AUTHENTIC LEARNING DESIGN FAILURES: THE NEED FOR LEARNER AND CONTEXTUAL ANALYSIS AND PARTICIPATORY DESIGN

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This design case examines what program leaders learned from failures in the design of a program of authentic learning about teaching diverse audiences through educational outreach. The program was initiated and then redesigned to develop the teaching and communication skills of graduate students from a wide range of backgrounds by engaging them in authentic experiences with middle school teachers and students. Analysis of post-program data revealed seven design failures related to the lack of upfront analysis to inform the program design. Each design failure was detailed through a fishbone diagram method to identify the corresponding contributing factors. The failures in this design case reinforce the need for upfront learner analysis and contextual analysis. A participatory design was also suggested from the post-program data analysis. An instructional design model was recommended for continuous program redesign.

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INTRODUCTION

The GK-12 program that is the subject of this work was originally an educational outreach program funded by the National Science Foundation (NSF) at a large public Midwestern university. GK-12 was intended to improve the pedagogical understanding and experience and research communication skills of domestic Ph.D. STEM students (Dyehouse et al., 2009; Weeks et al., 2015; Weeks & Harbor, 2014). When external grant funding ended, GK-12 became an internally supported program open to graduate students, postdoctoral researchers, and visiting scholars with no restrictions on participants' discipline, nationality, or prior experience. The program has continued for over a decade after we initially redesigned it as a self-sustained program open to a wide range of participants with more modest staff and fiscal support.

The central principle of the GK-12 program design is context-based authentic learning. Rooted in Dewey's (1938) theory of learning through interaction with the environment and Vygotsky's (1978) sociocultural theory, a variety of learning theories focus on the relationship between learning and context and were used both in the program design and training workshops the participants received, including experiential learning (Kolb, 1984), situated learning (Collins, 1988), cognitive apprenticeship (Collins et al., 1989), community of practice (CoP; Lave & Wenger, 1991), and authentic learning (Driscoll, 1994; Herrington & Oliver, 2000). Looking at learning from different angles, these theories share a proposition that learning should take place in a context where the learners are involved in the culture of the target settings, and with authentic problem-solving tasks. It is believed that context exerts significant influences on performance-based learning, transfer of learning, and attitude change (Lowell & Yang, 2022; Tessmer & Richey, 1997). Thus, in the design and redesign of the program, the design team strove to bring participants to authentic environments by following authentic learning as the theoretical framework (Herrington & Oliver, 2000) to bridge the gap between the learning contexts and performance context, as a means of building relevance and connection for participants through

| PRINCIPLES	DESIGN CONSIDERATIONS
Authentic contexts	• Participants are paired with a K-12 teacher according to their selected subject and placed in the corresponding classroom to learn, practice, and teach for the participating semester.
Authentic tasks	• Participants are required to identify a topic from their research and develop it into a regular lesson for this classroom. • Participants interact with a K-12 teacher and students to provide an experience that can be used in the design and delivery of a lesson during their engagement.
Expert performance	• The host teacher serves as the expert in classroom pedagogy. • Participants are experts in their disciplinary field of research. • The program supervisor and coordinator serve as experts in curriculum design and the development of authentic classroom learning activities that leverage disciplinary research.
Multiple roles and perspectives	• Participants come with different backgrounds (disciplines, educational level, culture, etc.) and pedagogical expertise. • Participants serve as student teachers at different levels and in different school subjects.
Collaborative construction of knowledge	• A series of four 4-hour workshops are designed for participants to interact with peers and provide feedback to others regarding their planned activities and lesson.
Reflection	• Participants keep reflective journal entries weekly. • Participants reflect on individual experiences during the workshops and at the final program meeting.
Articulation	• Participants give multiple oral presentations including research communication, activity practice, and simulated lesson teaching in the training workshop. • Participants design and submit multiple versions of their research-based activity and lesson plan.
Coaching and scaffolding	• The program provides financial (service-learning grants), pedagogical (instructional design and lesson planning lessons), social (community building and classroom visit) support, and peer and supervisor/coordinator/K-12 teacher coaching.
Authentic assessment	• Participants are evaluated based on the development of the lesson plan and the delivery of a fully developed lesson in the assigned classroom.

TABLE 1. Authentic learning principles and design considerations.

an authentic learning experience. The authentic learning principles and design considerations are shown in Table 1.

The program ran on a semester basis with two cohorts trained each academic year (fall and spring). We recruited participants through various channels, including top-down encouragement from department heads, communication and encouragement from former participants to their peers, class presentations, and email listserv marketing. Recruited participants went through a series of training workshops along with a staged process for involvement with local K-12 classrooms and teachers. The authentic learning-based program can be best demonstrated through a journey map (see Figure 1). The journey map is comprised of four rows along with the timeline of the program including:

1. Stages: the major milestones of the program include recruitment, upfront preparation, observation in the classroom, co-teaching with the host teacher, teaching independently, and program closure & recruitment of a new cohort.
2. Actions & channels: the program design and activities participants are involved in. The engagement levels increase along with participants' growing involvement in the authentic environment.
3. Thinking: the questions, considerations, or concerns that participants might have at different stages related to their personal goals.
4. Opportunity: the design opportunities and insights for the program leaders.

Based on feedback from participants, host teachers, administrators, and K-12 students, the program was successful in meeting its overall goals and was beneficial to participating
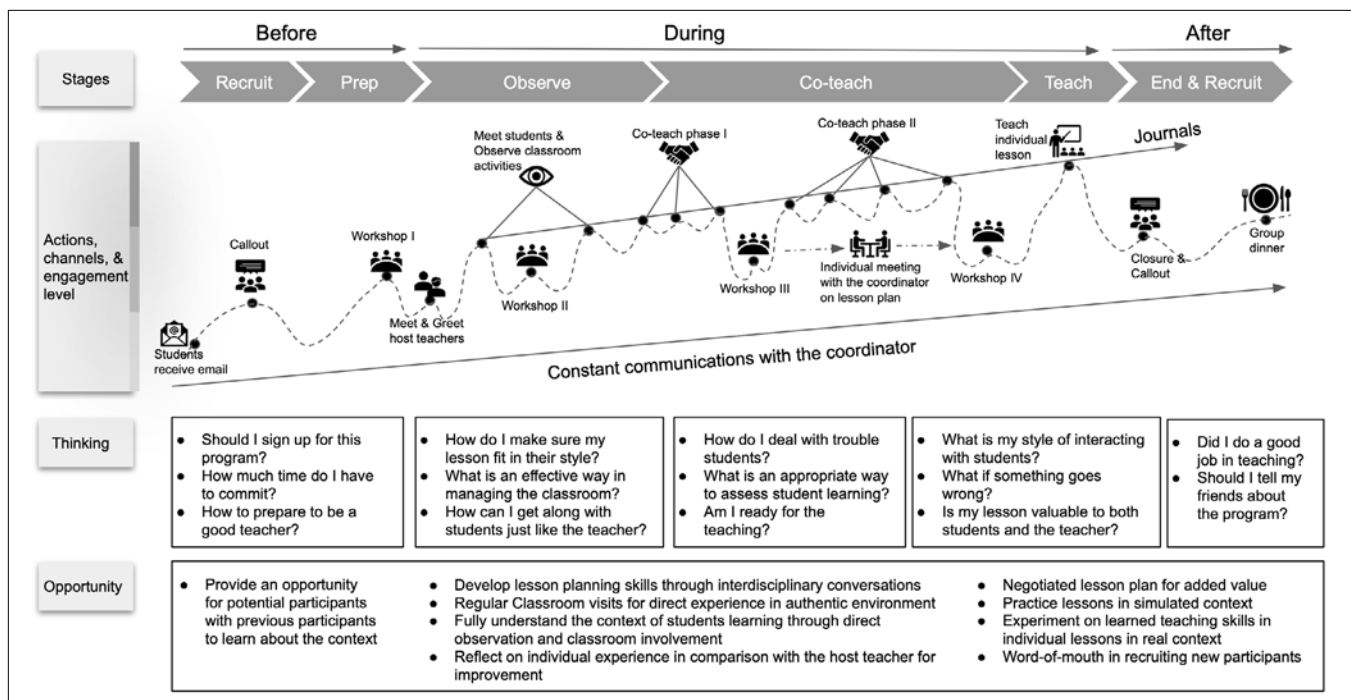
**FIGURE 1.** Journey map for program participants.

FAILING SYMPTOMS	
University context	Differing levels of participant engagement
	Participants leaving the program prior to completion
K-12 context	Conflicts in the classroom
	Cultural shocks and conflicts
	Lack of commitment
	Anxiety in the classroom
	Varied levels of transfer of learning

TABLE 2. Failing symptoms of program design.

graduate students, K-12 schools, teachers, and students (Roemmele et al., 2017; Weeks et al., 2015; Weeks & Harbor, 2014). However, we also experienced multiple challenges which we regarded as failures derived from our design and redesign process. The program has been continuously improved as the program leaders incorporate feedback from stakeholders, and as successive program coordinators brought new perspectives and approaches to update aspects of the program. In debrief sessions the program lead, coordinator, and a lead K-12 teacher encouraged open discussion of barriers, failures, and limitations as a way to improve the program for future participants. We collected data to dive into participants' experiences and identified more "failures". Here we discuss the failures that emerged from the program design, initial redesign, and operation of the program and attribute these failures to a lack of a systematic upfront analysis after the program was opened to a much wider population of participants.

