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STEM Collaborative Community Curriculum (STEMCCC): A Work in Progress Examining Teacher Co-Design in Community-Connected Middle Grades Engineering Work-in-Progress (WIP)

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Abstract

This Work-in-Progress (WIP) paper presents the STEM Collaborative Community Curriculum (STEMCCC) framework, a community-centered co-design model that positions teachers as curriculum authors alongside biomedical engineers and curriculum specialists. Grounded in collaborative design research and the theory of teacher professional learning, STEMCCC integrates locally relevant health challenges into middle-grade engineering modules. This paper introduces the framework and reports on an ongoing mixed-methods case study examining teacher experiences within the co-design process. Rather than evaluating student outcomes, this study investigates how structured collaboration shapes teachers' perceptions of curriculum relevance, pedagogical confidence, and the integration of engineering. Preliminary findings suggest that iterative co-design and shared authorship support professional agency and instructional coherence. Implications for community-connected engineering education and sustainable teacher-centered innovation are discussed.

Keywords

Engineering education; curriculum co-design; teacher agency; community-connected STEM; middle grades; work in progress

I. Introduction

Efforts to broaden participation in engineering increasingly emphasize meaningful, authentic learning experiences in the middle grades. During this developmental period, students are forming beliefs about their abilities, interests, and future career possibilities. Research indicates that early, hands-on engagement in engineering design can positively influence students' perceptions of competence and value in STEM [1]– [3]. However, curriculum reform efforts often focus primarily on instructional materials, paying less attention to how teachers are positioned within the design and implementation process.

In many PK–12 settings, STEM curriculum adoption follows a top-down pattern. Schools purchase externally developed materials, teachers receive limited training, and implementation expectations are established. While such models can provide structure, they may also limit teacher ownership and reduce responsiveness to local contexts [4],

[5]. Collaborative curriculum design offers an alternative, yet many implementations still treat teachers as adapters rather than co-authors [6]. This Work-in-Progress paper introduces the STEM Collaborative Community Curriculum (STEMCCC) framework and reports on an ongoing case study examining teacher experiences within this model. The focus is not on measuring student outcomes, but on understanding how structured co-design operates as both a curriculum development strategy and an embedded professional learning process in a community-connected pre-engineering learning initiative.

II. Conceptual Framing

STEMCCC draws from three complementary strands of research. First, scholarship on STEM identity highlights the importance of belonging, competence, and recognition in sustaining student engagement [1]– [3]. Learning experiences that connect to students' lives and communities are more likely to foster these dimensions [7]. Second, collaborative curriculum design research demonstrates that teachers who actively participate in curriculum authorship often report stronger pedagogical content knowledge and professional agency [4], [6]. Third, emerging work in engineering education underscores the value of integrating disciplinary rigor with local relevance [8], [9].

STEMCCC intentionally integrates these strands by positioning co-design as both an instructional and professional learning strategy. Rather than separating curriculum development from teacher growth, the framework treats them as interconnected processes supported through structured collaboration.

III. The STEMCCC Framework

The STEMCCC framework follows a four-phase iterative cycle: (1) Anchor and Define Outcomes aligned with community context priorities; (2) Co-Develop Curriculum through teacher–engineer collaboration; (3) Implement and Collect Data during pilot enactments; and (4) Reflect and Refine based on participant feedback. Each phase is designed to build upon the previous one, allowing ideas to evolve through dialogue and classroom experience.

In this implementation, the curriculum community context was on health issues identified as locally relevant for the citizens of San Antonio, Texas. The curriculum units to be co-developed were focused on obesity, diabetes, kidney disease, and cardiac disease.

Biomedical engineers contributed disciplinary expertise and real-world examples of engineered technologies to diagnose or support patients with the noted conditions. Teachers ensured alignment with knowledge and skills standards and instructional feasibility. Curriculum development specialists supported the coherence of the developed educational activities. This shared authorship model distinguishes STEMCCC from externally mandated curriculum adoption.

Table I. Conceptual Comparison of Curriculum Development Models

Feature	Top-Down Model	STEMCCC Model
Teacher Role	Implementer of externally developed curriculum	Co-designer and instructional decision-maker
Community Connection	Minimal or indirect	Anchored in locally identified community concern
Professional Learning	Workshop-based or episodic	Embedded within iterative co-design
Curriculum Adaptation	Limited modification	Continuous refinement through reflection cycles

IV. Research Questions

The research questions that guide this study are the following:

> RQ1: How do participating teachers perceive their experience with STEMCCC as a collaborative curriculum development model, particularly in terms of feeling included, contributing value, and supporting their own learning?
>
> RQ2: In what ways do participating teachers perceive curriculum relevance, pedagogical self-confidence, and engineering content integration when using the STEMCCC model?

V. Research Design and Methods

This mixed-methods case study included four middle school teachers, two biomedical engineers, and one curriculum specialist. Teachers volunteered to participate in a series of co-design workshops on Saturdays. Data sources included a background survey, a pilot exit survey, and a semi-structured focus group conducted after implementation. Qualitative data were analyzed using thematic analysis. Initial codes were informed by collaborative design literature and refined as patterns emerged. Two researchers independently reviewed coded data and reconciled discrepancies to strengthen trustworthiness. Survey responses were analyzed descriptively to identify patterns in teacher perceptions.

VI. Preliminary Findings

Consistent with RQ1, teachers described the co-design experience as meaningfully different from traditional professional development. Rather than receiving pre-packaged lessons, they helped shape the curriculum from the outset. Collaboration with biomedical engineers increased comfort with engineering concepts and supported clearer integration into science instruction [10].

Addressing RQ2, participants emphasized that grounding lessons in community health issues strengthened perceived relevance. Teachers observed students making personal connections to topics such as diabetes and cardiac disease, which teachers perceived as increasing engagement during design challenges. Further addressing RQ2, survey responses indicated that teachers felt better prepared to implement and adapt the curriculum independently [11].

Reflection sessions were consistently described as central to improvement [12]. Teachers valued the opportunity to refine lessons collaboratively based on classroom realities, reinforcing a sense of shared responsibility and instructional ownership.

VII. Discussion and Contribution

Although preliminary, these findings suggest that structured co-design frameworks can serve as both mechanisms for curriculum innovation and embedded professional learning environments [10]. By positioning teachers as co-authors [11], STEMCCC aligns with calls within engineering education to elevate teacher agency in engineering integration.

This study contributes to PK12 engineering education scholarship in three key ways. First, it offers a clearly articulated, process-oriented model for developing community-connected engineering curricula. Second, it reframes professional learning as embedded within curriculum authorship rather than separate training. Third, it provides early empirical insight into how teacher–engineer collaboration may strengthen instructional coherence in middle grades engineering.

VIII. Limitations and Future Work

Time constraints were a contributing factor to the program's limited scope. Mid-project loss of federal funding was another obstacle experienced during the implementation of the framework. This led to fewer participating teachers and engineering educators available to contribute. Findings reflect teachers' perceptions rather than direct measures of instructional change or student outcomes. Future phases will include expanded cohorts, classroom observations, and longitudinal analysis of curriculum sustainability and enactment.

IX. Conclusion

The STEMCCC framework offers a structured yet adaptable approach to community-connected pre-engineering curriculum co-development that centers teacher agency. Preliminary findings suggest that collaborative authorship and iterative refinement support meaningful professional growth. Continued research will examine scalability, sustainability, and longer-term instructional impact.

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