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Community-Based Integrated Instructional Model for Teaching Science Projects to Develop Digital Innovation and Creativity Skills among Secondary School Students

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Background and Aim: Digital innovation and creativity skills are essential for 21st-century learners through project-based science learning. This study aims to develop and evaluate a community-based integrated instructional model to enhance secondary school students' digital innovation and creativity skills, fostering authentic problem-solving, civic responsibility, and socially responsible innovation.
Materials and Methods: The model was developed by synthesizing science project-based learning and community-based learning frameworks, comprising four main components: Connector, Community Collaborator, Construct-Contextualize-Create, and Communicate. It integrates eight stages of science project-based learning and eight elements of community-based learning, emphasizing technology integration, real-world problem-solving, collaborative teamwork, and continuous assessment. Five experts evaluated the model's appropriateness and effectiveness.
Results: Expert evaluation demonstrated high overall effectiveness (M = 4.70, SD = 0.47). The model achieved perfect scores (M = 5.00) for digital tool integration for social innovation and generating innovative solutions to community challenges, showing particularly strong performance in promoting problem-solving and critical thinking within community contexts.
Conclusion: The community-based integrated instructional model demonstrates high suitability for enhancing digital innovation and creativity skills among secondary school students. It successfully bridges theoretical learning with practical community engagement, promoting civic responsibility and socially responsible innovation while maintaining flexibility for adaptation across diverse educational contexts.
Keywords: Community-Based Learning, Science Project-Based Learning, Digital Innovation Creativity Skills, Civic Engagement, Authentic Learning

Introduction

The rapid advancement of digital technologies and their increasing integration into various aspects of education have significantly transformed teaching and learning processes (Krajcik & Shin, 2022). In response to these changes, educators are exploring innovative instructional models to enhance students' skills in digital innovation and creativity. One such model gaining attention is the Community-Based Integrated Instructional Model for teaching science projects, which connects classroom learning with real-world community contexts to foster problem-solving skills, creativity, and civic engagement among students. This approach not only engages students in authentic learning experiences but also supports the development of 21st-century skills such as critical thinking, collaboration, and social responsibility.

Community-based learning, involving partnerships between educational institutions and community organizations to address local needs, has been recognized for its potential to enhance motivation, engagement, and the real-world application of knowledge (Furco & Root, 2010). Integrating community-based approaches with science project instruction—which emphasizes inquiry, investigation, and innovation—creates immersive learning experiences that encourage students to apply creativity and digital innovation in addressing authentic community problems (Svihla & Reeve, 2016; Barron & Darling-Hammond, 2008). This model combines authentic community engagement and systematic science inquiry to foster social innovation and continuous improvement.

The shift toward authentic and relevant learning experiences—accelerated by global challenges and the push for sustainable development—necessitates flexible and meaningful instructional models (Bowers, 2021). Community-based learning environments provide a platform for implementing science projects that transcend the boundaries of traditional classroom instruction. By leveraging community partnerships and digital platforms, students can investigate real problems, collaborate with diverse

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stakeholders, and innovate in ways that have tangible community impacts, promoting inclusive and socially responsible learning experiences (Tran & King, 2022). Moreover, the use of digital tools, virtual collaboration platforms, and data visualization technologies enhances the effectiveness of the Community-Based Integrated Instructional Model for teaching science projects (Perez et al., 2023).

Despite the recognized potential of community-based science project instruction, a critical gap exists in understanding how to effectively integrate digital innovation and creativity skills within this framework, particularly in secondary education contexts. This study addresses this gap by investigating how the Community-Based Integrated Instructional Model fosters digital innovation and creativity skills in secondary school students. The research provides valuable insights into integrating community-based approaches and science project instruction within modern education, offering a comprehensive framework that educators can adapt to diverse educational contexts while promoting authentic problem-solving and socially responsible innovation.

Objectives

1) To develop an instructional model based on community-based learning integrated with science project teaching that enhances digital innovation and creativity skills.

2) To provide guidelines for applying the Community-Based Integrated Instructional Model for designing science project instruction in diverse educational contexts.

3) To establish a comprehensive model that enhances students' digital innovation and creativity capabilities for the 21st century through authentic community engagement.

4) To evaluate the Community-Based Integrated Instructional Model by experts and achieve a rating of "good" or higher.

Literature Review

Science Project-Based Learning

Science project-based learning serves as a vital instructional framework in STEM education, promoting inquiry, problem-solving, and creativity. It typically involves identifying authentic problems, conducting investigations, analyzing data, and presenting solutions through iterative processes (Krajcik et al., 2023). Research indicates that integrating science project-based learning into curricula enhances engagement, scientific literacy, and positive attitudes toward STEM, fostering essential 21st-century skills (Chen & Yang, 2019). Studies show that science project-based learning improves secondary students' creativity in addressing environmental and sustainability issues, resulting in notable gains in innovative thinking and problem-solving abilities (Han et al., 2015). However, challenges such as limited community partnerships, time constraints, and inadequate teacher preparation hinder effective classroom implementation (Thomas, 2000). Combining science project-based learning with community engagement enhances learning outcomes and fosters civic responsibility (Billig & Waterman, 2014). Thus, while science project-based learning is promising, further integration with community contexts is essential for its success.

Community-Based Learning

Community-based learning integrates authentic community contexts into education to enrich learning experiences. Research demonstrates that it improves student motivation, civic engagement, and academic outcomes, especially when students collaborate with local organizations to address community needs (Celio et al., 2011). The inclusion of digital technologies further extends access to resources, supports communication with stakeholders, and enables students to document and share innovations (Butin, 2010). In STEM education, community-based approaches connect academic learning with real-world applications and promote socially responsible innovation (Riedler & Eryaman, 2016). Despite its benefits, challenges remain in building sustainable partnerships, aligning community needs with curriculum goals, and supporting teachers (Sandy & Holland, 2006). Overall, literature underscores the potential of community-based learning to transform educational practices and foster civic responsibility.

