ACADEMIA International Journal for Social Sciences
Volume 4, Issue 4, 2025 ISSN-L (Online): 3006-6638

Transforming Education through Skill-Based and STEAM-Oriented Pedagogies: A Review

Muhammad Irfan
Irfan.ebraheem@gmail.com
PhD Scholar, Department of Education, The Islamia University of Bahawalpur, Bahawalnagar Campus

Muhammad Zaman Faridi
zamanfaridi@gmail.com
PhD Scholar, Department of Education, The Islamia University of Bahawalpur, Bahawalnagar Campus

Sania Aslam
Saniaaslam2811@gmail.com
PhD Scholar, Department of Education, The Islamia University of Bahawalpur, Bahawalnagar Campus

Muhammad Abid Majeed
engg.abid209@gmail.com
PhD Scholar, Department of Education, The Islamia University of Bahawalpur, Bahawalnagar Campus

Areeba Shareef
areebashareef12@gmail.com
Ph.D. Scholar, Department of Education, The Islamia University of Bahawalpur, Punjab, Pakistan
Corresponding Author: * Muhammad Zaman Faridi zamanfaridi@gmail.com

Received: 18-09-2025 **Revised:** 21-10-2025 **Accepted:** 02-11-2025 **Published:** 12-11-2025

ABSTRACT

In this review, the impacts of Skill-Based Education (SBE) and STEAM-oriented education on today's education to an innovation-oriented world economy are discussed. Based on the recent literature, policy documents, and case studies in the region, the paper puts forth how these models focus on interdisciplinary, experiential, and student-focused approaches to learning. SBE attempts to bridge the gap in teaching at school and working at the workplace, and STEAM incorporates Art into the already existing Science, Technology, Engineering, and Mathematics combination with the idea of enhancing innovativeness and critical thinking. It has been seen that although these methods enhance the engagement of different learners, teamwork and finding solutions to problems, they are hindered by the outdated curricula, lack of proper teacher training and resources; predominantly in Pakistan and other South Asian nations. The review also emphasizes that reform can only work through teacher professional development, equitable resource distribution, and the use of new technologies. Looking at different models regionally, notably India's National Education Policy 2020, shows how effective policy integration and collaboration across sectors can improve outcomes. In sum, the paper argues that the challenges of the 21st century necessities transformative SBE and STEAM education, which demands ongoing innovation in curriculum and pedagogy, educator training, and policies that include all learners.

Keywords: *Skill-Based Education (SBE), STEAM Education, 21st-Century Skills, Experiential Learning, Pedagogical Innovation, Teacher Professional Development, Education Reform*

INTRODUCTION

The 21st century has posed the greatest challenges ever faced by our educational systems across the globe and a paradigm shift in how we equip learners in an ever-complicated, techno-dependent, and globalizing world is quite mandatory. Conventional teaching methods based on the teacher centric approach are being

replaced with new methods that focus on skill acquisition, interdisciplinary learning, and student agency (Mat & Jamaludin, 2024).

Skill-based (competency-based) and STEAM (Science, Technology, Engineering, Arts, and Mathematics) oriented pedagogies take the center stage of this change, as the two presented paradigms hold potential to provide a promising framework of preparing students with the competencies that will ensure their future success (Rafiq-uz-Zaman, 2025).

Skill-based or competency-based education (CBE) is a paradigm shift of traditional content-delivery models to results-oriented or outcomes-oriented models that focus on mastery of particular skills (Ekta Bhatia and Kumar, 2025). This innovation is a reaction to the increasing understanding that students cannot succeed with knowledge of disciplines alone, they need bundles of skills, attitudes, and values that would allow them to negotiate the realities of modern life (Barua et al., 2024).

The literature unites around a number of core domains of skills that make up the 21 st century competencies. They are learning and innovation skills (critical thinking, creativity, collaboration, and communication the so-called 4Cs), information, media, and technology skills, and life and career skills (Fitria et al., 2023; Jain et al., 2025). Competency-based education models put more focus on the knowledge acquisition but also on the possibility to apply this knowledge to the real life situations, displaying what some researchers refer to as adaptive expertise (Thorat, 2025). The Project-Based Learning (PjBL) has proven to be one of the most effective methods of acquiring these competences (Silitubun et al., 2024; Ulaini and Fitrisia, 2025). PjBL allows students to collaborate around real-life problems, build problem-solving skills, work in teams, and learn to communicate effectively developing their content knowledge (Megayanti et al., 2020a). It has been shown that a balanced PjBL experience leads to a positive impact on critical thinking, teamwork, creativity, and the student experience (Megayanti et al., 2020b; Mudinillah et al., 2024).

Overview of Skill-Based Education (SBE)

Skill-Based Education (SBE) regards the paradigm and the systems of education and training in a pedagogical context as the main approach to providing learners the necessary and critical competencies and soft skills for the contemporary job market and the possible evolving contemporary job market. Conventional education systems have predominantly target the cognitive domain of the learner, but SBE paradigm shifts to practical skills acquisition through experiential and hands-on learning of prepared and delivered tasks. This is of even great importance within the South Asian contexts where curriculum, infrastructural, techno-structural, and socio-economic inequities issues are systemic and largely retained, to remove them in harmony to education and training processes is challenging. This systemic inequitable-structural context is largely responsible for learner readiness gaps and the dispreparation of learners for workforce integration as Rafiq-uz-Zaman and Nadeem (2025) highlight. The excluded communities have no facilities of skill-based education (Rafiq-uz-Zaman, 2025h). In Punjab Pakistan skill-based education faced multiple challenges regarding its implementations (Rafiq-uz-Zaman and Nadeem, 2024).

Within the context of Pakistan, primary and secondary educational systems have been evaluated and feedback shows weak results of the learners when it comes to the estimated value and proficiency of the learners and the value and proficiency of the learners and the performance of the foundational and vocational skills and competencies and vocational skills and competencies of learners and the performance of foundational and vocational skills and competencies and vocational skills and competencies and vocational skills and competencies and weak results of the performance and of the primary and secondary educational systems have been evaluated and weak results of the performance and of the foundational and vocational skills and competencies and vocational skills of learners and the performance of foundational and vocational skills and competencies and vocational skills and

competencies and vocational skills and competencies and weak results of the performance and of the foundational and vocational skills and competencies. Studies assessing student self-reported abilities demonstrate that crucial analytical competencies like data analysis and research proficiency are notably weak. There is an even greater and more concerning gap regarding the mastery of practical vocations such as welding and woodworking, as learners self-assess their competencies to be barely proficient. This gap is particularly being an important neglected for functionality of the workforce (Rafiq-uz-Zaman & Nadeem, 2025).

Further compounding these challenges are underlying structural weaknesses within Pakistan's educational ecosystem. Planning and direction in teaching and training activities is greatly wanting with lack of coherency and the curricula is often not where the current industries demand their competencies. Traditional directive instructional strategies dominate and in most cases, they are based on memorization and do not tend to be combined with practical and industry relevant experiences. This organization culture weakens attempts to develop flexible, competent graduates ready to engage in the economy in an innovative manner. This structural deficiency can also be seen in relation to inadequate investments in teacher education, modernization of the infrastructure and interconnected networks with the private sector, which are all essential in the successful implementation of SBE delivery (Rafiq-uz-Zaman, 2025a). The comparative studies on the South Asian countries show that the Pakistani education systems based on skills lag behind the regional counterparts, especially India and Sri Lanka, both in the strategic implementation as well as mobilization of resources. The countries that share borders have improved in the form of policy frameworks that focus on decentralized ruling, sound public- private alliances, and equal access to vocational and technical education. On the other hand, Pakistan is still at her early phase of formulating consistent policy alignments that would accommodate curriculum modernization, teaching capacity building and equitable access to the programs. However, future and current policy programs within Pakistan are an indication of understanding that skills development and building are a strategic tool that can be used to spur economic development and reduce poverty. All these are geared towards systematising curriculum changes, increasing capacity in institutions, and integrating education and employment, thus increasing employability of youth at the national level (Rafiq-uz-Zaman, 2025b). All of these findings support the idea that Skill-Based Education constitutes a crucial direction toward the resolution of issues of chronic skills gaps and labor market preparedness in Pakistan and the South Asian region, in general. Systemic changes that focus on evidence based curriculum development, teacher professional learning and strategic industry bridge are necessary in changing education as an engine of socio economic development.

