Board 25: Informing Replication of the Bowman Creek Educational Ecosystem Pilot

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A native of Puebla, Mexico, Juan-Carlos Alarcon developed his love for music while playing piano at an early age. All through middle school and high school he participated in many musical ensembles. His high school music activities included the Elkhart Central High School Men's choir, the Shades of Blue show choir, Concert choir and the Indiana All-State choir. Besides his involvement in music at his school, he worked with liturgical music. At the age of twelve he began work as a church accompanist, and by the age of sixteen he led the choir in Sunday worship services. His church service deepened his love and passion for the organ. He is a proud member of the St. Joseph Valley Chapter of the American Guild of Organists, and he serves as the technology coordinator for the chapter. His musical activities have taken him to New York to perform at Carnegie hall in 2016, where he sang in a choir presenting chosen works of the African Diaspora. He also traveled to Florida to play as part of the Grammy award winning CD "American Dreamers, voices of hope, music of freedom" by John Daversa. Juan-Carlos continually advocates for music education, STEAM education, the arts, and for education and inclusion for all. Because of his desire to further the arts, he is involved in leadership roles both in school and local musical organizations. His positions include membership in the Elkhart County Symphony board of directors and also serving as the librarian for the symphony. Other positions include the Presidency of the IU South Bend chapter of the National Association for Music Education, and the Presidency of the University Choral Union. He also worked as a counselor for the IU South Bend Chamber Orchestra Intensive. During the summer of 2018, Juan-Carlos worked developing STEM curriculum for the Bowman Creek Academy, a week-long STEM camp sponsored by Bowman Creek Educational Ecosystem and the University of Notre Dame.

Due to the success, delivery and execution of the camp, Juan-Carlos received the Bud Ahearn leadership award. The mentors who selected Juan-Carlos for the award describe him as, "A positive influence in our classrooms, his ability to collaborate with others as well as his initiative led him to be a top contender for this award. [He] has furthered our confidence that he has traits and characteristics that will carry him far in his professional career." Because of his love for singing, playing, and music education, Juan-Carlos studies Organ with Celia Weiss and Voice with Emanuel-Cristian Caraman. He is currently pursuing his Bachelor of Music Education with a concentration in general, choral, and instrumental music at IU South Bend and currently teaches STEM and Music at Pierre Moran Middle school and Roosevelt Elementary school.

Informing Replication of the Bowman Creek Educational Ecosystem Pilot

Abstract

The Bowman Creek Educational Ecosystem (BCE2) is a pilot project developing a model for building an educational ecosystem with a multiplicity of outcome aims – attracting and retaining underrepresented groups in engineering and science, building STEM literacy within the regional workforce, and improving the quality of life of low-income neighborhoods. Thus, BCE2 aims not just at improving practices in STEM for greater inclusion and skill development, but also increasing retention of recipients of training or programming in the geographic regions where these interventions occur and are often most needed [1]. To do this, partnerships in the BCE2 pilot include a diversity of higher education institutions, the K-12 system, local government, and community organizations. In its final year of research and refinement through an NSF Improving Undergraduate STEM Education grant, researchers have expanded educational programming and partnerships into another city in the region as a prelude to full replication. This paper discusses initial findings and challenges related replication of identified core elements in a reduced-scale trial.

Introduction

The United States is behind most other developed nations in Science, Technology, Engineering and Math (STEM) performance [1]. Regrettably for the United States, STEM-related jobs have been growing considerably faster than the general job growth rate [2], and these jobs tend to provide consistently higher wages than other segments of the employment sector. In our global economy, therefore, STEM-based employment is key to stabilizing and rebuilding our middle class. Nonetheless, many cities, particularly those in post-industrial regions, struggle to attract, develop, and *retain* a skilled workforce that would help to bring greater investment in their communities. It is a common challenge and can create a vicious cycle of lost assets that would normally help to build quality of life and vitality in a community. With the current emphasis on knowledge-based economies, there is a growing divide between those who can and cannot engage in it, both at the level of the person and the community.

