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Do students recognize design features that promote interest in science and engineering?

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ABSTRACT

Unfortunately, most of the world is experiencing a shortage of employees for careers related to science, technology, engineering, and mathematics (STEM). Few students express interest in pursuing these fields, indicating that this shortage has no clear end. Thus, researchers and educators are grappling with ways to increase student interest in STEM fields. One suggestion is to include four critical curricular design features: (1) providing choice or autonomy in learning, (2) promoting personal relevance, (3) presenting appropriately challenging material, and (4) situating the investigations in socially and culturally appropriate contexts. In this mixed-methods study, we explore whether students recognize the incorporation of these curricular design features within a given curriculum and in what ways.

Keywords: engineering design, science education, scientific investigation, student interest

INTRODUCTION

Many of today's pressing challenges can be addressed by solutions with foundations in science, technology, engineering, and mathematics (STEM). Opportunities for STEM-related careers have increased by approximately 34% in the last decade (Boggs et al., 2022). However, there exists a shortage of STEM professionals globally, thus hindering scientific and engineering advancements that could address many of our problems (Kramer et al., 2015).

According to results from recent international assessments, one in three participating students stated they intended to pursue a STEM career. However, depending on the country, this number drops to as low as one in twenty (Organisation for Economic Co-operation and Development [OCED], 2023). Many studies predict that these rates are not high enough to fulfill the STEM professional shortage (Mostafa et al., 2018; Sayed, 2023), which is considered a major concern for many societies (OCED, 2023). Two primary factors influencing students' STEM career interests are attitudes toward STEM and science motivation (Razali, 2021). However, research shows that interest in STEM decreases in middle school (Archer et al., 2010; George, 2006). Thus, to address the global STEM professional shortage, we first need to address the issue of interest in STEM itself.

Theoretical Framework

In this study, we use the National Academies of Science, Engineering, and Medicine's (NASEM, 2019) *design features to promote interest and motivation through science investigation and engineering design*. NASEM (2019) suggests four design features to include in STEM curricula if we are to encourage student interest in STEM fields. These design features include

(1) providing choice or autonomy in learning,

(2) promoting personal relevance,

(3) presenting appropriately challenging material, and

(4) situating the investigations in socially and culturally appropriate contexts.

Research studies suggest that to increase interest in STEM and the number of students pursuing engineering and science careers, we must expose students to more engineering and science activities before their teenage years (Sneider & Ravel, 2021). Furthermore, facilitating interest is essential in motivating students to learn (Hidi & Renninger, 2006). Each of these curricular design features suggested by NASEM (2019) is described in more detail below.

Providing choice or autonomy

Presenting students with choice increases their active participation in learning (Kenny, 1993). Research studies provide evidence that increasing student choice not only correlates with increased test scores (Vansteenkiste et al.,

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2004) but is also associated with improved student interest (Nieswandt & Horowitz, 2015) and perceptions of learning science (Ayotte-Beaudet & Potvin, 2020). Furthermore, autonomy has been identified as a crucial element in engaging students in student-centered learning (Lee & Hannafin, 2016). However, other research studies suggest that ample choice without limitations or support may have a negative effect (D'Ailly, 2004).

Promoting personal relevance

Research studies also demonstrate that students prefer learning about content that they have or could encounter in their daily life (e.g., disease transmission) rather than content that is more abstract (e.g., molecules) or procedural (e.g., designing experiments) (Bybee & McCrae, 2011). Similarly, students prefer content that tangibly involves them in the learning process (Morgan et al., 2022). It allows them to be part of a solution now rather than in an unforeseeable future (Nieswandt & Horowitz, 2015). However, most classroom teachers are not setting students up to address challenges that occur in their own lives or are otherwise important to them (NASEM, 2019).

Presenting appropriately challenging material

STEM content, particularly science, is often perceived as difficult. However, this is not always considered a negative quality (Archer et al., 2010). If the STEM content engages students in a challenge while setting them up to be successful, difficulty can be a positive feature (Sullivan et al., 2014). This is a direct portrayal of Vygotsky's (1978) zone of proximal development (ZPD), in which learning is optimized when a task is appropriately challenging, and individuals are provided proper support to accomplish the task. Nieswandt and Horowitz (2015) indicate that instructors should appropriately align students' experiences between content they have mastered and content that requires assistance to master for optimal interest growth.