Although competency-based education has a promising theory, there are serious challenges to its implementation. Teachers, in turn, are not properly trained in the area of skill-based teaching, and the researchers have shown that there are gaps in their knowledge on how to integrate the skills of the 21 st century in their everyday practice (Fitria et al., 2023; Fitriati et al., 2023). The numerous teachers complain of the inability to evaluate complex competencies and lack of competence in moving away from the old method of grading to competency-based evaluation (Mutohhari et al., 2021). The secret is to have the continuous professional development, building of competency models, and actual assessment instruments that reflect the multidimensionality of learning (Ekta Bhatia and Kumar, 2025).

Emergence and Conceptualization of STEAM Education

The emergence of STEM education is a significant phenomenon in pedagogue history since it integrates Arts into the traditional application of STEM, Science, Technology, Engineering, and Mathematics to render the course more interdisciplinary. The theoretical expansion is founded on the shortcomings of the conventional STEM learning in the facilitation of creativity, innovation, and socio-emotional abilities in addition to the technical knowledge. The incorporation of Arts into STEAM education, which is not

artificial, will develop design thinking, critical thinking and creative problem-solving, which are essential coping mechanisms with the complexity of the 21st century global environment. This addition is a direct response to the criticism that STEM education is biased around technical skill to the detriment of more holistic cognitive and affective processes, and that STEAM is more balanced and welcoming view of education (Rafiq-uz-Zaman et al., 2025). Operation approaches to interdisciplinarity of STEAM may involve project learning, interdisciplinary design thinking and inquiry-based learning that will enable students to engage in solving problems and investigations in their groups. These forms of instruction are practice oriented and facilitate the cultivation of the skills of the 21st century, i.e. creativity, team-working, and critical thinking. The researches presented in the area of early childhood learning show the effectiveness of STEAM practices in forming the early childhood skills according to the play-based and culturally responsive pedagogy that helps to further the cognitive, socio-emotional, and creative learning. Indicatively, along with inquiry-based STEAM activities among young learners, the activities serve a long way in preparing the learners to negotiate complex issues and collaborate with others, which makes them prepared to accept a life-long learning and a global citizenry (Rafiq-uz-Zaman, 2025c). It is these types of early interventions that are the seeds of the maintenance of interdisciplinary competencies in the formal education. The educational and developmental theories applied to the concept of STEAM education reveal the necessity to appeal to the cognitive, social and emotional aspects. It is a transformational movement because it equips the learners to become creative, empathetic, and strong problem-solvers who will be able to endure complex challenges in the technological and social environments. The pedagogical shift of rigid, subject-centered instruction to flexible, transdisciplinary learning systems that foster inquiry and imagination is enabled through the theoretical foundation it has. However, there are also certain challenges related to implementation of STEAM like curriculum integration problems, the lack of distribution of resources, and the necessity to adjust the traditional didactic educational approach to collaborative and students-centered paradigms (Rafiq-uz-Zaman, 2025c). In the future, STEAM education will have more causes of intersection with the emerging technologies and alteration of the society demands. Its intersection with artificial intelligence, virtual reality, nature-related learning, and blending indigenous knowledge systems are the areas to proceed with in the future and render interdisciplinary education bigger and more pertinent. Policies and practices of education to enable access and culturally responsive education are needed such developments. Hence STEAM is not an educational system, it is a dynamic approach to education that has the capability of equipping students with critical thinking, creativity, and flexibility that would make them successful in an ever-changing world (Rafiq-uz-Zaman, 2025c). This makes STEAM learning one of the most significant stimuli in helping to create innovation preparedness and global citizenship in various learning environments. To create comprehensive and interdisciplinary learning opportunities, STEM (Science, Technology, Engineering, and Mathematics) education is boosted with Arts. Arts add to STEM by providing creativity, design thinking, and critical reflection necessary to become an innovator and be adaptable in the 21st century. The interdisciplinary model is a reaction to the criticism of more traditional STEM models that have been too concentrated on technical skill and have ignored creativity and socio-emotional skills (Rafiq-uz-Zaman et al., 2025). The interdisciplinarity of STEAM is defined and implemented mainly by project-based learning, interdisciplinary design thinking, and inquiry-based activities that facilitate active learning and problem solving (Rafiq-uz-Zaman et al., 2025). The current studies in the field of early childhood learning emphasize the importance of STEAM methods in developing fundamental 21 st - century skills, such as collaboration, critical thinking, and creativity, via play-based and culturally responsive methodologies (Rafiq-uz-Zaman, 2025c). STEAM interventions in different global environments have also been shown to lead to consistent cooperation, motivation and communication skills improvement in various international environments, whether it is elementary classrooms in Taiwan or inclusive environments in Thailand (Rafiq-uz-Zaman et al., 2025). The cognitive and socio-emotional development theories are consistent with the conceptual development of STEAM and place it at the leading edge of the transformative learning movement that equips students with the ability to cope in a

complex environment by developing into resilient, empathetic problem solvers (Rafiq-uz-Zaman, 2025c). Notably, the transition of STEM to STEAM highlights the necessity of reconciliation of the sciences and arts in order to prepare students sufficiently to work in the economies of the future that depend on innovation and in order to become global citizens who can be inclusive (Rafiq-uz-Zaman, 2025d).

PEDAGOGICAL METHODS AND IMPLEMENTATION STRATEGIES

Skill

According to the numerous empirical data and qualitative study, Skill-Based Education (SBE) in Pakistan demonstrates the crucial differences between desired educational goals and the real learner proficiency achievement. Research on student self-perceptions has shown that basic analytical abilities, inclusive of data analysis and research abilities among others, are quite low in the secondary school students. In a similar vein, tests of applied vocational skills such as welding and woodwork, reveal poor mastery with most learners' self-rating their ability as slightly proficient. This alienation underscores the fact that there is a lack of connection between curriculum intentions and the realities on the ground and SBE programs are in urgent need of a review and a subsequent upgrade in the implementation strategies of the programs in schools (Rafiq-uz-Zaman & Nadeem, 2025). Moreover, even the skills that are rated relatively higher, including cultural sensitivity, self-awareness and sports, only attain moderate level in proficiency of skills, highlighting discrepancies in the growth of skills in various fields (Rafiq-uz-Zaman & Nadeem, 2025). It is important to note that the challenges that degrade the effectiveness of Skill-Based Education in Pakistan lie in the systemic and structural vices of the ecosystem of education. The most common curricular models tend to be outdated and they do not reflect well the technical and industry-specific skills required in the modern-day labor markets. Conventional didactic pedagogic teaching that has defined the teaching and learning process is dominated by rote learning as opposed to experiential and learner-centered teaching that is critical in the acquisition of hands-on skills. Also, inadequate planning in the curriculum design and implementation, inadequate teacher readiness, and a shortage of industry-school relationships further complicate these shortfalls in ensuring the creation of a labor force that matches the changing needs of the economy (Rafiq-uz-Zaman, 2025a). These macro problems add to the capability of the educational institutions to provide applicable and relevant skills training that is translated into the proficiency of the learner. Regional comparisons indicate that Pakistan has not been an isolated situation but rather has aggravated its issues by comparison to its neighbors in South Asia. In the case of India and Sri Lanka, they have developed with respect to strategically designed policy structures that focus on decentralized governance, partnership between the government and the industry, modernization of their curriculums, and the equal access to technical and vocational education. The National Education Policy (NEP) 2020 in India, along with its focus on such initiatives as Atal Tinkering Labs and the integration of digital learning, has led to the development of quantifiable positive shifts in the field of critical thinking and creativity among students, which has been supported by powerful empirical monitoring tools (Rafiq-uz-Zaman & Malik, 2025). In contrast, Pakistan is in its early years of educational reformation, and there are continuous attempts to streamline the policies, increase infrastructure and raise the teaching capacity but has not been very successful in bringing change to the system at large scale. The increased regional collaboration in SAARC systems also lend some urgency to the specification of modern curricula, the appearance of competent teachers, the improvement of connections with the industry, and the accessibility of the program to all so that the competencies are developed in accordance with the global trends in the labor market (Rafiq-uz-Zaman, 2025b). Simultaneously, Science, Technology, Engineering, Arts, and Mathematics (STEAM) education has become one of the new models of teaching that can help a great deal to develop 21st -century skills, such as creativity, problem-solving, collaboration, and critical thinking. The systematic reviews conducted within a variety of international settings prove that the STEAM interventions and, more specifically, the interventions involving the project-based learning and the use of digital tools, including the augmented reality and coding workshops, are efficient in terms of