The Bowman Creek Educational Ecosystem (BCE2) in South Bend, Indiana, now in its sixth year, was, in part, a response to this need. Led by the College of Engineering at the University of Notre Dame, it draws on key principles from engaged learning and innovation ecosystem environments [2-5] and applies parts of the persistence framework [6] by providing opportunities for early research and active learning in the community. It has served as a pilot for the development of a generalizable model for building an educational ecosystem with a multiplicity of outcome aims – attracting and retaining underrepresented groups in engineering and science, building STEM literacy within the regional workforce, and improving the quality of life of low-

income neighborhoods – with initial success across these concerns. To meet these aims, partnerships in the BCE2 pilot have included a diversity of higher education institutions, the K-12 system, local government, and community organizations. Partnerships have been enthusiastic, at least in part because of the commitment to not only improving practices in STEM for greater inclusion and skill development, but also increasing retention of recipients of training or programming in the geographic regions where these interventions occur and are often most needed [7].

Prior to a full replication, partners and researchers were interested in an exploratory trial applying the model in a new context, as well as the analysis from a developmental evaluation to inform larger investments and scaling. As such, we used a reduced-scale replication for initial feedback. Given the complexity of the translation and the number of constraints, information gained from this exploration is conditional, with continued dialogue and sense-making with community and institutional partners regarding amendments over time.

The model, now referred to as the Community-Engaged Educational Ecosystem Model (C-EEEM, pronounced 'seam'), has been refined from the original design into core elements and critical factors using data collected through survey, interview, reflection, and observation from students, community partners, or program managers. In its final year of an initial NSF Improving Undergraduate STEM Education grant, researchers are bringing the C-EEEM into another city in the region as a prelude to scaled replication. Although researchers are interested in applying lessons from the BCE2 pilot, an intent of the preliminary replication is to explore other collaborative and leadership arrangements and the accompanying differences in the student cohorts, community projects, and observed outcomes. As a cross-sectoral collaboration, governance structures for replications may need to vary based on available resources of the organizational partners [8] as the model is moved into new contexts.

The Original Model and the Elkhart Catalyst

A core strategy embedded in the C-EEEM is the idea of *community capacity.* This concept is not new, as it is foundational to asset-based community development. Both capacity building and leveraging of resources in C-EEEM, however, is embedded into the design of educational programming and occurs across sectors, including educational institutions, local government, and neighborhood and city nonprofits. Because the C-EEEM builds bonds of trust and reciprocity through authentic community contribution, the development of collaborations and capacities within and with the low-income neighborhoods becomes a positive reinforcing loop. It builds trust and reciprocity between stakeholders, inspiring civic engagement beyond the investment of the students. Such approaches that focus on bridging divides and bringing greater opportunities to regions that struggle to attract and retain a skilled workforce promise a way forward.

Core elements from the original BCE2 site

In the distillation of the C-EEEM from the original BCE2 [7, 9], three core elements emerged: *multi-scale collaborative infrastructure, student learning for STEM and social responsibility, and neighborhood asset-based community development.* Each of these elements had supporting critical factors underlying them in the original site. The generalized model on the pilot, however, does not provide indications of the degree to which different factors matter and in what combinations.

Multi-scale collaborative infrastructure describes an underlying facilitative framework at different levels and spheres – public and academic – necessary to ensure the sustainability of the work. Critical factors underlying this core element, such as a network of volunteer STEM professional-mentors, include informal and formal partnerships and processes that support the continuity of project development and implementation, as well as assurances of community collaboration. *Student learning for STEM and social responsibility,* as a core element, refers to the learning outcomes of the curriculum. Students receive modules not only in STEM, but also in leadership and social responsibility. The emphasis on skillset and dispositional development inside of structural networks for community change distinguish C-EEEM from many other approaches. The cultural learning aspects of the ecosystem extend the concept of diversity across many domains (age, race, gender, education, and socio-economic status) through multidimensionally diverse teams. The underlying design for this core element leans heavily on characteristics that also support an innovative environment, which is generally characterized by a collaborative, social, open, contextual, and tangible culture of learning. Project teams and cultural norms are developed with this in mind, while community projects take into account not just STEM and workforce skills, but also building community commitment and place attachment. The third core element of the C-EEEM, *neighborhood asset-based community development,* is grounded in the idea that neighborhoods and their residents have a multitude of resources to improve quality of life beyond the typical focus on financial investments. This approach to community outcomes builds community engagement as well, especially when there is a tangible project planned in the natural or built environment of the neighborhood.

