STEM with a Conscience: Exploring the Development of STEM Skills and Social Values among Malaysian Students

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ABSTRACT

This study explores how participation in the MADANI School Adoption Program – BITARA STEM cultivates both STEM skills and social values among Malaysian secondary school students. Using a qualitative descriptive design, the research employed thematic analysis to analyse students' open-ended responses regarding the national problems they aspire to solve in the future. The data were analyzed comparatively across pre- and post-intervention phases to examine how students' thinking and aspirations evolved after engaging in the STEM-based program. Five overarching themes emerged: (1) Social and Moral Responsibility, (2) Economic and Livelihood Concerns, (3) Integrity and Governance, (4) Environmental and Disaster Awareness, and (5) Personal Development for Nation Building. Post-intervention findings revealed a clear shift from general empathy to solution-oriented thinking grounded in STEM skills including critical thinking, problem-solving, creativity, and technological literacy. Students articulated aspirations such as "building flood-resilient homes," "reducing electricity costs," and "eliminating bullying," demonstrating their ability to connect scientific understanding with humanistic and civic values. The study concludes that value-based STEM education nurtures learners who are not only scientifically literate but also empathetic, ethical, and socially responsible. It highlights the potential of Value-Based STEM Education to integrate 21st-century competencies with humanistic principles and the MADANI philosophy, thereby shaping future citizens who can use science and technology conscientiously for the benefit of society.

Keywords: STEM, STEM Skills, Social Values, Technology Literacy

INTRODUCTION

STEM education has undergone a profound transformation, evolving from a narrow emphasis on disciplinary knowledge to a broader mission of nurturing scientifically literate, ethically responsible, and socially engaged citizens. This shift reflects a growing recognition that science and technology are inseparable from societal well-being, thereby requiring educational approaches that develop not only technical competence but also ethical reasoning, empathy, and civic consciousness [1]. Recent high impact studies emphasize the integration of ethical and social responsibility education within STEM curricula, advocating strategies such as values clarification, ethical dilemma discussions, and service learning to cultivate students' capacity for informed and compassionate decision making that benefits society [2, 3]. Increasingly, interdisciplinary and transdisciplinary frameworks are promoted to enable learners to connect STEM knowledge with real world challenges, address issues of equity and sustainability, and develop a sense of agency in resolving socio-scientific problems [4].

Research findings further highlight that programs emphasizing empathy, civic engagement, and collective purpose not only enhance students' perseverance in STEM learning but also prepare them to act as responsible and community oriented problem solvers [5]. Moreover, the infusion of democratic values, critical thinking, and

civic responsibility within STEM education empowers learners to participate meaningfully in social transformation and contribute to addressing global challenges [6]. Consequently, contemporary STEM education is increasingly recognized as both a moral and intellectual pursuit that equips students to apply their knowledge responsibly in solving real world problems and advancing human well-being [7].

Globally, educators and researchers advocate for a new generation of STEM learners who possess not only critical thinking and problem-solving skills but also a strong sense of social and environmental responsibility. This vision is encapsulated in the Value Based STEM Education (VB STEM) framework, which integrates ethical and humanistic principles into STEM teaching and learning [8]. Rather than positioning values as peripheral, VB STEM situates compassion, integrity, and sustainability at the core of scientific inquiry. This approach aligns with scholarship demonstrating that STEM education can cultivate innovation, analytical reasoning, and reflective thinking essential for addressing complex social, economic, and environmental challenges [9]. Prior investigations further reveal that interdisciplinary, constructivist, and project-based approaches such as service learning, design based learning, and civic science enable students to apply STEM knowledge meaningfully, develop empathy, and foster a sense of agency in solving real world problems [10].

The integration of values and ethical awareness into STEM curricula deepens students' understanding of the societal and environmental implications of science and technology while motivating them to act as responsible citizens and innovators [11]. This paradigm of "STEM with a conscience" is reinforced by findings showing that nurturing empathy and civic mindedness within STEM programs enhances perseverance, engagement, and the ability to address issues of sustainability and justice [12]. As scientific advancement and societal well-being become increasingly interconnected, high impact research underscores the urgent need for STEM education to develop not only technical proficiency but also ethical awareness, empathy, and civic engagement, thereby preparing learners to innovate responsibly and act with social purpose in the twenty first century [9].