student engagement and interdisciplinary skills (Rafiq-uz-Zaman et al., 2025). Play based and inquiry driven STEAM practices that not only enhance cognitive development strategies, but also help in developing socio-emotional and creative skills, makes STEAM a ground breaking movement that can be used to transform the current educational demands of a global citizen (Rafiq-uz-Zaman, 2025c). However, the major issues of implementation as a societal concern remain, such as the inability to incorporate STEAM into national education systems, unequal distribution of resources, and the necessity to develop teachers on a regular basis in order to close the pedagogical disjunction. Teacher professional development is a critical factor in the context of Skill-based and STEAM education: to achieve success in the implementation process, it is necessary to provide teachers with interdisciplinary knowledge, the flexibility of pedagogical approaches, and cultural responsiveness. Nevertheless, the empirical evidence indicates that such obstacles like a long-term attitude to conservative approaches to teaching, the lack of clarity in the process of introducing the fields of STEAM in the classroom, and insufficient digital literacy are common among educators and hinder the process of transferring professional learning into practical classroom activities (Malik et al., 2025). Teacher resistance to change, infrastructural inadequacies and disparate administrative provision also limit the potential influence of innovative pedagogies (Malik et al., 2025). To handle these challenges requires a long-term commitment to teacher training programs, development of professional learning communities, and development of adaptive support systems that promote inquiry-based, culturally responsive teaching. In addition, socio-cultural and economic conditions also influence the context of skill-related and STEAM education in Pakistan. The issue of gender differences is also particularly acute, with cultural norms, poverty, and inaccessibility to technical and vocational education holding women back and underrepresenting them especially (Rafiq-uz-Zaman et al., 2024). To overcome these limitations, multi-sectoral means such as government policies, participation of the private sector, and community education should be put in place to create equitable and inclusive learning conditions. Also, bottom-up, contextually-specific innovations inspired by teachers in under-resourced, under-income schools demonstrate how revolutionary bottom-up solutions to education can be. Locally-focused projects, usually relying on basic digital technologies and community networks, oppose top-down approaches to sustainability and are an important way to reform and increase educational equity (Rafiq-uz-Zaman, 2025e). In short, it is evident that there is a strong need to introduce comprehensive changes to Skill-Based and STEAM education in Pakistan, which is backed by evidence-based reform of the curriculum, educator capacity building, modernization of the infrastructure, and multisectoral cooperation. The experience of other regional success stories like the systemic and equity-based approaches developed in India would be valuable as a learning experience, and the integration of new technological advances and inclusive pedagogical systems will likely help improve interaction and learning outcomes. These educational paradigms can be put in concert to help young people acquire the critical skills they will require to thrive in the world of the globalization of a more complex and more innovation-driven economy.

Education Pedagogies and Critical Success Factors

Skill-based Education models are strongly influenced by the experiential learning theories such as the cycle of Kolb that places a strong focus on concrete experience, reflective observation, conceptualization, and active experimentation as central to learning a skill (Rafiq-uz-Zaman, 2025f). The constructivist theories also promote learner-based teaching models where students are not passively receiving knowledge but are proactive to tackle the real world problems. Effective SBE programs people are more focused on real-life workshops, internships, and industry partnerships that allow learners to obtain real-life settings where skills are practiced. The key success factors found in student-based studies are the creation of motivational cultures by reward system, equipping teachers with new pedagogical and industry knowledge, and creating effective connections with the local employment and entrepreneurship centers (Rafiq-uz-Zaman & Nadeem, 2025). Along with that, community involvement and community sensitization have a crucial part in increasing the presence and adoption of skill-based programs among

the disadvantaged populations (Rafiq-uz-Zaman & Nadeem, 2025). There are however several obstacles to the implementation of SBE, particularly in South Asia, where the restriction of scalability and sustainability of skill development programs is imposed by the socio-cultural norms, insufficiency of resources and systemic inefficiency. There are gender-specific issues, including the inadequate access of women to vocational training, which require the multi-sectoral policies involving the government, the business sector, and civil society (Rafiq-uz-Zaman et al., 2024). Thus, the reforms should be comprehensive, which should consider the development of the curriculum, developing the capacity of teachers, improving the infrastructure, and equity to guarantee the effectiveness of SBE models. Artificial intelligence can be used for better school management and implementation of policies to fulfil the maintain the learning environment (Rafiq-uz-Zaman, 2025g).

STEAM Teaching Models and Techniques

The use of project-based learning (PBL) as the main instructional strategy is also a distinctive feature of STEAM pedagogy and promotes inquiry-based learning, creativity, and the integration of disciplines. Research shows that a PBL activity (usually supported by complementary measures, such as coding workshops, augmented reality (AR), makerspaces, and multimodal learning), encourages self-directed learning and critical thinking (Rafiq-uz-Zaman et al., 2025). This process will motivate students to cooperate to develop solutions to real issues, thus strengthening content knowledge and 21st century skills. As an illustration, elementary-level programs that introduce intersections of traditional arts e.g. Chinese paper-cutting with technology tools micro: bit created by BBC have demonstrated considerable positive effects on creative. Critical Thinking skills form a crucial part of Skill-Based Education (SBE) and STEAM pedagogies, since they form the basis of the skills of learners to interact with complicated problems, to innovate, to comply with new challenges. The development of critical, creative, and analytical thinking is the core component of these pedagogical strategies as it not only encourages learning but also enables the ability to use the acquired knowledge in diverse situations. Within the context of SBE, cognitive processes are operationalized with the help of experiential learning frameworks, which underline the focus on the active involvement in real-world activities. Such a strategy will help the learners shift to higher order thinking processes, i.e. analysis, evaluation and synthesis as opposed to rote memorization. An example would be students who participate in practical workshops and/or industry placements; such students are able to learn skills of reflective observation and problem-solving, which are essential to master skills and prepare to work in the workplace. Such processes are quite consistent with experience based on the experiential learning cycle of Kolb that emphasizes the iterative character of learning with the help of tangible experience and active experimentation (Rafiq-uz-Zaman, 2025f). Nevertheless, the studies conducted in Pakistani schools indicate that there are problems with the effective realization of these thinking skills because students indicate that they are not well proficient in the basic analytical skills like data analysis, research, which means that there is a gap between the planned educational outcomes and student experience (Rafiq-uz-Zaman & Nadeem, 2025). The integration of arts in STEM model offers a broader conceptualization of thinking through STEM education abbreviated as STEAM, which allows developing divergent and design thinking in addition to analytical reasoning. The interdisciplinary attribute of STEAM promotes inquiry based, project based learning in which learners undertake collaborative problem solving and innovative design projects. Such approaches do not only generate cognitive abilities but also creative abilities necessary in the 21st century to be innovative and flexible. Empirical research reports systems improvements in critical thinking and creativity when exposed to STEAM programs, especially with the inclusion of technology-driven approaches to facilitating engagement and computational thinking like augmented reality and coding (Rafiq-uz-Zaman et al., 2025). Moreover, it is a pedagogical approach that develops socio-emotional abilities because it builds inclusive and motivational learning environments that empower various students, such as those in early childhood and inclusive classroom environments (Rafiq-uz-Zaman, 2025c). Regardless of such encouraging results, there are a number of implementation issues that influence the process of developing

