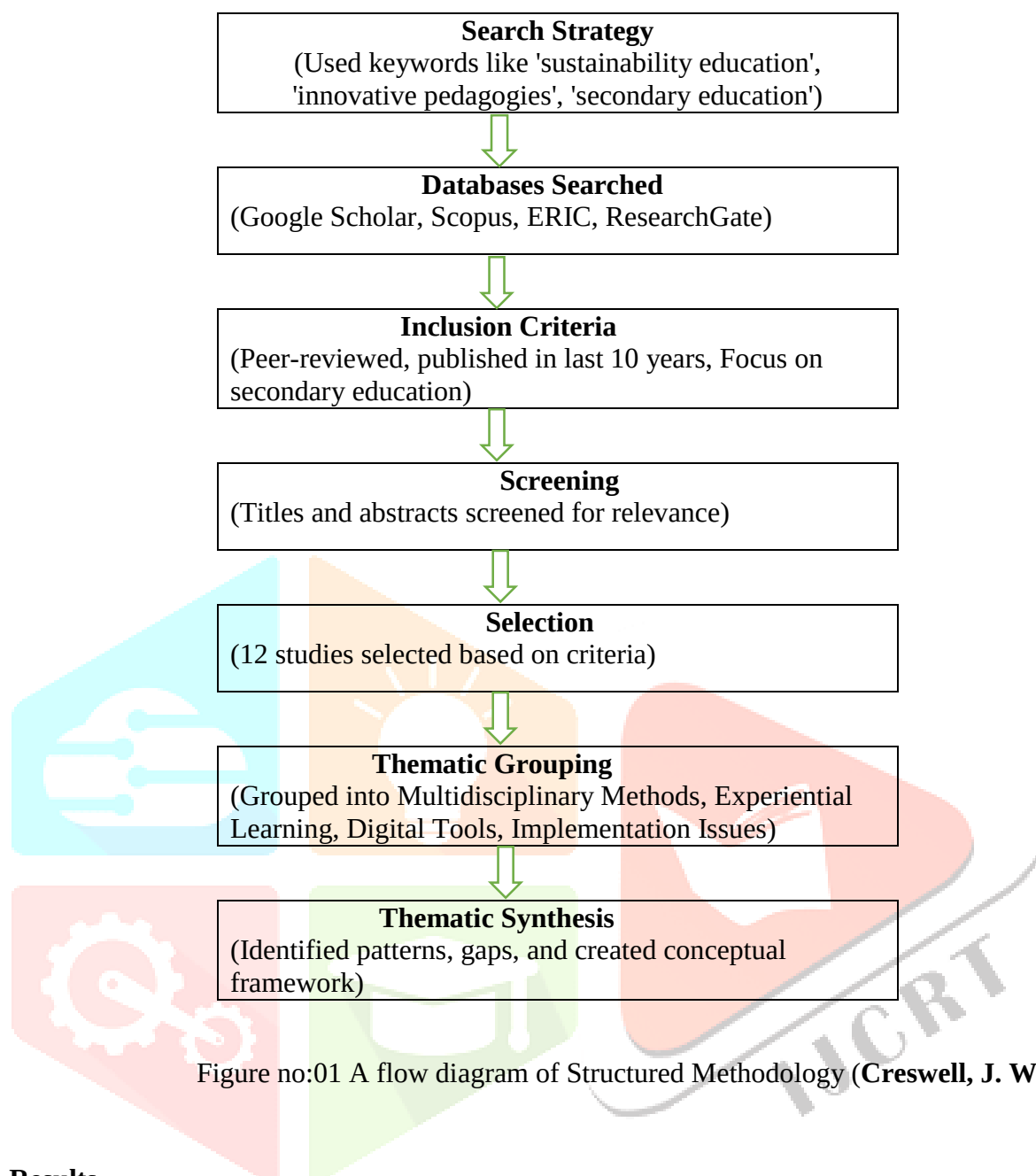


Figure no:01 A flow diagram of Structured Methodology (Creswell, J. W. 2014)

VIII. Results

Objective one: To identify and assess the innovative pedagogies that promote sustainability awareness and engagement in secondary education.