Situating the investigations

Community-based structures, such as ethnicity, geographic location, or social environment, can influence a person's participation in academic content. Furthermore, studies indicate that people and context are an important part of subtle and not-so-subtle influences on a person's interest in STEM (e.g., Calabrese-Barton et al., 2020). Situating content in local phenomena or contexts is a curricular feature that promotes a personal connection to the content and increases student interest (Tan et al., 2013; Tovar-Gálvez, 2021). More specifically, a curriculum that allows students to recognize issues specific to their community contextualizes learning, making content more meaningful (Tovar-Gálvez, 2021) and enabling students to envision themselves as active societal participants (Jordan et al., 2021). Familial or social relationships can also influence students' interests (Bergin, 2016). As teachers establish a sense of connectedness to content through students' cultural and social experiences, learning becomes more valuable (NASEM, 2019).

Research questions

Prior research (Calabrese et al., 2023) indicated that students participating in STEM programs promoting these curricular design features were able to recognize the inclusion of the features and even showed increase interest in science and engineering at the conclusion of the program. Although such programs may lead to increased interest in STEM, the research literature lacks additional concrete examples of curricular programs that manifest all these features together. Thus, there is a need for curriculum developers to explicitly provide concrete examples of activities that utilize these curricular design features coupled with research studies that investigate a relationship with student interest. In this study, we aim to answer the following research question: *Within a science and engineering curricular program, in what ways do students recognize four curricular design features associated with interest in STEM?*

MATERIALS AND METHODS

Participants

Study participants were ninth-grade students (*N* = 66) from a suburban middle school in the western United States. Two teachers led the two classes (*teacher A participants* = 33 and *teacher B participants* = 33). The 2023-2024 demographics for the selected school district were, as follows: 55.7% White, 30.2% Hispanic, 6.1% African American or Black, 3.9% multiple race, 1.9% Asian, 1.5 % Pacific Islander, and 0.7% American Indian. Additionally, 18.0% were English learners, and 13.6% were designated as a student with a disability. Finally, 49.7% were labeled economically disadvantaged (Utah State Board of Education, 2023), i.e., eligible for free/reduced lunch (Utah State Legislature, 2023).

Curricular Program

We provided the instructors with detailed lesson plans for the curricular program along with an individualized professional development session before instruction and additional one-on-one guidance as needed. As the curricular program was part of a three-year design-based research project (Songer et al., 2024), the instructors had multiple degrees of freedom within instruction. These were then evaluated and used to modify the curriculum for later use. The curricular program was implemented over six weeks as part of the regular science instruction. During the first two curricular sections, students observed and recorded data about the animal species in their neighborhoods and compared species richness to data from another location. Next, students studied species relationships, such as how differing conditions (e.g., a new competitor) would affect the population of those species over time. Given the different conditional changes, they made predictions on population change over time, conducted a computer simulation to apply the changes, and compared their predictions with the simulation's results. In the curriculum's third section, students completed the engineering design process to engage in real-world engineering practices. This included defining a problem pertinent to the local ecology, drafting potential solutions, building one of those solutions, reflecting on their solution and their process, and revising their solution. Specifically, student groups addressed economic and/or ecological problems caused by local invasive insects by designing and building an insect trap over at least two build iterations. The curriculum also required students to work within time, budgetary, and materials constraints to engineer their insect trap. At the end of the program, the students presented to their classmates or local stakeholders about their invasive species and solution (i.e., trap).

Instruments

To assess student interest in science and evaluate student recognition of including the four curricular design features, the researchers administered two Likert-style surveys: The design feature survey (DFS) and the individual interest questionnaire (IIQ).

Design feature survey

To evaluate students' views on the presence of the four curricular design features in the curriculum, all participants (N = 66) completed a survey, henceforth referred to as the DFS, at the end of the curricular program. The researchers designed the DFS with a single question dedicated to each of the NASEM (2019) curricular design features. That is, the DFS consisted of four statements for students to rate their level of agreement (see **Appendix A**). Each question included a five-point Likert scale where one indicated that the participant strongly disagreed and five indicated that they strongly agreed. A score of one indicated that the student strongly disagreed with the statement that the curricular unit included that design feature. In contrast, a score of five indicated that the student strongly agreed. Additionally, each question included an open-response feature for the participants to elaborate on their responses, such as by including how they felt the unit included that particular design feature. For example, the second statement on the DFS states "I felt like this information in this unit was appropriately challenging for me (not too difficult and not too easy)." A student who responded with a four, meaning slightly agree, stated "It was difficult, but I could do it." The Likert and open-ended portions required responses before participants could submit the DFS.