thinking skills in SBE and STEAM. The systemic factors that inhibit the delivery of a consistent, pedagogically sound experience that promotes critical and creative thinking include all the old-fashioned curricula, lack of teacher readiness and the lack of resources (Rafiq-uz-Zaman, 2025a). One of the most common challenges teachers meet consists in their inability to transfer the professional development to practice and interdisciplinary integration as well as student-centered methods (Malik et al., 2025). In addition, there are cultural and institutional oppositions towards new teaching methods that restrict the ability to develop independent and reflective students who can engage in complex thinking (Malik et al., 2025). Solving these issues will require specific investments in educator education, curriculum development, and technology use, as well as the policies that promote the growth of less-centered evaluation and adjustment of pedagogic approaches. Overall, it is possible to state that the focus placed on thinking in SBE and STEAM education is core to equip students with dynamic and complex workplace settings. These types of educational models strive, through the incorporation of critical, creative and analytical thinking processes into an experiential and interdisciplinary context, to provide students with the mental agility necessary to engage in lifelong learning and innovation. The potential can be achieved through concerted efforts against systemic barriers and through improvements in the structures of pedagogical support and environments that support and encourage robust thinking skills development. and student engagement (Sidekerskienė & Damaševičius, 2023). These interdisciplinary STEAM classes allow students to have a sense of aesthetic appreciation and technical ability at the same time and allow bridging the gaps between disciplines through real-world, contextually relevant activities. This flexibility of STEAM models gives the instructors an opportunity to adapt pedagogical interventions to the needs of various and different learners in various settings assimilating inquiry-based, student-based projects and the emergent digital technologies (White & Delaney, 2021). There is some indication that immersive technologies, such as AR, are more effective in motivating and helping learners experience embodied learning that standard lecture models do not ensure (Wahono et al., 2020). Together, these practices indicate the ability of STEAM to impact dynamic contextually rich learning environments, which are oriented towards innovation and creativity.

IMPACT ON 21ST CENTURY SKILLS AND STUDENT OUTCOMES

Enhancement of Core Competencies through STEAM

Empirical data show that STEAM learning is a powerful stimulant of such key 21st-century skills as cooperation, communication, problem-solving, and motivation. The learners who have undertaken the STEAM projects at various levels and situations in their education experiences claim to have a better ability to work effectively in teams and communicate complex ideas that are critical issues in a lifelong learning and employability (Rafiq-uz-Zaman et al., 2025). STEAM with its applied and interdisciplinary focus develops the skills of creativity and innovation that are essential in the adaptation of the global issues which are changing. The level of enhancements in the creative and critical thought might however vary depending on how the program is designed and the contextual factors such as readiness of the teachers and availability of materials (Rafiq-uz-Zaman, 2025d). Longitudinal research supports this idea and states that STEAM interventions may long-lasting influence not only the immediate skills development, but also future employability and preparation as a global citizen (López et al., 2024). Besides, the advantages of STEAM extend beyond the mental capacity building to inspiration and interest that are vital in enabling students to become persevering and resilient in tackling challenging issues. The perspectives of the inclusive classrooms using STEAM techniques introduce promising results in the possibility of enabling the diverse groups of students to acquire socio-emotional and collaborative abilities in order to survive in contemporary learning and working environments (Rafiq-uz-Zaman et al., 2025).

Skill Research

The available literature on Skill-Based Education (SBE) and STEAM (Science, Technology, Engineering, Arts, and Mathematics) education suggests that there are certain important aspects to the implementation of these policies, performance, and a constant problem that these pedagogical systems have in South Asia and, in particular, in Pakistan. The empirical literature regarding SBE notes that it is a massive discrepancy between the intended outcomes of learning and the perceived degree of competence in soft and practical skills that learners possess. The wide surveys of secondary school students in Punjab province can serve as an illustration, since students tend to judge their expertise in such simple spheres of knowledge as data analysis, research, welding and woodworking more as slightly above average, which shows the irrelevance of the curriculum and the quality of instruction (Rafiq-uz-Zaman & Nadeem, 2025).

This inconsistency is a push towards institutional vulnerabilities on the change of training of skill include programs to tangible instruction to learners' competencies, and that is the reason behind the significance of reviewing and altering program approaches to complete alignment of teaching courses with applied field practices. Complementary studies point out institutional flaws which are institutionalized in the education system in Pakistan and are contributing highly to these proficiency divisions. The curricular models tend to be obsolete and do not correspond with the modern industrial demands whereas the teaching methods are mainly rote oriented and not experiential based on the knowledge of the skills (Rafiq-uz-Zaman, 2025a). Furthermore, critical thinking skills are the needs of era and may be increased by literature (Hassan et al., 2025). In addition, there are resource limitations which include infrastructure, teacher preparedness, and limited partnership between the public and the private and they also contribute to the hindrance of the successful implementation of SBE. Comparative analysis indicates that Pakistan remains behind regional peers like India and Sri Lanka where policy frameworks promote high stakeholder participation, equal access and full curriculum renewal (Rafiq-uz-Zaman, 2025b).

These discussions reiterate the point that Pakistan cannot achieve its dream of having a skilled labour force without structural changes that include specification of the curriculum as well as capacity building and improvement of resources that will serve as the means through which the country will help its people achieve their education objectives. The existing body of knowledge about STEAM education also confirms its capability as a new pedagogical technique that develops the key 21st-century skills, such as creativity, critical thinking, collaboration, and problem-solving. The systematic reviews of the world empirical research show that STEAM interventions (in particular, the application of project-based learning and integration of technology, i.e., augmented reality experiences and coding festivals) are effective in improving student engagement and interdisciplinary skills (Rafiq-uz-Zaman et al., 2025). As the context of early childhood education has shown, play-based and inquiry-based STEAM lessons support socio-emotional growth and cognitive benefits, which makes STEAM a revolutionary trend in education (Rafiq-uz-Zaman, 2025c). However, these encouraging results are accompanied by a plethora of issues related to the curriculum integration and inequality of resources, which hinder the mass implementation and uniformity of the quality of pedagogical practices. Professional growth of teachers is revealed as a determining factor of success of both SBE and STEAM pedagogies. The need has always been confirmed by the researchers to engage in extensive and long-term training programs to transform educators into interdisciplinary, pedagogical flexible and culturally responsive professionals capable of applying the student-centered, inquiry-based models of learning efficiently (Malik et al., 2025). But, ingrained stickiness to conventional didactic models, in-between integration policies and technological constraints are also crucial impediments to transfer of professional learning, and frequently lead to the existence of a disconnect between teacher training and classroom application (Malik et al., 2025).

It is suggested to improve professional learning communities and maintain continuous mentorship to help educators overcome these obstacles and encourage them to use the innovative methods of teaching.

Besides pedagogical and institutional issues, socio-cultural and economic conditions also significantly affect the situation with skill-based and STEAM education in Pakistan. Gender inequalities are also still high especially in relation to the participation of women and empowering them through vocational and technical training (Rafiq-uz-Zaman et al., 2024).

To overcome such barriers, multisectoral partnerships between government efforts and those of the private sectors as well as sensitizing communities through awareness programs in order to establish a fair access to education and culturally understanding learning environments. Moreover, grassroots innovation by educators in low-income settings can show the potential of bottom-up strategies that utilize constrained resources and local expertise in developing educationally relevant solutions to context, which are often not taken into account in larger-scale top-down EdTech developments (Rafiq-uz-Zaman, 2025e). Identification and multiplication of these micro-innovations would play a major role in sustainable changes to education. Comparative analysis of Pakistan and Pakistan in contrast to its neighbors gives good lessons not only to policy but also to practice. The example of the National Education Policy (NEP) 2020 in India is a decentralized and multi-stakeholder structure, and it brings in the aspects of public-private collaboration and equity-based programs, including the creation of Atal Tinkering Labs, with their effect on critical thinking and creativity in students being measurable (Rafiq-uz-Zaman & Malik, 2025). Although at present, Pakistan is struggling with the systemic limitations, it can embrace a comparable structure of assimilation and empirical surveillance measures, as well as gender-sensitive and stakeholder-based approaches (Rafiq-uz-Zaman & Malik, 2025).

