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Research Article

Synergizing Innovative Practices in Teacher Education for Sustainable Learning and Living to Meet the Local and Global Challenges

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ABSTRACT

Sustainable development is achievable through the concerted efforts to ensure economic, social, and material advancement for the present generation while preserving the rights of future generations to survive. The UN SDG seeks to ensure a high-quality living environment for all individuals by utilizing human enterprises, thereby fostering sustainable economic, social, and technological practices for the evolutionary and developmental progress of humanity. Education for Sustainable Development (ESD) is a pedagogical approach that prepares individuals to make informed choices and undertake actions that promote sustainable utilization of resources for the present and future as well as adopting anthropocentrism. Education for Sustainable Development (ESD) is essential to quality education and is pursued at all educational levels. Teacher and teacher development is having a crucial role in the dynamics of ESD for moving towards SDGs. In the present techno-driven, ephemeral, socio-economic, and cultural landscape where the educational paradigm is moving from a pedagogical to a cybergogical approach, teachers' roles have to be reframed to equip the learners to meet the changing demands of the 21st century. At present, the curriculum is evolving to a Universal Design System with multiple approaches from a site-bound axiom. It is highly essential to probe into the sustainability of the system of teacher formation and metamorphosis to validate that the teacher education is accountable to accommodate the changing culture of innovation, collaboration, and integration—cultural, disciplinary, and technological.

This study examines current practices prevailing in teacher education at both global and local levels, evaluating their corroboration with sustainability—social, economic, ecological, aspirational, and technological. A pluralistic approach, where there is a mixing of quantitative and qualitative paradigms of research, has been utilized. To delve into the existing practices and developments in teacher education, a rigorous review coupled with content analysis has been used. The compatibility of these practices, along with sustainable conceptualization, was derived by collecting data from a sampled group of teacher educators employing a focus group discussion. The outcomes of these techniques were further corroborated using the derivatives obtained from an interview with a group of experts. The educational landscape of India in the post-globalized, post-pandemic era is moving to a rigorous and dynamic shift, objectifying knowledge as the prime economy. In this context, the study also examines the notion of sustainable education, the NEP 2020 framework for teacher education, and the impediments and the suggestive strategies to overcome the same pertaining to Indian teacher education. It underscores the deficiencies in curriculum transactions and proposes avenues for synergising the varied innovative methodologies to make the teacher education system more sustainable by overcoming its fragilities.

Keywords: SDG, ESD, Teacher Education, innovative practices, NEP 2020, Sustainable learning, Sustainable living.

INTRODUCTION

Sustainable development is "*development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs*" (UN, 1970). The prevailing model of sustainable development today encompasses three dimensions. It seeks to guarantee sustainable development in the domains of nature, economics, and society (UN, 2005). Comprehensive education will teach future generations how to contribute to the long-term growth of society and how to understand how changes in the economy, the environment, and society are all linked (UNESCO, 2005; McKeown, 2006; De Haan et al., 2010). Strategic target areas were delineated, including gender equality, health promotion, environmental conservation, rural development, peace and human security, sustainable consumption, cultural diversity, and sustainable urban development. ESD provides direction for educational research, pedagogy, and alterations in teacher education (UNESCO, 2005b, 2005c). Utilizing sustainable development as a regulatory framework, ESD encompasses inherent contradictions, problems, and conflicting objectives. This presents a considerable barrier while also showcasing enormous potential for enhancing innovative educational approaches.

Conventional education perpetuates unsustainability by uncritically replicating norms, fragmenting comprehension, distinguishing winners from losers, acknowledging only a limited range of human capabilities and needs, failing to consider alternatives, promoting dependency and conformity, and catering to the consumerist apparatus. We must restore a genuine education that acknowledges the merits of historical thought and practice while also reimagining education and learning to secure the future. (Sterling, 2001)

Why Sustainable Teacher Education?

