



Exploring STEM Education for Real-World Climate Change Concerns to Empower Students as Change Agents

Kurniawan Arif Maspul^{1*}

¹ University of the People; kurniawanarifmaspul@my.uopeople.edu

Abstract: This article explores the application of STEM (Science, Technology, Engineering, and Mathematics) curriculum to real-world problems, with a focus on increasing the relevance and community involvement in climate change projects. Students are empowered to actively contribute to the resolution of problems in their communities when they are involved in community-based activities. This method encourages student involvement, critical thinking, and a sense of social responsibility. STEM projects must be aligned with suitable grade levels and selected major real-world problems to be successful and appropriate. Climate change was chosen as a real-world topic because of its urgency and far-reaching repercussions, which necessitate multidisciplinary approaches and innovative solutions. Students gain critical thinking skills, problem-solving ability, and a sense of environmental stewardship by immersing them in the subject of climate change. The article outlines a qualitative approach that involves literature review, group discussions, and educator observations to lay a solid theoretical foundation and ensure the strategy's success. The debate focuses on the significance of meaningful educational experiences, ways for preparing educators for community involvement, and the need to recognize and celebrate accomplishments. Students get a deeper knowledge of scientific principles while developing the skills and mindset to address global concerns as responsible global citizens by integrating STEM education, community involvement, and climate change.

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*Correspondensi: Kurniawan Arif

Maspul

Email:

kurniawanarifmaspul@my.uopeople.edu

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Introduction

It is widely acknowledged in today's educational landscape that educational experiences should be meaningful and applicable to the actual world (Coates, 2010; Wilson et al., 2019). This article goes into the use of STEM (Science, Technology, Engineering, and Mathematics) curriculum in tackling real-world problems, with a particular emphasis on boosting relevance and community engagement in climate change projects. Students are enabled to actively contribute to the resolution of challenges affecting their local communities by adopting community involvement (Fajrina et al., 2020; Susskind & Cruikshank, 1987). This strategy encourages not only more student participation, but also critical thinking skills and a sense of social responsibility. STEM projects must be aligned with the proper K-12 grade level and selected as important real-world problems to ensure their success and appropriateness (Niehoff, 2018). The decision to focus on K-12 students in this effort is built on the belief that this period of academic and psychological development is crucial for engaging students in meaningful and effective learning experiences.

Climate change, an urgent global issue with far-reaching consequences for our planet and future generations, has been chosen as the project's real-world challenge. Climate change is defined as long-term changes in temperature, precipitation, and weather patterns caused mostly by human activities such as the use of fossil fuels and deforestation (Chakraborty et al., 2014; Lazarus, 2008). It is a complicated and diverse problem that necessitates multidisciplinary approaches and creative solutions. Students can acquire critical thinking skills, problem-solving ability, and a sense of environmental stewardship by immersing them in the subject of climate change. This option is entirely in line with the goals of STEM education, which aim to integrate science, technology, engineering, and mathematics to solve complex issues and stimulate creativity and innovation.

Furthermore, the Next Generation Science Standards (NGSS), a generally acknowledged framework for science education in the United States, promote the inclusion of climate change as a focus point in STEM education. Understanding global climate change and its repercussions is emphasized as a major discipline concept in the NGSS (Carlsen & Bruggemann, 2022; *Next Generation Science Standards: For States, by States*, 2013). Educators can improve students' scientific literacy and provide them with the information and skills to make informed decisions about environmental issues by involving them in real-world scenarios such as climate change.

Climate change is also in sync with the ideas of problem-based learning (PBL). (Savery, 2015) defines PBL as an instructional technique that presents students with complicated, authentic problems and encourages them to actively explore and propose solutions. Students can use their STEM skills to analyze data, conduct research, and propose new solutions to alleviate the effects of climate change by immersing them in the subject of climate change. This method encourages higher-order thinking, teamwork, and the development of transferable abilities that will be important in their future academic and professional endeavors.

This project's issue statement centers on the question, "How can our community mitigate the effects of climate change and promote sustainable practices?" (Pecl et al., 2017) This problem statement underlines the crucial need to address climate change and the need of establishing long-term solutions within the context of the local community. Rising temperatures, extreme weather events, sea-level rise, and biodiversity loss are all consequences of climate change (Burkett et al., 2008; Upadhyay, 2020). These consequences have a direct impact on our community's ecosystems, water supply, agriculture, and public health. We empower students to become change agents and build a feeling of environmental responsibility by including them in the quest for answers. In addition, tackling climate change is consistent with the United Nations Sustainable Development Goals, particularly Goal 13: Climate Action and Goal 12: Responsible Consumption and Production (Carlsen & Bruggemann, 2022; Jung et al., 2018). By integrating students in climate change mitigation activities, educators may help to attain these global goals and build a feeling of global citizenship and responsibility.