The SAARC countries are sharing the same problems at regional level of having an outdated curriculum, lack of industry connections, and inadequate infrastructural capacity, which has contributed to the urgency of harmonization of policies as well as cross-national cooperation to bring the standard of vocational and technical education to a higher level in South Asia (Rafiq-uz-Zaman, 2025b). Lastly, technology based pedagogies is another rising innovation in STEAM learning. Digital escape rooms and immersive learning have been cited to develop critical thinking, involvement and teamwork, successfully dismantling perceived barriers to traditional STEM education as being monotonous or daunting (Sidekerskienė & Damaševičius, 2023). These projects demonstrate the relevance of innovative instruction methods involving gamification with multi-disciplinary problem-solving in order to introduce inclusive and engaging learning experiences. The future of STEAM and SBE pedagogies is more involved with the integration with new technologies, indigenous knowledge systems, and nature-based learning that require the development of flexible policy frameworks and investment in digital infrastructure to increase its reach and influence (Rafiq-uz-Zaman, 2025c). Further studies are essential to assess long-term results and generalizability of such innovative practices in the variety of educational settings. and Perceived SBE Proficiency. Although SBE is used to provide students with the necessary practical and soft skills, research has shown that there is a big gap between the skills that were expected to be gained and the perceptions that the students have. A study conducted in Punjab schools has shown that perceived level of competency in basics like data analysis and research skills, and more importantly vocational skills such as welding, woodwork, etc., that are part and parcel of most technical careers are low in the schools (Rafiq-uz-Zaman & Nadeem, 2025).

The majority of the students claim their competencies are on a level of slightly competent, which indicates a disconnect between the goals of the curriculum and the real outcomes of learning (Rafiq-uz-Zaman & Nadeem, 2025). The results of this study highlight the urgency of ensuring that the implementation strategies of SBE are refined to increase the quality of instructions and student engagement. It is significant that student-centered assessment resources, such as group evaluation rubrics are used to more effectively represent and help in the development of skills in SBE settings which are multidimensional (Raj et al., 2021). Moreover, the gaps in skills can be addressed by modifying the curricular approaches to ease intrinsic motivation and providing adequate exposure to the industry and

instilling confidence in the skills of the learners (Tian et al., 2021). Such discrepancies in scheduled and actual skill achievement need continuous review of the program and appropriate changes in order that the curriculum, methods and testing of instruction will all draw inward to generate meaningful and useful learners' skills acquisition.

Skill-Based and STEAM Pedagogy Synergies

Combination of concepts of skill-based education and STEAM pedagogies produces strong synergies of transformative learning (Alali, 2024). The similarities between the two approaches are that both have structural commitments on: Real-life practice of the acquired knowledge (Salinas-Navarro et al., 2023). The interdisciplinary integration reflecting the interactions between professionals, occurring in the modern environment (Vanoy, 2022). Constant evaluation and feedback that facilitates the continuous development as opposed to summative evaluation (Ekta Bhatia and Kumar, 2025). An example of this integration is the Project-Oriented Problem-Based Learning (PoPBL), which integrates a project-based approach with the focus on problem solving (Alali, 2024; AlAli, 2024). Students who participate in STEAM-based PoPBL have been found to be positively impacted by several areas of competency, such as critical thinking, creative problem-solving, collaboration, and communication (Alali, 2024).

Transformative Pedagogy of STEM Education.

STEAM education has developed out of a predecessor, STEM, but with an inclusion of the Arts, based on the idea that technical and scientific skills are to be complemented by aesthetic literacy and creativity (Rodrigues-Silva and Alsina, 2023). The purpose of such an interdisciplinary approach is to make whole-person problem-solvers capable of cutting across disciplinary borders and looking at problems through many different lenses (Rafiq-uz-Zaman, 2025).

Theoretical Underpinnings of STEAM

STEAM education is based on constructivist learning theories, which focuses on practical, experiential education in which students build knowledge, through inquiry, and design (Mariano and Chiape, 2021). The combination of Arts with STEM subjects is not only additive but transformative and induces divergent thinking, increases creativity and makes the approaches to a problem more mature (Aguilera and Ortiz-Revilla, 2021; Hujjatusnaini et al., 2022). The study shows that STEAM-based learning contributes to student creativity, as evidenced by such indicators as fluency, flexibility, originality, and elaboration (Gracia et al., 2024; Rafiq-uz-Zaman, 2025). The students who participate in STEAM activities demonstrate a better level of motivation, self-efficacy, and collaboration abilities of different ages and educational levels (Mariano and Chiappe, 2021). This method is especially useful in cultivating critical thinking and problem-solving skills that are vital to eliminating the complex 21 st century challenges (Dek and Kumar, 2024). STEAM Models and Practices Implementation. There are a number of pedagogical strategies that are usually associated with effective STEAM implementation. Project-based and problem-based learning are the main forms of instruction, and they offer students a chance to work on real-life problems that demand the cooperation of various fields (Leavy et al., 2023). In the modern STEAM education, technology integration is very important. New opportunities of the immersive learning experiences that are personalized are presented by new technologies like augmented reality and virtual reality and artificial intelligence (Al-Zahrani et al., 2024; Leavy et al., 2023). Nevertheless, the successful implementation of technology necessitates the shift to technocentrism to draw in the activities that are pedagogically sensible and are able to supplement, instead of substitute meaningful human engagement (Dek and Kumar, 2024).

METHODOLOGY

It is an extensive and a detailed overview of Skill-Based Education (SBE) and STEAM practices in the instruction by bringing together the findings of a whole host of new research, policy reports, and comparative reportages. The point using it all was to have a clear cut and coherent picture of the ways these approaches are used and how they are changing specifically across South Asia. The whole process involved working with available resources, scanning peer-reviewed journals, official education policy documents, and reports on the region. All the sources were read thoroughly and classified into themes. This assisted us in identifying similar trends, existing challenges and emerging concepts emerging in the field. We were keen to issues such as whether or not the curricula are relevant, teacher training, the role of technology, gender inclusion initiatives, and international collaboration. The studies that we took interest in in particular were the ones that were concerned with hands-on learning, project-based work, and interdisciplinary teaching because these are the approaches to learning that are actually involved in both SBE and STEAM. Comparing the policy management, funding, and what actually occurs in the classroom in different countries we were able to draw some interesting comparisons. All along the way, we continued to revisit one main question which is how these educational models can contribute to developing the skills that everyone requires throughout the 21st century such as creativity, collaboration, critical thinking and problem solving? It is through the interwoven nature of all these threads that this paper attempts to provide a comprehensive picture of ways in which both SBE and STEAM are challenging the traditional education system so as to make them more practical, inclusive, and future-ready.

TEACHER PROFESSIONAL DEVELOPMENT AND IMPLEMENTATION CHALLENGES

Teacher Training in STEAM and SBE Contexts

Teacher professional development is the most important step toward effective integration of STEAM and SBE into K-12 curriculum because it will provide educators with the necessary interdisciplinary pedagogical skills, as well as knowledge of the material to be covered. More complicated problems such as curriculum integration and pedagogical transformations will have to be overcome through cumulative training efforts that will move towards flexible, cooperative and culturally receptive instructional approaches (Malik et al., 2025). These researches highlight the difficulty of educators to implement professional learning in classroom operations, and many of them are caught by the urge to use traditional methods of teaching and lack knowledge about how to implement interdisciplinary and project-based models (Malik et al., 2025). One major problem in school education department of Punjab “Teacher Shortage” (Rafiq-uz-Zaman, 2024). Professional learning communities (PLCs), on-the-job learning, and case-based training should be provided continuously to ensure that teachers feel confident and competent in STEAM and SBE environments (Fatima et al., 2025). Also, teacher preparation should include equity and inclusivity issues, as the delivered instructional strategies should be able to meet the needs of various learners, such as students with disabilities. Single National Curriculum may help to remove the societal or gender discrimination (Nadeem et al., 2024). This preparation will help to design inclusive classrooms in line with the universal design principles and sensitive to socio-cultural diversity (Fatima et al., 2025). Therefore, professional growth that is organized and long-term is one of the keys to the potential of STEAM and SBE pedagogies.