Knowledge expansion and technological advancement have changed the web of life and living systems dramatically. Exponential digital blooming implicit in the form of AI has changed the entire learning system, catalyzed by the pandemic influences and implications. In response to the remarkable shift happening in the familial ecosystem, the educational landscape is also responding positively by moving to novel transformational tools and approaches. The intersection of AI and XR has significantly made a mammoth effect on changing the scenario. All these bring new challenges and necessitate the learner to equip and adapt to new situations. Educational institutions have to adopt a change in organizational structure, facilitating agile development. Some changes have already begun to emerge in the education sector. Schools are now viewed as a part of the larger ecosystem, which includes cooperation and the development of networks and partnerships with other educational institutions, scientific organizations, theaters, universities, social service organizations, technology companies, and businesses. Here, instructors and students become acquainted with the competencies and skills that employers and other community members view as vital. By permitting nonlinear learning paths rather than assuming every student would follow linear progressions along a single, standardized path, novel techniques guarantee that these curricula are more flexible, dynamic, and individualized than static.

It is well known that social processes are influenced by educational systems, but social and cultural shifts also have an impact. Since every student has a unique learning path and a unique set of prior knowledge, skills, and attitudes, approaches to curriculum design and learning progression have shifted from a "static, linear model of learning progression" to a "nonlinear, dynamic model." Considering these developments, the emphasis and goal of today's education system performance monitoring have changed from the conventional evaluation of accountability and compliance to the evaluation of ongoing system improvement through feedback at all levels.

Teachers have a potential role to play in this regard. The teacher of the present has to develop the competencies to equip their learners to meet the changing needs of the time. Here is the need for a sustainable teacher education system. Researchers assert that teacher education is fundamental for providing educators with the skills, knowledge, and attitudes essential for fostering sustainability-oriented thinking in future generations. (Rieckmann, 2012). There is a necessity for ESD training to augment knowledge and cultivate sustainability competencies. The primary objective is to create transdisciplinary, integrated, and active methodology-driven programs that implement profound transformations across education. Academic curricula must be revised to positively influence the advancement of Education for Sustainable Development (ESD). (Lorente-Echeverría et al., 2022)

Researchers and policymakers are currently concentrating on the development of professional competencies and enhancing teachers' commitment and motivation. Teacher educators primarily focused on curriculum instruction,

pedagogy, and the domains of student development. They require supplementary skills to navigate real-life circumstances. Educators must perceive themselves as integral to the community rather than solely confined to their classroom responsibilities. Consequently, they must be autonomous and proficient in fostering community engagement (UNESCO, 1995).

LEARNING FROM LITERATURE

The United Nations' Sustainable Development Goals (SDGs) and the European Union's policies establish targets for tackling environmental challenges faced by societies and communities. The UN and the EU underscore the significance of promoting entrepreneurial and innovative education to tackle these issues. Teacher education is crucial in these activities, as educators and teacher trainers significantly impact the education of future citizens. The study investigated the integration of entrepreneurial, sustainable, and pro-environmental education within the primary teacher education curricula of Nordic nations (Finland, Sweden, and Iceland). Competencies are extensively examined within the framework of cross-curricular themes, including Sustainable Development and Education for Sustainable Development (ESD), particularly with the United Nations Decade for ESD (2004–2015). Education for Sustainable Development (ESD) enumerates several competencies across various domains, excluding teacher education. A competence model for Education for Sustainable Development (ESD) for educators was developed in the Austrian research initiative KOM-BiNE (Competences for ESD in Teacher Education). (Rauch et al., 2013)

Studies highlight that integrating ESD principles into teacher training programs enhances educators' capacity to address complex sustainability challenges through interdisciplinary approaches and participatory methodologies (Ryan & Tilbury, 2020; De Haan, 2010). The Competence Model for Education for Sustainable Development (ESD) within the formal education sector seeks to guide the organization of teaching and evaluate the learning results of students instructed on matters pertaining to ESD (De Haan et al., 2010). Experiential learning methods, such as eco-audits and community engagement projects, have been shown to significantly enhance teachers' ability to translate sustainability concepts into practical classroom applications (Burmeister et al., 2012; Farrell & Hart, 2018).

Implementation of ESD in teacher education faces numerous challenges. Limited resources, resistance to curriculum changes, and the lack of ESD-specific pedagogical frameworks often hinder progress (Cebrián et al., 2015; Jucker, 2011). Varying levels of awareness and understanding of sustainability concepts among educators exacerbate these difficulties (Evans et al., 2017). Addressing these gaps requires systemic reforms, including policy support, institutional collaboration, and targeted professional development initiatives (Franklin, 2016; Gadotti, 2008).