PROGRAM EVALUATION

We conducted both formative and summative evaluations to identify the weaknesses of the program design as a basis for continuous improvements and to understand participants' experiences in the program. Formative evaluation methods included focus group conversations during training workshops, weekly journal entries, individual conversations with participants and the host teachers, and observations by the program coordinator in the workshops and classrooms. The summative evaluation included administering surveys and conducting semi-structured interviews. Data were collected from multiple sources formally and informally at different stages of the program each semester, to understand participants' experiences. Although participants and K-12 teachers generally had positive evaluations of the program, data analysis revealed issues that led to negative learning experiences for some participants. By using a fishbone diagram
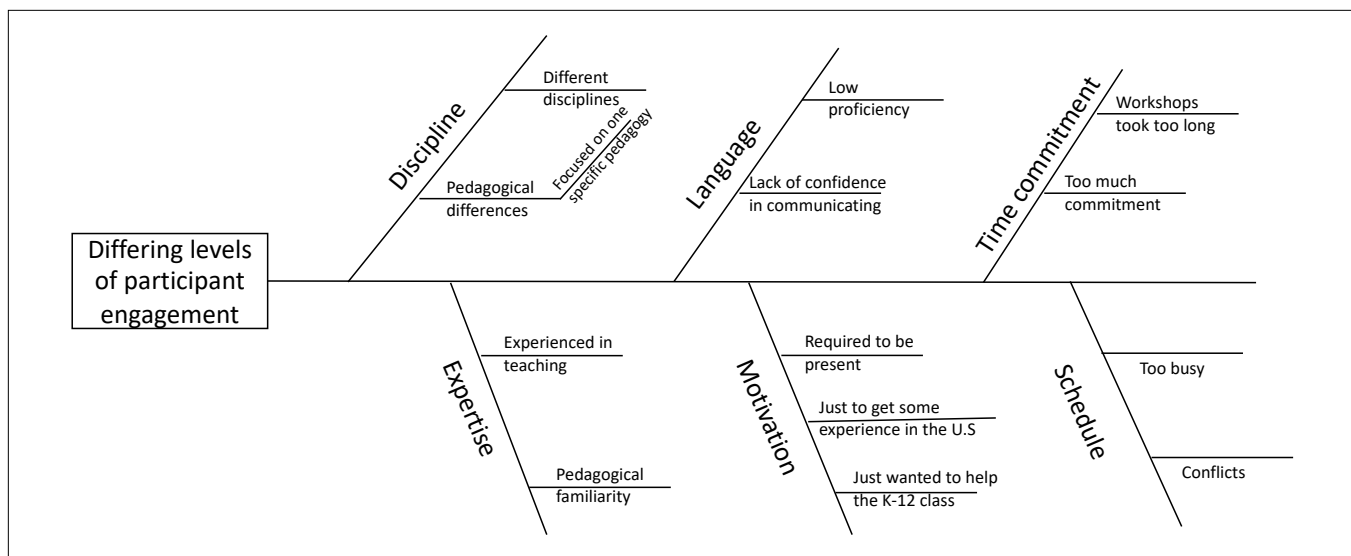
FIGURE 2. Cause analysis of differing levels of participant engagement.

methodology (Ishikawa, 1990), we were able to identify the root causes of the failures. In the next section we detail the issues existing in the design and implementation processes based on the data collected in the program evaluation.

DESIGN FAILURES

Design failures in instructional design have not been extensively reported or discussed in the literature, even though failure can be a valuable learning opportunity and that it is possible to 'fail forward'. In this case, we focus on failures related to personalizing participants' learning experiences and creating positive learning experiences for a diverse group of participants.

The analysis of the data collected for the program evaluation revealed some major issues or challenges. We categorized the seven failing phenomena into two settings according to where they occurred: (a) university context and (b) K-12 context, as shown in Table 2. In this section, we describe each failure and its causes based on the collected data.

Failure 1. Failing to Engage Some Participants in the Workshops and Community of Practice (CoP)

We strove to develop a community of practice (CoP) to leverage social learning in participants' professional development. However, not all participants showed the same level of engagement or enthusiasm for this community. For example, some participants stayed largely quiet during the whole session and were reluctant to be involved in activities, and some participants skipped social events such as dinners or did not show up at all. Through an analysis of multiple sources of data, along with a cause-and-effect analysis via a fishbone diagram, we identified six major factors that contributed to low engagement (see Figure 2): discipline,

language, time commitment, expertise, motivation, and schedule. The program leaders did not use an understanding of the participants' diverse backgrounds and situations in program design, resulting in lower engagement from some participants as their needs were not accommodated.

Discipline. We recruited participants from different disciplines at a large public university. Over multiple years, participants came from over 30 disciplines (including Aerospace Engineering, Agriculture, Anthropology, Biological Science, Business, Chemistry, Civil Engineering, Computer Graphics Technology, Computer Science, Earth, Atmospheric, and Planetary Sciences, Education, Electrical Engineering, Fisheries & Aquatic Science, Food Science, Information Technology, Industrial Engineering, Mathematics, Mechanical Engineering, Political Science, and Statistics). Participants from different disciplines had different experiences and were accustomed to different pedagogical approaches to their own learning. Despite the recognized value of the interdisciplinary nature of the program and the rich conversations that arose as we discussed learning research and implications for pedagogy, some participants stated that they perceived a lack of relevance in workshops that were designed around a pedagogical approach that did not match the norms in their disciplinary experience. Participants reported that the pedagogical approaches covered in the workshops were not extensively contextualized to their fields of study (e.g., how group discussion can be utilized in math education), which created a gap between these participants' expectations and the workshops.

Expertise. Participants came in with different levels of teaching experience and pedagogical familiarity, both in terms of K-12 teaching and university teaching. Participants with experience in education or prior teaching experience had a lower perception of the value of the workshops than those with little or no prior training or experience in teaching. For

example, one participant pointed out the lack of usefulness of the workshop when she stated, "(I) think I am not the target audience - a novice teacher…"

Language. Some participants came from countries where English was not the native language or language of education, and so had varying levels of English proficiency. They reported having some difficulties in the classrooms or the workshops as they could not understand others well or express themselves fluently. This was voiced more frequently by the visiting scholars who only stayed in the U.S. for a short period of time. This led to a lack of confidence for some participants, and some expressed a "fear" of interacting with peers in and out of the workshops.

Motivation. Participants showed and reported different levels and types of motivation to participate in this program. Some participants who were less engaged in the workshop component of the program included those primarily interested in working with local K-12 students rather than learning about pedagogy and instructional techniques, and international students who were primarily interested in gaining teaching experience in the U.S. Attending the workshops was mandatory, which negatively impacted participants' attitudes during workshops, as they perceived the workshops to be an unnecessary hurdle to them getting to full engagement with K-12 students and classrooms.

Time Commitment/Schedule. The scheduled length of the workshops was problematic for some participants. To make the workshops as accessible as possible for the range of participants, the program leaders designed four four-hour sessions on Friday evenings with dinner provided. Participants were mainly Ph.D. students who had a jam-packed schedule for other responsibilities (typically courses, research, and/or teaching) in their own programs. They were expected to invest at least four hours on Fridays every other week in addition to a full day in the K-12 classroom each week. Some found it extremely hard to squeeze the full session of workshops into their schedule. In addition, they needed to leave time for other activities including a background check, meet and greet session with teachers, individual meetings with the program coordinator, application for an internal grant, and the development of a lesson plan. Some participants concluded that the scale of the time commitment outweighed the benefit of achieving personal goals such as having teaching experience. Although the participants were provided full information on these commitments in advance and met with past participants who emphasized the scale of the commitment, those who struggled with time and effort management questioned the need for all of the elements of the program, and in particular the workshops.