This initiative gives several chances for academic advancement, critical thinking, and environmental awareness by concentrating on climate change as a real-world concern for

students. Students not only gain a better comprehension of scientific ideas, but they also gain the abilities needed to confront global concerns as future problem solvers and responsible global citizens. Community engagement and the application of STEM principles in tackling climate change provide a tremendous platform for students to develop a profound awareness for the environment and a sense of stewardship that extends beyond the classroom.

Method

This breakthrough article presents exceptionally intelligent and influential methods for smoothly integrating STEM education with the critical topic of climate change. The qualitative method promotes educational quality by doing an in-depth literature analysis, vibrant group discussions in the UoPeople's M.Ed class, and thorough educators observations. It starts with a thorough review of scholarly articles, research papers, and educational frameworks to create a sound theoretical foundation. Engaging multiple stakeholders in dynamic interactions enables the sharing of opinions and experiences, creating the process collectively. Real-world situations that are associated with educational goals are selected to offer students practical chances to make a meaningful impact. Community engagement is critical in establishing relationships and meaningful learning experiences. Students receive hands-on experience and build critical thinking and problem-solving abilities when STEM curriculum is aligned with real-world situations and experiential learning is used. The system is constantly evolving with a complete assessment methodology and impact evaluations, assuring its success and motivating students to become responsible global citizens in the face of climate change.

Result and Discussion

It is critical in today's educational landscape to make educational experiences meaningful and applicable to the real-life environment (Wilson *et al.*, 2019). This following discussion looks at how STEM (Science, Technology, Engineering, and Mathematics) curriculum can be applied to real-world problems. Students can actively assist in fixing problems that affect their local communities by incorporating community involvement (Fajrina *et al.*, 2020). This strategy encourages students' greater participation, critical thinking, and feeling of social responsibility.

Real-World Challenge Selection

We will focus on K-12 students for this initiative. Climate change is the chosen real-world challenge, as identified in the Niehoff resource "7 Real-World Issues That Can Allow Students to Tackle Big Challenges." Real-World Challenge Selection and Grade Level (Niehoff, 2018). To ensure the STEM project's success and appropriateness, it must be connected with the proper grade level and choose a significant real-world difficulty. The study will target K-12 students, who are at a critical juncture in their academic and psychological development.

The real-world challenge chosen for this project is climate change, a worldwide issue that poses serious hazards to our planet and future generations. Climate change refers to

long-term changes in temperature patterns, precipitation, and weather patterns driven mostly by human activities such as the use of fossil fuels and deforestation (Chakraborty et al., 2014). It is a complicated and diverse problem that necessitates interdisciplinary approaches and novel solutions. Students will acquire critical thinking skills, problem-solving talents, and a sense of environmental stewardship by concentrating on climate change. Climate change was chosen as the real-world challenge because it matches with the goals of STEM education, which strives to integrate science, technology, engineering, and mathematics to solve complex problems and inspire creativity and innovation.

Climate change was chosen as the real-world issue for K-12 learners based on research and instructional ideas. The Next Generation Science Standards (NGSS), a generally accepted paradigm for science education in the United States, promotes comprehending global climate change and its consequences as a key disciplinary concept (National Research Council, 2013; Carlsen & Bruggemann, 2022). Educators can improve students' scientific literacy and equip them to be informed citizens capable of making informed judgments about environmental issues by involving them in real-world situations such as climate change.

Furthermore, the topic of climate change is consistent with problem-based learning (PBL) ideas. (Savery, 2015) defines PBL as an instructional strategy that presents students with complicated, authentic problems and encourages them to actively study and propose solutions. Students can use their STEM abilities to analyze data, conduct research, and propose new methods to lessen the effects of climate change by immersing them in the subject. This method encourages higher-order thinking, teamwork, and the development of transferable abilities that will be useful in their future academic and professional pursuits. The STEM initiative, which targets K-12 learners and focuses on climate change as the real-world challenge, gives multiple chances for academic progress, critical thinking, and environmental awareness. Students will not only increase their comprehension of scientific principles by addressing this critical global issue, but they will also build skills that will be essential for their responsibilities as future problem solvers and responsible global citizens.