Systemic Resources and Barriers

The effectiveness of Skill-based Education (SBE) programs, especially in the context of Pakistan, helps to provide important lessons on the effectiveness and failure of the existing educational methods. Empirical evidence of students attending secondary schools in Punjab shows that there is a chronic disengagement between the theoretically desired acquisition of practical skills and soft skills and how learners think of

themselves as capable. In particular, such fundamental competencies as data analysis and research skills are stated at a significantly lower proficiency level by the students themselves. Equally, the applied vocational skills such as welding and woodwork are also low with majority of the students terming their ability in such areas as slightly proficient (Rafiq-uz-Zaman & Nadeem, 2025). Such pervasive feeling of unpreparedness among students highlights the sense of urgency to introduce changes in the educational system to bring the content of the curricula and its instruction closer to the practical skills demand in the real world. Nevertheless, some of these skills have a relatively higher rating of proficiency though it is not very high. Social and interpersonal skills, such as cultural sensitivity and self-awareness, become the aspects, in which students feel more competent. Also, physical activities and sports are rated more than majority of other useful skills, which can imply that experience based and kinesthetic learning environment can create higher confidence and involvement (Rafiq-uz-Zaman & Nadeem, 2025). The overall moderate scores in a wide range of abilities, however, are a clear sign of an uneven and unstable progress in competencies, and it can be concluded that there is an extreme need to employ strategies that will help in a holistic approach to growth in both mental and practical areas of competencies. Such ubiquitous lack of proficiency is not merely a symptom of the flaws in the curriculum and in pedagogical practices but also systemic limitations to the effective development of skills. Research shows that curriculums are mostly characterized by lack of relevance with the current industrial demands and are stuck in the archaism of teaching methods that are more inclined to rote learning and memorization than experiential education (Rafiq-uz-Zaman, 2025a). These structural gaps are some of the factors that lead to the poor acquisition of critical analytical and vocational skills by the students. Moreover, poor teacher readiness, absence of adequate hands on training opportunities, and inadequate industry networks serve to widen this gap by not offering the learner meaningful contexts and models to practice their skills. This is unlike the other developments in the region the situation in Pakistan is different as their neighboring nations such as India and Sri Lanka employ more holistic and modern approaches. The advancement of specification of curricula and the support of teacher development programs, as well as the improvement of industry-school partnerships in these countries has resulted in more efficient skill acquisition and employability results (Rafiq-uz-Zaman, 2025b). The current attempts by Pakistan aimed at improving vocational education and technical training should therefore go on focusing more on revising curriculum, developing capacity and availability of programs to all to help bridge the existing gap of proficiency. On the whole, the results of student self-assessment are important pointers to the issues of Skill-Based Education in Pakistan. They stress the necessity to revise the implementation strategies in order to manage the skill gaps with the help of interactive, project-based, and technologically-enhanced pedagogies. These reforms, as a priority area, will assist in developing a workforce that is more competent and skilled to meet the requirements of a modern innovation-driven economy, which will eventually lead to increased career readiness and national growth.

Implementation

Although the above advantages have been acknowledged, the barriers of these systems in learning systems hinder the extensive implementation of STEAM and the SBE systems. Deficiencies in resources availability and access are constrained by structural weaknesses such as inadequate technological infrastructure, lack of enough funds, and socio-economic differences and disproportionately impact the marginalized groups (Rafiq-uz-Zaman, 2025a). Innovation is also suppressed by cultural and institutional resistance where policy inertia and bureaucratic restrictions delay the processes of reform (Rafiq-uz-Zaman & Nadeem, 2025). Financial restrictions and technological barriers such as unstable internet access in low-income settings in addition make the adoption of technology-integrated pedagogies harder (Rafiq-uz-Zaman, 2025e). In response to them, there is a need to have coordinated policy interventions such as the increase of budgetary allocations, incentives to innovations and multi-stakeholder engagement, which involves the combination of governments, the private sectors and communities. By focusing on grassroots, teacher-led innovation has an opportunity to take advantage of solutions on a local level and

promote sustainability change in relation to systemic constraints (Rafiq-uz-Zaman, 2025e). All in all, these obstacles must be overcome in an attempt to reform the educational ecosystem to be able to provide modern skill-based learning and interdisciplinary learning.

It is time to transform the system of education towards skills and STEAM to promote a change on a number of levels. On the classroom level, educators should be assisted with the adoption of active and student-centered pedagogies that support instead of direct learning (Chowdhury, 2024; Mat and Jamaludin, 2024). This involves availability of quality instructional resources, technological aids and collaborative planning time (Fitriyah et al., 2024). Evaluation systems need to be re-evaluated to be brought up to competency outcome functions that incorporate a variety of assessments such as performance tests, portfolios, and real-life demonstrations of the learning process (Thorat, 2025). Governments and educational authorities have to offer favorable frameworks at the policy level that allow innovation and also maintain equity and quality (Barua et al., 2024). These involve the investment in the education of the teachers, pre-service and in-service to create the capacity to implement the new pedagogical methods (Abdulgananeey et al., 2025; Ulaini and Fitrisia, 2025). Digital infrastructure requirements (especially in under-resourced areas) should also be considered in terms of policies, so that every student has an opportunity to apply technology-enhanced learning (Dek & Kumar, 2024). Policies are influenced on the students learning (Bukhari et al., 2025). Gender differentiation was found between male and female in using technology or access to technologies in higher education (Rafiq-uz-Zaman et al., 2025a).

COMPARISON AND REGIONAL VIEWPOINT OF SKILL-BASED AND STEAM LEARNING.

Comparative Studies in South Asia.

The comparative studies of Pakistan and India indicate both similarities and differences in STEAM and SBE policy frameworks and strategies of implementation. The National Education Policy (NEP) 2020 in India addresses a decentralized and multi-stakeholder model that actively involves the public-private partnerships as well as equity-based interventions including infrastructure programs such as Atal Tinkering Labs and robotics programs (Rafiq-uz-Zaman & Malik, 2025). Conversely, the strategy of Pakistan though aspirational has been confronted by systemic inefficiency and inadequate monitoring of results empirically. Nevertheless, Pakistan can derive lessons out of the Indian systemic assimilation to strengthen its own reforms especially through the increase of gender sensitive programs as well as establishing external stakeholder engagement (Rafiq-uz-Zaman & Malik, 2025). The similarities between the two countries are in the infrastructure, training of teachers and socio-economic disparities, which require policies that are contextually specific. SAARC based regional cooperation suggests the coordination of skill development, focusing on modern curricula, improvement of teaching proficiency, and industry connection to satisfy international labor market needs (Rafiq-uz-Zaman, 2025b). These comparative views point to the possibility of knowledge sharing and policy learning to maximize the result in both domestic settings.

Important Reflections and Research Requirements.

Although the data on the strong evidence of skill-based and STEAM pedagogies is significant, there are a number of essential questions that demand constant consideration. To begin with, additional longitudinal studies are required that would monitor the long-term outcomes of such methods on the achievements of students, such as their career success and their involvement into the civic life (Mat and Jamaludin, 2024). Second, the issue of cultural adaptation is still under-investigated, and most studies are carried out in Western settings, even as the problem of adaptation gains worldwide attention (Rafiq-uz-Zaman, 2025). Third, equity and access issues require proper exploration. Although STEAM and competency-based education could be a solution to meet the needs of a diverse group of learners, there are implementation

gaps in practice that can continue to widen inequalities (Ariza and Olatunde-Aiyedun, 2024; Dek and Kumar, 2024). The studies should study the effectiveness of these methods in various cultural settings, socioeconomic environments, and groups of learners. Lastly, educational transformation has the potential opportunities and threats posed by the fastest-growing technological development, especially artificial intelligence and simulative technologies (Al-Zahrani et al., 2024). The next study needs to explore the role of new technologies in helping to achieve meaningful learning and safeguard against techno-centric approaches that focus more on tools than learning (Dek and Kumar, 2024).