The BCE2 pilot programming included exposure to training, community projects, and weekly seminars highlighting STEM fields. This approach of engagement, awareness building, collaboration and authentic problem-solving contributed to student formation as future professionals and community residents. Again, findings from qualitative and quantitative methods (reflections, interviews, ethnographic observations, surveys) on progress in attraction and retention to disciplinary interests, particularly along the dimension of identity, as well as *feeling connection to the region* [7]. This was a critical finding.

About the exploratory trial

As noted, prior to a full replication, partners and researchers were interested in an exploratory trial applying the C-EEEM in a new context, as well as the analysis from a developmental evaluation to inform larger investments and scaling. As such, we used a reduced-scale replication for initial feedback. Given the complexity of the translation and the number of constraints, information gained from this exploration is conditional, with continued dialogue and sense-making with community and institutional partners regarding amendments over time.

Selection of site, recruitment and selection of students

The selection of the City of Elkhart for an initial reduced-scale exploratory replication site was based on both context and opportunity. Researchers had an interest in being in the same state and region, ensuring a common technical college system and workforce development institutions. With the shift in community context, partners, and a myriad of other factors, the idea was that keeping regional context constant would increase the likelihood that variance in outcomes related to institutional partners and regional cultural elements would be minimized. The choice was also opportunistic; because the cities are in the same region, stakeholders from the neighboring city had heard about the BCE2 project in South Bend and were interested in exploring a similar effort in their community. At its launch, the primary partner for the exploratory trial, named the Elkhart Catalyst, was the Elkhart Community School System.

With Elkhart Catalyst firmly anchored to the local high school, it would not only have different initial stakeholder dynamics than the BCE2, but also a different learning environment because of the younger average age. Recruitment for year one occurred primarily through the local high school, although there were unsuccessful recruitment efforts made at the local technical college as well. A key barrier to recruitment with this audience was the part-time status of most of the students; many already had full-time employment to pay for school, so an internship was not a possibility. Aside from the historic partner colleges in the region for BCE2, nearby Goshen College was targeted for recruitment as well.

Although the initial cohort of interns would be quite small, for those that would come from the local high school, the administration still sought diversity in the composition of the team. Teachers nominated potential interns, and screening occurred through an application and interview process. Selection was based on trying to honor the C-EEEM principle of multidisciplinary diversity within the small cross-section. Two seniors, a junior, and a sophomore from the high school were selected, including one female and one person belonging to an underrepresented minority group in STEM. Academically, the cohort ranged from high-achieving to learning challenges. One student from the University of Notre Dame was also part of the cohort for this exploratory trial, for a total of five interns and one Teacher-Mentor at the site.

Modifications to delivery of the model

In the development of the new educational ecosystem Elkhart Catalyst, program designers and researchers ensured attention to the core elements – *multi-scale collaborative infrastructure, student learning for STEM and social responsibility, and neighborhood asset-based community development*. A logic model was developed to frame the different outcome aims (see Figure 1). As a nascent effort, however, the collaborative infrastructure for the first year was rudimentary, and the effects of the amended demographics and curriculum was yet untested. Community partners in the effort were grounded less in the neighborhood and more in the city planning department. The curriculum was reduced-scale, although students were still exposed to:

- BCe2 Orientation Week at parent site;
- Community Engagement Workshop (Stakeholder Roundtable) and Outreach Training;
- Service-oriented Leadership Module 1 & 2 and Diversity Module;
- GIS Training and Arduino Training 1 & 2;
- Project Management Module; and
- Design-thinking workshop

From an asset-based community development lens, the first year was primarily spent collecting information on what is likely to be the focus neighborhoods.