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Total Experience Approach

The Total Experience of the Community-Based Integrated Instructional Model integrates multiple dimensions, including learner engagement, instructional design, community partnerships, technology integration, collaboration, and experiential learning. By addressing authentic community challenges, students are motivated to participate in meaningful science investigations that meet local needs (Stehle & Peters-Burton, 2019). Instructors benefit from partnerships providing authentic learning contexts, diverse expertise, and real-world application opportunities (Bringle & Hatcher, 2009). Technology facilitates flexible, interactive environments through digital collaboration platforms, data analysis tools, virtual presentations, and portfolio systems (Kim et al., 2020). Collaboration is further strengthened through interdisciplinary teamwork and stakeholder engagement, encouraging students to exchange ideas and develop digital innovation skills (Salam et al., 2019). This Total Experience approach emphasizes hands-on engagement and community-connected problem-solving in science project instruction (Kokotsaki et al., 2016). Students gain scientific knowledge while developing creativity, digital literacy, and civic engagement. The integration of community partnerships and digital tools creates a dynamic, inclusive learning experience that aligns with sustainable educational goals.

The Community-Based Integrated Instructional Model

The Community-Based Integrated Instructional Model combines authentic community contexts with structured pedagogy to enhance learning and civic engagement. Frameworks such as the Community-Engaged Learning Model outline systematic processes for embedding community partnerships into curricula and emphasize reciprocal relationships between schools and communities (Jacoby, 2015). Integrated STEM models that incorporate community contexts have been shown to improve students' understanding of real-world applications and enhance problem-solving and innovation skills (Kelley & Knowles, 2016). Experimental studies in science education demonstrate that community-based integrated approaches can significantly enhance motivation, scientific literacy, and creativity, leading to improved project performance and deeper understanding of science-society connections (Cervantes et al., 2015). Overall, these studies highlight the transformative potential of community-based integrated instruction in science education—fostering engagement, relevance, and social responsibility to prepare students for addressing community and global challenges.

Conceptual Framework

The conceptual framework of the Community-Based Integrated Instructional Model is grounded in the integration of three core components: science project-based learning principles, community-based learning approaches, and digital innovation and creativity development. This framework positions the community as both a learning context and a collaborative partner in the educational process. The model emphasizes authentic problem identification within community settings, systematic scientific inquiry processes, collaborative stakeholder engagement, and the application of digital tools and platforms to support innovation and creativity. Through this integrated approach, students engage in meaningful learning experiences that bridge academic knowledge with real-world application, developing essential skills including critical thinking, problem-solving, digital literacy, collaboration, and civic responsibility. The framework operates through cyclical phases of community needs assessment, project design and planning, investigation and innovation, community implementation, and reflection and evaluation. This iterative process ensures continuous improvement and sustained engagement between educational institutions and community partners, ultimately preparing students to become socially responsible innovators capable of addressing contemporary challenges through creative digital solutions.

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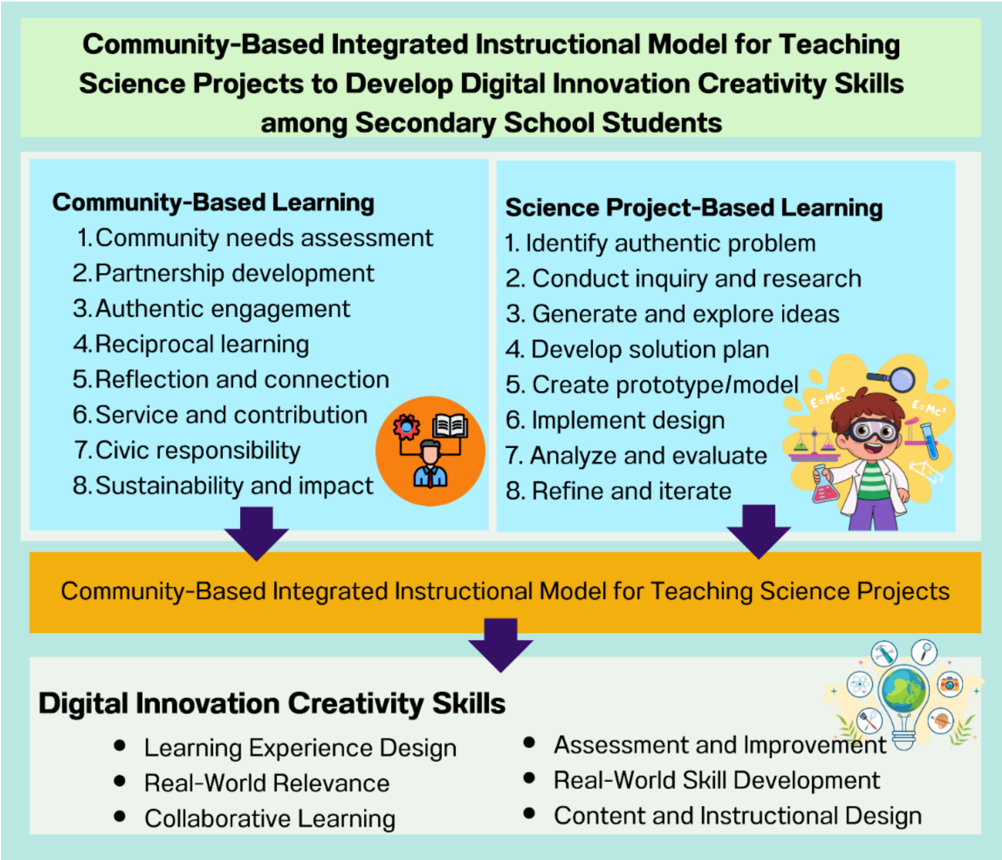

Figure 1: The Conceptual Framework of the Community-Based Integrated Instructional Model

Methodology [11 point]

The research is divided into two phases as follows:

Phase 1: The Development of the CBI Model

The CBI Model will be developed by analyzing and synthesizing 40 documents, including articles and research related to instructional model components, community-based learning, science project-based learning, community partnerships, and digital innovation and creativity skills published from 2015 to 2024. This includes the following steps:

Step 1. Synthesis of instructional model components for enhancing digital innovation creativity skills through community engagement.