Individual interest questionnaire and student interviews

Students completed a modified version of Rotgans's (2015) IIQ (see **Appendix B**). In this seven-item questionnaire, participants rate their level of agreement with statements related to their interest in science. In the present study, the researchers kept all seven IIQ questions; however, the questions were slightly modified to be more updated or generalized to all science. For example, on the original IIQ, one question states, "When I am reading something about biochemistry, or watch something about biochemistry on TV, I am fully focused and forget everything around me." The survey for the present study changed this question to read, "When I am reading something about science or watching something about science on TV/streaming, I am fully focused and forget everything around me." In this study, the IIQ was presented online in a five-point Likert format where a score of 1 indicated that the participant strongly disagreed with the statement, and a score of 5 indicated that they strongly agreed with the statement. All questions on the IIQ were required for the students to submit.

To determine which students would be selected for interviews, the researchers separated the IIQ responses by the classroom teacher. They calculated the means and standard deviations of the responses for each respective classroom. The researchers divided the students into three categories within each classroom by their total IIQ score. A high score meant that the total IIQ score was greater than one standard deviation above the mean, a low score meant that the total IIQ score was less than one standard deviation below the mean, and an average score meant that the total IIQ score was within one standard deviation of the mean inclusive. After the researchers separated the responses into groups, each participant was assigned a number ranging from 1 to the total number of students in their respective group. Using a random number generator, the researchers selected one interview participant from each category within each class period (i.e., one low, one medium, and one high IIQ score from all four class periods). Thus, the researchers interviewed a total of 12 students.

Using the results from the IIQ, twelve semi-structured interviews were conducted with the selected student participants. To ensure that students had been exposed to the majority of the curriculum, the interviews took place during the last unit of the curriculum after students had begun building their traps. Each interview was approximately ten minutes in length. During the interviews, the researchers asked students if they felt the curriculum included the four curricular design features. Additionally, the researchers asked students to explain their enjoyment or lack thereof for each aspect of the curriculum (see **Appendix C**).

Data Analysis

Design feature survey

The researchers computed the descriptive statistics for the items on the DFS. Specifically, the researchers conducted the means and standard deviation for each item.

Student interviews

To analyze the selected student interviews, the researchers conducted a thematic analysis in two cycles, first with holistic coding, followed by pattern coding to condense the codes into themes (Saldaña, 2009). Two researchers coded each question response as a whole unit, though each response could have anywhere from one to three codes applied.

The researchers first coded one interview to establish an initial set of codes. Then, the researchers separately coded four additional interviews, using the established codes and creating new codes as necessary. The researchers then met to compare codes on these four interviews, reconciling any discrepancies until there was 100% agreement. After comparing codes, any codes created during the comparison process were added to the code book. The researchers then repeated this process twice, individually coding four student interviews in the third cycle and three in the final cycle. The researchers met and consolidated/reconciled codes between each cycle, establishing 100% agreement for each cycle.

After all 12 interviews were coded, the researchers separately grouped the codes that appeared to be related into overarching themes. The researchers then met to compare the groups. Once the researchers established 100% agreement on the groups for the codes, they established themes based on the

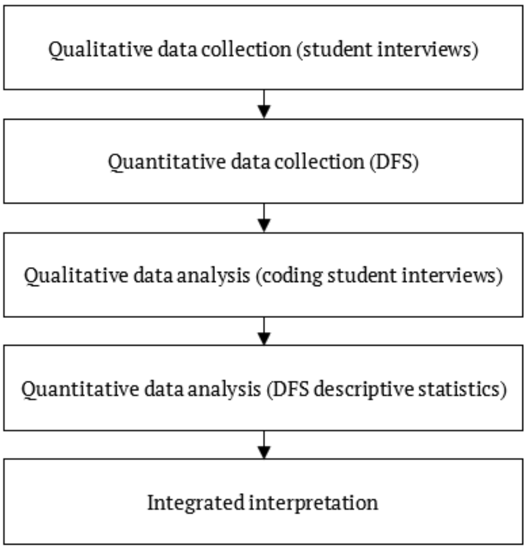

Figure 1. Sequential independent structure (Source: Authors' own elaboration)