INNOVATIONS AND FUTURE DIRECTIONS IN STEAM AND SBE

A research problem is proposed in this section, focusing on how STEAM and SBE innovations apply in the future. New technologies such as artificial intelligence, virtual reality, and digital interactive tools are integrated into STEAM and SBE pedagogies with greater levels of engagement and learning outcomes. Digital escape rooms, such as an example, offer the experience of immersive environment which encourages critical thinking, teamwork, and problem solving hence helping to overcome the motivational barriers that can be encountered in STEM education (Sidekerskienė & Damaševičius, 2023). The potential of localized, technology-based solutions that are culturally and contextually relevant, especially in low-income situations, is shown by grassroots innovations by teachers. These micro-innovations, whether in the form of WhatsApp learning communities or DIY STEM kits, are key drivers of educational change that cannot be found in the higher levels of policy-making (Rafiq-uz-Zaman, 2025e). It is also seen in the future trends that STEAM intersects with the indigenous knowledge systems and nature-based learning strategies, extending the realm of interdisciplinary education to ensure sustainability and cultural responsiveness (Rafiq-uz-Zaman, 2025c). These dynamic trends have to be catered to by policy formulation and practice to enable flexible, inclusive, and technologically enhanced learning environments to equip learners with complex, innovation-driven futures (Malik et al., 2025). Although the interest in STEAM education has increased, there are still serious implementation difficulties. They involve teacher readiness, where most teachers have not been sufficiently trained on interdisciplinary education (Rafiq-uz-Zaman, 2025); the curriculum, where most education systems are designed to focus more on disciplinary divisions instead of transdisciplinary, and assessment, which focuses on measuring the scores of learning across disciplines (Dek and Kumar, 2024; Diaz, 2024). There are a number of priorities related to the development of STEAM education, which are identified in the literature. First, the extensive teacher training programs, aimed at content knowledge and pedagogical skills training on the facilitation of integrated learning, are necessary (Hlukhaniuk et al., 2020). Second, evaluation systems will need to adapt to the dynamics of STEAM skills, and standardized testing will need to be replaced with more accurate performance testing (Dek and Kumar, 2024). Third, equity issues require to be taken into account, so that every student, irrespective of their socioeconomic status or geographic area, is provided with high-quality STEAM learning (Dek and Kumar, 2024).

CONCLUSION

Skill-based and STEAM-based education as a means of transformation can provide an effective opportunity to solve modern educational imbalances and labour requirements and can be applied in the South Asian context, in particular. Skill-based Education fuses both theoretical and practical competencies that are necessary in the employability context, whereas STEAM expands the interdisciplinary learning experience by introducing creativity and critical thinking to STEM. The empirical findings suggest that the given pedagogies can greatly help to develop the essential 21st-century skills, such as collaboration, communication, and problem-solving. However, issues of implementation, teacher development, systemic obstacles and disparities of resources should be tactically managed to achieve their full potential. Comparative regional studies can be of good lesson and emphasize the necessity of context-specificity and equity-based policies. Moreover, adoption of emerging technologies

and grass root innovations, as well as assimilation with indigenous and nature based paradigms, can launch STEAM and SBE to future-ready models of education. Lastly, policymakers, educators, industry partners and communities need to do concerted efforts to generate inclusive, effective and engaging skill- and STEAM-based learning environments to motivate learners to become competent in the 21st century and beyond.

REFERENCES

Abdulganeey, I., Abu, S., Awah, L. C., Akande, I. J., Koranteng, U., & Umekwe, E. (2025). Rethinking nigerias basic education curriculum for the future amidst global competency standard: Integrating 21st-century skills. Journal of Global Research in Education and Social Science.

Aguilera, D., & Ortiz-Revilla, J. (2021). STEM vs. STEAM education and student creativity: A systematic literature review. Multidisciplinary Digital Publishing Institute.

Alali, R. (2024). ENHANCING 21ST CENTURY SKILLS THROUGH INTEGRATED STEM EDUCATION USING PROJECT-ORIENTED PROBLEM-BASED LEARNING. Geo Journal of Tourism and Geosites.

AlAli, R. (2024). ENHANCING 21ST CENTURY SKILLS THROUGH INTEGRATED STEM EDUCATION USING PROJECT-ORIENTED PROBLEM-BASED LEARNING. Editura Universitatii Din Oradea.

Al-Zahrani, A., Khalil, I., Awaji, B., & Mohsen, M. A. (2024). AI technologies in STEAM education for students: Systematic literature review. None.

Ariza, J. lvarez, & Olatunde-Aiyedun, T. G. (2024). A systematic literature review on STEAM pre- and in-service teacher education for sustainability: Are teachers ready? Modestum Limited.

Barua, A., Arafat, Y., & Shahriar, A. (2024). SWOT ANALYSIS OF NATIONAL CURRICULUM FRAMEWORK 2021 AND ITS TEXTBOOKS FROM GENDER PERSPECTIVE. European Journal of Education Studies.

Bukhari, S. T., Rafiq-uz-Zaman, M., & Bano, S. (2025). Analysing the Impact of Education Policies and Their Implementation on the School Education System in Punjab, Pakistan. Inverge Journal of Social Sciences, 4(1), 98–110.

Chowdhury, N. (2024). From chalkboards to smartboards: The role of pedagogical innovation in enhancing student engagement. None.

Dek, C., & Kumar, B. (2024). A systematic review of STEAM educations role in nurturing digital competencies for sustainable innovations. Multidisciplinary Digital Publishing Institute.

Diaz, S. M. (2024). STEAM en repblica dominicana: Retos presentes y oportunidades para el futuro. None.

Ekta Bhatia, Prof. (Dr.), & Kumar, P. (2025). Competency-based education: A comparative study of traditional vs. Modern approaches. None.

Fatima, N., Rafiq-uz-Zaman, M., Arshad, I., Rasheed, I., & Fatima, A. (2025). The role of human resource management in teacher training for inclusive education: A phenomenological study. Indus Journal of Social Sciences, 3(3), 551–564. https://doi.org/10.59075/ijss.v3i3.1921

Fitria, D., Lufri, L., Elizar, E., & Amran, A. (2023). 21st century skill-based learning (teacher problems in applying 21st century skills). International Journal Of Humanities Education and Social Sciences (IJHESS).

Fitriati, F., Rosli, R., Iksan, Z. H., & Hidayat, A. (2023). Exploring challenges in preparing prospective teachers for teaching 4C skills in mathematics classroom: A school-university partnership perspectives. Taylor & Francis.

Fitriyah, A., Aminah, U., & Safitri, A. D. (2024). Educational innovation through the independent learning initiative in indonesia. None.

Gracia, E., Nurohman, S., & Wilujeng, nsih. (2024). Analysis the implementation of STEAM approach on creative thinking ability in science learning. None.

Hassan, B., Rafiq-uz-Zaman, M., & Khan, Z. A. (2025). Beyond Memorization: Cultivating Critical Thinking Skills through Classic Literature in Secondary Education for the 21st Century Learner. Review of Education, Administration & Law, 8(1), 115-124. https://doi.org/10.47067/real.v8i1.410

Hlukhaniuk, V., Svitlana Tsvilyk, and, & Shymkova, I. (2020). STEAM EDUCATION AS a BENCHMARK FOR INNOVATIVE TRAINING OF FUTURE TEACHERS OF LABOUR TRAINING AND TECHNOLOGY. Rezekne Academy of Technologies.

Hujjatusnaini, N., Corebima, A. D., Prawiro, S. R., & Gofur, A. (2022). The effect of blended project-based learning integrated with 21st-century skills on pre-service biology teachers" higher-order thinking skills. State University of Semarang.

Jain, T., Mohan, S., & Grover, Y. (2025). Skills in action: Transforming competency-based learning for future success. International Journal For Multidisciplinary Research.

Langoday, Y. R., Nurrahma, N., & Rijal, S. (2024). Policy reflection: Kurikulum merdeka as educational innovation in the era of society 5.0. Edunesia : Jurnal Ilmiah Pendidikan.

Leavy, A., Dick, L. K., Meletiou-Mavrotheris, aria, Paparistodemou, E., & Stylianou, E. (2023). The prevalence and use of emerging technologies in <scp>STEAM</scp> education: A systematic review of the literature. Wiley.

López, M. V. S., Usca, N., Rosero, J. R. S., & Quevedo, W. (2024). Creative thinking in art and design education: A systematic review. Education Sciences, 14(2), 192. https://doi.org/10.3390/educsci14020192

Malik, N., Bano, S., & Rafiq-uz-Zaman, M. (2025). Navigating the future of learning: A review of teacher professional development and implementation challenges in K–12 STEAM education (2015–2025). Physical Education, Health and Social Sciences, 3(3), 615–628. https://doi.org/10.63163/jpehss.v3i3.681

Mariano, W. K., & Chiappe, A. (2021). Habilidades del siglo XXI y entornos de aprendizaje STEAM: Una revisin. University of Murcia.