Failure 2: Failing to Sustain Participants to Program Completion

Although at the beginning of each semester, all participants showed strong interest in the program, occasionally a participant decided to leave the program partway through the semester for a variety of reasons. In some cases, external events or conditions beyond the control of the participants or the program led to a participant leaving. Regardless of the reasons, when a participant left the program, it was challenging, particularly if a connection between the participant and a K-12 teacher and their students had already been established. The data analysis revealed that participants departed early from the program for several reasons, including participants' perceived lack of support from their advisor or host teacher, nonaligned career goals, time commitment/schedule, emerging situations, credit requirements, mismatched K-12 subjects, and transportation (see Figure 3).
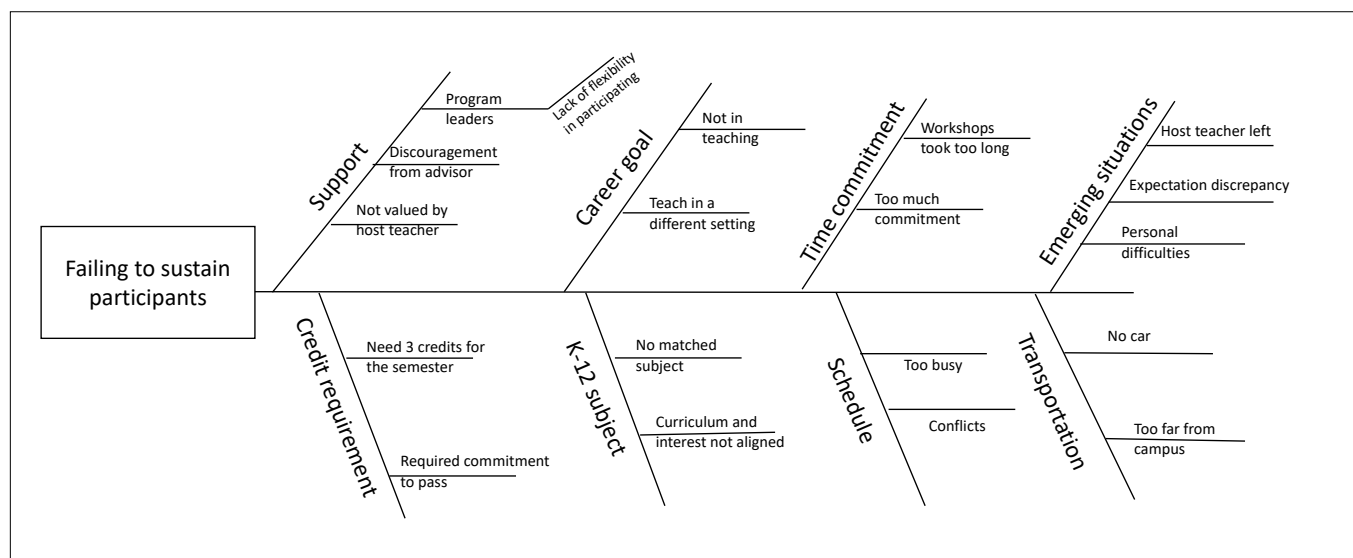
FIGURE 3. Cause analysis of failing to sustain participants to program completion.

Support. To get participants' full commitment, it was necessary to have support and encouragement from their academic advisor (major professor). When participants' advisors did not see the value of the program or were ambivalent, participants were discouraged, even if they continued to participate in the program. As a critical part of the collaboration, host teachers also played a key role in supporting participants' involvement. Despite their expertise in their subject matter, participants' ideas and insights were not always valued in the classroom. Although most host teachers were supportive and encouraging, in some situations the host teacher simply used the participant as a grader. The feeling of being undervalued by a host teacher demotivated participants and contributed to their withdrawal. Additionally, the program had established rules and routines which made some types of participant accommodations challenging. The lack of flexibility for some participants was not perceived as supportive.

Career goal. Coming from different disciplines and backgrounds, participants had different career goals in either education or industry. Even among those interested in education, most participants indicated their goal of teaching at the college or university level rather than in K-12 schools (typically participants were focused on tertiary education). One participant commented that she would never become a K-12 teacher after that experience as she did not think she could fit into the classroom with such dynamics. Mismatched career aspirations led to a perceived low usefulness for engaging in this program for some participants.

Time commitment/Schedule. As discussed earlier, the required time commitment led some participants to exit the program. Even those who had a strong motivation and who perceived the advantages of spending long hours in the classrooms were "overwhelmed" and "hesitant" in the first couple of weeks.

Emerging situations. Surprises happened and things sometimes just did not go as either the program or participants planned. For example, one host teacher went on maternity leave and the transition to the substitute teacher was not well-planned upfront, which caused the participant's withdrawal due to a perceived unpleasant experience in the classroom. The program did not provide participants with a thorough introduction to the variety of K-12 settings, teaching styles, and student types. This resulted in some participants perceiving discrepancies between what they expected and what they really experienced in the classroom, such as the host teacher's teaching style and student behavior. Some individuals also encountered personal difficulties (e.g., work change) beyond their control which forced them to leave the program.

Credit requirement. Participants had the option of registering for two academic credits for participating in this program if receiving academic credit would be helpful for them. All requirements needed to be fulfilled to pass the course. Some participants indicated that the workload in this program was much higher than a regular 3-credit course. One participant commented, "people are selfish. Of course, everyone is selfish. This is a two-credits; why would I go more?" In some cases, to meet the minimum credit requirements for a full-time graduate assistantship, some participants dropped out of the program because they needed three extra credits for the corresponding semester instead of two.

K-12 subject. Among the limited list of subjects that are offered in K-12 schools, a subset of subjects was available each semester, depending on which teachers volunteered to participate. Sometimes participants were assigned to subjects that they did not perceive as being related to their field of study, such as a language major participant being assigned to an Arts classroom. In addition, even when the overall subject seemed to be a good match, the curriculum for a particular semester, as determined by state schedules, may not have been of interest to a participant. Despite the program's effort to find commonalities between participants and host teachers, some participants chose to leave the program because they felt that the mismatch between the participant and the host teacher's subject was significant enough to warrant leaving the program.

Transportation. Participants without access to a car faced transportation barriers, as the participating schools were too far to walk from the campus. Participants had to transfer bus lines to get to schools on public transport, and some participants biked to a school. Winter travel made it even harder due to low temperatures and inclement weather.

Failure 3: Conflicts in the Classrooms

The program faced several conflicts throughout its multi-year implementation, as reported by both participants and teachers. Some of these conflicts led to tension between teachers and participants, while others caused friction between the program and the school. These conflicts covered a range of issues, including personal, academic, and financial. Data analysis revealed that the key factors contributing to the program's failure were personality, management skills, philosophy, student behavior, workload, inconsistent commitment, and financial pressure (see Figure 4).

Personality. In designing the program and selecting partnering teachers, the program leaders did not consider the personalities of participants and host teachers due to a lack of upfront analysis. Participants were experts in the subject matter while host teachers were the experts in K-12 classroom teaching. This lack of upfront analysis resulted in potential issues arising from strongly opinionated individuals, such as frustration when it came to designing teaching activities or building teacher-student relationships. For example, some participants reported that the host teachers were
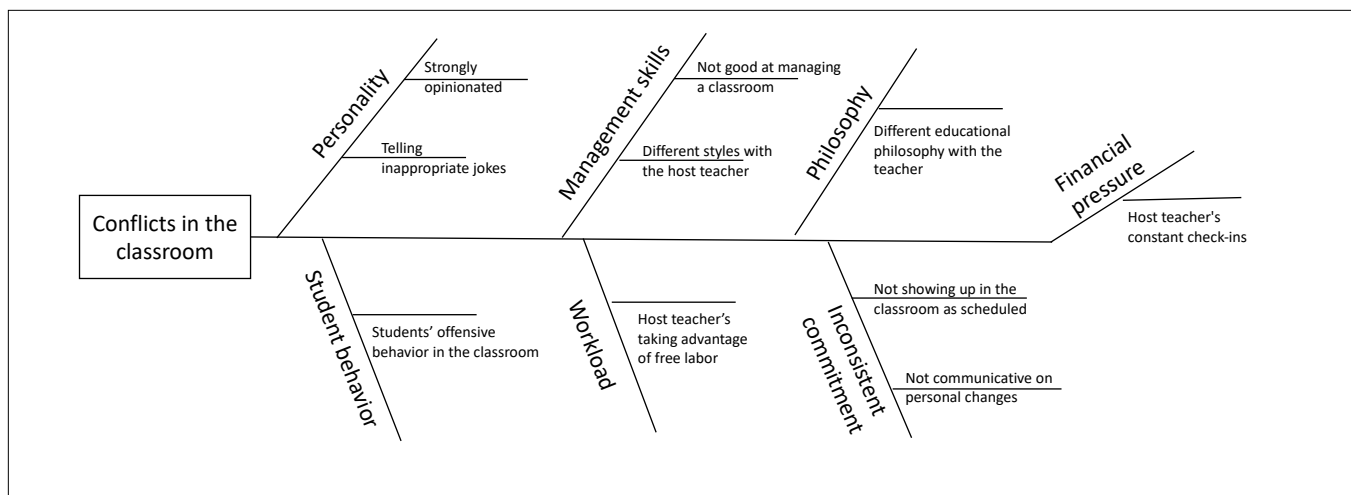
FIGURE 4. Cause analysis of conflicts in the classroom.

too "strong" in running the classes. Communicating with a much younger group of students (K-12) made it necessary for participants to be mindful of personal humor. One participant was reported multiple times by the host teacher for telling inappropriate jokes to kids in the classroom. A coffee chat between the program coordinator and the participant revealed good intentions from the participant but a lack of knowledge of how to interact with middle-school aged students.