In order to attain the first objective of the study namely “To identify and assess the innovative pedagogies that promote sustainability awareness and engagement in secondary education.” The researcher collected and reviewed literature from existing data base.

Brundiers, K., Wiek, A., & Redman, C. L. (2020). Real-world learning opportunities in sustainability highlighted on Innovative Pedagogies Enhancing Sustainability Awareness and Engagement. The review spotted several innovative pedagogies that effectively enhance sustainability awareness and engagement in secondary education such as Project-based learning (PBL) emerged as a notable approach, enabling students to address the real-world sustainability challenges through hands-on projects, such as school gardens or energy

conservation initiatives (Brundiers et al., 2020). Gamification and digital tools, including simulations and virtual labs, were also found to improve student engagement and understanding of complex sustainability concepts (Huang et al., 2019; Kavanagh et al., 2021). Moreover, inquiry-based learning and storytelling were highlighted as effective methods to foster critical thinking and emotional connection to sustainability issues (Eilam & Trop, 2012). These pedagogies not only improve knowledge retention but also encourage students to take proactive roles in sustainability efforts. The National Curriculum Framework for School Education (NCFSE) and the National Education Policy (NEP) 2020 emphasize the importance of integrating sustainability into the curriculum through experiential and activity-based learning. NEP 2020 come up with a holistic, multifaceted method of education by promoting the inclusion of environmental and sustainability ideas over subjects (NEP, 2020). In the same way, NCFSE showcases the need for pedagogies that enhances critical thinking, problem-solving, and ethical reasoning, line up with the goals of sustainability education (NCFSE, 2023). These frameworks come up with a strong policy foundation to execute innovative pedagogies, but their outcome depends on effective teacher training and allocation of resources.

The review by Brundiers et al. (2020) identifies innovative pedagogies such as Project-Based Learning (PBL), gamification, inquiry-based learning, and storytelling as effective tools for enhancing sustainability awareness in secondary education. These approaches promote hands-on engagement, critical thinking, and emotional connections to real-world sustainability challenges, aligning with policy frameworks like NEP (2020) & NCFSE (2023), which emphasize experiential and interdisciplinary learning. However, the successful implementation of these pedagogies depends on adequate teacher training, institutional support, and resource allocation, which are often inconsistent. While these methods show promise in fostering sustainability literacy and proactive student involvement, their long-term impact and scalability remain uncertain without systemic reinforcement. To maximize effectiveness, future efforts must prioritize structured teacher development, equitable access to resources, and robust evaluation mechanisms to ensure these innovative strategies translate into meaningful and widespread sustainability education.

Objective Two: To explore approaches for integrating interdisciplinary and experiential learning methods into secondary curricula to enhance sustainability literacy.

The existing literature highlights that integrating interdisciplinary and experiential learning into secondary education requires a holistic and systemic approach to effectively address sustainability challenges. Interdisciplinary learning breaks down traditional subject silos by connecting disciplines such as science, social studies, and the arts, enabling students to grasp the interconnected nature of sustainability issues (Wals, 2014). For instance, studying climate change through both scientific data and socio-economic impacts helps students develop a more nuanced understanding. However, implementing such an approach demands curricular flexibility, as rigid subject boundaries often hinder meaningful integration.

On the other hand, experiential learning through field trips, community-based projects, and outdoor education plays a crucial role in grounding sustainability concepts in real-world contexts (Krasny & Tidball, 2015). These methods not only enhance engagement but also foster a deeper emotional and ethical connection to

local environmental challenges. Successful implementation often relies on collaborations with local organizations, NGOs, and government bodies, ensuring that students engage in authentic problem-solving. However, challenges such as logistical constraints, funding limitations, and resistance to pedagogical shifts can impede widespread adoption. Additionally, teacher preparedness is critical, as educators must be trained to facilitate experiential and interdisciplinary learning effectively (Ferreira et al., 2007).