Problem Statement and Contextual Importance

Meanwhile, climate change is a serious challenge to our community, affecting many parts of our ecology, economy, and overall well-being (Pecl *et al.*, 2017). "How can our community mitigate the effects of climate change and promote sustainable practices?" is the issue statement for this project. This problem statement captures the critical need to address climate change and emphasizes the need for long-term solutions in our local environment. Climate change has far-reaching repercussions, including rising temperatures, extreme weather events, sea-level rise, and biodiversity loss (Upadhyay, 2020). These effects have an impact on our community's ecosystems, water supplies, agriculture, and public health. Students are driven to study the intricate links between human activities and the environment by framing the issue statement around mitigating the effects of climate change.

Students must be included in this problem statement because they will be the future leaders and decision-makers who will inherit the effects of climate change (Rickards et al., 2014). We enable learners to be change agents and build a feeling of environmental

responsibility by actively incorporating them in the solution-finding process. This project allows students to hone their critical thinking abilities, gain scientific literacy, and gain a knowledge of the social, economic, and ethical components of climate change prevention. Addressing climate change and supporting sustainable habits has conceptual value that transcends beyond the classroom. It is consistent with the UN Sustainable Development Goals (SDGs), particularly Goal 13: Climate Action and Goal 12: Responsible Consumption and Production (Jung *et al.*, 2018; Carlsen & Bruggemann, 2022). Educators may contribute to the achievement of these global goals and foster a sense of global citizenship and responsibility by including students in this effort.

Furthermore, the issue statement is consistent with the STEM education typology principles, emphasizing the integration of science, technology, engineering, and mathematics to address real-world challenges (Sutaphan & Yuenyong, 2019). It encourages students to use their STEM skills and expertise to analyze data, devise new solutions, and make informed judgments regarding environmentally friendly behaviors. Students get a complete grasp of the complex and multidimensional nature of climate change by embracing interdisciplinary perspectives. "How can our community mitigate the effects of climate change and promote sustainable practices?" outlines the project's focus and emphasizes the urgent need for action in our local context. By involving students in this issue, we empower them to become future leaders who actively contribute to climate change mitigation and sustainability (Ortiz, 2019). This project is in line with global aims and STEM education type principles, and it provides a platform for students to develop critical abilities and a feeling of environmental responsibility.

Vision for the STEM Project

This STEM project's objective is to provide students with a transformative educational experience that goes above and beyond typical classroom learning. Students will be empowered to become engaged agents of change and develop a profound grasp of the interdependence of science, technology, engineering, and mathematics by concentrating on the real-world challenge of climate change and its impact on their community. Students will be able to learn from and with their peers by participating in collaborative work through this project (Dare, 2019; SURATNO, 2020). Collaborative learning promotes the development of cooperation, communication, and problem-solving abilities, all of which are necessary in dealing with complicated issues such as climate change. Students will collaborate in groups to share ideas, do research, and design creative solutions.

This STEM project will rely heavily on fieldwork. Students will have the opportunity to engage directly with their local environment outside of the classroom. They will gather information, observe natural events, and chronicle the effects of climate change in their neighborhood. Fieldwork is a hands-on and immersive activity that allows students to establish a stronger connection with their surroundings and a clearer understanding of the value of environmental care (Al-Azawi, 2019). This project will rely heavily on data analysis. Students will learn how to gather and interpret scientific evidence on climate change. They will investigate a variety of data sources, such as climate records, temperature readings, precipitation data, and biodiversity surveys. Students will develop critical thinking skills

and obtain insights into the patterns and trends of climate change in their neighborhood by studying and interpreting data.

In addition, the project will use computational thinking, allowing students to harness the power of technology to fight climate change. They will learn how to model climate scenarios, assess the impact of various initiatives, and analyze large data sets using computational tools and software. Computational thinking fosters logical reasoning, algorithmic thinking, and problem-solving abilities, all of which are necessary for addressing the multifarious difficulties of climate change. The project will emphasize hands-on design and prototyping. Students will have the opportunity to develop and build prototypes of sustainable solutions using their knowledge of science, technology, engineering, and mathematics. (Tselegkaridis, 2022) They could produce models of renewable energy systems, water conservation measures, or novel approaches to reducing carbon emissions. This hands-on approach develops creativity, invention, and an entrepreneurial perspective, allowing learners to become problem solvers.

Moreover, the STEM project seeks to provide students with an all-encompassing and integrated learning experience. Students will get a thorough understanding of climate change and its ramifications by mixing collaborative work, fieldwork, data analysis, computational thinking, and hands-on design and prototyping. They will be prepared to provide sustainable solutions and have a positive impact on their community's reaction to climate change. Students will not only receive subject-specific information from this project, but they will also develop a feeling of environmental responsibility and become champions for sustainable methods.