Step 2. Synthesis of the elements of science project-based learning.

Step 3. Synthesis of the elements of community-based learning approaches.

Step 4. Synthesis of the features of digital innovation and creativity skills.

Step 5. Designing the CBI Model as follows:

1) The study, analysis, and synthesis of concepts and literature related to the meaning, elements, and details of instructional model components, community-based learning, science project-based learning, community partnerships, stakeholder engagement, and digital innovation and creativity skills.

2) The design of a draft version of the CBI Model to enhance the total experience. The model consists of four main components: Connector (Role of the teacher as facilitator and community liaison), Community Collaborator (Role of the student as active investigator and community member), Construct, Contextualize, and Create (Investigating, analyzing, and developing community-based solutions), and Communicate (Sharing, evaluating, and refining innovations with stakeholders).

3) Proposal of the model to an advisor for recommendations and revision.

Phase 2: The Evaluation of the Appropriateness of the CBI Model

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1) The creation of a 5-point Likert scale questionnaire about the appropriateness of the CBI Model. The questionnaire consists of six main components and 18 elements: 1) Objectives of the Instructional Model, 2) Components of Science Project-Based Learning, 3) Components of Community-Based Learning, 4) Digital Innovation Creativity Skills, 5) Impact on Digital Innovation Creativity Skills, and 6) Overall Evaluation. Then, the analysis of the results was performed by applying the standard deviation (SD) and average values.

2) The evaluation of the CBI Model by 5 experts, divided into groups: 2 experts in instructional models, 2 experts in educational evaluation, and 1 expert in community-based education or service-learning.

Results

Phase 1: The Results of the Synthesis of Instructional Model Components

The results of the synthesis of instructional model components for enhancing digital innovation creativity skills through community engagement, using content analysis techniques from articles and research papers by Billig and Waterman (2014), Bringle and Hatcher (2009), Kokotsaki et al. (2016), Salam et al. (2019), Stehle and Peters-Burton (2019), and Krajcik and Shin (2022), are presented in Table 1.

Table 1: Synthesis of Instructional Model Components for Enhancing Digital Innovation Creativity Skills through Community Engagement

Instructional Model Components for Enhancing Digital Innovation Creativity Skills	Billig & Waterman (2014)	Bringle & Hatcher (2009)	Kokotsaki et al. (2016)	Salam et al. (2019)	Stehle & Peters-Burton (2019)	Krajcik & Shin (2022)
1. Connector (Role of the teacher)	✓	✓	✓	✓	✓	✓
2. Community Collaborator (Role of the student)	✓	✓	✓	✓	✓	✓
3. Construct, Contextualize, and Create (Investigating, analyzing, and developing community-based solutions)	✓	✓	✓	✓	✓	✓
4. Communicate (Sharing, evaluating, and refining innovations with stakeholders)	✓	✓	✓	✓	✓	✓

The table synthesizes key components from various instructional models aimed at enhancing digital innovation and creativity skills through community-based approaches. It examines six studies conducted between 2009 and 2022, highlighting the essential elements for effective community-engaged learning processes.

The Synthesis of Science Project-Based Learning Elements

The synthesis of science project-based learning elements with content analysis techniques from articles and research papers (Krajcik et al., 2023; Chen & Yang, 2019; Han et al., 2015; Kokotsaki et al., 2016; Thomas, 2000; Svihla & Reeve, 2016; Kelley & Knowles, 2016; Barron & Darling-Hammond, 2008; Cervantes et al., 2015; Kim et al., 2020).

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Table 2: Synthesis of the Elements of Science Project-Based Learning

Elements of Science Project-Based Learning	Krajcik et al. (2023)	Chen & Yang (2019)	Han et al. (2015)	Kokotsaki et al. (2016)	Thomas (2000)	Svihla & Reeve (2016)	Kelley & Knowles (2016)	Barron & Darling -Hammond (2008)	Cervantes et al. (2015)	Kim et al. (2020)
1. Identify an authentic problem	√	√	√	√	√	√	√	√	√	√
2. Conduct inquiry and research	√	√	√	√	√	√	√	√	-	-
3. Generate and explore ideas	√	√	√	√	√	√	√	√	√	√
4. Develop a solution plan	√	√	√	√	-	-	-	√	√	√
5. Create prototype/model	√	√	√	√	√	√	√	√	√	√
6. Implement design	√	√	√	-	-	√	√	√	-	-
7. Analyze and evaluate	√	√	√	√	√	-	-	√	√	-
8. Refine and iterate	√	√	√	√	√	√	√	√	√	√

The synthesis reveals eight core elements of science project-based learning with varying degrees of consensus across the literature. Three elements demonstrated universal agreement (100%): (1) identify authentic problem, (2) generate and explore ideas, and (3) create prototype/model, indicating these are foundational to all science project-based learning approaches. The elements refine and iterate appeared in 90% of studies, highlighting the critical importance of iterative improvement processes in authentic scientific practice.