Policy Support and Systemic Challenges

The National Education Policy (NEP) 2020 and the National Curriculum Framework for School Education (NCFSE, 2023) provide a robust policy foundation for these pedagogical shifts. NEP 2020 advocates for environmental education to be woven into all subjects, promoting a multidisciplinary approach that aligns with global sustainability education frameworks. It also emphasizes experiential learning through internships, community service, and project-based assignments that tackle local ecological issues. Similarly, NCFSE encourages real-world, problem-based learning, making education more relevant and engaging for students.

Despite these progressive policies, effective execution remains a challenge. Systemic barriers such as inflexible curricula, inadequate teacher training, and insufficient institutional support hinder seamless integration. Furthermore, community partnerships, though essential, require structured frameworks to ensure sustained collaboration. Without addressing these gaps, the potential of interdisciplinary and experiential learning in fostering sustainability literacy may remain underutilized.

In conclusion, Interdisciplinary and experiential learning are powerful pedagogical tools for embedding sustainability in secondary education, as they promote critical thinking, real-world problem-solving, and emotional engagement. While policies like NEP 2020 and NCFSE provide a strong directive for their adoption, systemic reforms are necessary to overcome implementation barriers. Key steps include revising curricula to allow flexibility, enhancing teacher training programs, securing funding for experiential activities, and fostering long-term community partnerships. Without these structural changes, the transformative potential of these approaches may not be fully realized. Moving forward, a collaborative effort among policymakers, educators, and local stakeholders will be essential to create an education system that effectively prepares students to address sustainability challenges with knowledge, skills, and civic responsibility.

Objective Three: To analyze the difficulties and enabling factors in adopting innovative pedagogies for sustainability and propose actionable solutions.

Adopting Innovative Pedagogies: Challenges and Facilitating factors. According to Evans et al. (2017), the review noted a number of challenges to implementing new pedagogies for sustainability, such as a lack of funding, strict curricula, and inadequate teacher preparation. Another persistent challenge was equal funding and access to technology, especially in underprivileged institutions. Partnerships with local communities, professional development initiatives, and excellent leadership are all conducive factors (Wals & Benavot, 2017). The assessment offers practical ways to address these issues, including specialized teacher training programs, conducting workshops and allocating required amount for sustainable projects, and regulatory

changes that encourage flexible curriculum. In order to foster an atmosphere that supports sustainability education, it was also advised that schools, communities, and legislators work together.

In order to address these issues, the National Education Policy (NEP, 2020) and the National Curriculum Framework for School Education (NCFSE, 2023) promote systemic changes. NEP 2020 mandates the creation of adaptable, competency-based curricula and the incorporation of sustainability into teacher preparation programs (NEP, 2020, pp. 4, 12–14). Equal access to resources is also emphasized, particularly in underserved and rural communities (NEP, 2020, pp. 6, 24–25). On the other hand, NCFSE emphasizes the necessity of developing inclusive and interactive learning settings where educators and students work together to address sustainability issues (NCFSE, 2023, pp. 11–13, 30–31). The effectiveness of these policy frameworks, which provide a roadmap for removing challenges, hinges on their efficient execution and ongoing support for educational systems.

Existing research has shown that integrating novel pedagogies for sustainability education in secondary schools presents a number of systemic problems. Lack of proper finance, infrastructure, and technological access is one of the most urgent problems, especially in rural and underprivileged schools (Evans et al., 2017). Sustainability issues are hard to integrate dynamically in many institutions because of rigid or not updated curriculum that do not support transdisciplinary and experiential learning techniques. Furthermore, inadequate teacher preparation continues to be a significant challenge since teachers frequently lack the pedagogical know how and self-assurance necessary to successfully apply project-based learning, gamification, or community-engaged teaching strategies.

Inequalities in sustainability education are made worse by socioeconomic differences in addition to structural limitations. Students' exposure to experiential learning is often limited in marginalized communities because schools sometimes struggle to secure funds for field trips, digital resources, or connections with environmental organizations. Another issue is institutional opposition to change, where standardized testing and rote learning are promoted over creative teaching methods by established administrative policies and assessment systems.