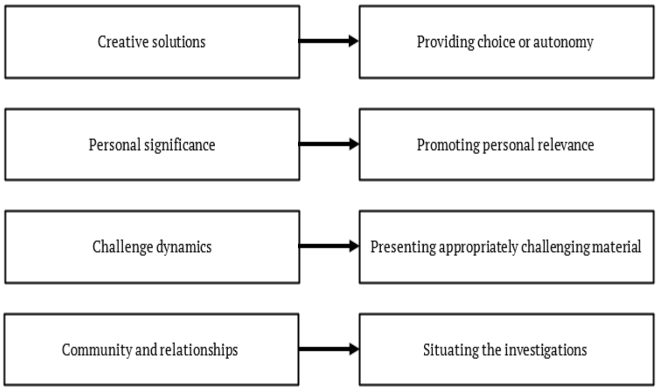

Figure 2. Theme and curricular design feature alignment (Source: Authors' own elaboration)

relationships of the grouped codes. In total, the researchers coded 98 student responses, applying 165 codes (46 unique codes with several responses having multiple codes). Finally, the researchers condensed the codes into five themes.

Mixed methods

This study uses a sequential-independent design (Schoonenboom & Johnson, 2017). First, the researchers conducted the student interviews, and then the students completed the DFS. The analyses for each strand were conducted independently, starting with the thematic analysis of the student interview transcripts and followed by the computation of the descriptive statistics for the DFS data. Finally, the results were interpreted simultaneously (see **Figure 1**).

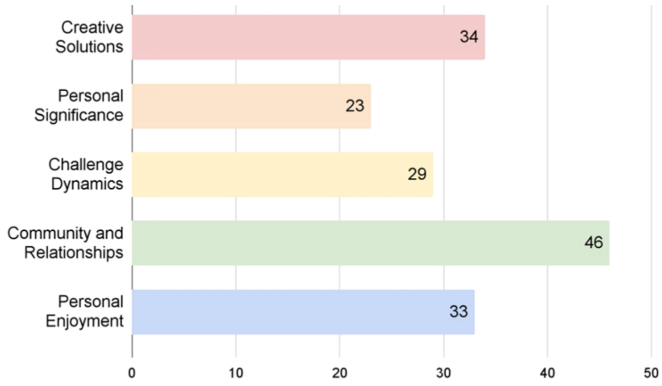

Figure 3. Theme frequencies (Source: Authors' own elaboration)

RESULTS

In the present study, we aimed to answer the following research question: *Within a science and engineering curricular program, in what ways do students recognize four curricular design features associated with interest in STEM?*

Quantitative Results

On the DFS, students reported average levels of inclusion of the four curricular design features (see **Table 1**), with all scores ranging between a 3 and 4. The highest reported curricular design feature was provided choice or autonomy, and the lowest reported curricular design feature was promoted personal relevance.

Qualitative Findings

After the researchers' pattern coding, students' responses could be categorized into five themes: creative solutions, challenge dynamics, personal significance, community and relationships, and personal enjoyment. Four of the five themes align with the curricular design features (i.e., all except personal enjoyment). However, due to the nature of the responses, the themes highlighted specific details of the curricular design feature. The alignment of the themes and curricular design features can be seen in **Figure 2**, and the distributions of the themes can be seen in **Figure 3**. Subsequent sections of the paper will explore each theme in detail.

Creative solutions

The creative solutions theme aligns with the providing choice or autonomy curricular design feature. When asked about the opportunity to make choices, students often mentioned the variety of resources they had and the creative freedom the curricular program allotted them. Some students

Table 1. Curricular design feature survey results

Statement	M	SD
1. I felt like I was able to make choices during the ISE unit.	3.86	0.86
2. I felt like this information in the ISE unit was appropriately challenging for me (not too difficult and not too easy).	3.68	0.86
3. I felt like the information in the ISE unit was relevant to my life.	2.98	1.00
4. I felt like this information in the ISE unit is important to my community.	3.74	0.88

Note. M: Mean & SD: Standard deviation

Table 2. Creative solutions quotes

Student	Quote
Student 1	"There was definitely limitations with the resources we did have, but it actually worked really well for my group, but I think we had a lot of freedom because we could do whatever we wanted."
Student 2	"Well, he gave us a list of resources, which I understand because like, we can't just get anything we want, but I think we had like good selection of stuff."
Student 3	"I enjoyed having a sort of creative control aspect to it. I like seeing whether or not things would work out."

Table 3. Personal significance quotes

Student	Quote
Student 4	"I get a lot of invasive insects in my room, so being able to try to, like, problem solve it was helpful so that I could, like, get rid of them. And it was also just sort of helpful to see how it would affect like the economy and the environment and everything."
Student 5	"Not necessarily ... I feel like science is definitely super important. Some of the projects we did were helpful. Some of them I don't know if we'll use."
Student 6	"It gave me an opportunity to see what a career in that could be like and whether I enjoyed it or not. And then it also just gave me the opportunity to see whether that was something I would want to do when I grew up."

did point out that they were limited in the resources and materials they were given.

However, this was described as a reasonable or positive constraint, demonstrating the students' adaptability in navigating these limitations. There were no students who expressed that they felt like they didn't have any choice or freedom during the curricular program.

When asked what they found enjoyable about the project, many students also mentioned the open-endedness of the curricular program. Although uncertainty can sometimes be portrayed as a negative feature, the students embraced the challenge, viewing it as an important aspect of the learning process. The students expressed that they liked having an element of uncertainty in the efficacy of their traps before placement. Allowing the students to engage in their autonomy and creativity within the curriculum enabled them to cultivate critical thinking skills and establish an element of comfort with risk-taking (**Table 2**).

Personal significance

The personal significance theme closely aligns with the promoting personal relevance curricular design feature. As relevance is subjective upon the individual's perspectives, students' descriptions of how the curriculum related to their personal lives varied. There were three instances where students acknowledged that science and invasive species were important topics but not necessarily the exact content they learned. For instance, when one student was asked if they felt that the material was relevant to their personal life, they acknowledged the importance of science while pointing out that they may not use it outside of the classroom (see Student 5's response in **Table 3**). Additionally, there were only two instances where students expressed that they did not see any personal significance to the curriculum.

Two common responses emerged among the students who noted the curricular program's relevance: prior experiences with invasive insects and the recognition of the importance of problem-solving skills in their personal contexts. Drawing from personal experiences of the consequences of invasive insects in their local environments, these students found resonance in the curriculum's focus on local issues and potential solutions. Additionally, by honing their problem-solving skills within the curriculum context, students gained confidence and empowerment, preparing them for the challenges they may encounter outside of the classroom.

Multiple students used their engineering design task as a chance to explore the engineering and science fields as potential areas of study. Through hands-on engagement with the curriculum, students gained valuable insights into the applications of engineering and science concepts, which provided interest and curiosity in these fields.

Challenge dynamics

The challenge dynamics theme closely aligns with the presenting appropriately challenging material curricular design feature. Responses regarding the level of challenge or difficulty of the curriculum were widely varied. While some students felt the unit was easy, others felt it was much harder than what they were used to. Additionally, some students noted variability in difficulty across different parts of the curriculum, suggesting that certain aspects posed more challenges than others.

A commonly expressed notion among students was that part of the challenge of the project stemmed from the type of effort required to complete the program. Rather than having straightforward tasks, the project required a certain level of problem-solving skills that necessitated critical thinking and continual evaluation of potential solutions. Thus, students were required to engage deeper in the material, possibly in ways they had not experienced previously, fostering curiosity and resilience (**Table 4**).

Community and relationships

The Community and Relationships theme aligns with the situating the investigation curricular design feature. During the interviews, many students spoke highly of the collaborative aspect of the curriculum. This was true for different units, including but not limited to the engineering design portion and outdoor observations. The collaborative environment fostered a sense of camaraderie, as students enjoyed the chance to collaborate with their peers to refine and enhance their ideas. Students also mentioned enjoying the shared experience created by being on a "team" working toward "fixing the community together." There was one student who chose to work on their own, but there were no instances of students complaining about their communal aspect.

Table 4. Challenge dynamics quotes

Student	Quote
Student 7	"I don't know. It depends on where you're at, but for me, It wasn't hard or easy to do whatever it was like right there in the middle."
Student 8	"[It was] pretty easy because [the insect] was kind of small. We just had to draw it in because it only liked one thing."
Student 9	"I would say it was kind of difficult because when we first planned it out, it looked like it was going to be easy, but then we had to change some stuff that we had to do, so it was a little difficult."
Student 10	"I think it was more difficult because in 8th grade it was like right in front of us, but in this unit we had to like figure it out."

Table 5. Community and relationships quotes

Student	Quote
Student 11	"I think it's good if I have like another person with me because I can–I can make choices on my own. I'm a functioning human–But with other people I can expand on my choices cause without, 'cause I can reference my ideas to their ideas, and we can combine our ideas, or we can pick one or the other."
Student 12	"I think that like it helped like raising more awareness about all these insects and stuff, and I guess just gets people more involved in actually trying to stop them."
Student 13	"I didn't catch anything, but like, if everyone were to, like, learn how to build a trap and set them out, maybe there wouldn't be as many roaming."

Table 6. Personal enjoyment quotes

Student	Quote
Student 14	"If I'm not interested in the stuff I'm learning about, I don't do well with it at all. So like I didn't do well last year at all, but this year I'm doing better. I have a better grade."
Student 15	"I thought it was interesting. It was fun making the trap."
Student 16	"[This unit was] more enjoyable because we got to do more and interact with more stuff."
Student 17	"I'd probably say [this unit was] less enjoyable because I think learning about atoms was a little bit more interesting, and we did some fun activities in that unit."

Students also mentioned the importance of the unit in connection with the local issue of invasive insects. Although some students did not recognize invasive species as a pervasive topic, many did verbalize how the curriculum increased their awareness of the issue. Furthermore, several students mentioned the importance of community awareness and involvement in resolving such issues. The only negative responses involving community or relationships were from students whose traps were ineffective, though even those had a hopeful tone, expressing a belief in the community's collective capacity to overcome the invasive insects' problem (**Table 5**).

Personal enjoyment

Though not a curricular design feature, interest and enjoyment go hand in hand. One student mentioned how their heightened interest in the curriculum material translated into improved academic performance, noting that they were doing better than they were previously. Only two students directly expressed that they did not enjoy the material, and both mentioned that they had previous experience with other enjoyable activities in their science classes.

In contrast with students' experiences with prior STEM curricular units, the present curriculum was considered highly involved. Many used phrases like "busy work" and "notes" or "packets" to describe prior classroom content, whereas words like "interactive," "project," and "fun" to describe their experience with the new curriculum. This shift towards more dynamic and hands-on learning experiences resonated with students. However, the few students who stated that they enjoyed previous content more also used similar words to describe why they enjoyed the previous content (**Table 6**).

DISCUSSION

In this paper, we aimed to explore whether students recognized the four curricular design features recognized by others as being associated with interest in STEM within the given curriculum. Student experiences varied in both the qualitative findings and quantitative findings. As each question required an opinion-based response, it is unlikely that all students would have the same opinion in every aspect. Thus, it is no surprise that the quantitative findings lean more toward the middle of the Likert scale, implying the curriculum included each curricular design feature to a moderate degree. However, unpacking the qualitative findings provides deeper insight into how the curriculum included the curricular design features and potentially even positively affected the learning experience.

Perhaps the most uniform response in the interviews was students' interpretations of their level of autonomy during the unit. Without prompting, many students pointed out that they were, in fact, limited, though they still felt they had supportive options to choose from. This is consistent with D'Ailly's (2004) guidelines for presenting students with meaningful choices with restrictions.

One unique result was exploring whether the material was "appropriately challenging." As this was part of the curriculum administered in a public high school setting, "appropriately challenging" is expected to vary from student to student. Furthermore, while some students' responses hinted directly at what some might consider appropriately challenging (e.g., "right there in the middle"–Student 7), some students found the material too difficult, while others found it too easy. In a heterogenous setting such as a public high school, one would anticipate that material that is "appropriately challenging" for one student may be too easy or too difficult for another. However, what is interesting is the language that students used to describe the material consistently suggested engagement. This is consistent with Archer et al.'s (2010) finding that a desirable amount of challenge requires students to "use their brains" (p. 629), as well as a portrayal of ZPD (Vygotsky, 1978) in context.

As the curriculum included local invasive insects, many students acknowledged their personal experiences with the insects before the curriculum. However, with the trap-building and presentation activities, students became aware of their ability to unite with their community to solve a local issue. This is similar to Tovar-Gálvez's (2021) finding of using the material to create a sense of possible connectedness with their community. After the curricular program, students naturally wanted to raise awareness in their community and potentially reduce the number of invasive insects in their area.

Though personal enjoyment was not a stated curricular design feature, students' comments on whether or not they enjoyed the material provided insight into the possible impact of including these curricular design features on students' interest in the curriculum. When asked about the curricular program, students often took the time to mention their enjoyment of the trap-building exercise. Specifically, building the trap itself proved to be a memorable experience. One student even went as far as to make their connection that because they enjoyed the curricular program, their grade had improved. By contrast, students who suggested they did not enjoy the material referenced other activities they did in prior classes as those where a connection was made.

CONCLUSIONS

Attempting to increase student interest in STEM content can prove challenging for many teachers. Thus, there exists a need for more examples of content that both aligns with educational standards and fosters student interest. Following the NASEM (2019) guidelines, we included four curricular design features to increase student interest in their science classes. More specifically, we included more elements of choice (e.g., designing their traps), personal relevance (e.g., familiarity with local insects), appropriate challenge (e.g., trap building), and cultural and social situations (e.g., awareness of local issues).

The students' comments provide evidence that the inclusion of these curricular features provoked generally positive responses during the learning process. However, specific examples of curricular design features (e.g., building traps to capture invasive insects) worked better for some students than others. We are not suggesting that all students recognize or appreciate any one example. For example, we will never have one example that provides relevance or significance to all students, as noted by Student 5. Nevertheless, we encourage curriculum developers to realize and study additional, new examples as we continue to explore this inclusion of curricular design features associated with interest.

Limitations

While the interview questions were geared toward deciphering students' recognition of the curricular design features, many responses had multiple codes. Furthermore, many of the multi-coded responses fell into multiple themes, further suggesting the recognition of the curricular design features despite the nature of the question.

It is important to note that the researcher who conducted student interviews regularly visited the classroom, which could have impacted students' verbal responses. However, the researcher's visits were limited in terms of frequency and student involvement. Similarly, the IIQ and DFS were conducted in the presence of the regular classroom teacher; however, the teacher did not have access to the results.

Finally, validity and reliability were not calculated for the IIQ and DFS within the context of the study. However, Rotgans (2015) deemed the IIQ valid in its original form with secondary students, and only minor revisions were made to the instrument for the study. The DFS is limited to only one question for each design feature with an explicit description of the design feature itself. Thus, though the researchers do not foresee any threats to the instrument's validity, they recommend exercising caution when translating it to additional contexts.

Implications and Future Research

Students' positive responses provide additional evidence to support the association of the curricular design features with student interest. Teachers should attempt to include these curricular design features in multiple formats when possible to increase the number of students who may recognize or be impacted by them. However, more multifaceted analyses are needed to determine how students interpret the benefits of these features.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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APPENDIX A: DESIGN FEATURE SURVEY

Please rate your level of agreement with the following statements from strongly disagree (1) to strongly agree (5). Then explain your answer.

1. I felt like I was able to make choices during this unit.
2. I felt like this information in this unit was appropriately challenging for me (not too difficult and not too easy).
3. I felt like the information in this unit was relevant to my life.
4. I felt like this information in this unit is important to my community.

APPENDIX B: INDIVIDUAL INTEREST QUESTIONNAIRE

Please rate your level of agreement with the following statements (1 = strongly disagree, 5 = strongly agree).

1. I am very interested in science.
2. I read a lot about science outside of school.
3. I always look forward to my science lessons because I enjoy them a lot.
4. I have been interested in science since I was young.
5. I watch a lot of science-related shows or movies (e.g., Discovery Channel, Life in Color, NASA X, and Star Trek).
6. Later in my life I want to pursue a career in science or a science-related discipline.
7. When I am reading something about science, or watching something about science on TV/streaming, I am fully focused and forget everything around me.

APPENDIX C: SEMI-STRUCTURED INTERVIEW QUESTIONS

1. Can you describe the unit that you are completing right now in this class?
2. Pick a science unit you have completed in eighth grade. What was the unit on? Did you find [this] unit more or less enjoyable than your eighth grade unit? Why or why not?
3. Were the [curricular program] activities relevant to your life? If so, how do you feel that this unit relates to your personal life?
4. How much choice did you have in how you built your trap? Did you enjoy making your own choices or not? Why?
5. How difficult or easy was it for you and your team to design a trap for your invasive insect? Do you feel like it was more difficult or easier than the eighth grade unit you talked about earlier? Why?
6. One aspect of this unit was having you and your team design a trap for an insect that is causing destruction or harm to crops and people in Utah. What did you think of this activity that might help solve a problem in your community? Was it interesting for you or not? Did you enjoy it (or not)? Why or why not?