Conducting inquiry and research was present in 80% of studies, emphasizing systematic investigation as essential for evidence-based solution development. Moderate consensus was found for three elements: develop a solution plan (70%), analyze and evaluate (60%), and implement design (60%). The variation in these elements reflects diverse pedagogical emphases and contextual adaptations across different educational settings.

Overall, the synthesis identifies a strong core of universally recognized elements that form the foundation of science project-based learning, while allowing flexibility in other components to meet specific educational goals, student needs, and resource availability. This comprehensive eight-element framework provides educators with a robust structure for designing science project-based learning experiences that integrate inquiry, creativity, systematic problem-solving, and iterative improvement—all critical for developing digital innovation creativity skills among secondary school students in community-based contexts.

The Synthesis of Community-Based Learning Elements

The synthesis of community-based learning elements with content analysis techniques from articles and research papers (Furco & Root, 2010; Celio et al., 2011; Jacoby, 2015; Sandy & Holland, 2006; Bowers, 2021; Tran & King, 2022; Butin, 2010; Riedler & Eryaman, 2016; Salam et al., 2019; Bringle & Hatcher, 2009).

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Table 3: Synthesis of the Elements of Community-Based Learning

Elements of Community-Based Learning	Furco & Root (2010)	Celio et al. (2011)	Jacoby (2015)	Sandy & Holland (2006)	Bowers (2021)	Tran & King (2022)	Butin (2010)	Riedler & Eryaman (2016)	Salam et al. (2019)	Bringle & Hatcher (2009)
1. Community needs assessment	√	√	√	√	√	√	√	-	√	√
2. Partnership development	√	√	√	√	√	√	√	√	√	√
3. Authentic engagement	√	√	√	√	√	√	√	√	√	√
4. Reciprocal learning	√	√	√	√	-	-	√	√	√	√
5. Reflection and connection	√	√	√	√	√	√	√	√	√	√
6. Service and contribution	√	√	√	√	√	√	-	√	√	√
7. Civic responsibility	√	√	√	-	-	√	√	√	√	-
8. Sustainability and impact	√	√	√	√	√	√	√	√	√	√

The synthesis reveals eight core elements of community-based learning with strong consensus across the literature. Three elements demonstrated universal agreement (100%): (1) partnership development, (2) authentic engagement, and (3) reflection and connection, indicating these are foundational to all community-based learning approaches. Sustainability and impact also received 100% consensus, emphasizing the field's commitment to creating lasting community benefits.

Community needs assessment appeared in 90% of studies, highlighting the importance of identifying genuine community challenges. Service and contribution showed 90% consensus, demonstrating widespread recognition that students must make tangible contributions to community welfare. Reciprocal learning appeared in 80% of studies, reflecting the value of mutual knowledge exchange between students and community members. Civic responsibility showed moderate consensus at 60%, suggesting varying emphasis on civic education outcomes across frameworks.

Overall, the synthesis identifies a robust framework characterized by high consensus on partnerships, authentic engagement, reflection, needs assessment, and sustainability. This comprehensive eight-element framework provides educators with a structured approach for designing community-based learning experiences that integrate authentic community contexts, reciprocal relationships, and sustained impact—critical for developing digital innovation, creativity skills, and civic responsibility among secondary school students.

The Synthesis of Digital Innovation Creativity Skills Features

The results of the synthesis of the features of digital innovation creativity skills from Perez et al. (2023), Stehle and Peters-Burton (2019), Kim et al. (2020), Kokotsaki et al. (2016), Kelley and Knowles (2016), and Krajcik and Shin (2022) are summarized in Table 4.

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Table 4: Synthesis of the Features of Digital Innovation Creativity Skills

Features of Digital Innovation Creativity Skills	Perez et al. (2023)	Stehle & Peters -Burton (2019)	Kim et al. (2020)	Kokotsaki et al. (2016)	Kelley & Knowles (2016)	Krajcik & Shin (2022)
1. Learning Experience Design	√	√	√	√	√	√
2. Real-World Relevance	√	√	√	√	√	√
3. Collaborative Learning	√	√	√	√	√	√
4. Assessment and Improvement	√	√	√	√	√	√
5. Real-World Skill Development	√	√	√	√	√	√
6. Content and Instructional Design	√	√	√	√	√	√

The synthesis reveals six core features of digital innovation creativity skills with complete consensus (100%) across all studies: (1) Learning Experience Design, (2) Real-World Relevance, (3) Collaborative Learning, (4) Assessment and Improvement, (5) Real-World Skill Development, and (6) Content and Instructional Design. This universal agreement demonstrates a cohesive understanding of essential components for developing digital innovation and creativity skills.

Learning Experience Design emphasizes creating engaging, technology-integrated environments that foster creativity and critical thinking. Real-World Relevance ensures learning activities connect to authentic contexts and genuine challenges. Collaborative Learning promotes teamwork through digital platforms for collective problem-solving and communication skill development. Assessment and Improvement reflects continuous, formative evaluation using digital tools for project-based assessments and real-time feedback. Real-World Skill Development focuses on practical competencies for professional and civic contexts. Content and Instructional Design underscores a structured curriculum that effectively integrates digital tools and creativity development.

The unanimous consensus indicates a well-established understanding of digital innovation and creativity skills in educational research. This comprehensive framework provides educators with clear guidance for developing students' creative problem-solving, technological fluency, collaborative innovation, and continuous improvement—essential competencies for addressing complex community challenges through science project-based learning.

From Figure 2, it can be seen that the Community-Based Integrated Instructional Model for Teaching Science Projects to Enhance Digital Innovation Creativity Skills was divided into 3 main parts, which were as follows:

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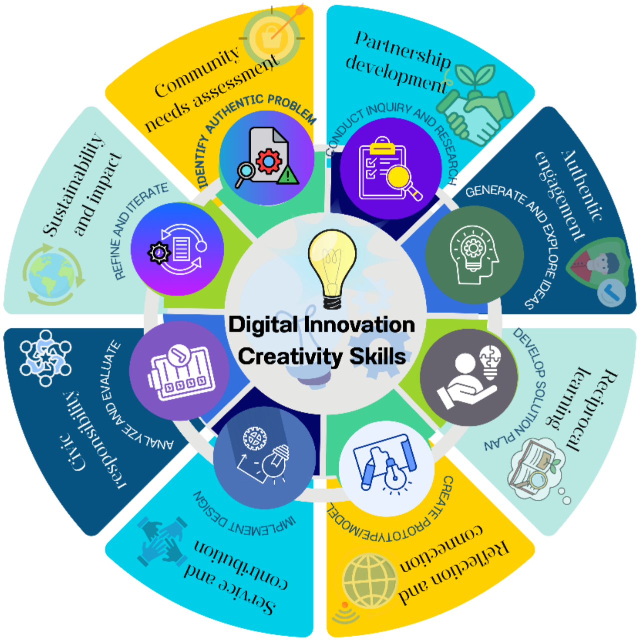

Figure 2 Community-Based Integrated Instructional Model for Teaching Science Projects to Enhance Digital Innovation and Creativity Skills

Part 1: Synthesis of the Elements of Science Project-Based Learning

The science project-based learning component consists of 8 elements as follows:

1) Identify Authentic Problem: Identifying authentic problems involves recognizing and clearly articulating genuine community challenges or scientific questions. At this stage, students work with community partners to define precise investigation questions and learning objectives that address real needs. This approach ensures that both community priorities and educational goals, along with realistic constraints such as resources, time, and stakeholder expectations, are integrated effectively.

2) Conduct Inquiry and Research: This step entails the systematic gathering of relevant scientific data and information from diverse sources, including literature reviews, community interviews, field observations, and existing datasets. Students analyze this information to deepen their understanding of the community problem and inform decision-making in the solution development process.

3) Generate and Explore Ideas: During this phase, students engage in creative ideation to generate multiple potential solutions for the identified community problem. This step emphasizes brainstorming, hypothesis development, and innovative thinking, often involving input from community stakeholders to ensure relevance and feasibility.

4) Develop Solution Plan: The ideas generated are systematically evaluated to develop the most feasible and impactful solution plan. This involves assessing each idea's viability in meeting community needs, scientific validity, available resources, and potential for sustainable impact, ensuring the best approach is identified through collaboration with community partners.

5) Create Prototype/Model: Developing a prototype or model is a critical phase where the selected concept is transformed into a tangible representation, whether physical, digital, or conceptual. The prototype provides a means to test the solution's functionality, gather stakeholder feedback, and identify potential issues before full implementation in the community context.

6) Implement Design: This phase focuses on translating the prototype into action within the community setting. Students work with community partners to implement their innovations through pilot programs, field testing, community workshops, or deploying digital solutions, while carefully documenting the process and outcomes for evaluation.

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7) Analyze and Evaluate: The analysis and evaluation stage examines the implemented solution to assess its effectiveness and identify areas for improvement. Students use scientific methods, data collection techniques, community feedback, and stakeholder input to evaluate impact, feasibility, and alignment with both scientific principles and community needs.

8) Refine and Iterate: Finally, iterative improvements are made based on evaluation results, community feedback, and testing outcomes. This process mirrors authentic scientific and innovation practices, ensuring that the final solution meets high standards of quality, effectiveness, and community relevance while building students' capacity for continuous improvement and responsive design.

Part 2: The Community-Based Learning Process

The community-based learning component consists of 8 elements as follows:

1. Community Needs Assessment: This foundational element serves as the central starting point for structuring community-based learning activities. Students and teachers work with community partners to systematically identify genuine challenges, priorities, and assets through dialogue, surveys, community meetings, and contextual analysis. This ensures that science projects address authentic needs rather than perceived problems, establishing meaningful objectives tied to both learning outcomes and community benefit.

2. Partnership Development: Collaborative relationships between educational institutions, students, and community organizations are established and maintained throughout the project. These partnerships provide the structural foundation for authentic engagement, offering access to community expertise, resources, and real-world contexts. Strong partnerships ensure mutual benefit and sustained collaboration.

3. Authentic Engagement: Students participate in meaningful activities that contribute real value to the community rather than superficial involvement. This element emphasizes genuine participation where students work alongside community members as partners in co-creating knowledge and addressing challenges. Authentic engagement transforms traditional learning environments into interactive and dynamic spaces that connect academic work with community impact.

4. Reciprocal Learning: A combination of knowledge exchange flows in multiple directions—students learn from community members' lived experiences, local knowledge, and practical wisdom, while sharing academic research, technical skills, and fresh perspectives. This mutual learning encourages all participants to invest effort and sustain interest, recognizing diverse forms of expertise and validating community knowledge alongside academic knowledge.

5. Reflection and Connection: Structured reflection activities represent phases of learning progression that help students critically examine their experiences, connect them to scientific concepts and academic content, and consider broader social and environmental issues. Through guided reflection, students develop a deeper understanding as they advance through the learning pathway, fostering metacognitive awareness and a sense of intellectual and civic growth.

6. Service and Contribution: This element recognizes the importance of students making tangible contributions to community welfare through their science projects. Whether through direct service, research that informs decision-making, innovations that address community needs, or capacity-building activities, students' work bolsters community well-being by reinforcing positive outcomes and providing meaningful benefits for continued community engagement.

7. Civic Responsibility: Through community-based science projects, students develop an understanding of their obligations to society and their capacity to effect positive change. Competitive and collaborative activities foster civic achievement and social consciousness. These elements provide students with opportunities to recognize their agency as citizens and develop dispositions for ongoing civic engagement and social responsibility.

8. Sustainability and Impact: As a key component of community-based learning, this element promotes long-term benefits and ongoing relationships beyond single projects. Through sustained collaboration, capacity-building activities, and designs that communities can maintain independently, students and community partners develop strong connections and foster a sense of shared responsibility while achieving mutual goals that extend beyond the initial project period.

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Part 3: Digital Innovation Creativity Skills Assessment

Digital innovation and creativity skills are assessed through four key dimensions as follows:

1) Learning Experience Design emphasizes creating engaging, technology-integrated environments where students actively investigate community problems using digital tools, fostering creativity and critical thinking about social impact. By integrating digital technologies—such as data collection applications, analysis software, visualization platforms, collaborative tools, and presentation technologies—educators ensure learning is interactive, relevant, and aligned with both educational and community goals. This approach helps students acquire digital literacy, computational thinking, data analysis capabilities, adaptability, and innovative thinking.

2) Real-World Relevance ensures learning activities connect to authentic community contexts and genuine challenges. Digital tools enable students to investigate real problems, collect and analyze community data, simulate scenarios, and design innovations that mirror professional research and civic engagement practices. Projects addressing actual community issues help students build collaboration skills, critical thinking, scientific reasoning, ethical decision-making, and adaptability—practical competencies crucial for navigating the evolving landscape of science, technology, and civic participation.

3) Collaborative Learning promotes teamwork through digital platforms that enable students to work with peers, community members, and diverse stakeholders to co-create knowledge and solutions. These environments facilitate communication across boundaries, support joint project development, and provide spaces for collective reflection. By working in diverse teams with authentic community partners, students develop communication, negotiation, cultural competence, conflict resolution, and interdisciplinary problem-solving skills, leading to comprehensive solutions that integrate diverse forms of knowledge and expertise.

4) Assessment and Improvement reflects continuous, formative evaluation using digital tools for project-based assessments, digital portfolios, community presentations, stakeholder feedback, peer reviews, and reflective journals. Real-time feedback from multiple sources—teachers, peers, community partners, and self-reflection—encourages students to refine their innovations and develop a growth mindset. This iterative process fosters ongoing improvement, metacognitive awareness, and responsiveness to community needs.

5) Real-World Skill Development focuses on practical competencies for professional and civic contexts, preparing students to address complex community challenges through scientific innovation. Students develop skills that are transferable to careers and civic roles where creative problem-solving, technological fluency, and collaborative innovation are essential.

6) Content and Instructional Design underscores a structured curriculum that effectively integrates digital tools with creativity development, ensuring systematic progression through community-based science projects while maintaining alignment with learning objectives and community impact goals.

Phase 2: The Evaluation of the Appropriateness of the CBI Model

Table 5 Evaluation Results of the Community-Based Integrated Instructional Model (CBI Model)

No.	Title	Evaluation Lists	$\bar{x}$	S.D.	Level of Suitability
1	Objectives of the Instructional Model	1) Clear alignment with learning goals and community needs	4.60	0.52	Highest
		2) Relevance to digital innovation, creativity, and civic responsibility	4.60	0.52	Highest
		3) Specificity in defining desired outcomes and community impact	4.60	0.52	Highest

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No.	Title	Evaluation Lists	x̄	S.D.	Level of Suitability
2	Components of Science Project-Based Learning	1) Completeness of the inquiry process	4.80	0.42	Highest
		2) Practicality and applicability in authentic community contexts	4.80	0.42	Highest
		3) Facilitation of creativity and scientific problem-solving	4.80	0.42	Highest
3	Components of Community-Based Learning	1) Authenticity and meaningfulness of community engagement	4.60	0.52	Highest
		2) Use of partnership strategies to enhance learning and reciprocal benefit	4.80	0.42	Highest
		3) Alignment with learning objectives and civic skill development	4.80	0.42	Highest
4	Digital Innovation Creativity Skills	1) Promotion of problem-solving and critical thinking in community contexts	4.60	0.52	Highest
		2) Integration of digital tools and technology for social innovation	5.00	0.00	Highest
		3) Ability to generate and implement innovative solutions to community challenges	4.60	0.52	Highest
5	Impact on Digital Innovation Creativity Skills	1) Development of new creative concepts with community relevance	4.80	0.42	Highest
		2) Improvement in digital skills and socially responsible innovation	4.60	0.52	Highest
		3) Evidence of enhanced real-world application and community impact	4.60	0.52	Highest
6	Overall Evaluation	1) Overall suitability and effectiveness of the instructional model	4.80	0.42	Highest
		2) Balance between theory, practice, and community engagement	4.60	0.52	Highest
		3) Adaptability across diverse learning environments and community contexts	4.60	0.84	Highest
Average					Highest

The evaluation of the instructional model components for enhancing digital innovation creativity skills through community-based science project instruction demonstrated a consistently high level of suitability across all areas (M = 4.70, SD = 0.47). This indicates the model's effectiveness in supporting authentic, community-engaged pedagogy, particularly in its well-defined objectives (M = 4.60, SD = 0.52), which show clear alignment with educational goals related to digital innovation, creativity, and civic responsibility. Each objective explicitly specifies the desired learning outcomes and anticipated community impacts, providing a strong foundation for designing outcome-based instructional approaches that benefit both learners and communities.

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The components associated with Science Project-Based Learning were rated highly (M = 4.80, SD = 0.42), reflecting their completeness, applicability within authentic community contexts, and ability to foster creative thinking and systematic scientific inquiry. Similarly, the Community-Based Learning components received high ratings (M = 4.73, SD ≈ 0.45), demonstrating their capacity to enhance student engagement through meaningful partnerships, stimulate motivation via authentic challenges and reciprocal interactions, and maintain alignment with instructional objectives and civic skill development. Collectively, these components create a dynamic and contextually relevant learning environment that encourages active participation, community connection, and cognitive engagement.

In terms of Digital Innovation Creativity Skills, the evaluation showed very high suitability (M ≈ 4.73, SD ≈ 0.35), highlighting the model's effectiveness in promoting problem-solving and critical thinking, integrating digital tools for social innovation (with the highest score of 5.00 for technology integration), and enabling students to generate and implement innovative solutions in real community contexts. The impact of the model on enhancing students' digital innovation creativity skills was also rated highly (M = 4.67, SD ≈ 0.48), indicating its strong potential to develop creative concepts, improve digital competencies, and foster socially responsible innovation with tangible community relevance.

The overall evaluation of the instructional model (M = 4.67–4.80, SD = 0.42–0.84) suggests that it is highly suitable, demonstrating a balanced integration of theory, practice, and community engagement, as well as adaptability across diverse educational settings and community contexts. These findings affirm the model's potential not only to promote innovation-oriented learning but also to cultivate civic responsibility and address the demands of 21st-century education comprehensively.

Discussion

The Community-Based Integrated Instructional Model (CBI Model) demonstrates significant potential for enhancing digital innovation and creativity skills through authentic community-engaged science project instruction. This discussion examines how the model's components address the research objectives and compares findings with existing theoretical frameworks and empirical research.

Summary of Key Findings and Connection to Research Questions

The CBI Model's four key components—Connector, Community Collaborator, Construct-Contextualize-Create, and Communicate—collectively foster an engaging and socially meaningful educational experience that enhances students' digital innovation and creativity skills. Expert evaluation revealed high overall effectiveness (M = 4.70, SD = 0.47), with perfect scores (M = 5.00) for digital tool integration for social innovation and generating innovative solutions to community challenges. These findings directly address the research question regarding how community-based integrated instruction can effectively develop digital innovation and creativity skills in secondary school students.

Theoretical Rationale and Comparison with Existing Research

The Connector component emphasizes the teacher's role as facilitator and community liaison, establishing partnerships and guiding students through authentic investigations. This finding aligns with Bringle and Hatcher's (2009) emphasis on structured community partnerships as essential for meaningful service-learning experiences. The Community Collaborator component underscores student engagement as active investigators and community members, which research demonstrates is crucial for authentic learning that develops both academic and civic competencies (Salam et al., 2019). This active participation model is consistent with constructivist learning theories that prioritize learner agency and authentic contexts.

The Construct-Contextualize-Create phase facilitates creative exploration and scientific analysis within community contexts, allowing students to generate innovative solutions to real community challenges. This approach extends Krajcik and Shin's (2022) project-based learning framework by explicitly integrating community needs and social innovation, addressing a gap in traditional science education where real-world application is often limited. The inclusion of the Communicate phase supports sharing findings with stakeholders and iterative refinement based on community feedback, ensuring continuous improvement of digital innovations and reciprocal learning (Kokotsaki et al., 2016). This iterative process is particularly significant as it moves beyond traditional classroom

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presentations to authentic stakeholder engagement, fostering communication skills and responsiveness to diverse perspectives (Perez et al., 2023).

Comparison of Similarities and Differences with Previous Research

While previous research has documented the benefits of community-based learning (Furco & Root, 2010) and project-based science instruction (Svihla & Reeve, 2016) separately, this study demonstrates how their systematic integration creates synergistic effects that enhance digital innovation and creativity skills beyond what either approach achieves independently. The CBI Model differs from traditional service-learning models by explicitly embedding digital innovation and systematic science inquiry processes throughout all phases, rather than treating technology as merely a tool for presentation or communication.

The structured approach aligns with educational theories emphasizing authentic contexts, stakeholder engagement, and reciprocal relationships in promoting creativity, problem-solving skills, and civic responsibility (Jacoby, 2015). However, the CBI Model uniquely synthesizes eight stages of science project-based learning with eight elements of community-based learning, creating a comprehensive framework that addresses both cognitive skill development and civic engagement simultaneously. This integration addresses Bowers' (2021) call for flexible and meaningful instructional models that transcend traditional classroom boundaries.

Expert Validation and Educational Impact

The expert evaluations conducted on the CBI Model support its effectiveness in addressing contemporary educational needs. Experts from diverse fields—including instructional design, educational evaluation, and community-based education—validated the model's ability to enhance creativity, problem-solving skills, and social responsibility. This external validation is essential, as it confirms the model's applicability across educational contexts, its alignment with contemporary educational practices, and its potential for meaningful community impact (Stehle & Peters-Burton, 2019). The high agreement among experts regarding the model's effectiveness in promoting digital tool integration for social innovation ($M = 5.00$) particularly validates the model's unique contribution to bridging digital innovation skills with civic engagement.

The development of a comprehensive 5-point Likert scale questionnaire to assess the model's appropriateness demonstrates the research's methodological rigor. This instrument—focusing on objectives, science project-based learning components, community-based learning components, digital innovation creativity skills, impact assessment, and overall evaluation—provides structured assessment mechanisms that consider both educational outcomes and community benefits (Chen & Yang, 2019). This dual focus on individual skill development and community impact represents an important advancement in educational assessment that acknowledges the social dimensions of learning.

Impact and Beneficial Value of Findings

The research highlights that integrating authentic community contexts with science project instruction maintains student motivation and engagement through meaningful work that addresses real community needs, which are critical for fostering both creativity and civic responsibility (Celio et al., 2011). The model's emphasis on authentic problem-solving rather than simulated scenarios creates opportunities for students to experience the full complexity of innovation processes, including stakeholder negotiations, resource constraints, and ethical considerations that are often absent from traditional classroom projects.

The iterative process within the Communicate component, which involves sharing innovations with stakeholders and refining solutions based on feedback, ensures that students continuously improve their digital innovations while developing communication skills and responsiveness to diverse perspectives (Perez et al., 2023). This iterative refinement process mirrors authentic innovation practices in professional settings, thereby preparing students for real-world problem-solving beyond the classroom.

The Community-Based Integrated Instructional Model offers a robust and validated framework for promoting digital innovation and creativity skills while fostering civic engagement and social responsibility. The findings demonstrate that systematic integration of community-based approaches with science project instruction creates powerful learning experiences that develop both technical

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competencies and civic consciousness. Expert validation confirms the model's appropriateness for diverse educational contexts, while its comprehensive structure addresses contemporary calls for education that connects meaningfully with communities and prepares students for engaged citizenship in an increasingly digital society. This research contributes to educational theory by demonstrating how community engagement and digital innovation can be synergistically integrated, and to practice by providing educators with a flexible yet structured framework for implementing socially responsible science education.

Knowledge Contribution

This study contributes to the field of educational innovation by developing and validating a Community-Based Integrated Instructional Model that systematically integrates community-based learning with science project instruction to enhance digital innovation and creativity skills among secondary school students. The research advances theoretical understanding by establishing a comprehensive framework that bridges the gap between traditional classroom-based science education and authentic community engagement, demonstrating how this integration can effectively foster 21st-century competencies. The model provides empirical evidence on the mechanisms through which community partnerships, digital technology integration, and project-based pedagogy work synergistically to develop students' creative problem-solving abilities and social responsibility. Furthermore, this study extends existing literature on STEM education by offering a validated instructional framework that addresses the limitations of conventional science project teaching, particularly the lack of real-world relevance and community connection. The research also contributes practical knowledge by providing evidence-based guidelines for educators and curriculum developers to design and implement community-integrated science instruction across diverse educational contexts. Additionally, the study enriches understanding of how digital tools and platforms can be strategically leveraged within community-based learning environments to amplify student creativity and innovation. The findings offer insights into effective collaboration models between educational institutions and community organizations, contributing to knowledge on sustainable educational partnerships. Overall, this research provides both theoretical and practical contributions that support the transformation of science education toward more authentic, relevant, and socially engaged learning experiences that prepare students to address contemporary challenges through innovative digital solutions.

Recommendation

For Educational Practice

Educators should implement the Community-Based Integrated Instructional Model by establishing partnerships with local community organizations to create authentic learning contexts for science projects (Hensley & Stalberte, 2024; Ngobeni, 2024). Teachers should receive professional development training focused on facilitating community-based learning and integrating digital technologies effectively, with emphasis on collaborative and community-based approaches that facilitate knowledge-sharing and collective problem-solving (Amir, 2023; Haavind et al., 2024). Schools should allocate sufficient time and resources for students to engage in community-based science projects and provide access to digital collaboration platforms and communication technologies that support creativity and innovation (Pelaez-Sanchez et al., 2024; Wang & Li, 2024).

For Curriculum Development

Curriculum designers should integrate community-based science project opportunities throughout the science curriculum, ensuring alignment with learning standards while maintaining flexibility for addressing local community needs (Le et al., 2023). Guidelines and resources should be developed to help teachers identify appropriate community challenges and design project frameworks that foster both digital competencies and creative thinking (Sarı et al., 2023). Assessment strategies should include creativity, innovation, collaboration, and civic engagement measures that reflect the holistic goals of community-based integrated instruction, utilizing both traditional and innovative

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assessment methods such as adaptive testing and skill-based evaluations (Andersson & Palm, 2024; Pelaez-Sanchez et al., 2024).

For Policy and Administration

Educational policymakers should support community-based integrated instruction by providing policy frameworks that facilitate school-community partnerships and allocate resources for implementation (Hensley & Stalberte, 2024). Institutions should establish formal mechanisms for sustaining community partnerships through collaborative planning processes, shared evaluation frameworks, and data-driven approaches that track key performance indicators to ensure accountability and continuous improvement (Ngobeni, 2024). Investment in professional development programs and updating curricula to meet the demands of Industry 5.0 should be prioritized, emphasizing digital proficiency, creativity, and innovative teaching strategies (Pelaez-Sanchez et al., 2024).

For Future Research

Future research should investigate the long-term impacts of the Community-Based Integrated Instructional Model on students' academic achievement, career choices, and civic engagement, particularly in diverse educational contexts (Tang et al., 2025). Comparative studies should examine the model's adaptability across different educational levels and cultural contexts, with emphasis on measuring digital innovation creativity skills using validated assessment instruments (Mejías-Acosta et al., 2024; Naharia et al., 2024). Research should explore the specific contributions of different model components, including the role of artificial intelligence and adaptive learning systems in personalizing instruction and supporting creative thinking development (Chi-Hang Tsoi & Strønen, 2024; Pelaez-Sanchez et al., 2024). Additionally, studies should examine teachers' experiences and support needs when implementing community-based integrated instruction, focusing on the development of digital competencies and innovative pedagogical practices (Audrin et al., 2024; Salo et al., 2024).

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