Notwithstanding these challenges, a number of supportive elements can help sustainable pedagogies be successfully adopted. In order to promote curriculum improvements and an innovative culture, strong leadership at the district and school levels is essential (Wals & Benavot, 2017). Programs for professional development that are specifically designed for sustainability education can equip educators with the skills and information they need. Additionally, schools can receive extra resources, opportunities for hands-on learning, and policy assistance through partnerships with local communities, non-governmental organisations, and legislators.

Systemic Reforms and Policy Interventions

The National Curriculum Framework for School Education (NCFSE, 2023) and the National Education Policy (NEP) 2020 provide calculated answers to these problems. In order to support the success of multidisciplinary sustainability education, NEP 2020 highlights the necessity of adaptable, competency-based curriculum. In order to prepare teachers to use cutting-edge pedagogies, it also promotes incorporating sustainability into

teacher preparation programs. The strategy also emphasises how crucial it is to allocate resources fairly, especially for low-income and rural schools, in order to close the infrastructure and digital divide.

In a similar to this, NCFSE encourages inclusive and participatory learning settings that motivate educators and students to work together to address sustainability issues. It advocates for problem-based, experiential learning that links classroom instruction to actual ecological and social concerns. Though these policy frameworks have a solid theoretical basis, successful implementation is essential to their effectiveness. This calls for consistent funding, strong oversight systems, and proactive participation from all parties involved, including communities, governments, business organisations, and schools.

The Direction of Education for Sustainability:

In summary, implementing innovative pedagogies for sustainability education is not without its difficulties, but the potential advantages such as improved student involvement, critical thinking, and practical problem-solving abilities make the change imperative. Resource limitations, strict curricula, and insufficient teacher preparation are major challenges, but these can be lessened with the help of policy-driven curriculum flexibility, focused professional development, and strategic alliances.

Although NEP 2020 and NCFSE,2023 offer a forward-thinking blueprint, their goals can only be achieved by coordinated implementation efforts. While educational institutions should cultivate an innovative culture via leadership and community participation, policymakers must guarantee sufficient financing and facilities, especially for underprivileged schools. In order to confidently use experiential and multidisciplinary methods, teachers who are essential facilitators need ongoing training and assistance.

In the end, the transition to education focused on sustainability necessitates a comprehensive and cooperative approach. Schools can raise a generation of ecologically aware and engaged citizens who can handle the urgent sustainability crises of our day by tackling current issues through policy action, resource allocation, and pedagogical empowerment. Although the process is difficult, revolutionary transformation in education is possible with deliberate dedication and teamwork

IX. Discussions and conclusions:

The findings of this review complement and broaden the corpus of literature already available on using creative pedagogies to advance sustainability in secondary education. Studies by Brundiers et al. (2020) & Eilam and Trop (2012), which highlight the value of practical, real-world experiences in fostering environmental literacy and agency, are in line with the emphasis on project-based learning (PBL) and experiential learning as efficient strategies for raising sustainability awareness. As mentioned by Huang et al. (2019) and Kavanagh et al. (2021), the combination of digital tools and gamification probably highlights how technology may be used to make sustainability education more interesting and approachable. As emphasized by Ferreira et al. (2007) and Evans et al., (2017), these pedagogies exhibit promise, but their implementation frequently encounters challenges including scarce resources, strict curricula, and insufficient teacher

preparation. Disparities in sustainability education result from these obstacles, which are most noticeable in underfunded schools with limited access to funds and technology.

These findings provide a strong policy foundation for integrating sustainability into secondary education since they are in line with the National Curriculum Framework for School Education (NCFSE) 2023 and the National Education Policy (NEP) 2020. Both of them emphasize the need for a holistic approach to education that connects sustainability to real-world situations and advocate for interdisciplinary and experiential learning (NEP, 2020; NCFSE, 2023). Even though these regulations offer a path forward, planned adjustments such as curriculum development, teacher preparation, and community collaborations are necessary for their effective execution. This supports the findings of Wals and Benavot (2017), who contend that in order to establish an environment that supports sustainability education, cooperation between communities, schools, and legislators is necessary. Evans et al. (2017) confirm the review's conclusion that teacher training and professional development are essential for adopting new pedagogies. The efficacy of these pedagogies may be limited if teachers lack the confidence and expertise to integrate sustainability into their lesson plans.