Integrating ESD into teacher training can directly contribute to SDG 4 by promoting inclusive, equitable, and quality education (Albareda-Tiana et al., 2020; UNESCO, 2017). Similarly, by fostering health literacy and well-being awareness, teacher education aligns with the objectives of SDG 3 (Davis & Ferreira, 2009). Innovations in pedagogy and curriculum, such as the use of digital tools and interdisciplinary teaching strategies, also contribute to SDG 9 by encouraging creativity and critical thinking among both educators and students (Chinedu et al., 2018; McKeown & Hopkins, 2014).

Overall, the literature underscores the critical role of teacher education as a catalyst for sustainable development. A holistic approach—combining policy support, institutional innovation, and teacher capacity building—is essential to fully realize the potential of ESD in advancing the SDGs. Future research should focus on developing scalable models for ESD integration and evaluating their long-term impact on educators and students (Tilbury, 2011; Lotz-Sisitka & O'Donoghue, 2011).

In Indian tradition, teachers have been regarded as role models not only by the students themselves but also by society. Teacher education programs should be alert to these requirements and so strategies that would assist teachers to develop commitment among students to protect the sovereignty and integrity of India.

Research in teacher education institutions need greater support and motivational inputs to ensure higher quality. The content of teacher education programs in India requires substantial change according to the changes in society and technology, but the rigidity of the system is one of the major obstacles. There exists a persistent resistance to change in the system of teacher education in the country, with no effective mechanism being developed to facilitate the radical reform of teacher education. Many changes have been attempted in the areas of academic content, pedagogy, and organizational structures, but without much success. It has been found that efforts to consolidate existing structures overrule essential professional considerations. The issues of teacher education planning, pre-

service education programs, and in-service education of teachers need to be handled in a much more comprehensive manner. (Musthafa & Rini, 2010)

The present study analyzes contemporary practices in teacher education both at global and local levels, assessing their alignment with sustainability—social, economic, ecological, and technological. This paper explores sustainable education, the NEP 2020 framework for teacher education, and the challenges along with proposed ways to address them in the context of Indian teacher education. It highlights the shortcomings in curriculum implementation and suggests strategies for integrating diverse new approaches to enhance the sustainability of the teacher education system by addressing its vulnerabilities.

METHODOLOGY

A multiple-line approach was utilized to accomplish the varied objectives of the study. A gestaltist view of the sustainability of the present programs of teacher education across the globe was revealed through a review of related literature. The trends and developments of teacher education in India and its strengths and weaknesses are also revealed. To evolve inferences about the present practices of teacher education and to elucidate its strengths and weaknesses, a questionnaire was administered to 126 teacher educators to assess their perceptions regarding the extent to which current practices in teacher education, both curricular and co-curricular, across all levels, are incongruent with sustainable innovative conceptualization. The primary aim was to reveal the strengths and weaknesses of the present teacher education practices and to explore the extent to which these practices are in alignment with the concept of sustainability and competent enough to meet the local and global challenges. The perception of teachers on the different innovative practices in teacher education evolved from a literature review is also analyzed. A debriefing outlining the study's objectives and completion time was provided to the participants. The demographic data were also collected from the participants. The participants were requested to provide their gender, age, position, teaching experience, and the type of management of their institution, indicating whether it was in an urban or rural area. A Likert-type scale from 1 to 5, indicating strongly agree to strongly disagree, was utilized for the responses. A checkbox was included to obtain consent for participation following each question, and after the questionnaire, space was allocated for writing further information, recommendations, and opinions. It is believed that no ethical considerations arise from this process, as total confidentiality of the data provided was ensured.

Following this, to validate the perceptions and observations of sampled teacher educators, a focus group discussion was conducted adhering to the standard operation procedure for conducting a focus group discussion. The derived results were further corroborated using the perceptions of subject experts in the field. For this, an unstructured interview was used.

The data obtained from these three techniques to analyse the varied aspects of the single phenomenon—the practices in teacher education and their agility in aligning with sustainability conceptualization—lead to valid conclusions.

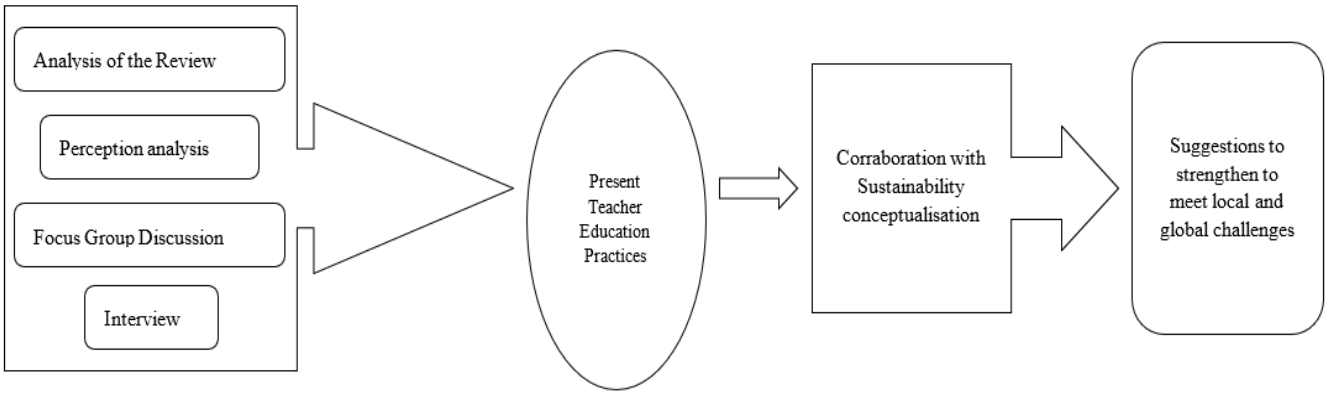


Fig 1: Procedure adopted- Flow diagram

RESULT AND DISCUSSION

The primary aim of this research quest was to analyse the present teacher education system, pool out the different innovative strategies in teacher education in India, and further suggest what needs to be done to make a sustainable one to meet the local and global challenges. The teacher education system is criticized for unproductive teaching-learning strategies, stereotypical attitudes and beliefs of teachers, classroom practices lacking the active participation of students, and teachers' professional identity/professionalism (Gul & Shah, 2019). Not only this, but teachers' motivation, performance, competency, attitude, and lower sense of accountability are also frequently reported (Messo & Messa, 2017).

With the advent of the knowledge era, teacher education needs to prepare teachers to face the changing technological contexts and to model pedagogies and tools for better forms of learning. Despite much enthusiasm about the roles of technology in education, its role in transforming teacher learning in ways aligned with advances in the learning sciences and contemporary sociocultural perspectives, few changes have occurred. The focused area at present includes renewal of delivery of information with online repositories and courses, the rise of web-supported classrooms, participation in learning networks and communities, and knowledge creation in knowledge-building communities. The contemporary focus on socio-cognitive and socio-cultural views of learning and increased worldwide attention on teachers' lifelong learning require new ideas and new approaches for teacher development. E-learning developments expand the professional activity systems of teachers; they give teachers anytime-anyplace access to learning; provide teachers with opportunities to view, reflect, and discuss exemplary Emerging E-Trends and Models in Teacher Education and Professional Development, and instances of teaching practice; allow teachers to participate in communities of practice, to share ideas, reflections, and resources with their peers and other experts in their countries or beyond; and in some cases, challenge teachers to become knowledge designers and creators.

The analyses of emerging trends in e-learning suggest important implications for teacher development as well as issues that need to be considered. First, technological innovations are linked to social and pedagogical innovations (Scardamalia & Bereiter, 2003). Merely having the opportunities to interact more frequently does not translate into high-quality teacher learning. Technology can provide powerful environments eliciting modern views of learning but may not change teachers' beliefs and practice (Riel, 1998). It depends on how teachers interpret the uses of tools and how they use them to transform the learning processes. For example, the effects of online learning vary depending on whether teachers are self-regulated. More importantly, e-learning is not to be disconnected from the larger learning context involving the designer's norms and practices of the collective community. At a more advanced stage, some teachers may take on more collective responsibility—they will have increased ownership and become knowledge-generating new knowledge with others in a knowledge-building community. These approaches could overlap, take place sequentially, or occur concurrently under different contexts. Different pathways for teacher development may also exist in different systems and contexts. Questions about culturally sensitive Developmental pathways in teachers' e-learning growth need to be investigated. There are many differences regarding technological development and access to resources in different countries, regions, and institutions. In many other parts of the world, progressive pedagogies have not taken hold. The knowledge-building perspective (Bereiter, 2002; Scardamalia & Bereiter, 2003; Scardamalia, Bereiter, & Lamon, 1994), with its strong epistemology and technology, offers an avenue for those wanting to put forward innovative pedagogies. Exploratory research on teachers' networks suggests that teachers are more concerned with obtaining information or getting advice from experts rather than seeing their ownership in the communities (Lamon et al., 2005). On the other hand, there are some encouraging examples of teachers contributing as key members in the knowledge-building society (KSN). The integration of technology and teaching practices from several perspectives is a dance of interacting parts (Bateson, 1979), which produces patterns of interaction in an ecological system.

The recommendations from numerous commissions and committees about education have shaped the teacher education policy in India over time. The significant ones include the Kothari Commission (1966), the Chattopadhyay Committee (1985), the National Policy on Education (NPE 1986/92), the Acharya Ramamurthi Committee (1990), the Yashpal Committee (1993), and the National Curriculum Framework (NCF, 2005). The Right of Children to Free and Compulsory Education (RTE) Act, 2009, and the National Education Policy (NEP) 2020 have significant ramifications for teacher education in the nation. The National Council of Teacher Education (NCTE), a statutory entity of the Central Government, is facilitating pre-service training for the organized and systematic advancement of teacher education in the country.

By 2030, teacher education in India will progressively transit into interdisciplinary colleges and universities, requiring a minimum qualification of a 4-year integrated B.Ed. degree. The B.Ed. programs will encompass training in established and contemporary pedagogical techniques, including foundational literacy and numeracy, multi-level instruction and assessment, teaching children with disabilities, catering to children with special interests or talents, utilizing educational technology, and promoting learner-centered and collaborative learning.

The National Education Policy 2020 incorporates specialized, abbreviated local teacher education programs for distinguished local individuals who may be employed as 'master instructors' at schools or school complexes. Concise post-B.Ed. certification programs will be offered extensively in multidisciplinary colleges and universities for educators seeking to transition into specialized teaching domains, including instruction for students with disabilities or leadership and management roles within the education system.

A significant disparity exists between the actual and anticipated quality of teacher education. The uneven distribution of teacher education adversely affects educational accessibility. In addition to concerns such as discrepancies in vision and mission, the excessive activism of open universities and distance education, along with the lack of genuine certification and recognition of universities and institutions, significantly undermines the quality of teacher education.

In continuation of identifying the existing practices in teacher education at a global level and speculating on the trajectory of teacher education development strategies and policy perspectives in the Indian context, the investigators tried to reveal the perception of teacher educators on the sustainability practices prevailing in the existing teacher education system. The following domain and respective attributes were identified as the weakest linkages in teacher education on innovation and sustainability. Table 1.

Table 1: Perceived Domain-Specific Attributes

	Domain	**Attribute/s**
1	Hybrid and Blended Learning Models	Integration of online and in-person instruction, allowing flexibility and accessibility while maintaining high academic standards.
2	Active Learning Strategies	Techniques like flipped classrooms, problem-based learning (PBL), and collaborative group work that shift the focus from passive listening to active engagement.
3	Interdisciplinary Research Collaboration	Encouraging collaboration across disciplines to tackle complex, real-world problems, resulting in more innovative and holistic solutions.
4	Open Access Publishing	Open-access journals and repositories, allowing research to be freely available to a global audience, increasing knowledge sharing and collaboration.
5	AI-Assisted Learning Tools	Use of artificial intelligence to personalize learning experiences, adapt to student needs, and provide immediate feedback.
6	Gamification in Education	Incorporating game-like elements (rewards, challenges, levels) in coursework to increase engagement, motivation, and learning outcomes.
7	Project-Based Learning (PBL)	Students work on real-world projects that integrate theory and practice, fostering critical thinking, problem-solving, and teamwork skills.
8	E-Portfolios for Assessment	Digital portfolios that allow students to showcase their work, track their progress, and reflect on their learning journey.
9	Community-Engaged Scholarship	Partnerships between academia and local communities that involve students and faculty in solving community-based challenges.
10	Global Virtual Collaborations	Collaborative research and coursework between institutions across different countries, utilizing virtual platforms to break down geographical barriers.

	Domain	Attribute/s
11	Personalized Learning Pathways	Tailoring educational content, pace, and assessments to the individual needs and interests of each student, often using learning management systems (LMS).
12	Data-Driven Decision Making	Using analytics and big data to improve academic practices, enhance learning outcomes, and optimize resource allocation.
13	Entrepreneurial Academics and Startups	Encouraging faculty and students to commercialize research and start ventures, fostering innovation and economic development.
14	Crowdsourced Research	Leveraging collective intelligence and citizen science to gather data, solve problems, and generate new research insights.
15	Sustainability in Academia	Fostering research and teaching focused on sustainability issues, as well as implementing sustainable practices within campuses and institutions.
16	Increased Focus on Mental Health and Well-being	Integration of mental health resources and well-being initiatives into academic environments, recognizing the importance of emotional and psychological health for learning.
17	Virtual Reality (VR) and Augmented Reality (AR) in Education	Use of VR and AR to create immersive learning environments, particularly in fields like medicine, engineering, and the arts.
18	Intergenerational Learning	Programs that bring together students, older adults, and intergenerational communities to learn from each other's experiences and perspectives.
19	Collaborative Online International Learning (COIL)	Programs that connect students and faculty across different countries in joint virtual classrooms, promoting global learning and cultural exchange.
20	Research as a Pedagogical Tool	Engaging students in the research process from the outset of their academic careers, allowing them to contribute to new knowledge and develop critical inquiry skills.

Considering the perception of the teacher educators, the investigators moved into a corroboration by conducting a focus group discussion of experts in the field of teacher education as detailed in the methodology part. The suggestive measures evolved from the FGD to make teacher education sustainable. Teacher education to meet 21st-century learning commences with six major approaches in teacher education, for instance, the social justice approach, master-apprentice approach, teacher identity approach, reflective practices approach, competence approach, and applied knowledge approaches (Darling-Hammond et al., 2017). The innovative practices must be synergized, keeping the above principles. This would stimulate self- and social consciousness, engage the teachers in action research, and positively influence the decision-making processes of teachers.

Making teacher education sustainable involves creating an environment where teacher training and development can evolve in response to societal needs, environmental challenges, and educational advancements while also maintaining long-term effectiveness and equity. Sustainable teacher education requires a multi-faceted approach that integrates pedagogy, policy, community involvement, and environmental considerations. Below are key strategies for making teacher education sustainable, as represented in Figure 2.

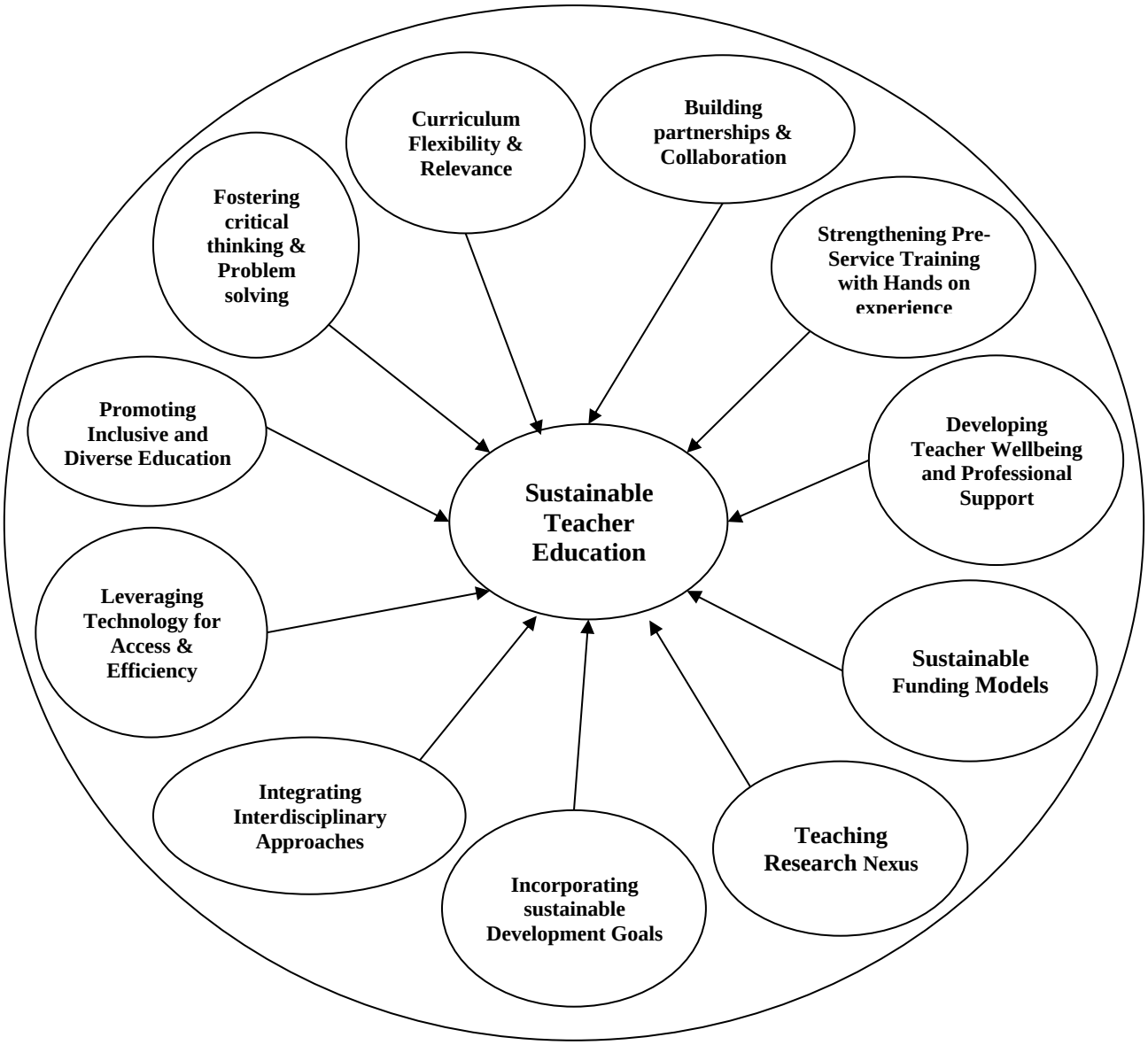


Fig 2: Perceived components of Sustainable Teacher Education

Sustainable teacher education requires an integrated approach that combines flexibility, inclusivity, technology, community engagement, and a focus on long-term environmental and social sustainability. By addressing these aspects, teacher education can create a workforce of educators who are well-equipped to meet current and future challenges in dynamic and responsible ways. This holistic approach not only improves teacher quality but also contributes to a more sustainable and equitable global education system.