INPUTS	ACTIVITIES and OUTPUTS	OUTCOMES	IMPACT
Investments	**Activities and participation**	**What happens as it is working**	**Where we expect it leads**
Teacher(s) from Elkhart Community Schools. **Elkhart Catalyst (Community-Engaged Educational Ecosystem) faculty and staff.** **# of students for project planning and implementation** **Local professionals** **Elkhart enFocus** **Horizon Education Alliance** **Funding Support** ▪ **Community foundation** ▪ **WorkOne**	**C-EEEM Curriculum delivery (Pilot Year and continuing):** 1. **Leadership Development** 2. **Project Management** 3. **Experiential Pedagogy (for teachers)** **Network development – professionals and teachers; project/curriculum development by Teacher-Mentor(s) with C-EEEM for academic year (Year two and continuing):** ***[Measurement for some of these is binary, e.g. the curriculum developed and delivered as planned Y/N; for network development, is the number of those engaged growing and is the tenure for participation increasing?]***	**Teacher-Mentor** **Increased enthusiasm/skills for engaging students in authentic, experiential project-based learning (Pilot Year)** ***[Measurement: observation and interview]*** **Active engagement in network (Pilot Year and continuing)** ***[Measurement: observation and interview]*** **Students** **Increased attraction to: STEM career options, Elkhart region as a place to live, and civic engagement; increased self-efficacy in STEM activities; project management skills** ***[Measurement: observation; survey and interview data of students]*** **Community** **Projects to address housing planned and data collected. (Pilot Year)** ***[Measurement: binary – did planning and project data collection happen? Y/N]*** **Professional Mentor networks for Elkhart Catalyst developing and strengthened (Pilot Year and continuing)** ***[Measurement: continued participation in Elkhart Catalyst]***	**Sustained Teacher-Mentor Community of Practice for continuous improvement in engaged pedagogy for STEM (Long term)** *[Measurement: observation and data on participation – numbers, tenure, attrition]* **Elkhart Catalyst institutional and mentor network infrastructure in place** *[Measurement: full participation of critical institution partners; continued participation; quality and degree of participation (formal commitments, etc.)]* **Community Vitality - Improvement along project-related domains** [Measurement long term: e.g. housing condition data on neighborhoods; increased housing condition, housing value, safety; etc.] **STEM Career Building and Civic Leadership Regionally** *[Measurement long term – if we are able to follow alumni over time, we can follow where they are at specific ages – education, career, location]*

Figure 1 Logic Model

Delivery was amended based on contextual differences. Because the Elkhart Catalyst is dominated by high school students rather than college-aged students, program designers modified the typical delivery of the C-EEEM. Based on experiences with high school interns in the BCE2, program designers shortened the length of the day to half of what is expected for college-aged students. Also, as a trial, the internship itself lasted half as long as the BCE2 internships. The environment that the students worked in for Elkhart Catalyst was quite different from the parent site of BCE2. The latter uses a repurposed warehouse that also serves as an arts and artisan food incubator. In its first year, the Elkhart Catalyst was located in a donated space of an office building. The culture of the learning environment, therefore, may be influenced by proximate businesses.

Findings from the field

Developmental assessment regarding this first replication site was collected in partnership with Horizon Educational Alliance, which is a local nonprofit focused on cradle-to-career educational development in Elkhart County, Indiana. Given that the number of students in the new site was quite small and that multiple factors were changing concurrently, stakeholders agreed that targeted qualitative data would be most useful to iterative improvement.

C-EEEM researchers and program designers framed the areas of interest for the information to be collected and verified by Horizon, with allowances for emergent themes from interviews. The intention was to unbiasedly collect perspectives from interns and the Teacher-Mentor that address questions of interest for C-EEEM development generally and the Elkhart Catalyst specifically. In this first year, with substantial changes to the demographics of the cohort and the delivery of the programming, *the emphasis was on the student learning and experiences*. Findings were based on short reflections, a post-program, semi-structured interview with each participant, and observations of one class session and the final presentation.

Summary information

Based on a review of findings against the specified logic model, Horizon staff found that program outcomes were met. In addition, interview and observational information provided rich information regarding program improvement. This information highlights a number of challenges and differences to consider as the effort moves forward.

Overall, there was general consistency across the cohort regarding several elements of this initial year. First, all agreed that program participation was a beneficial and positive experience and that the relationship developed with the City of Elkhart was an important part of the learning experience. The cohort also agreed that including students in Elkhart Catalyst that came from the focus neighborhood(s) was important to the success of the data project as well as to the learning outcomes. Nonetheless, the degree of academic diversity, at least in a small cohort, was both a

challenge and an attribute. An additional challenge was that interns had some frustration with the lack of tangible projects in the community in the first year.

Although any particular improvements suggested were not necessarily mentioned by everyone in the cohort, there were a number recommendations for training and program modifications. First, the number of participants was deemed too small and should be expanded, at minimum, with additional college students. Interns identified the need for continuing to develop projects throughout the year so that the process keeps momentum. For training, interns needed an expanded diversity module, more guidance regarding community engagement, and greater access to professionals with particular expertise for the project(s). Finally, for a cohort that has a dominance of high school students rather than college, there was a need for additional challenge through outside readings.

The experience yielded a broad range of learning outcomes identified by student interns. Interns identified skill and knowledge gains, including project management, Geographic Information Systems (GIS) data collection, and an increased understanding of how local government works. Beyond that, there were shifts in disposition and cultural competency. For those interns that did not self-identify as a leader initially, there was a substantial shift in self-efficacy and an awareness of their ability to be agents of change in their community. Conversely, interns from more advantaged backgrounds articulated a greater awareness of the different experiences that others have within their community and a deeper understanding of challenges that come with those experiences.

Discussion

The Elkhart Catalyst exploratory trial of a replication of BCE2 was both motivating and challenging. The C-EEEM, as a distillation of BCE2, also seeks to weave a culture of STEM learning and community contribution into the fabric of the regions in which it is replicated whilst building a sense of community and a regional workforce. Key to this aim are engagement, cooperation, collaboration, and bringing a sense of connectedness and fun to experiential learning. These qualities are difficult to capture in assessment information, but qualitative data can provide context and insights into the culture of the learning environment, and other socially constructed concerns. Researchers recognize that information collected on this preliminary replication is contingent information and will use it toward progressive movement toward the larger goal and continuous learning at the new site.

Funded through the local community foundation, the center of gravity for this effort moved away from higher educational institutions and toward the high school level; this itself presents both challenges and opportunities. The opportunity to explore the model in a setting not dominated by a research university and led by a school district is enormous. Although still a cross-sectoral collaboration and with positive response, the manifestation in the first year of this educational

ecosystem was quite different than the parent site, even in its first years. This is certainly influenced by a myriad of factors: type of partner(s), cultural differences in the community, contextual differences of the site, demographics of the students, length of internship, length of the day, amongst others. This has raised a number of questions, including that of an effective balance of college and high school aged students, which had been estimated heretofore. Based on feedback and evaluation, the balance needs to turn somewhat back toward higher education. Recruitment in a city without a similar anchor institution may prove difficult. Program designers intended to lean more heavily on the local technical college for higher education participation, but barriers related to student constraints prevented this in the initial year. Discussions regarding mitigating some of the barriers have already begun, but it may require long-term solutions such as credit bearing internships.

Despite it being the pilot year, interns found the experience educational and valuable; nonetheless there were definite places for improvement. All of the students noted that they benefited from the project management skill development, including learning how to plan and manage work, coordinating with others, managing time, and learning how to overcome challenges. Similarly, they all noted that it was beneficial to learn GIS skills, particularly for the project that they worked on. There were also heartening dispositional outcomes from the interns at all levels of academic achievement. Students all appreciated the different types of contributions that each other student could bring. Moreover, the students from a higher socioeconomic status had their "eyes opened" to challenges of other families in their community, and students that were not previously engaged or self-described leaders indicated a change in their ability to offer something to their community. On the other side, many felt that the time was insufficient to do a complete project and the program length either needed to be extended or there needed to be more groundwork done ahead of time.

One difference from the original site that was confounding was the lack of indication from the intern interviews of a shift in place-attachment. As a finding from the original C-EEEM at BCE2 [7], researchers consider it an important outcome in the C-EEEM's role in regional place-based workforce development. Reasons for the silence regarding connection to the local city are not something that can be pinpointed. Nonetheless, there are distinct differences that could be contributing factors: 1) age/maturity of participants; 2) length of time of the internship; 3) sense of camaraderie in the co-learning environment; 4) engaging culture at the site; 5) sufficient contact with community members during the internship; or something not yet considered. As noted, the space itself at the BCE2 parent site is a creative and engaging environment. There are many factors to consider over the next few years at the new site, the space may be an early consideration.

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