Management skills. At the beginning of the program, many participants lacked experience and skills in managing a K-12 classroom. Developing effective classroom management strategies takes time and experience. Keeping an open mind, in the beginning, was important to develop such skills. However, when participants had different management or teaching styles than the host teacher and were not open to learning a different approach from an experienced teacher, co-teaching activities in the classroom became an unpleasant experience for both sides.

Philosophy. Some participants expressed their disagreement with the teaching philosophy of certain host teachers and felt that some teachers had a negative attitude toward the teaching profession. This led to a lack of respect or trust from the participants toward these teachers. This philosophical difference hindered the interactions and involvement of some participants in the classroom.

Student behavior. One of the schools participating in the program was an alternative school that served students with behavioral issues that prevented them from remaining in traditional classrooms. These students presented significant challenges in terms of behavior, respect, and inappropriate humor. A participant assigned to this school experienced difficulties in this regard. These students presented significant challenges in terms of behavior, respect, and inappropriate

humor. A participant assigned to this school experienced difficulties in this regard.

Workload. Several participants felt unhappy with the amount of work assigned to them in the classroom, as they believed it to be excessive. For example, one participant was primarily responsible for providing one-on-one tutoring for special education students. Some teachers, who had previously worked with student teachers from the College of Education, treated GK-12 participants in a similar manner and expected them to take on more responsibilities than they were comfortable with.

Inconsistent commitment. Occasionally, participants failed to attend scheduled events without providing proper notice. They did not communicate clearly with their host teachers or the program coordinator about changes in their plans. In one instance, the program leader found out that a participant had stopped showing up from the host teacher. The reasons for this could vary, from difficulties in balancing other research or work commitments, to a participant's decision to leave the program for personal health reasons.

Financial pressure. Each participant had the opportunity to apply for a service-learning grant to support their teaching and bring some extra teaching materials to the classroom. K-12 teachers in general have very limited financial support to purchase class materials and often pay for supplies using personal funds. Therefore, the offer of some financial support for teaching materials became an incentive for teachers to participate. However, the grants were not 100% guaranteed. The host teachers sometimes pressured participants to either apply for the grants early or apply for more grants. Constant check-ins on grant writing progress from teachers made some participants nervous, and some participants shared that they thought the host teacher was more focused on the additional teaching materials than the value of the participant's knowledge and expertise.
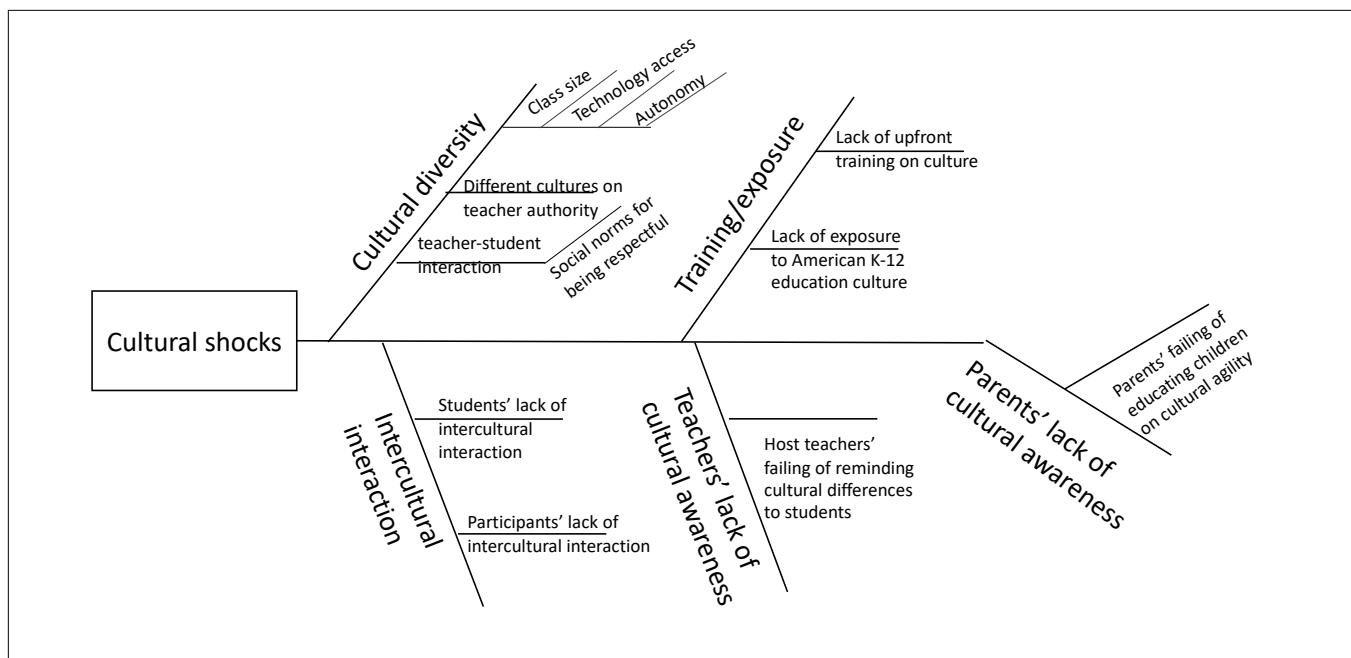
FIGURE 5. Cause analysis of cultural shocks.

**Failure 4: Cultural Shocks**

Participants with international backgrounds frequently reported cultural shocks. There were two main types of shock: (a) participants perceived strong cultural differences due to a lack of understanding of the local educational system and culture (e.g., teacher authority); (b) feelings of being disrespected by K-12 students, and sometimes even by the teachers, because of the strong differences in teacher-student behavior norms in the US compared to their home country experiences. Cultural awareness had not been considered a training element in the original program design, because the initial program was limited to domestic students. The program leaders understood that participants would experience differences in the classrooms but did not adequately prepare participants for this. The factors that caused this failure included cultural diversity, lack of training/exposure and prior experience, lack of intercultural interaction, and teachers'/parents' lack of cultural awareness (see Figure 5.).

Cultural diversity. The program has attracted participants from over a dozen countries with diverse cultural backgrounds, including China, Egypt, Germany, Ghana, India, Indonesia, Iran, Nepal, Russia, Saudi Arabia, South Korea, Turkey, and Zambia. Hofstede's cultural dimensions theory (2010) suggests that these countries vary in their cultural values in terms of power distance, collectivism vs individualism, uncertainty avoidance, femininity vs masculinity, short-term vs long-term orientation, and restraint vs indulgence. Some of the cultural differences that participants experienced were related to classroom interactions, specifically around power distance. Participants noticed variations in the level of

authority held by teachers, with U.S. teachers generally having less power and influence over students. This led to some uncomfortable situations, such as when students asked inappropriate questions or made insensitive comments about the participant's culture. For example, one student asked a participant why people eat dogs in her country. Another student claimed that all people were terrorists in one participant's home country. International participants had high expectations of teachers being respected by students, especially when they were concerned with their "outsider" role in the classroom and were often dismayed by student behavior. For example, multiple participants expressed their surprise and disappointment after seeing students' walking in and out of class freely, talking back, and confronting a teacher on a teacher's mistake. The way students dressed also astonished one participant as it made her feel like school was a "fashion show" while students in her country had to wear a uniform. Other perceived differences included the class size, students' technology access, and autonomy in the classroom.

Training/exposure. The integration of international participants into the program could have been smoother if cultural training had been provided for both participants and host teachers to minimize cultural misunderstandings and conflicts. However, this crucial aspect was overlooked during the program redesign. Most of the international participants had no prior knowledge or experience of the American K-12 education system, making cultural training even more essential. Despite the workshops addressing similarities and differences between American and international K-12 schools, they failed to provide strategies for reducing cultural shocks. The lack of cultural training was a missed opportunity
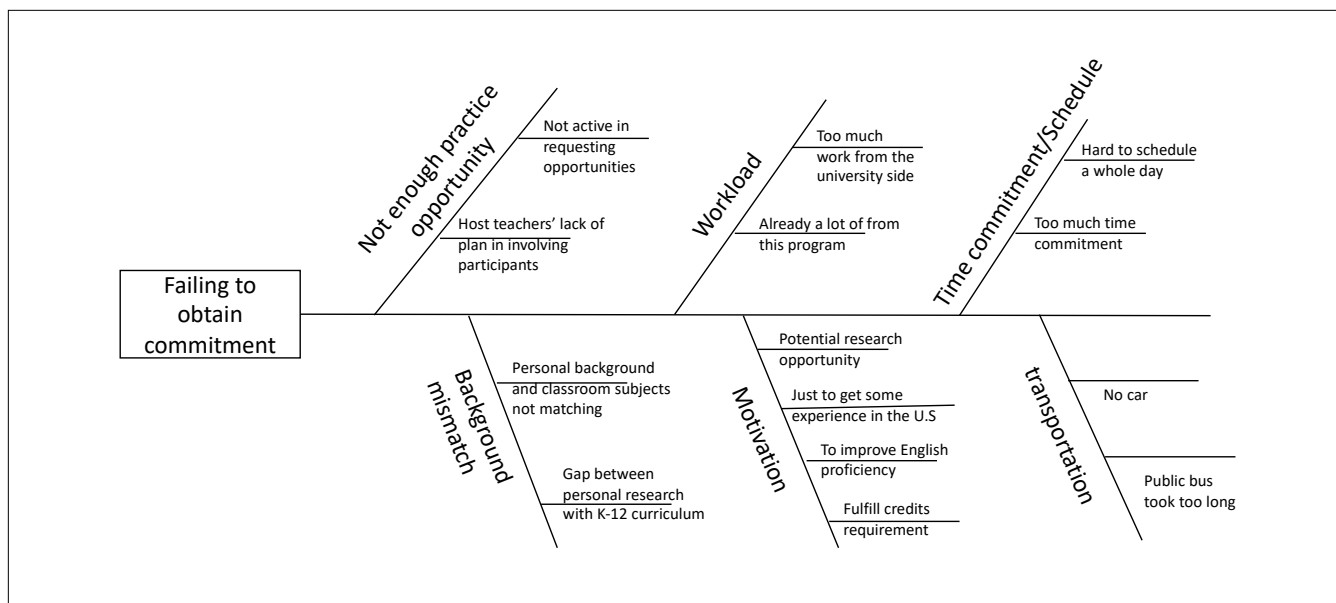
FIGURE 6. Cause analysis of failing to obtain commitment.