Outside of Class STEM Work

Students will actively connect with the local community through fieldwork to improve their understanding of climate change and sustainable practices. Data on energy use, trash management, and environmental indicators will be collected. Students will obtain a better understanding of the local implications of climate change and firsthand knowledge of the present state of sustainable activities in their community by conducting fieldwork (Li, 2021). Students will also be able to extend their ideas and learn from professionals who are actively working on climate change mitigation by interacting with local groups and experts. Interviews with professionals will provide vital insights into the community's concerns and potential solutions. Visits to renewable energy facilities will also expose students to cutting-edge technologies and practices that support sustainability efforts.

Inside Class STEM Work

Students will examine the data gathered during fieldwork in the classroom. They will undertake data modeling, detect trends, and draw meaningful conclusions using mathematical and scientific principles. This analytical technique will assist students in comprehending the relationship between numerous aspects such as energy usage and environmental consequences. Students will build sustainable ideas and offer innovative solutions using computational thinking (Üret, 2021). They will utilize programming and coding to simulate scenarios, evaluate the effectiveness of various interventions, and

optimize the solutions they offer. This method encourages critical thinking, problem solving, and the use of technology to address real-world issues.

The project will also include hands-on activities in which students will design and construct prototypes. They may, for example, design solar-powered equipment or model eco-friendly infrastructure. This component of experiential learning allows students to apply engineering and technical principles to create concrete solutions. Students will obtain a complete grasp of climate change and sustainable activities as a result of this comprehensive approach (Chang, 2022; Kier, 2022). They will learn data analysis, computational thinking, scientific investigation, and engineering design. Furthermore, by combining mathematical and scientific principles, students will be able to assess the feasibility and effectiveness of their proposed solutions.

This STEM project's vision corresponds with the STEM education typology principles, emphasizing the integration of science, technology, engineering, and mathematics to address real-world concerns. It fosters a sense of environmental responsibility and community engagement while encouraging collaboration, critical thinking, and innovation (Bybee, 2013; Juškevičienė et al., 2021)

Strategies for Community Involvement

To maximize community involvement and create a lasting impact, the following strategies can be implemented:

1. Expert Presentations

Inviting local environmentalists, scientists, and officials to deliver talks about climate change and sustainability is an effective approach to exchange knowledge and experiences. These specialists can offer useful insights into the most recent research, cutting-edge technologies, and policy initiatives. The presentations can be set up as guest lectures, workshops, or seminars, with opportunities for students to participate in discussions and ask questions. These talks create a deeper awareness of the difficulties and potential solutions associated with climate change by introducing students to a variety of perspectives and expertise.

2. Community Panels

Organizing panel discussions with community members who have expertise in renewable energy, urban planning, or environmental conservation is a great approach to get students and local stakeholders talking. Panelists can explore the challenges and opportunities related with sustainable practices by sharing their experiences and providing real-world examples. These debates broaden students' perspectives and stimulate critical thinking. It also enables the exchange of ideas and the investigation of potential collaborative solutions. Community panels provide a venue for students to engage in meaningful dialogue and connect with members of the community who are actively working towards sustainability.

3. Collaborative Partnerships

Establishing sustainable ties with local businesses, government agencies, and non-profit groups is a great technique for increasing community involvement. These collaborations can take many forms, including internships, mentorship programs,

and collaborative projects. Students can obtain personal knowledge and insights into real-world sustainability efforts by working alongside professionals in the industry. Designing and implementing sustainable solutions in collaboration with local organizations can be part of collaborative initiatives (Hiscock, 2020). Such collaborations generate a sense of ownership, shared responsibility, and active participation in the community's sustainability initiatives. It also provides students with important networking opportunities and prospective career paths in industries relevant to sustainability.

The STEM initiative gives chances for community members to actively contribute to climate change mitigation and sustainability by implementing these measures. Experts, community panels, and collaborative partnerships encourage information sharing, interdisciplinary collaboration, and the application of novel ideas. These approaches promote community engagement, raise awareness, and form long-term relationships for sustainable development, all of which align with sustainable principles.

Initiating Sustainable Partnerships

To ensure the long-term sustainability of partnerships with community members, the following steps can be taken:

1. Clear Objectives

Defining shared goals and objectives is critical for establishing a common purpose and ensuring alignment with the needs of the community and educational outcomes. Clarifying the partnership's goals helps in the development of trust, commitment, and mutual understanding. It is critical to include all stakeholders in the process of developing objectives, including students, instructors, community members, and organizational representatives (Setyowati, 2021). This collaborative approach guarantees that the partnership serves the community's specific needs and objectives while providing students with relevant educational experiences.