Grounded in constructivist theory, which posits that learners actively construct knowledge through experience and reflection, contemporary STEM education emphasizes inquiry driven, project based, and experiential approaches that promote deep conceptual understanding and practical problem solving skills [13]. Rather than passively receiving information, students engage directly with real world phenomena, formulate and test hypotheses, and connect new ideas to prior knowledge, thereby mirroring the iterative processes of scientific inquiry and engineering design [14]. Kolb's Experiential Learning Theory further explicates this process through a cyclical model comprising concrete experience, reflective observation, abstract conceptualization, and active experimentation, which aligns closely with effective STEM pedagogies [15].

Evidence from educational research indicates that embedding Kolb's model and constructivist principles into STEM curricula enhances students' problem solving abilities, critical thinking, creativity, and engagement while strengthening collaboration and self-directed learning skills [16]. For instance, project oriented and inquiry focused learning experiences have been shown to improve not only academic performance but also essential twenty first century competencies such as communication, adaptability, and reflective thinking [13]. These pedagogical approaches cultivate self-awareness, persistence, and adaptability—qualities fundamental to lifelong learning and responsible innovation—by situating learning within authentic contexts and encouraging students to apply, evaluate, and refine their understanding iteratively [17]. Consequently, the integration of constructivist and experiential learning frameworks establishes a strong foundation for STEM education, empowering learners to become reflective and innovative problem solvers capable of addressing complex challenges in an evolving global landscape [15].

Beyond cognitive development, ethical growth is now recognized as a vital dimension of STEM learning. Frameworks such as Ethical Reasoning in STEM [18] emphasize that engagement with socio scientific issues such as environmental degradation, technological inequality, and sustainability can foster students' moral reasoning, empathy, and sense of social responsibility. Research demonstrates that when students explore complex, value laden issues through scientific and technological perspectives, they develop a deeper appreciation of the human implications of innovation and are encouraged to consider not only how scientific solutions function but also why they matter and whom they serve serve [19]. Integrating ethical and communal goals into STEM education through strategies such as service learning, project based inquiry, and explicit ethical

instruction has been shown to strengthen students' problem solving capacity, critical thinking, creativity, and perseverance while simultaneously nurturing empathy, integrity, and civic engagement [20].

For instance, research indicates that empathy and citizenship are significant predictors of perseverance in STEM learning, and that structured interventions addressing socioscientific challenges can increase students' willingness to act on social and environmental issues [2]. Furthermore, reflective and experiential learning activities, including moral dilemma analyses and community-based projects, enable students to connect scientific understanding with humanistic values, thereby embodying the concept of "STEM with a conscience" [21]. Qualitative analyses of student reflections further reveal that value-oriented and experiential STEM learning cultivates the moral imagination necessary for responsible and sustainable innovation in an increasingly complex and interconnected world [22].

Studies further reveal that empathy and citizenship are significant predictors of perseverance in STEM learning, and that structured interventions addressing socioscientific challenges can enhance students' willingness to act on social and environmental issues [2]. Reflective and experiential learning activities, including moral dilemma analyses and community based projects, also enable students to connect scientific understanding with humanistic values, embodying the concept of "STEM with a conscience" [21]. Analyses of student reflections show that value oriented and experiential STEM learning cultivates the moral imagination necessary for responsible and sustainable innovation in an increasingly complex and interconnected world [22].

The present study aims to explore how participation in a school based STEM program cultivates both cognitive and moral dimensions of learning among Malaysian secondary school students. Specifically, it seeks to examine how students conceptualize and respond to national and community challenges through a STEM perspective, and how their reflections demonstrate the integration of STEM competencies such as critical thinking, creativity, collaboration, and technological literacy with ethical awareness, empathy, and social responsibility. Using a qualitative thematic analysis of students' open ended responses, the study provides insights into how STEM learning experiences nurture value based, socially conscious, and solution oriented thinking. Ultimately, this research contributes to the broader discourse on Value Based STEM Education by offering contextually grounded evidence of how STEM programs can develop ethically aware innovators who apply science and technology conscientiously for societal well-being and sustainable development.

METHODOLOGY

This study adopted a qualitative research design to examine how participation in a school based STEM program cultivates both STEM related competencies and social values among Malaysian secondary school students, responding to calls for research that captures the nuanced and context specific experiences of learners [23]. The qualitative approach was selected to elicit the depth and richness of students' reflections and to interpret the meanings they attached to their learning experiences, consistent with recent scholarship that underscores the value of reflective inquiry and thematic analysis in understanding students' perspectives and identity development in STEM contexts [24]. Anchored in an interpretive paradigm, the study viewed knowledge as socially constructed through participants' experiences and cultural contexts, aligning with findings that highlight the importance of context and learner voice in STEM education research [25].

Data were analysed thematically using Braun and Clarke's six phase framework, which is widely applied in STEM education studies for its systematic capacity to identify recurring ideas, patterns, and relationships while preserving contextual meaning [26]. The analysis was managed using ATLAS.ti software to ensure transparency, traceability of coding decisions, and reliability throughout the process, consistent with established standards of rigor in qualitative STEM research. This methodological orientation is supported by prior studies demonstrating that thematic and reflective analyses can uncover how STEM programs promote not only technical abilities such as problem solving, creativity, and analytical reasoning but also social competencies including collaboration, empathy, and leadership, particularly when students engage in authentic, project based, and culturally relevant learning experiences [27, 28].

The research was conducted within the MADANI School Adoption Program, a collaborative STEM initiative under the BITARA STEM framework that aligns with Malaysia's national education priorities to nurture holistic

learners who integrate scientific reasoning with ethical awareness. Similar to other Malaysian and regional STEM initiatives, the BITARA STEM framework emphasizes experiential, project-based activities such as design challenges, sustainability projects, and innovation tasks. These approaches have been shown to strengthen students' problem solving abilities, inventive thinking, and social responsibility by engaging them in authentic community issues [29].

Participants comprised 120 primary school students aged between 10 and 12 years old, who voluntarily engaged in the program and completed written reflections before and after their participation. This approach is supported by existing research demonstrating the effectiveness of reflective writing in capturing conceptual development and value formation among learners [30]. The open ended prompt, "What problem would you like to solve for the benefit of your country or community in the future?" was designed to elicit genuine expressions of students' aspirations, social awareness, and understanding of STEM as a means for public good, aligning with studies that emphasize the value of connecting STEM learning to societal relevance and civic engagement. Voluntary participation without incentives and the inclusion of ethical safeguards ensured authenticity and contextual integrity, reflecting established best practices in educational research.

A. Data Collection

Data were collected through open ended written reflections administered during the program, a method widely recognised for enabling participants to articulate their beliefs, motivations, and conceptual understandings independently and thoughtfully within STEM and values-based learning contexts. Written reflections have been shown to enhance students' self-awareness, critical thinking, and capacity to connect personal experiences with broader learning objectives, particularly when they are encouraged to consider the societal and ethical dimensions of STEM [31]. Prior research also demonstrates that reflective writing promotes authentic belonging, motivation, and engagement by allowing students to express their personal purpose for pursuing STEM and relate their learning to real world challenges [28].

The digital submission process and subsequent analysis using ATLAS.ti ensured confidentiality, data integrity, and systematic coding, consistent with recognised standards of transparency and reliability in qualitative research. Employing a single qualitative instrument was appropriate for the exploratory nature of this study, as open reflections are particularly effective for capturing the nuanced ways in which students link STEM competencies with social and ethical considerations rather than quantifying outcomes. This approach aligns with studies showing that reflective practices, whether in written journals, essays, or digital platforms, reveal the depth and complexity of students' learning trajectories and the development of their identities as ethical and socially responsible STEM learners [32].

A. Data Analysis

Thematic analysis in this study was guided by Braun and Clarke's six phase framework, a widely recognised approach for ensuring systematic and transparent interpretation in qualitative STEM and educational research [33]. In Phase 1, the researchers immersed themselves in students' reflections to achieve deep familiarisation with the data, a process essential for capturing its richness and complexity and for establishing a strong interpretive foundation. Phase 2 involved line by line coding to highlight meaningful expressions, following best practices in detailed and context sensitive coding that reveal both cognitive and ethical dimensions of learning. In Phase 3, related codes were organised into broader categories, leading to the identification of preliminary themes such as social responsibility and civic engagement. This approach aligns with research in civic science and socio scientific inquiry, where students' reflections often demonstrate a shift from empathy to community centred, solution oriented reasoning [34]. Phase 4 entailed iterative review and refinement of themes to ensure coherence and alignment with the research aims, consistent with recommendations for maintaining analytical rigor and thematic clarity.

During Phase 5, each theme was clearly defined and named, resulting in five final themes: social and moral responsibility, economic concerns, integrity and governance, environmental awareness, and personal growth for nation building. These themes mirror those identified in international STEM education research on responsible citizenship [2, 35]. Finally, Phase 6 involved synthesising and reporting the findings through representative

excerpts that illustrated each theme, alongside a comparative analysis of pre and post program reflections. This process revealed a developmental progression toward the integration of scientific reasoning with empathy, ethics, and civic sensibility. Throughout the analysis, reflexive memos and collaborative discussions were used to enhance transparency and minimise bias, reinforcing the credibility and trustworthiness of the findings. Overall, this comprehensive and reflective approach not only captured what students valued but also illuminated how their ethical intentions were translated into practical scientific thinking, demonstrating the effectiveness of thematic analysis in uncovering the intricate relationship between STEM learning and social values.

RESULTS & DISCUSSION

The thematic analysis revealed five major themes, namely social and moral responsibility, economic and livelihood concerns, integrity and governance, environmental and disaster awareness, and personal growth for nation building, as shown in Table I. Collectively, these themes reflect the breadth of students' aspirations to contribute to societal well-being through STEM learning. The findings correspond with a growing body of research indicating that integrated, project-based STEM education cultivates not only technical competence but also ethical reasoning, civic awareness, and a strong sense of social responsibility [1, 9, 36]. Studies demonstrate that when students engage with authentic and contextually meaningful challenges such as sustainability initiatives or community centred innovation projects, they transcend general expressions of empathy to propose more specific, technically informed, and ethically grounded solutions to societal problems.

Project oriented and problem-based learning approaches have been consistently shown to enhance critical thinking, collaboration, and communication, while simultaneously nurturing students' intrinsic motivation to contribute to their communities [37]. Moreover, embedding ethical and humanistic perspectives within STEM curricula deepens students' understanding of the societal implications of science, technology, and innovation, thereby fostering what has been described as a form of "STEM with a conscience" [38]. The observed progression in students' reflections, from broad moral awareness in pre-program responses to more nuanced, solution focused, and ethically reasoned perspectives in post-program responses, resonates with evidence from recent studies that underscore the transformative potential of interdisciplinary and contextually relevant STEM education [1, 39]. This developmental shift highlights the importance of designing STEM programs that purposefully integrate ethical, social, and technical dimensions, preparing students not only as competent professionals but also as conscientious innovators who can apply scientific knowledge responsibly in addressing complex local and global challenges.

Table I Themes, Subthemes, Descriptions, and Illustrative Quotes from Students' Reflections

Theme	Subthemes	Description	Illustrative Quotes
Social and Moral Responsibility	• Anti-bullying • Respectful behavior • Helping others	Students want to build a better, more ethical society.	"Mengurangkan kes buli," "Kurangkan mengata tentang orang," "Saya mahu menolong orang"
Economic and Livelihood Concerns	• Price control • Poverty reduction	Concerned about cost of living and equitable economy.	"Menurunkan harga barangan," "Saya akan turunkan harga barang"
Environmental and Disaster Awareness	• Flood mitigation • Environmental care	Awareness of flood and climate issues; applying engineering ideas.	"Membuat rumah banjir untuk para mangsa banjir"
Integrity and Governance	• Anti-corruption • Justice	Recognition of corruption as a moral and national issue.	"Mengurangkan pengambilan rasuah"
Personal Development for National Contribution	• Self-improvement • Academic excellence	Self-improvement linked with national pride and contribution.	"Saya akan menjadi ranking no. 1 Malaysia"

B. Theme 1: Social and Moral Responsibility

Students initially expressed a desire to address social issues such as bullying, respect, and empathy, often stating aims like "stop bullying" and "help others in need." This focus on emotional and moral well-being reflects the importance of embedding humanistic and ethical values in STEM education to foster social justice and citizenship [40, 41]. After participating in the STEM program, students' reflections became more structured and solution oriented, for example, proposing to "create an anti-bullying awareness application" or "design a school campaign using technology." This progression illustrates a shift from moral intent to applied innovation, where empathy and ethical reasoning are translated into concrete technological solutions. Consistent with existing research, this transformation demonstrates that project-based and problem-centred STEM learning strengthens students' capacity to integrate technical creativity with civic responsibility, cultivating socially conscious innovators equipped to address real community challenges [40, 42].

C. Theme 2: Economic and Livelihood Concerns

Students frequently identified economic challenges such as rising living costs, unemployment, and poverty as key societal concerns. Early reflections were general and empathetic, with statements such as "reduce prices" and "help poor families." After participating in the STEM program, students' ideas became more analytical and solution oriented, proposing innovations such as "develop energy saving systems to reduce electricity bills" and "use solar technology to lower household costs." This shift indicates the development of critical thinking and applied problem solving, core competencies of STEM learning that enable students to connect economic sustainability with scientific and technological innovation.

Research shows that project based and inquiry driven STEM approaches enhance students' capacity to analyze complex socio-economic issues and design feasible solutions through systems thinking that links energy, economy, and society [1, 43, 44]. Integrating sustainability focused engineering projects within STEM curricula has also been shown to strengthen students' understanding of the interdependence between environmental and economic factors. This progression from empathetic awareness to solution driven innovation highlights STEM education's transformative potential in cultivating compassionate, analytical thinkers who can contribute meaningfully to sustainable development.

D. Theme 3: Integrity and Governance

Students frequently highlighted issues such as corruption, crime, drug abuse, and dishonesty, which were initially expressed as moral imperatives including "stop corruption" and "avoid drugs." After participation in the STEM program, students' reflections became more action oriented, presenting community-based initiatives such as "build a youth education program on integrity" and "create awareness systems using digital media." This thematic progression demonstrates how ethical STEM learning contributes to the development of civic responsibility by encouraging students to perceive themselves as agents of positive change who integrate moral conviction with innovation and collaboration.

The integration of social governance concerns into technological solutions has been viewed as central to STEM literacy, encompassing not only technical competence but also ethical awareness and civic agency [4, 45]. Within the field, integrated STEM education has been recognized for nurturing ethical reasoning and social engagement, enabling the consideration of complex issues such as corruption and crime through informed, community-centered innovation. The inclusion of social responsibility and integrity within STEM curricula, through project-based learning, civic science, and explicit ethical instruction, has been associated with enhanced willingness among learners to address socio scientific issues and strengthened commitment to social reform [10]. Through such approaches, the cultivation of responsible STEM professionals is achieved, and students are empowered to contribute meaningfully to the public good, reaffirming the pivotal role of education ix shaping ethical and civically engaged citizens.

E. Theme 4: Environmental and Disaster Awareness

Environmental and ecological issues were identified as some of the most prominent concerns in students' reflections, with frequent references to floods, pollution, waste management, and climate change. Prior to the

STEM program, students expressed empathy and focused on immediate forms of assistance, such as "help flood victims." After participating in the program, their reflections revealed a shift toward applying scientific and engineering reasoning, as demonstrated in ideas such as "designing flood resistant houses," "improving drainage systems," and "creating waste segregation tools." This transition was interpreted as evidence of developing an engineering design mindset and enhanced environmental literacy, both of which are regarded as key outcomes of effective STEM education. It has been established in the literature that problem-based and project-based STEM learning contributes to improved environmental understanding, problem solving ability, and applied creativity through engagement in authentic, context specific challenges [46, 47].

For example, approaches incorporating the engineering design process and real environmental contexts have been found to enable learners to conceptualize and implement feasible, evidence informed solutions to ecological problems [48, 49]. Furthermore, project-based STEM learning has been associated with the strengthening of systems thinking, allowing students to recognize the interdependence of environmental, social, and technological factors. The observed shift from emotional concern to analytical and solution-oriented reasoning corresponds with international evidence that experiential STEM activities promote environmental responsibility and empower learners as innovative problem solvers and agents of change. Collectively, these findings affirm the essential role of experiential STEM education in equipping students with the skills, values, and dispositions necessary to address environmental challenges and contribute to sustainable development.

F. Theme 5: Personal Growth and National Contribution

A number of students articulated aspirations for personal excellence and self-development as pathways to national progress, with reflections such as "I want to be successful so I can help the country" and "I want to become a scientist or engineer to improve Malaysia." These expressions illustrate an emerging perception of STEM careers as service oriented, combining individual ambition with civic purpose. Within literature, such career motivation has been found to be closely associated with self-efficacy, future orientation, and ethical intent, constructs that are central to Social Cognitive Career Theory [50, 51]. Participation in STEM programs involving authentic inquiry and experiential learning has been associated with enhanced confidence, broader professional aspirations, and greater commitment to socially meaningful goals.

Exposure to role models, real world STEM applications, and supportive learning environments has also been linked to the development of moral purpose, where knowledge is regarded to advance societal well-being rather than solely personal success. This transformative orientation corresponds with contemporary frameworks that integrate ethical, social, and technical elements of STEM education, positioning learners as contributors to both national and global development [52, 53]. Collectively, these insights affirm the importance of fostering STEM education that balances personal achievement with civic responsibility, preparing future scientists and engineers to act as ethical innovators and agents of positive change.

G. Cross-Theme Synthesis: The Development of STEM with a Conscience

The students' reflections across all five themes revealed a distinct progression in their intellectual and moral learning dimensions related to their STEM experiences, as shown in Table II. Initially, before engaging with the program, students expressed a general sense of empathy and ethical concern, demonstrating a desire to contribute positively to society and alleviate suffering. However, their expressions often lacked depth and technological specificity. Post-participation in STEM activities, students' reflections evolved towards a more actionable, solution-oriented mindset grounded in scientific reasoning. They began to propose tangible initiatives such as creating technological solutions, leveraging engineering approaches to address community challenges, and applying scientific methods to foster social welfare. This shift indicates that the program not only heightened students' awareness of societal issues but also enhanced their ability to integrate scientific inquiry with ethical considerations, suggesting the development of responsible citizenship [54, 55].

This combination of STEM skills—including critical thinking, creativity, problem-solving, and digital literacy—with social and humanistic values such as empathy, civic responsibility, and integrity, emerged prominently in their reflections. Students demonstrated the ability to transform theoretical knowledge into practical applications that address crucial human needs. The results imply that experiential and inquiry-based

STEM education not only encourages technical innovation but fosters a moral imperative, effectively transitioning students from passive recipients of information into engaged, reflective problem solvers. The findings align with the broader perspective that STEM education should not only contribute to technological and economic advancement but also address essential ethical and social dimensions of human growth [56, 57].

These transformations within student reflections highlight the potential of integrated educational approaches that combine STEM with values-based education, indicating a significant shift toward more conscientious and socially aware learning methodologies in the STEM domain [58, 59].

Table II Comparison of Pre- and Post-Program Themes on Evolution of Students' Aspirations and STEM Skills

Theme	Pre- STEM Learning Experience	Post STEM Learning Experience	STEM Skills Reflected
Social and Moral Responsibility	Students expressed general moral concerns such as stopping bullying, helping others, and promoting kindness. Reflections were emotional but lacked concrete action.	Students proposed structured, actionable solutions such as developing anti-bullying campaigns, designing apps, or using media to promote respect.	Ethical reasoning, creativity, communication, social awareness
Economic and Livelihood Concerns	Responses focused on everyday struggles like high prices, job shortages, and poverty, framed as broad social problems.	Reflections showed analytical thinking and applied solutions, such as using renewable energy to reduce costs or developing energy-saving systems.	Critical thinking, problem-solving, systems thinking
Integrity and Governance	Students mentioned corruption, dishonesty, and crime as moral issues to be avoided.	Students proposed awareness programs, digital monitoring tools, and community engagement efforts to promote integrity.	Ethical judgment, digital literacy, civic responsibility
Environmental and Disaster Awareness	Students expressed empathy for flood victims or general concern about pollution and waste.	Students demonstrated scientific reasoning by suggesting engineering or technological solutions (e.g., flood-resistant homes, improved drainage, recycling systems).	Engineering design, environmental literacy, innovation
Personal Growth and National Contribution	Aspirations centered on personal success (e.g., becoming a scientist or engineer) without explicit connection to social purpose.	Students linked career goals to national development and community well-being, recognizing STEM careers as pathways for contribution.	Self-efficacy, career awareness, goal orientation

H. Implications for STEM Education

The findings of this study carry significant implications for rethinking the design and purpose of STEM education in contemporary classrooms. The results suggest that embedding socially relevant problem-solving into STEM learning can significantly enhance both the cognitive and moral engagement of students. When learners are encouraged to explore real-world issues such as environmental challenges, social inequality, or community well-being, they develop a stronger sense of connection between science and society. This integration nurtures critical and creative thinking, while simultaneously strengthening ethical awareness and empathy.

Educators and curriculum designers should therefore view STEM not as a collection of isolated disciplines but as a value-driven, interdisciplinary practice that empowers students to apply their knowledge responsibly. Project-based learning, design thinking, and community-based inquiry can serve as effective pedagogical models to bridge the gap between technical competence and moral understanding. Furthermore, assessment practices should move beyond content mastery to recognize ethical reasoning, collaboration, and reflection as legitimate indicators of STEM learning success.

By positioning science and technology within a moral framework, teachers can inspire learners to become innovators with integrity, individuals who possess the curiosity to explore, the creativity to invent, and the conscience to ensure their innovations contribute to the greater good of humanity. In this way, STEM education can become a transformative force for cultivating not only future scientists and engineers but also responsible citizens who understand that the ultimate purpose of knowledge is to serve humanity.

CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

This study aims to investigate how students' reflections on national and community issues reflect the development of both STEM competencies and social values through value-oriented STEM learning experiences. The thematic analysis demonstrated that when students participate in real-world, context-relevant STEM activities, they begin to blend critical thinking, creativity, and problem-solving abilities with essential qualities such as empathy, integrity, and social consciousness. The evolution from general ethical concerns to a more informed, socially responsible understanding signifies a learning model aptly described as "STEM with a conscience," which integrates cognitive and moral growth.

Viewing STEM education through this lens reveals that it transcends mere preparation for scientific or technical careers; it serves as a transformative journey that nurtures ethical innovators and responsible global citizens. The findings underscore the need to create educational experiences that encourage students to apply STEM knowledge to address pressing societal challenges, such as environmental sustainability, equitable access to technology, and community well-being. When students recognize the significance of their education in relation to the collective challenges facing humanity, their motivation deepens, and their perception of STEM's relevance extends beyond the classroom.

However, the study acknowledges that cultivating STEM with a conscience necessitates intentional pedagogical frameworks. Educators play a crucial role in establishing environments that foster inquiry, critical reflection, and empathy. Therefore, future STEM initiatives should incorporate opportunities for ethical discussions, interdisciplinary collaboration, and reflective practices within hands-on inquiry-based learning. It is also imperative for schools and policymakers to integrate value-based frameworks into STEM curricula at the national level, ensuring that scientific literacy is complemented by ethical literacy.

To further advance research in this area, there is a need for longitudinal and multi-context studies to track the development of these integrated competencies over time and in varied educational settings. Comparative studies across different cultural or socioeconomic backgrounds could shed light on how contextual factors influence students' ethical reasoning and engagement with STEM. Furthermore, participatory action research that involves teachers, community partners, and students could provide richer insights into how STEM education can facilitate both social and environmental advancement.

In conclusion, this study confirms that nurturing STEM with a conscience is not merely an aspirational goal; it is a critical requirement for equipping young individuals to navigate an increasingly complex world. When education empowers students to intertwine their knowledge with empathy and purpose, it establishes a strong foundation for a new generation of scientists, engineers, and innovators who appreciate progress not only through the lens of discovery but also in terms of human dignity, justice, and sustainability.

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