to better prepare participants and host teachers for cultural differences and could have greatly improved the program experience.

Intercultural interactions. The host teachers reported that most students from the participating K-12 schools had limited exposure to other cultures and had never traveled beyond their home state. This lack of diversity in their background resulted in students lacking intercultural competency skills. Despite having experience interacting with people from different cultures at the college level, international participants were not prepared for interacting with K-12 children and teachers. While there were many positive and rewarding intercultural interactions between international participants, teachers, and students, there were also negative interactions reported by participants that were disheartening. It is worth noting that the lack of intercultural competency skills among the students and host teachers can be a barrier to creating positive and effective intercultural interactions.

Teacher/parent lack of cultural awareness. Many of the K-12 students expressed curiosity about other cultures. However, in some cases, this curiosity led to a negative perception of cultures that were different from their own. This indicates that parents and teachers had not effectively nurtured an environment in which students could develop a cultural awareness and understanding necessary for successful intercultural interactions. It is likely that the lack of intercultural exposure and education in the students' upbringing and education has resulted in a limited understanding of other cultures and a lack of cultural empathy.

Failure 5: Failing to Obtain Some Participants' Commitment

The program failed to obtain all participants' full commitment. Even the most engaged participants showed some level of commitment hesitation at times, as this program was not their only or top priority, regardless of their motivations and purposes. Although almost all participants completed the program successfully, some were not fully involved or engaged in the authentic learning environment. Reasons for the lack of commitment included the lack of practice opportunities, too much workload, time commitment and schedules, background mismatch, motivation, and transportation (see Figure 6).

Not enough practice opportunities. Opportunities for hands-on practice in the classroom were crucial for participants to perceive the value of their time and effort invested in the program. The availability and quality of these opportunities varied based on the participants and their host teachers. When participants were not proactive in seeking out classroom activities or when host teachers failed to plan for their involvement, the perceived value of the opportunity decreased, resulting in a decline in participant commitment. This highlights a missed opportunity for the program to better collaborate and communicate with host teachers, to ensure that they understand the importance of participant involvement and actively encourage it.

Workload. The program participants were graduate students, post-doctoral researchers, and visiting scholars who had other full-time responsibilities outside of the program. To have a quality experience in the program, they needed to spend 8 hours in a K-12 classroom each week, attend workshops, complete journal entries, and prepare a
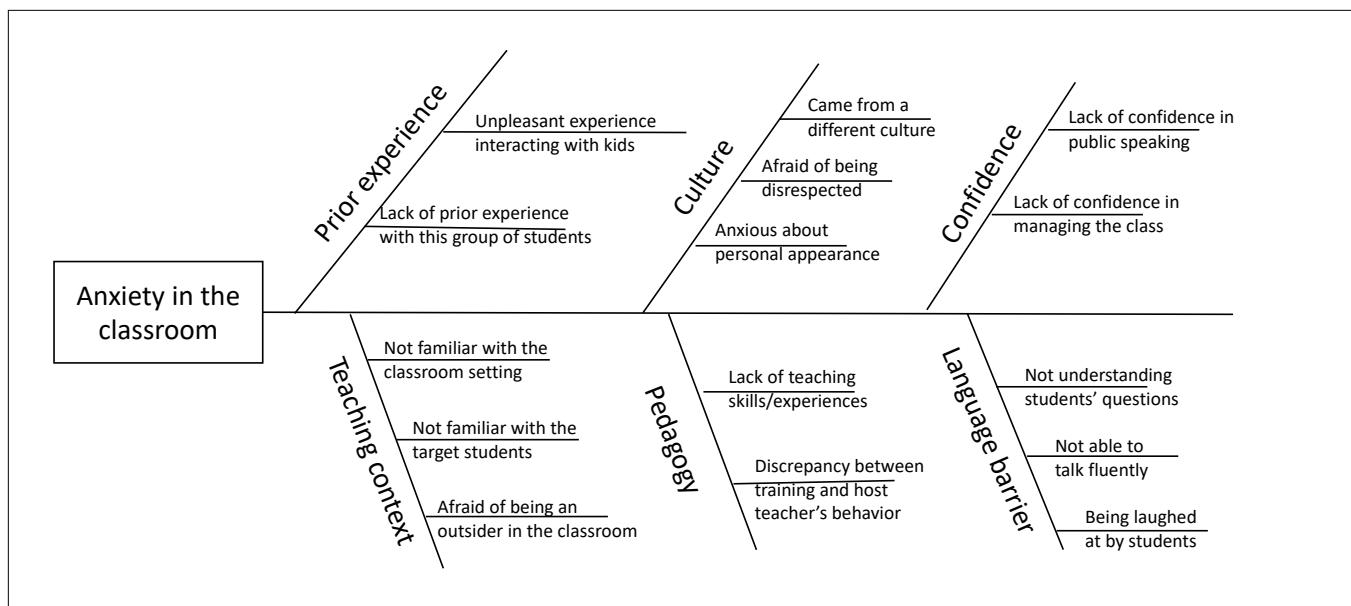
FIGURE 7. Cause analysis of anxiety in the classroom.

lesson plan. While many participants were able to balance this workload and manage their time effectively, for some, the added workload was overwhelming and resulted in a decreased commitment to the program.

Time commitment/schedule. The program demanded that the participants spend one full day or two half days per week in a K-12 classroom. However, some participants found it challenging to schedule a whole or half day for the classroom visit due to courses they were taking, research schedules, or other university and personal commitments.

Background mismatch. When participants were assigned to a K-12 classroom subject that was not closely related to their background or research, they would need to spend additional time exploring a topic for classroom teaching compared to peers with a close subject match who could convert one piece of their research into a lesson.

Motivation. Based on journal entries and interviews with a subset of participants, the motivations for joining the program were often divided into two categories: egoistic or altruistic. Egoistic motivations included seeking potential research opportunities in the K-12 setting, gaining teaching experience in the U.S., improving English skills, and fulfilling program credit requirements. Altruistic motivations included sharing real-world related knowledge with students and teachers, introducing new pedagogical methods for engineering, teaching K-12 children to code to build the STEM talent pipeline, and/or filling gaps in the existing curricula. However, when conflicts arose, participants with primarily egoistic motivations may have lacked commitment to the program.

Transportation. The program was unable to provide transportation assistance to participants, which proved to be a significant barrier for those without access to a personal car. Using public transportation added to the time and complexity of their participation in the program, making it a test of their commitment to the program. This lack of transportation support was a major challenge for participants and hindered their ability to fully engage in the program and its opportunities.

Failure 6: Anxiety in the Classroom

Anxiety was prevalent in the first few weeks of the program, regardless of participants' backgrounds and expertise. The program leaders expected it to happen and viewed it as natural for participants engaged in an unfamiliar authentic environment. Therefore, no intervention was deployed to tackle this specific issue. However, the data analysis revealed that participants were not able to make the most out of their experience when anxiety persisted. Factors causing anxiety in the classroom included prior experiences, culture, confidence, context, pedagogy, and language barrier (see Figure 7).

Prior experience. One participant expressed her culture-related fear due to an unpleasant prior experience in a less diverse area where she was subjected to negative culture-related comments. One participant who immigrated to the U.S. when he was young described middle school as "a jungle" where anything could happen. One participant mentioned being bullied while in middle and high school and had negative feelings about the school environment. Most participants did not have any prior experience interacting with U.S. middle school students in a teaching-related role, which also caused some levels of anxiety.
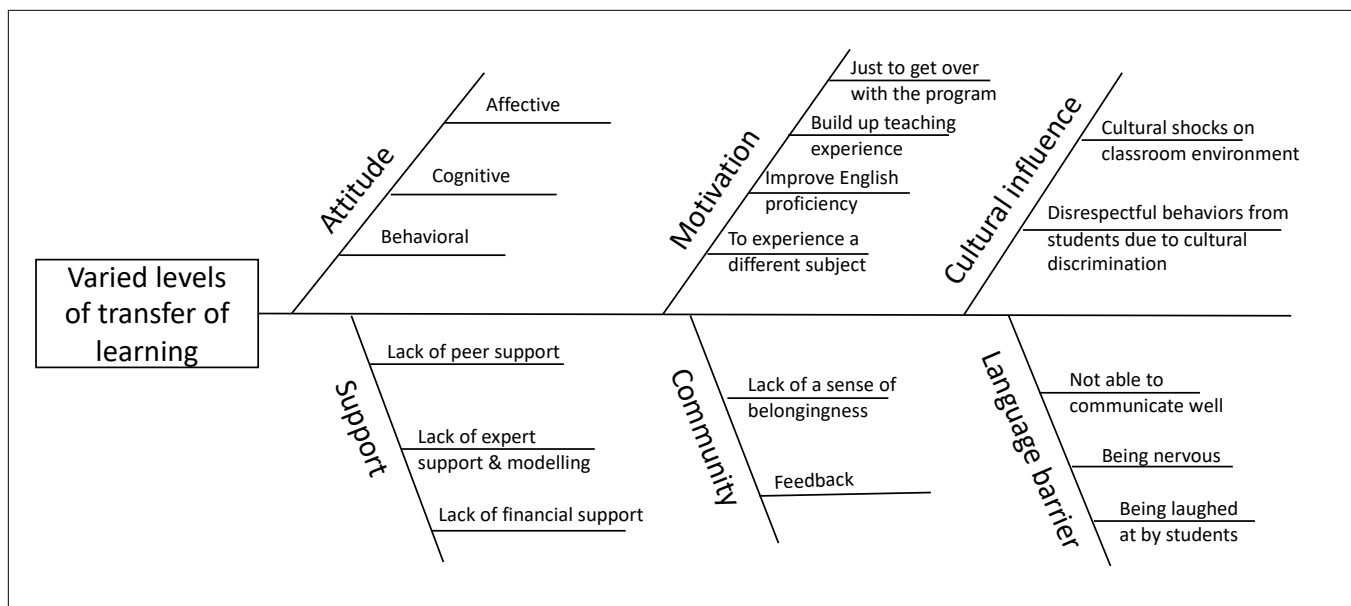
FIGURE 8. Cause analysis for varied levels of transfer of learning.

Culture. The program saw a growing proportion of international graduate students over the years. Even for domestic students, local K-12 schools often had cultures that were different from where they were from. Participants from non-Western countries expressed concerns about being negatively discriminated against in the classroom, while international participants from Europe did not share such concerns. One participant expressed concern about her appearance, stating "As a Saudi woman wearing a hijab, I was scared of teaching K-12 because of the judgment." This highlights the unique challenges faced by international participants, particularly those from non-Western countries, and underscores the importance of addressing these concerns to ensure a positive and inclusive experience for all participants.

Confidence. The prospect of regularly speaking in front of a large group of students made some participants nervous, particularly when the audience was composed of schoolchildren whose reactions were difficult to predict. Another concern among participants was a lack of confidence in their classroom management skills. Most participants did not have prior experience managing classrooms, and even those who had been college teaching assistants recognized that managing a K-12 classroom was vastly different from managing a college classroom. In chaotic classroom situations, some participants felt unsure of how to handle the situation and had to rely on the intervention of the host teacher.

Teaching context. Participants often expressed initial concerns about teaching in K-12 classrooms because they were not familiar with the setting at the start of the program. One participant was confident about the content but had "fear" due to the "different contexts". Another participant feared the fact that she knew nothing about the context before starting to visit the classroom. Most participants were in their 20s and were worried about not being taken seriously or even being teased by the students. Not knowing the target students added an additional layer of fear. Since participants only visited the classrooms once a week, they were concerned about being treated as outsiders or observers on top of other factors.

Pedagogy. Pedagogically, most participants did not have prior teaching experience or training, despite their expertise in a subject matter. The lack of experience and skills, according to one participant, caused some "apprehension of how to keep students engaged." The training workshops provided pedagogical training. However, some participants expressed high anxiety due to the discrepancy between what they were trained to do, and what they observed as the pedagogical approach of some host teachers.

Language barrier. For international participants who self-identified as having limited proficiency in English, the language barrier was a constant source of anxiety in the classroom. Some participants reported feeling nervous about not understanding students' questions or being able to clearly express themselves. Some participants reported asking students to repeat their questions or seeking help from host teachers or other students. Some participants were laughed at for struggling to come up with a word to answer a student's question. These types of experiences increased the anxiety of some participants about visiting the classroom.

Failure 7: Varied Levels of Transfer of Learning

Based on an evaluation of their transfer performance, participants' transfer of learning varied greatly when applying learned knowledge and skills in their teaching.

The performance gap is derived from both individual and environmental factors, including attitude (affective, cognitive, and behavioral), motivation, cultural influence, support, community, and language barrier (see Figure 8).

Attitude. Participants' attitudes played a key role in their transfer process (Yang & Watson, 2022; Yang et al., 2020). An analysis of interviews and journal entries showed that participants had different affective, cognitive, and behavioral attitudes. Those who were not satisfied (affective), did not perceive the value and usefulness of the program (cognitive), or did not respond actively (behavioral) had relatively low transfer compared to those who had positive attitudes in all three attitudinal dimensions.

Motivation. Motivation exerted a mediating force between attitude and transfer. The various motivations participants had that might negatively impact their transfer included (a) just to get over with the program to fulfill either credit requirement or their personal

commitment; (b) to build up some teaching experience, especially in the U.S for some international participants; (c) to improve English proficiency; (d) to experience a different subject from their own backgrounds.

Cultural influence. Perceived cultural differences and negative interactions had some impacts on both attitudes and performance. Some participants were surprised or even shocked, which caused some frustration in the classroom. According to participants, not being treated respectfully and being treated differently than other participants (e.g., a participant from Scotland reported being adored by students with her accent and other cultural differences) brought challenges for some participants (e.g., Asian and African) to teach effectively.

Support. Some participants did not receive equal peer support as others due to the discipline they came from or the classrooms they were assigned to. The program failed to provide such support due to limited participants and resources. The lack of host teacher support and modeling opportunities hindered some participants' learning and performance, as they perceived the host teacher's support as one of the determinants for their successful transfer. The financial support provided by the university guaranteed the needed materials for the lessons to be successfully implemented. However, some participants were not able to get the funds in a timely manner, which forced them to change their plans.

Community. According to participants, the sense of a learning community facilitated their learning and transfer. However, not everyone was able or willing to develop a sense of belonging, either because of a language barrier or conflicting schedules that made them absent from program events. Constant feedback among peers was encouraged

in the learning community, on top of the program coordinator's feedback on their progress (e.g., lesson planning). However, when participants did not submit journal entries or lesson plan drafts, they would not be able to receive needed feedback to drive their continuous improvement.

Language barrier. Language was a factor behind multiple program design failures due to the lack of consideration of this factor in the design process. When participants were not able to communicate well with students, the effectiveness of their teaching was reduced, even when their lessons were well planned. Prior to the teaching days, some international participants became nervous about being the main teacher while the host teacher stepped down temporarily. They would not have been as nervous in their home countries as they knew what to say when things occurred. Being laughed at or teased by students previously left "trauma" for some participants as they were concerned similar things might happen during their teaching. According to participants, they would do much better if the language barrier was not in the way.

The causes of program failure as discussed earlier can be categorized into learner and contextual factors. The responsible persons for the causes are also identified (see Table 3, next page). Most of the factors identified fit Gilbert's (1996) Behavior Engineering Model (BEM) in identifying human performance issues (i.e., they are either individual or environmental factors).

THE INITIAL REDESIGN PROCESS AND DESIGN FAILURE

The original design of the GK-12 program under NSF support was based on an analysis of a restricted group of graduate student participants (domestic STEM doctoral students, Dyehouse et al., 2009). At that time, all participants received a full NSF fellowship to participate in the program for the whole year under the support of a large team who were funded to manage and support the program. When the NSF grant ended, and the program moved to a self-sustained model open to a larger group of participants, there was a need for a program redesign to reflect more diverse participants, a change to no fellowship support for participants, and a reconsideration of goals and related evaluations with modest staffing. Participants' demographics changed over several program years with more non-STEM, master's-level, and international students, and visiting scholars volunteering for the program.

The program redesign followed a relatively linear design process with minimum iteration as shown in Figure 9.

We identified two key program goals: (a) professional development for graduate student participants as future faculty or industry professionals and (b) professional development

CAUSE			RESPONSIBLE PERSON
Individual /Learner	Personal characteristics	• Personality • Inconsistent commitment	Participants & program
	Attitudinal	• Attitude • Philosophy • Motivation • Career goal • Confidence	Participants & program
	Capacity	• Language • Expertise • Management skills • Language barrier • Pedagogy	Program & participants
	Behavioral	• Intercultural interactions • Prior experience	Participants
Environmental / Contextual	Support & resources	• Support • Community • Training/exposure • Transportation	Program, peers, academic advisor, & host teachers
	Cultural	• Culture • Cultural diversity • Cultural influences • Teachers'/parents' cultural awareness	Participants, program, host teachers, & parents
	Disciplinary	• Disciplines • Background mismatch • K-12 subject	Program
	Performance context	• Teaching context • Workload • Student behavior • Not enough practice opportunity • Emerging situations	Program, host teachers, participants, & K-12 students
	Program design	• Time commitment • Schedule • Credit requirement	Program & participants

TABLE 3. Causes and responsible persons.

for K-12 teachers. The program adapted key activities related to these goals. However, participants in the program varied each session; The program staff did not know who would be in the program until a couple of weeks into each semester. Additionally, only one paid graduate assistant (the program coordinator) was responsible for program implementation. Hence, we did not perform an upfront learner analysis to inform program redesign due to participant uncertainty, a very short timeframe, and limited staff resources. We designed and redeveloped the activities with available resources while recruiting stakeholders (participants, K-12 teachers, and university sponsors), which included workshops, classroom participation, and reflective activities. We took a reactive approach (i.e., understanding the emerging challenge and reacting to it) for progressive re-design and operation of the program. Instead of an upfront systematic analysis to fully understand the contexts and participants, we used a
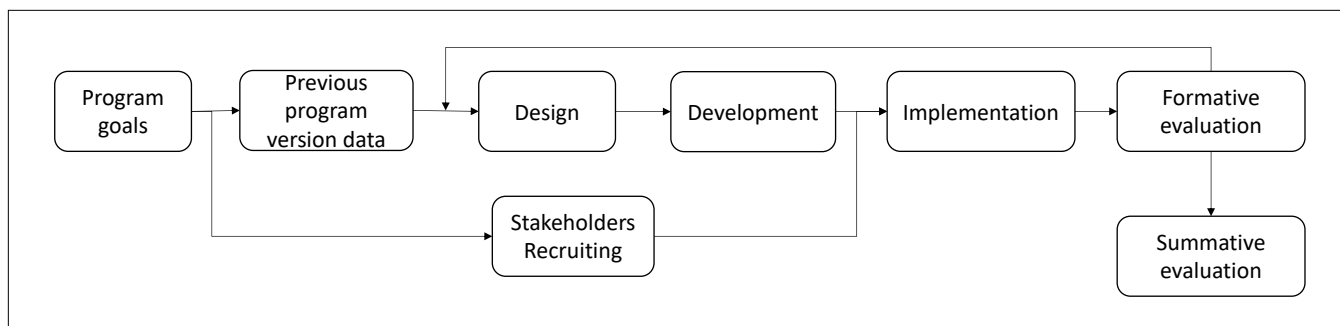
FIGURE 9. The linear program redesign process.

post-program partial analysis to drive program modifications for future sessions.

To help understand the program elements and how they interact with and influence each other in the multidimensional layered program, causal loop diagrams (CLD) were created to guide the formative and summative evaluations of the program. An example of a CLD designed to understand factors and variables in achieving the goal is shown in Figure 10. The positive/negative signs indicate the changes of a dependent variable when an independent variable changes. For example, when participants increase their classroom visits, their interactions with target students will increase.

METHODS AS WE SHOULD HAVE DEPLOYED

Each semester we had a plan and a framework for the program. However, what we did not explicitly include was an upfront analysis of incoming learners and the contexts they would be involved in, to drive explicit ways to modify the program based on diverse and changing needs. We implicitly assumed that a program redesigned and refined around our prior learners would generally be reasonable for the range of learners in the next semester. However, the lack of just-in-time personalization and a reactive design process led to inevitable mismatches/failures, as described in earlier sections. Specifically, learner and contextual analyses were not in place to understand learner and contextual needs, which caused the failures in re-designing and implementing the program. We learned from our failures, rather than anticipating new needs to proactively reduce the chance of future failure. In addition, an analysis of interviews with participants revealed the need to include a participatory design approach, to infuse more empathy and ownership in the design process.

Learner Analysis

Learner analysis is an indispensable step of the instructional design process and aims to understand learners and personalize the learning to drive positive learning experiences. It "is characterized as an iterative process that informs vital instructional design decisions from front-end analysis to evaluation" (Saxena, 2011, p. 94). Conducting a
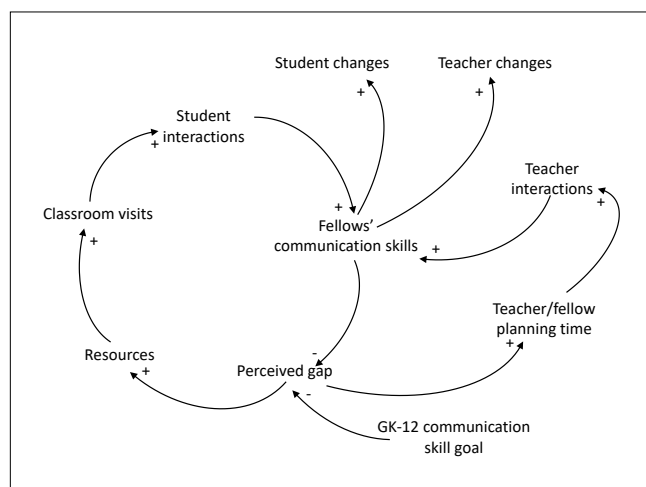
FIGURE 10. An example causal loop diagram (Dyehouse et al., 2009), used by permission

learner analysis enables an effective design that addresses diverse needs. Generally, this includes analyzing the learner population in terms of its size, demographics, characteristics, prior knowledge, motivation, cultural backgrounds, language proficiency, technology access, and other program-relevant variables (e.g., for our program logistics, access to transportation to schools). A learner analysis for this program should have included the factors listed in Table 3 to proactively address potential design failures.

However, when redesigning the program for a wider population of participants, we failed to conduct a learner analysis to understand the diverse needs and goals due to a combination of reasons including (a) a lack of knowledge of learner analysis from the program leaders, as it was not a routine pedagogical approach in their disciplines; (b) limited staffing as only one half-time graduate assistant was funded to run the program (the program supervisor was a full-time professor with institutional leadership roles who was passionate about the program but could only commit small amounts of time to keep it running); (c) the challenge of not knowing who the participants would be until two weeks into each semester.

There are always alternatives that could have been used to address situations where target learners are not available.

For example, we could recruit potential participants for the purpose of learner analysis from the pool of the target population (master students, Ph.D. students, post-doctoral fellows, and visiting scholars). Learner personas with detailed individual characteristics based on data collected from potential participants can be developed to represent the variance between learners to inform the design process. Making assumptions about learners based on prior experience without knowing them creates a hurdle for the design down the road.

Contextual Analysis

The theoretical framework of the original program design required an extensive contextual analysis as a foundational element for authentic learning. There has been little guidance in the field of instructional design in terms of how to conduct contextual analysis, as it is often used synonymously with Needs Assessment (Stefaniak, 2021). When designers conduct analyses in the instructional design process, they tend to focus on the learner analysis without going much further into contextual elements (Stefaniak, 2021). The GK-12 program provides a useful example of context, why a contextual analysis is needed, and contextual factors that were considered important in this case.

A learning context is concerned with the actual physical and social settings of the activities that learners conduct or are involved in, with a systematic consideration of the elements involved including individuals, objects, actions/tasks, the social others, rules and expectations from the communities, and the connections with performance context for learning transfer. Tessmer and Richey (1997) proposed a three-part view of context including orienting context, the instructional context, and the transfer context considering its influences on learning and performance. The orienting context "precedes the learning event and contains factors that influence the prospective student's motivation and cognitive preparation to learn" (Tessmer & Richey, 1997, p. 90). Instructional context has received the most attention in the instructional design process as it contains direct factors and environments for the delivery of instruction. Transfer context, related to the knowledge application environment, is often neglected. In the GK-12 program, because of our authentic design that weaves learning and application together, the instructional context and transfer context are closely related and sometimes are the same when participants learn in the K-12 settings. There are three levels of contextual factors within each context, namely, learner, immediate environment, and organizational factors (Tessmer & Richey, 1997). The learner factors across the three contexts are learner profile, goal setting, perceived utility, and perceived accountability (orienting context); learner role perception and learner task perception (instructional context); utility perceptions, perceived resources, transfer coping strategy, and experiential background (transfer context). The immediate environment

factors include social support (orienting context); sensory conditions, seating, instructor role perception, learning schedules, and content culture (instructional context); transfer opportunities, social support, and situational cues (transfer context). The organizational factors across the three contexts are incentives and learning culture (orienting context); rewards & values, learning supports, and teaching supports (instructional context); transfer culture, and incentives (transfer context).

Among the principles of authentic learning, authentic context and task are foundations of providing an authentic learning experience and relating learners' actions directly within a situated context. The GK-12 program contexts contained multiple layers and different levels of interactions to be accounted for (see Figure 11). At the macro level is the environment of factors such as State education standards and the school system. Micro level 1 is the programmatic level consisting of factors such as staff, funds, and evaluation, Micro level 2 is the classroom level within the classroom environments, including factors such as time commitment in the classroom, participant-teacher interaction, and participant-students interaction. When conducting contextual analysis, it is important to account for factors at different levels.

The authentic context that participants experienced was typically different from their previous educational and teaching experience, even for domestic students who had prior college teaching experience. For example, a participant
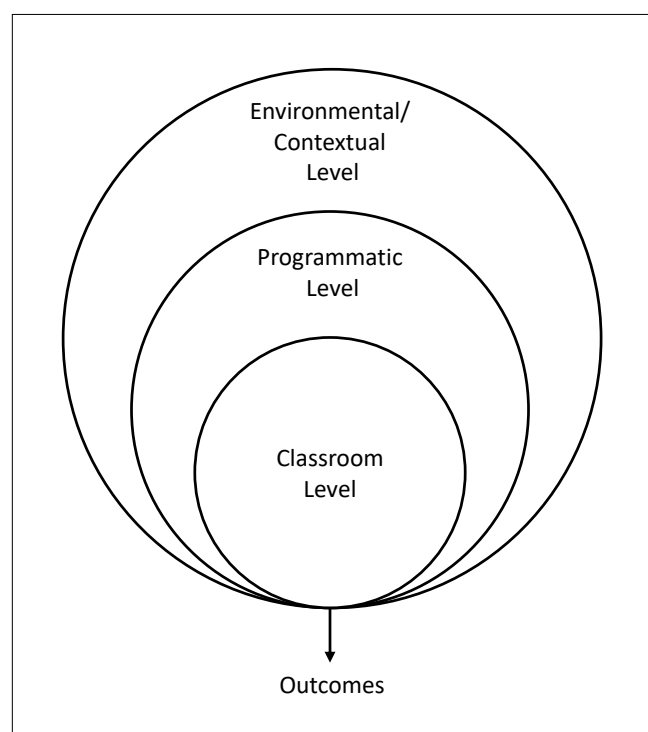
FIGURE 11. Multiple levels of the GK-12 program (Dyehouse et al., 2009), used by permission.

who was assigned to a special education classroom described the classroom as a "one-room schoolhouse like the early 1900s with a group of students who are working in all kinds of different levels in all kinds of different subjects." Such experiences were even sometimes new to the program staff, as the teachers participating in the program and their classes varied from semester to semester. A contextual analysis was necessary for desired outcomes. To conduct a contextual analysis, Tessmer and Richey (1997) proposed a model consisting of three phases: (a) strategy planning. In this phase, the designer determines the parameters of the task and contextual factors (e.g., table 3), identifies data targets, selects the appropriate methods (e.g., survey, interview, or observation), and constructs/modifies the tool; (b) data collection and analysis; (c) design and development. Although the contextual analysis was used to some extent in the original NSF-funded program design, it was not explicitly revisited as part of the redesign for the broader internally sustained program model.

Participatory Design and Co-Design

One participant explicitly expressed her wish, "when I joined the program, I was thinking maybe we would codesign with people from different disciplines. I think that would also be a really nice research opportunity for everyone." According to Yang et al. (2020), since participants came from multiple disciplines, the signature pedagogies of each discipline should be considered in efforts to build connection and relevance between the workshops and participants. A participatory design approach would have brought forward the insights and expertise from the group of participants but may have faced challenges related to the short timeline for program redesign.

Participatory design is a human-centered design practice (Sanders & Stappers, 2008) that "utilizes users as partners in design phases" (Farmer, 2022, p. 12) but that has not been extensively adopted in the field of instructional design. One approach to collaborative design is co-design, in which the collective creativity of designers and participants is leveraged in the design process (Sanders & Stappers, 2008). In a co-design process for GK-12, the role of participants and host teachers in the program would change compared to a traditional instructional design approach (e.g., ADDIE). Participants and host teachers would be involved as designers along with the program leaders, with boundaries blurred and roles mixed. In addition to providing insights and expertise in the ideation and design process, participants' emerging sense of dual identities as teachers and researchers would also be supported. Co-design with learners involved as designers to serve their own learning experience can not only get buy-in from learners that increase commitment but also allow them to personalize their learning experience and their professional development.

Incorporating learner analysis, contextual analysis, and participatory design into the program redesign process are crucial steps to creating a successful program. However, it is important to note that these measures alone do not guarantee success. From our perspectives as the program staff, the program has been successful in achieving its established goals and benefiting graduate participants, K-12 students, and teachers. However, there is always room for improvement, and we must consider the areas of failure identified through our analysis in order to make necessary changes and continue to improve the program.

NEXT STEP: CONTINUOUS PROGRAM REDESIGN

To address the failures that emerged in the program, and to facilitate a more positive authentic learning experience for learners, the factors that caused the failures need to be taken into consideration in an ongoing redesign process. Program redesign should not be a one-time event, but rather a continuous process as learners' demographics change, along with emerging contextual factors. By analyzing design failures and their causes through a preliminary causal analysis, we revealed a strong need for a systematic upfront analysis that covers both learners and contexts to anticipate and address potential future "failures". To accomplish this, we have planned to adapt an instructional design model proposed by Davidson-Shivers et al. (2018) and the first two analysis phases of the International Society of Performance Improvement's (ISPI) performance improvement model, as the goals of the program are focused on improving participant learning and performance (see Figure 12)

Analysis & Information gathering. The design process starts with the analysis stage, which contains multiple phases to understand the vision and problem (organizational analysis), identify the current realities of the environment for participants' actual performance (environmental analysis), evaluate the target learning or performance, obtain data to clarify program and stakeholders' needs, determine existing gaps/failures, identify the factors causing the gaps by looking at both learner and contextual factors, and analyze instructional components including goals, contexts, learners, and contents. Information gathering for insights about existing materials and programs is important to inform the concurrent design.

Evaluation planning. According to Davidson-Shivers et al. (2018), this is the stage where designers & participants can collaboratively co-plan formative and summative evaluations based on an analysis of data and information collected from the analysis stage. An evaluation planning worksheet could be created for the formative evaluation and summative evaluation, respectively, detailing the questions and steps (e.g., stakeholders, content, evaluator/reviewer, methods/tools, timeline, data collection and analysis, data report)

FIGURE 12. A redesign model adapted from Davidson-Shivers et al., (2018).

Concurrent design. With the information and evaluation plans, a concurrent design can then take place. At this stage, major stakeholders (including program participants and host teachers) will be involved to co-design a revised program structure, motivational strategies, identify support, and select the pedagogical approaches. An iterative design and development process can be initiated at the beginning of this stage to ensure timely design and development, especially considering the limited time for program redesign. A concurrent design approach can enable a "seamless and simultaneous design and development process." (Davidson-Shivers et al., 2018, p. 68). The initial implementation can be carried out as a pilot test or first stages of the program for each cohort, to gain some insights into continuous revisions of the program redesign. Formative evaluations are conducted for continuous improvement based on the implementations.

Full implementations. With the insights from the initial implementation, major revisions, and interventions can be developed and deployed.

Summative evaluation. The purpose of the summative evaluation is to determine the value, value-added, and potential continuation (Davidson-Shivers et al., 2018). This last step is planned before the design process and will be carried out by an independent evaluator following a developed worksheet. The summative evaluation does not indicate the end of the redesign process. Instead, the findings from the

evaluation will inform an iterative concurrent design when applicable.

CONCLUSION

In conclusion, this case study highlights the importance of considering the needs of the learners and the context in which the program was taking place when designing an authentic learning education outreach program. Through program evaluation, we identified the shortcomings of the original program and used a cause-effect analysis approach to understand the reasons for its failure. We identified individual and environmental factors that highlighted the lack of upfront learner and contextual analyses, as well as the need for co-design to better engage participants and build connections considering the diverse and interdisciplinary nature of the program. The deployment of learner analysis, contextual analysis, and the co-design will not necessarily guarantee the success of a program. Rather, they are approaches to obtaining critical insights into learner and environment related factors to inform the design process. The success of a program can be justified by whether the established goals are achieved based on the program evaluation. Yet, the success of a program does not indicate positive learning experiences for all learners. As we fail forward in a successful educational outreach program, we propose an instructional design framework for continuous program redesign by adapting a concurrent design framework. This

narrative suggests that future programs should consider integrating upfront learner and contextual analyses, as well as participant co-design in initial design. It also encourages those involved in programs to seek out problems and failings (in addition to celebrating successes), as the basis for continuous program improvement.

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