2. Regular Communication

Open and consistent lines of communication are critical for the success and longevity of collaborations. Meetings, emails, progress reports, and shared web platforms are all ways to accomplish this. Regular communication allows for continued collaboration, the exchange of ideas, and the prompt resolution of problems. To guarantee that everyone is interested, informed, and actively engaging in the partnership, it is critical to include all stakeholders in the communication process. Regular communication also allows us the opportunity to celebrate accomplishments, resolve issues, and make required changes to collaboration activities.

3. Reciprocal Benefits

Recognizing and covering community members' help is essential for long-term partnerships. Identifying ways to give back to the community shows genuine gratitude for their contributions and underscores the importance of their participation. Students, for example, can arrange workshops or give lectures to the community to share their knowledge and talents. They can also join in voluntary

activities that benefit the community and are in line with the partnership's ideals. Students and educators demonstrate their commitment to active involvement by providing reciprocal benefits such as educational materials, knowledge, or help in community projects. This ensures that the connection remains mutually beneficial and durable.

These measures support in the establishment and maintenance of long-term collaborations with community members, ensuring that the collaboration thrives over time. Clear objectives lay the groundwork for mutual understanding, while regular communication promotes continued collaboration and adaptability, and reciprocal rewards reaffirm the value and significance of community efforts (Hamilton, 2021). The STEM initiative emphasizes long-term values such as community engagement, mutual respect, and a long-term commitment to combating climate change and fostering sustainability by applying these approaches.

Strategies to Assist Educators in Getting Ready for Community Service

A thorough set of recommendations, accompanied by substantial innovative examples, can be followed to enable educators to effectively adopting community involvement techniques. To begin, creating chances for professional development is critical. Educators can attend workshops on effective community engagement, such as those that help educators create relationships with community stakeholders, understand local environmental concerns, and incorporate community-based initiatives into the curriculum. Collaborative learning communities can also be formed in which educators can exchange best practices, resources, and issues connected to community involvement, establishing a supportive peer network.

Second, encouraging teamwork is essential for successful community involvement. Educators can form alliances with local businesses, non-profits, and government entities. A science teacher, for example, can work with a local environmental organization to create a project in which students gather and analyze data on water quality in neighboring rivers. Interdisciplinary collaboration is also beneficial since educators from various disciplines can collaborate to build integrated projects that address environmental challenges. A team of science, art, and social studies professors, for example, may collaborate on a project in which students build public art works to raise awareness about climate change.

The third approach is to establish specific learning objectives. Project-based learning is an effective strategy in which students handle real-world environmental concerns. Students, for example, can work on sustainable garden projects while learning about plant biology, environmental conservation, and community gardening techniques. Service-learning programs can also be integrated into the curriculum, allowing students to apply their academic knowledge and abilities to meet community problems. Conducting energy assessments for local businesses and recommending energy efficiency upgrades is one example.

Educators must have access to materials and assistance. Creating a community resource database with information on local sustainability resources can help educators connect with relevant partners and get needed resources. Furthermore, providing grant

writing assistance prepares educators to effectively apply for money to support their community involvement programs. Another important method is to encourage contemplation and assessment. Educators and students can keep reflective journals or portfolios that capture their community involvement project experiences, obstacles, and lessons learned. This helps in evaluating the efficacy of methods and identifying areas for improvement. The impact of community involvement efforts on knowledge, attitudes, and behaviors related to sustainability can be measured via surveys, interviews, or pre- and post-project assessments.

It is critical to recognize and celebrate accomplishments in order to sustain community involvement activities. By establishing sustainability awards, educators, students, and community partners who have made substantial contributions to environmental protection and community involvement are recognized and honored. Displaying students' projects at community events allows them to share their accomplishments, encourage others, and gain support for future sustainability initiatives. Educators can be assisted in efficiently conducting community involvement projects by following these tactics and incorporating new examples. This enables them to design relevant learning experiences that meet academic criteria while also instilling in learners a sense of environmental responsibility and active citizenship.

Conclusion

STEM projects become more relevant, interesting, and meaningful for students when they include community involvement and address real-world concerns. Students gain key STEM skills while actively contributing to the well-being of their community through the proposed climate change initiative. The approaches mentioned foster meaningful interactions that transcend beyond the classroom, fostering long-lasting connections and a sense of empowerment in students. In supporting such programs, we can raise a generation of environmentally conscious citizens capable of shaping a sustainable future.

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