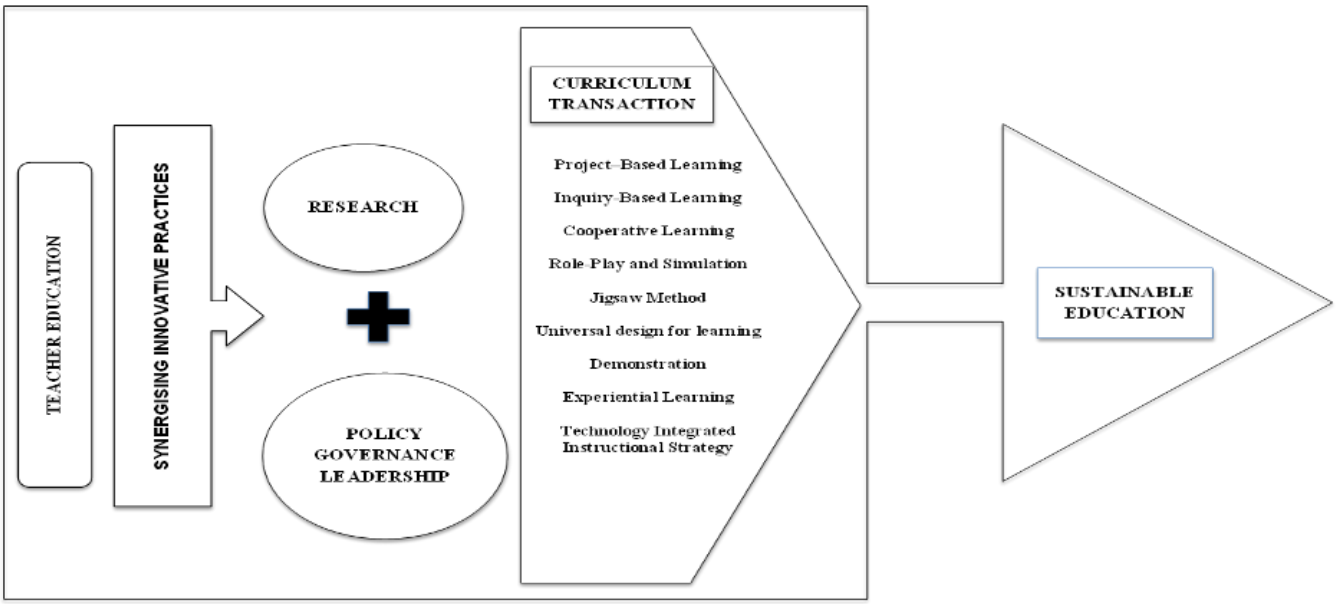
CONCLUSION

By analyzing the data through multiple sources and validating the results obtained, the study provided certain crucial challenges and strategies to overcome these to make the system more sustainable and progressive. The biggest challenge facing teacher education today in terms of sustainability is multifaceted, spanning across curriculum design, professional development, institutional support, and external factors like policy and societal expectations. These challenges hinder the long-term effectiveness and adaptability of teacher education programs and, by extension, the quality and sustainability of teaching in classrooms. Teacher education programs often lack training to address the growing diversity of students, including those with disabilities and marginalized communities. Additionally, they often lack training on digital platforms and advanced technology, leaving teachers unprepared for the evolving educational landscape, particularly in the context of inclusive education. Teacher education frequently neglects actual experience, resulting in inadequately prepared educators. This results from insufficient school-

community connections and an emphasis on theoretical knowledge, leading to a deficiency in practical experience and effective mentorship. Numerous teacher training programs emphasize material knowledge at the expense of pedagogical abilities, overlooking teaching techniques and emotional intelligence. Effective pedagogy necessitates classroom management, evaluation of student learning, and the establishment of inclusive environments. Teacher education frequently neglects to cover these "soft skills."

Teacher education encounters numerous issues, such as inadequate emphasis on ongoing professional development, unequal access to excellent education, regulatory and institutional obstacles, budgetary limitations, and a deficiency in teacher autonomy and agency. Inadequate lifetime learning opportunities, insufficient support for teacher resilience, and geographical and socioeconomic obstacles exacerbate these challenges. Gender, ethnic, and social disparities endure in teacher education, necessitating programs to strive for inclusivity and accessibility for all demographic groups. Policy fragmentation and variable standards and accreditation impede long-term viability. Financial limitations, like overcrowded classrooms and obsolete materials, impede the quality of instruction. Insufficient technological infrastructure obstructs the execution of novel teaching methods. Teacher autonomy and agency are frequently governed by top-down policies, resulting in disengagement and hesitance to innovate. Restricted teacher leadership chances and the tension between globalization and local requirements present further issues. Culturally responsive training is crucial for inclusivity; nonetheless, several teacher education programs are deficient in this regard.

The challenges facing teacher education today are interconnected and require a multi-pronged approach to address them. Sustainability in teacher education will depend on the ability to adapt to changing student needs, integrate technology, foster lifelong learning, and create inclusive, well-supported teaching environments. Teacher education programs must be responsive to the evolving demands of the educational system, ensuring that educators are prepared not only for the present but for the challenges and opportunities of the future (Tan, 2015). Addressing these challenges will help create a more sustainable, equitable, and high-quality education system that benefits both teachers and students, which ultimately leads to a sustainable education system and the accomplishment of sustainable development. The proposed model through this exploration is presented in the figure 3.



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