Furthermore, as stressed by NEP 2020 and NCFSE, fair access to resources is essential to guaranteeing that all students, regardless of socioeconomic status, may gain from sustainability education. This is in line with Sterling's (2016) research, which contends that transformative education ought to be available to everyone.

This analysis concludes by highlighting how innovative pedagogies, including project-based learning, experiential learning, and digital technologies, can raise students' understanding of and interest in sustainability in secondary school. In addition to improving students' comprehension of sustainability, these techniques provide them the tools they need to actively address environmental issues. But for them to be implemented successfully, significant obstacles must be overcome, such as scarce resources, strict curricula, and insufficient teacher preparation. These findings' connection with NEP 2020 and NCFSE provide a solid policy basis for incorporating sustainability into secondary education. However, institutional adjustments are required to guarantee its execution. Future research should concentrate on long-term studies to evaluate how various pedagogies affect students' attitudes and behaviors over time, as well as the development of adaptable models for resource allocation and teacher training. The next generation will be better equipped to contribute to a more sustainable future if educators and policymakers close these gaps and foster an atmosphere that supports sustainability education.

References

- Brundiers, K., Wiek, A., & Redman, C. L. (2010). Real-world learning opportunities in sustainability: From classroom into the real world. *International Journal of Sustainability in Higher Education*, 11(4), 308–324. <https://doi.org/10.1108/14676371011077540>
- Brundiers, K., Wiek, A., & Redman, C. L. (2020). Real-world learning opportunities in sustainability: From classroom into the real world. *International Journal of Sustainability in Higher Education*, 21(4), 738–753. <https://doi.org/10.1108/IJSHE-01-2020-0012>

- Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification." Proceedings of the 15th International Academic MindTrek Conference, 9–15. <https://doi.org/10.1145/2181037.2181040>
- Eilam, E., & Trop, T. (2012). Environmental attitudes and environmental behavior—Which is the horse and which is the cart? Sustainability, 4(9), 2210–2246. <https://doi.org/10.3390/su4092210>
- Evans, N., Stevenson, R. B., Lasen, M., Ferreira, J. A., & Davis, J. (2017). Approaches to embedding sustainability in teacher education: A synthesis of the literature. Teaching and Teacher Education, 63, 405–417. <https://doi.org/10.1016/j.tate.2017.01.013>
- Ferreira, J. A., Ryan, L., & Tilbury, D. (2007). Mainstreaming education for sustainable development in initial teacher education in Australia: A review of existing professional development models. Journal of Education for Teaching, 33(2), 225–239. <https://doi.org/10.1080/02607470701259515>
- Henderson, K., Tilbury, D., & Wortman, D. (2017). Whole-school approaches to sustainability: Challenges and opportunities. Environmental Education Research, 23(4), 497–512. <https://doi.org/10.1080/13504622.2016.1204638>
- Huang, H. M., Rauch, U., & Liaw, S. S. (2020). Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. Computers & Education, 55(3), 1171–1182. <https://doi.org/10.1016/j.compedu.2010.05.014>
- Huang, Y. M., Shadiev, R., Sun, A., & Hwang, W. Y. (2019). A systematic review of research on the use of technology-supported collaborative learning in sustainability education. Educational Technology Research and Development, 67(5), 1215–1235. <https://doi.org/10.1007/s11423-019-09663-6>
- Kavanagh, S., Luxton-Reilly, A., Wuensche, B., & Plimmer, B. (2021). Gamification in education: A systematic mapping study. Journal of Educational Technology & Society, 24(1), 75–88. <https://www.jstor.org/stable/26977858>
- Ministry of Education. (2020). National Education Policy 2020. Government of India. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
- National Council of Educational Research and Training. (2023). National Curriculum Framework for School Education (Pre-draft). NCERT. https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf