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Scenario specification structuring effective collaborative communication

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ABSTRACT

The support from the Howmet Aerospace Foundation Grant No. 223990 led to the development of digital resources for hands-on STEM that would be useful for student learning in an online world, compiled as "Tools for Teachers a STEM for Success Guide".
100 teachers and over 500 students from 20 schools participated in the project. This article describes the project activities, results and lessons learned that allowed them to pivot from a face-to-face model to an online model as well as the benefits that a co-design strategy brings to broaden participation and inclusion in multi-stakeholder collaborative projects.

Keywords: Scenario, Collaboration, Effective Communication, STEM, Online Education, Tools.

1. INTRODUCTION

Due to the pandemic, educators and parents face the need for tools that support effective online education, especially in Science, Technology, Engineering, and Math (STEM). Facilitating, organizing, and engaging in STEM activities is challenging especially remotely. To assist STEM learning, a system for sharing and supporting essential practices was identified as a need for educators in New Jersey. The authors received a grant to create professional development materials for K-12 educational professionals. To do this, the authors co-designed an open-source, freely distributed guide to aid anyone interested in working to provide STEM instruction and activities for students, including parents, educators, and other stakeholders. This guide provides a framework of the considerations from Crisis Management, through approaches to modes of online instruction, to implementation, whether in the classroom, at home, or in another setting. It also provides instruction specific to the basics of effective communication, facilitation, and organization in remote and digital learning situations for hands-on STEM.
During this project, the researchers identified several disconnects between planned outcomes and stakeholder views, needs, and levels of preparedness. This led to the use of methods of qualitative research to inform, adjust, and optimize the process of resource development. This article examines the vital role scenario alignment plays in Instructional Design during the shift to online and remote instruction during the COVID-19 crisis as revealed in the creation of the "Tools for Teachers guidebook" (Lipuma et al., 2021). As of May 2022 individuals in 16 countries have downloaded the document[1].

2. AIM

This article presents the original charge of the funded project, the activities that were undertaken, and the resulting resources for digital instructional support developed. After that, it discusses the process of co-design and scenario alignment that allowed for the production of the resulting materials and insights gained by collaborative communication to develop a shared vision of the refined scenario of the strategic planning and Curriculum and Instructional Design (CID) processes. Finally, the work concludes with implications of this work for Trans-Disciplinary Communication (TDC).

3. THEORETICAL FRAMEWORK

The following literature serves as the foundation for the theoretical framework applied herein toward professional development for CID in online environments.
"*A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives*" (Anderson et al., 2001)
"*Converged Learning: The Spectrum of Technology-Mediated Learning*" (Lipuma & Yáñez León, 2021b).
"*Enhancing teaching through constructive alignment*" (Biggs, 1996).
"*The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation*" (Frey, 2018).
"*Trans-Disciplinary Communication*" (Callaos, 2022).
The authors have performed and identified various systematic literature reviews on education, collaboration, and communication (Chermack et al., 2001; Clarke & Crane, 2018; Klein, 2008; Lipuma & Leon, 2022; Lipuma & Yáñez León, 2022; Yáñez León & Lipuma, 2021). The intention behind these reviews was to identify a new space in which the co-design approach facilitates conversations to move beyond the application of external treatments.

[1] https://dashboard.bepress.com/may2022dashboard

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3.1 Basic definitions and implications

Constructive Alignment (CA): "It is the idea that the content, Pedagogical Content Knowledge (PCK), methods of instruction and delivery, as well as assessments must all connect and reinforce one another. The CA provides a clear plan and a coherent path for learning aligned with the PCK. Additionally, the concepts being taught are reinforced for learners. Finally, it provides a picture of prior and future knowledge" (Biggs, 1996; Shulman, 2004).

Curriculum-Based Assessment (CBA): The CBA is an evaluation process that makes use of academic content selected directly from the material taught. "The assessment measures created are aligned with the content and so "CBA can be a highly useful tool in student evaluation and instructional decisions within a problem-solving framework" (Frey, 2018, p. 447).

Curriculum and Instructional Design (CID): encompasses the range of areas that deal with the organization of content to be taught along with the structure of methods and supports to accomplish that teaching. The curriculum describes those activities at a larger scope while instructional design deals with the planning and execution closer to the interaction with learners.

Information and Communication Technology (ICT): ICT has risen in America in recent years. "The convergence of telecommunication and computer technology has given rise to what, at least within Europe, is generally called information and communication technology or ICT. The emergence of ICT has radically altered a number of aspects of both the way we live and the way we work" (Bouwman et al., 2005, p. 3).

Professional Development (PD) of Teachers: The effective PD of teachers deepens content knowledge, transforms teaching practices, and fosters individual and group learning. "There are several key factors to consider in designing PD programs for teachers. PD is most effective when teachers are treated as professionals and active learners who construct their own understanding and the development programs are situated in classroom practice" (Frey, 2018, p. 1306).

Scenario: The authors are defining the concept of the scenario to include three categories: your goal, the target audience, and the situation in which the interaction occurs. Each of these components contains other elements to be considered (see table 1).

Scenario Planning: Scenario planning has been defined in several ways. Michael Porter (1985) defined scenarios as "an internally consistent view of what the future might turn out to be—not a forecast, but one possible future outcome". Schwartz (1991) defined scenarios as "a tool for ordering one's perceptions about alternative future environments in which one's decisions might be played out". Ringland (1998) defined scenario planning as "'that part of strategic planning which relates to the tools and technologies for managing the uncertainties of the future". Schoemaker (1995) offers "a disciplined methodology for imagining possible futures in which organizational decisions may be played out" as a definition for scenario planning" (Chermack et al., 2001, p. 8).

Trans-Disciplinary Communication (TDC): The TDC is fundamental in creating a shared vision. "Trans-disciplinary communication would mean to communicate 1) "across, ―through disciplines and/or 2) ―beyond, ―on the other side‖ of, disciplines, i.e. ―to go beyond disciplines" (Callaos, 2022, p. 4). Creating this common lexicon of terms as a foundation for the work is important in any co-design or multi-disciplinary project. The researchers worked with a wide range of professionals from a variety of contexts and circumstances with different goals and potential target audiences. Structuring this foundation provides a starting point from which new ideas, concepts, and shared visions for common communication can be developed (see figure 1).

The Collaborative Convergence Pyramid (CCP): "A framework to facilitate Sustainable Solutions and improve the trans-disciplinary communication between stakeholders both internally and externally and also amongst the four sectors: Academy, Government, Organizations, and Society. This current description is a representation of trans-disciplinary work because its focus is innovation. When applied to social innovation the goal is to work collaboratively to create a new space by creating a common focus" (Lipuma & Yáñez León, 2022, p. 381).

To better understand the need for scenario alignment and how our co-design was applied, some details of the project are presented.

4. RESEARCH METHODOLOGY

The goal of the Tools for Teachers project was to assist educators to find a secure foothold during a crisis and identify effective paths forward for implementing online instruction.

The key activities proposed were recruitment and surveying of educators (Yáñez León, 2021) to ascertain their needs to teach STEM successfully in the online environment and produce the appropriate protocols to review the existing literature (Yañez Leon, 2022), materials and supports to aid them. Responding to the pandemic circumstances, led to the need for some small adjustments to the planned activities and timelines.

Table 1.- Dimensions of scenario

Goal	Target	Situation
Objectives, Outcomes, Deliverables	Audience analysis, Prior Knowledge, Metrics	Conditions, Context, Circumstance

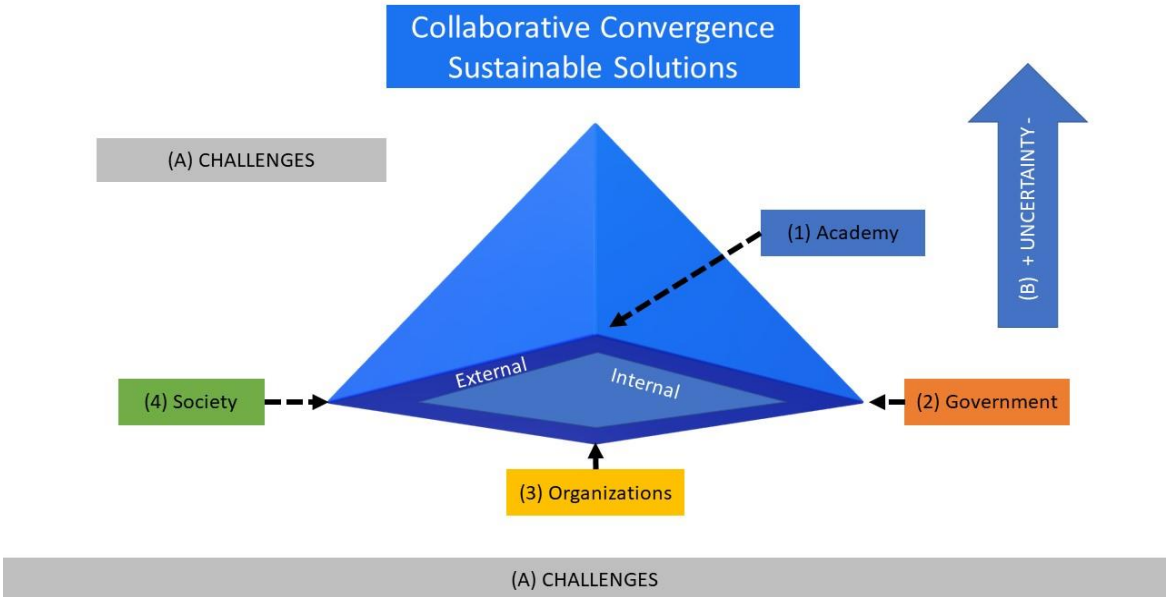

Figure 1.- CCP framework.

We developed a course with five modules using the Canvas Learning Management System (LMS)2 to test and refine the content and materials in conjunction with groups of K-12 educators. Then focus groups and workgroups provided feedback to refine the modules and increase their usefulness. This resulted in the building of the STEMforSuccess.org website3. In conjunction with this development work, we engaged in activities tied to STEM Month 2021, including virtual live-stream events and video demonstrations through the Collaborative for Leadership Education and Assessment Research (CLEAR) YouTube channel4. Finally, the project aimed to compile the results of all the efforts and disseminate them.

4.1 Resulting activities from the project

Long Branch didactic sequence: From our initial work with the Long Branch district, they asked for specific assistance in developing a didactic sequence about common sense media materials. During three online sessions, the authors worked with thirty-seven teachers in a collaborative co-design approach.

This collaborative team develop a HyFlex didactic sequence and compiled a shared database of resources and tools for online education. A set of pressing questions and practical issues were also collected and discussed amongst the stakeholders.

Other districts posed similar questions about their own content needs and challenges, and we worked with them to co-design solutions and increase the resources and tools database. Links to all these resources are provided in the Tools for Teachers guide linked on the main STEM for Success page (see references 5 and 6).

Tools for Teachers guide: In light of the crisis, the authors secured funding from the Howmet Aerospace Foundation to develop the “"Tools for Teachers' digital professional development” (Lipuma et al., 2021). The CID process was undertaken and yielded a basic design for course materials. However, as the development phase progressed into pilot testing, it quickly became clear that the crisis was significantly different from other professional development scenarios. To more effectively learn what would be most effective for the target group, the authors applied basic strategic planning to the CID scenario planning. This required an explicit statement of the elements of the scenario to facilitate the co-design process and open collaborative communication.

That moves from the statement of the author's goal to the creation of a shared vision that resulted in the guide (Lipuma et al., 2021).

5. DESCRIBING CO-DESIGN

When considering how effectively to adjust plans to meet the needs of a target population to attain CA, CBA will help align the curriculum as you perform your CID. Within CID, the process begins with assessing needs and determining the existing best practices for both the content area and methods of instruction. However, when working with ICT, especially in remote and online instruction, there is an added layer of complexity. Designing instruction outside of the scenario in which it will be used can pose issues and require more planning and result in a need for training. This situation is made more difficult when the professionals to be developed themselves will need to face a complex scenario in which their students may lack access to materials, technology, and requisite knowledge to apply the methods and materials being prepared.

In this context, the researchers of Tools for Teachers recognized the need to develop customized resources rather than universally applicable treatments. Thus, the educational stakeholders joined the development process of CID so it could be co-designed.

[2] https://canvas.njit.edu/

[3] https://www.stemforsuccess.org/

[4] https://www.youtube.com/c/STEMforSuccess

"The core activities of co-design are based on the premise of collaboration and the development of creative social environments, where the increasing demands on participation (Smith et al. 2017; Jenkins 2006) can be channeled (Calvo & Sclater 2020). Yet achieving collaboration in co-design is not easy as people need to understand each other, and develop rapport and trust" (Calvo & Sclater, 2021).

5.1 The need for Co-design

During the preplanning of the work and securing of funding, the researchers envisioned a diverse group of students and educators facing a common set of challenges that had familiarity with teaching STEM and using videos in their practice. The main issues planned for related to the basic need to introduce a range of online instructional situations. Other considerations dealt with the diverse methods of instruction and the collection of tools useful for attaining the goals of the participants for the identified CID. However, when engaging with the population of educators and administrators, the vast heterogeneity of the group and the situations they faced demonstrated a need to adjust plans. This was the impetus for the adoption of the co-design to allow all the participants across schools and districts to share, learn from one another, and find supporting voices that shared the vision of the needs and potentials of online learning and support.

Rather than focusing on defining the initiative, the effort was focused on the co-design of the elements through collaboration with the actors who had an agency at the point of contact in the given scenario. In the official report to the NSF we discussed:

"It is important to be intentional and persistent in fostering a sense of partnership with all stakeholders…. While teachers applauded many aspects of the project's PD, they most appreciated the opportunity to bond with other teachers. Generally, teachers have few opportunities to interact and discuss ideas and plans with teachers at other schools and even within their schools. Thus, the more time that PD provides for educators to discuss activities, desired supplies and to collaborate" (Bukiet et al., 2017).

5.2 Process of Co-design

The Collaborative for Leadership, Education, and Assessment Research (CLEAR) closely collaborates with many K-12 stakeholders and co-designs its activities with educators and administrators. It also engages in activities with a variety of networks and communities. CLEAR "Envisions a world where everyone can research and innovate to solve our problems effectively. We utilize a collaborative K-20 multi-stakeholder approach to support effective education and collaborative leadership to increase the participation and engagement of traditionally underrepresented groups" (CLEAR, 2021). The CLEAR team's active participation as key members of communities of practice in STEM education, either on advisory boards or as a backbone organization results in other organizations seeking collaboration with CLEAR as a reliable partner.

For the development of the didactic sequence with the Long Branch district we implemented the first 4 steps of the CCP framework:

1.- Pre-Planning
2.- Strategic planning
3.- Identification of models for collaboration
4.- Evaluation and Assessment metrics for collaboration

This led to a series of meetings and online workshops with all stakeholders to identify resources, activities, learning outcomes, and outputs as well as to better define the intended impacts. Through the collaborative nature of the meetings, the diversity of its participants, and the shared vision, an effective vertical and horizontal articulation of the learning objectives were achieved. This facilitated the creation of a "HyFlex didactic sequence" that could be utilized for: face-to-face synchronous, online synchronous, and a-synchronous instruction, across all teachers of the district. The input of stakeholders was instrumental in the design of the learning objects and videos as well as the monthly STEM Hands-on live streams.

6. DISCUSSION AND IMPLICATIONS

Recognizing the need for effective communication as part of collaboration in co-design led the researchers to examine the elements of scenarios in that context. They adopted the perspective of the sender in a basic communication model. As partners are sought and brought together to work collaboratively, these partners become the target audience or receiver. These receivers then define the other elements to be investigated. Knowing the goal and targets allows for preplanning to create a common space for collaboration leading to the common planning and arrangement of the situation in which this will happen. The situation is often envisioned as the physical location and medium at the moment of the collaboration but it also involves planning and participation by everyone involved since co-design promotes engagement and partnership. As these planned actions lead to communication and negotiation of understandings to form consensus, context and circumstance become a significant set of factors to consider. Working to align scenarios for collaborators from a range of disciplines requires more than translation between or among multiple perspectives. Depending on the scope and scale of the collaboration, the involved parties will find the need to move to an interdisciplinary area as the work transcends any one or even a collection of disciplines.

6.1 Aligning scenarios to foster collaborative communication in co-design.

If conceived of simplistically, the communicator, plans to send out a message to attain the goal to a target using a medium hoped to be effective. The situation is the way the message is received through the given medium and then processed and acted upon by the receiver. However, real-world situations lead to complex scenarios with dynamic context, and circumstance as the process continually evolves. As a result, trans-disciplinary projects (TDP) considering co-design or collaborative communication on a large scale should work to make explicit the elements of the scenario

envisioned by the participants and or co-designers. Then as participants are invited to become collaborators and partners, mechanisms for considering their perspectives on the emerging shared scenario must be utilized. In this way, as the scenario changes, collaborative trans-disciplinary communication (TDC) works to innovate to meet challenges that arise over time.

6.2 Shared vision from co-design

The first step of the revised planning process for CID was to recruit educators and survey them about their online learning environment needs. We learned from the surveys that the teachers did not think that the development of the LMS would be worthwhile. When speaking with educators, science and math coordinators, principals, and superintendents, they all expressed the feeling of being overwhelmed and disconnected. As the pandemic wore on and everyone continued to be remote, all our participants felt more virtual time at a conference would not be well spent. There was no possibility of a face-to-face meeting. The vast majority of teachers did NOT want an online course structure, and the use of discussion boards would be minimal.

This led us to shift to focus groups and working groups across the participating districts at all K-12 levels to allow the voices of the front-line workers to become prominent as they communicated about individual experiences. From this, shared circumstances became clearer, and a means of support and communication helped build a shared voice, and vision for what could be helpful more broadly. This led to a new plan of what to create the support they needed.

Approximately a dozen focus group and working group meetings were held from January through April 2021. By the end, we had met with over 100 educators and administrators from all levels of the K-12 system. Moreover, different groups from this cohort expressed the need for supplies and other supports beyond payment for time. We allowed each set of district personnel to customize the compensation and materials to best match their specific scenario and that they felt would be of most use. We provided support to all participants as best we could and sought to extend our reach by delivering STEM resource kits of physical materials (whose contents were determined through an earlier co-design process), supplemented with video programming through live streams and our YouTube channel.

The work adapted the initial plan to the educators' identified needs and preferences and led to the development of virtual live-streamed events for teachers and students to watch, as well as video and electronic documents (activity plans, journal articles, etc.) for STEM Month and continuing STEM education.

For New Jersey STEM Month 2021, our undergraduate role models and high school interns produced a set of videos highlighting the work of female STEM professionals. From November through June, we held 10 Livestream events and our video for the NSF-run STEM for All video showcase was presented. As a result of the monthly streams and our special events, educators requested we develop an Earth Day special event. The results of the efforts were compiled for dissemination through our Tools for Teachers guide, which can be found on our website www.STEMforsuccess.org. Other products of the work are available on our STEM for Success YouTube channel and through the NJIT STEM for Success Digital Commons repository.

In the end, we were able to provide support for K-12 educators, students, and their families as well as those working to provide them with STEM education experiences in the remote virtual mode. This work positively affected the NJIT undergraduate role models, our high school STEM interns, and the well over 100 educators and 500 students they interact with. Together the participants and workers on the Tools for Teachers project produced more than 100 digital assets that are freely available and will persist long after the pandemic is over but which will always be of value for teaching STEM especially online or remotely.

7. CONCLUSION

Collaborative communication enabled the development of a shared and readily understood approach. Instead of producing tools that the researchers had expertise in and employing best practices noted as highly effective, the collaborative communication used in the co-design process allowed for trans-disciplinary communication to emerge. The partners involved in the co-design were able to create materials that spoke to a larger group and provide support beyond the limited scope of the original plan so resources were used to greater effectiveness for a larger impact on the target population of K-12 students. As a result, this year, our project was selected to be recognized at the NSF-sponsored "STEM for All Video Showcase: COVID, equity, and social justice"[5]. We also were chosen to present our work at the 2021 NSF INCLUDES National Network Convening in July (Lipuma & Yáñez León, 2021a). Several of our partner districts and other new schools sent middle and high school students to intern over the summer or work with us over the 2020-21 academic year. These STEM Student Interns wrote articles (Mora, 2022), made videos, and presented live presentations. They also created content for our YouTube channel and STEM Month journal. Finally, our project was able to reach a wider group of students, especially those who were at risk or face the hardest road to STEM. We worked with the Essex County Detention Center's Sojourn High school and other schools to support teachers working with at-risk students. Several faced extreme challenges when teaching students in juvenile detention situations, particularly during the pandemic.

In the end, stepping back from the initial research plan allowed for greater collaboration and thus success. By inviting the participants to collaborate and become partners in design, greater success was achieved. By developing aligned scenarios, the collaborative partnership developed innovative solutions through a

[5] https://stemforall2021.videohall.com/presentations/2042

co-design new style of communication and involvement.

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