Mat, N. C., & Jamaludin, K. A. (2024). Effectiveness of practices and applications of student-centered teaching and learning in primary schools: A systematic literature review. None.

Megayanti, T., Busono, T., & Maknun, J. (2020a). Project-based learning efficacy in vocational education: Literature review. None.

Megayanti, T., Busono, T., & Maknun, J. (2020b). Project-based learning efficacy in vocational education: Literature review. IOP Publishing.

Mudinillah, A., Kuswandi, D., Erwin, E., Sugiarni, S., Winarno, W., Annajmi, A., & Hermansah, S. (2024). Optimizing project-based learning in developing 21st century skills: A future education perspective. Qubahan Academic Journal.

Mutohhari, F., Sutiman, S., Nurtanto, M., Kholifah, N., & Samsudin, A. (2021). Difficulties in implementing 21st century skills competence in vocational education learning. Institute of Advanced Engineering and Science (IAES).

Nadeem, M. A., Khan, Z. A., & Rafiq-uz-Zaman, M. (2024). A Comparative Analysis of Public and Private School Teachers Perception on Single National Curriculum Implementation. International" Journal of Academic Research for Humanities", 4(3), 209-218. https://doi.org/10.5281/zenodo.13741847

Rafiq-uz-Zaman, M. (2024). Evaluation of challenges faced by the early childhood care and education due to the shortage of teachers in Punjab, Pakistan. Journal of Childhood Literacy and Societal Issues, 3(2), 58-74. https://doi.org/10.71085/joclsi.03.02.50

Rafiq-uz-Zaman, M. (2025a). From chalkboards to competence: Rethinking skill-based education in Pakistan for a business-led innovation economy. International Journal of Academic Research for Humanities, 5(3), 1–13. https://doi.org/10.5281/zenodo.17112058

Rafiq-uz-Zaman, M. (2025b). Bridging the skills divide: A comparative study of skill-based education across SAARC countries with a policy roadmap for Pakistan. Social Science Review Archives, 3(3), 787–795. https://doi.org/10.70670/sra.v3i3.913

Rafiq-uz-Zaman, M. (2025c). STEAM: A contemporary concept and a set of early childhood education. Journal of Childhood Literacy and Societal Issues, 4(1), 122–140. https://doi.org/10.71085/joclsi.04.01.77

Rafiq-uz-Zaman, M. (2025d). Beyond STEM: A narrative review of STEAM education's impact on creativity and innovation (2020–2025). Inverge Journal of Social Sciences, 4(4), 1–16. https://doi.org/10.63544/ijss.v4i4.175

Rafiq-uz-Zaman, M. (2025e). Beyond the blackboards: Building a micro-edtech economy through teacher-led innovation in low-income schools. Journal of Business Insight and Innovation, 4(1), 46–52. https://doi.org/10.5281/zenodo.16875721

Rafiq-uz-Zaman, M. (2025f). The Integrated Skill-Based Education Framework (ISEF): An empirically grounded model for reforming skill-based education in Pakistan. Global Social Sciences Review, X(III), 157–167. https://doi.org/10.31703/gssr.2025(X-III).14

Rafiq-uz-Zaman, M. (2025g). Use of Artificial Intelligence in School Management: A Contemporary Need of School Education System in Punjab (Pakistan). Journal of Asian Development Studies, 14(2), 1984-2009.

Rafiq-uz-Zaman, M. (2025h). Empowering the Excluded: A Review of Skill-Based Education for Eunuchs in South Asia. Global Political Review, X(III), 60-69. https://doi.org/10.31703/gpr.2025(XIII).06

Rafiq-uz-Zaman, M., & Malik, N. (2025). STEAM for the future: A comparative evaluation of educational strategies in Pakistan and India. ProScholar Insights, 4(3), 137–147. https://doi.org/10.55737/psi.2025c-43113

Rafiq-uz-Zaman, M., & Nadeem, M. A. (2024). Comparative Analysis of Skill-Based Education Curriculum in Pakistan and India: A Contemporary Review. International" Journal of Academic Research for Humanities", 4(3), 188-197. https://doi.org/10.5281/zenodo.13646448

Rafiq-uz-Zaman, M., & Nadeem, M. A. (2025). Gauging the gap: Student perceptions of skill proficiency in skill-based education within schools of Punjab, Pakistan. ACADEMIA International Journal for Social Sciences, 4(2), 2307–2317. https://doi.org/10.63056/ACAD.004.03.0553

Rafiq-uz-Zaman, M., & Nadeem, M. A. (2025). Unveiling critical success factors for skill-based education programs: A student-centred analysis in Pakistani schools. Inverge Journal of Social Sciences, 4(3), 11–19. https://doi.org/10.63544/ijss.v4i3.139

Rafiq-uz-Zaman, M., Bukhari, S. T., Malik, N., Rehman, L., & Qamar, A. H. (2025a). Gender differences in the use and challenges of breakthrough technology in higher education: Evidence from Punjab. The Critical Review of Social Sciences Studies, 3(3), 1056–1073.

Rafiq-uz-Zaman, M., Malik, N., & Bano, S. (2025). Effectiveness of STEAM education in enhancing 21st century skills: A systematic review. Journal of Asian Development Studies, 14(3), 590–598. https://doi.org/10.62345/jads.2025.14.3.49

Rafiq-uz-Zaman, M., Nadeem, M. A., & Rasheed, I. (2024). Empowering women through skill-based education in Pakistan: A narrative review. Global Sociological Review, IX(IV), 52–59. https://doi.org/10.31703/gsr.2024(IX-IV).05

Raj, R., Sabin, M., Impagliazzo, J., Bowers, D., Daniels, M., Hermans, F., Kiesler, N., Kumar, A. N., MacKellar, B. K., McCauley, R., Nabi, S., & Oudshoorn, M. (2021). Professional competencies in computing education: Pedagogies and assessment. ACM Transactions on Computing Education, 21(3), 6570. https://doi.org/10.1145/3502870.3506570

Rodrigues-Silva, J., & Alsina, ngel. (2023). Conceptualising and framing STEAM education: What is (and what is not) this educational approach? Federal University of Minas Gerais.

Salinas-Navarro, D., Pacheco-Velzquez, E., Silva-Ovando, A. C. da, Meja-Argueta, C., & Chong, M. (2023). Educational innovation in supply chain management and logistics for active learning in latin america. Journal of International Education in Business.

Sidekerskienė, T., & Damaševičius, R. (2023). Out-of-the-box learning: Digital escape rooms as a metaphor for breaking down barriers in STEM education. Sustainability, 15(9), 7393. https://doi.org/10.3390/su15097393

Silitubun, E., Costa, B., & Nizam, Z. (2024). The role of project-based learning in developing 21st century skills. None.

Thorat, Dr. S. M. (2025). Beyond exams: Designing competency-based assessments for the 21st century learner. International Journal of Advanced Research in Science, Communication and Technology.

Tian, X., Minunno, F., Schiestl-Aalto, P., Chi, J., Zhao, P., Peichl, M., Marshall, J., Nösholm, T., Lim, H., Peltoniemi, M., Linder, S., & Mäkelä, A. (2021). Disaggregating the effects of nitrogen addition on gross primary production in a boreal Scots pine forest. Agricultural and Forest Meteorology, 308–309, 108337. https://doi.org/10.1016/j.agrformet.2021.108337

Ulaini, N., & Fitrisia, A. (2025). Enhancing vocational education in egypt: The role of project-based learning in developing 21st-century skills. None.

Vanoy, R. J. A. (2022). STEM education as a teaching method for the development of XXI century competencies. None.

Wahono, B., Lin, P., & Chang, C. (2020). Evidence of STEM enactment effectiveness in Asian student learning outcomes. International Journal of STEM Education, 7, 36. https://doi.org/10.1186/s40594-020-00236-1

White, D. E., & Delaney, S. (2021). Full STEAM ahead, but who has the map? A PRISMA systematic review on the incorporation of interdisciplinary learning into schools. LUMAT: International Journal on Math, Science and Technology Education, 9(2), 1387. https://doi.org/10.31129/lumat.9.2.1387