STEM Interest Among Rural Youth in an Informal Program

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Abstract
In order to develop science, technology, engineering, and math (STEM) knowledge and solutions that address global concerns, there is a need to develop pathways to strengthen STEM interest among rural youth, especially girls. Previous research suggests that informal STEM programs can stimulate participant interest due to the absence of pressures from external assessment (Rogoff, et al, 2016). However, little is known about which instructional methods in an informal STEM program focused on place-conscious programming in a rural community will support the development of youth STEM interest. The purpose of this study was to examine the impact of three instructional methods (hands-on, role models, and culminating projects) on STEM interest development for rural youth, ages eight to twelve, in an informal place-conscious STEM program. Data were collected through observations, focus group interviews, and STEM interest surveys. Participants included youth (N=31) in grades 3rd through 5th grades attending two local schools in one rural community. Results indicated STEM interest increased through collaborative work, new knowledge, and action research. Results also showed gender differences in STEM interest development. Girls' STEM interest (n=16) was heightened through seeing the personal relevance to their community, whereas boys' STEM interest (n=14) was heightened through actively working together. This study contributes to the empirical literature regarding STEM interest, informal education, and instructional methods for rural youth. Recommendations are made for future studies.

Keywords: Place-Conscious Pedagogy, Informal Education, STEM Interest, Rural, Instructional Methods, Gender Differences

Introduction

This study proposes an answer to the worldwide issue of developing Science, Technology, Engineering, and Math (STEM) solutions to current and future issues. The focus is on developing interest in STEM through informal programming for youth. This study's youth participants were eight to 12 years of age. It was speculated that the youth of this age group would be more likely not to have developed peer groups and, therefore, more malleable in developing STEM interests that may be sustained throughout their academic journey. Additionally, rural areas were selected due to the underwhelming financial support these areas typically receive from dominant out-of-school time (OST) programs. Furthermore, a focus on gender differences was examined due to the unequal distribution of STEM career development in our current society.

Pilot Work

Qualitative community pilot interviews were conducted alongside a review of forward-facing documents to identify STEM issues in rural communities that need resolutions and are of importance. This qualitative research was based on a participatory-based research methodology. Key rural community members were identified through convenience sampling. Conversations were recorded, transcribed, and analyzed for codes, categories, and themes. These were triangulated with state legislative primer topics for the upcoming year. The data was viewed with a lens based on the Cultural Learning Pathways Framework (Bricker & Bell, 2014). The issues were evaluated based on places, positions, and actions important to communities. The identified STEM issues were utilized to inform the curriculum development of an informal rural program. The data revealed an overarching theme of Climate Change. Climate Change was categorized by discussion around water and the issues of flood, drought, and wildfires. The issues selected for curriculum development were based on STEM relevance to their possible solutions.

Climate Change was central to discussions, but other issues were also noted. A primary concern was the sustainability of rural communities. Each interview revealed additional concerns about the retention of the population. Specifically, youth outmigration from rural communities was a concern. It was considered that youth involved in learning about STEM solutions based on their community might generate maintained interest (Hidi & Renninger, 2006). The approach to solve this issue was a place-conscious curriculum design (Greunewald, 2003).

Problem

An informal STEM curriculum was developed alongside local university scientists following the pilot work that identified STEM issues. These original curriculum units were focused on engineering around water, temperature data related to wildfires, and planting geography based on water sources. The lesson outlines were based on Gruenewald's (2003) place-conscious design principles. Place-conscious design differs from place-based by considering other sociological factors essential to a place other than location. These factors include socioeconomic, political, and cultural influences. The lessons developed were focused on natural history, cultural journalism, and action research.

Place-Conscious Curriculum Framework

In the development of each curriculum unit, each lesson was focused on the three topics outlined by Greenwood. For the natural history lesson, the purpose is to provide “firsthand experience with the living world outside the classroom” (Gruenewald, 2003). Participants are oriented to the community through a question series based on the STEM topic. Another lesson focuses on cultural journalism. The lesson’s objective is accomplished by inviting local community members or role models to their space. The participants are provided a space to ask questions to gain insight into their community and their interaction with the STEM topic. The final lesson is based on action research. Action research provides the opportunity for participants to take action about the STEM topic based on their newly acquired knowledge. Gruenewald’s purpose for action research was to provide space to “potential engage teachers and students as problem solvers and place-makers” (2003, p. 640).

Solution

In order to incorporate place-conscious design into an informal program, attention was given to proven instructional methods. These instructional methods were then purposefully coupled with each place-conscious method to gain an enhanced methodology for increasing STEM interest in rural youth. The instructional methods that demonstrated the highest potential were hands-on, role models, and culminating projects.

The hands-on lesson was intertwined with the natural history of the community. The lesson developed engaged participants in recalling where they saw water being moved in their community. Participants should be encouraged to take notes during the lesson. Following the opening discussion, bags of PVC pieces are handed out. A challenge is presented in an inquiry-based approach to building a water pump. Participants are provided a bag of precut PVC parts and a video on how to assemble a pump. No other instruction was provided, only the challenge of building the pump to move water from one five-gallon bucket to another. The participants are allowed to watch the video as many times as they want, encouraged to take notes, and given minimal troubleshooting tips from the facilitator. The main problem is examining the valve and positioning it in the correct orientation. In groups of three, youth work together to pump water from one bucket to another. Afterward, participants are invited to document any other notes they may have.

The role model lesson was designed in alignment with cultural journalism. The researcher identifies and invites local community members with STEM topic knowledge to speak to the group. This session is intended to be more of a dialogue than a presentation of knowledge. Participants are provided pre-written interview questions to ask the invited community members. Community members are provided some training on interacting and relating with youth to bridge the age gap and build comfortability. After introductions to the group, youth are invited to ask their pre-written question and any follow-up questions during the time. Youth are curious and will ask other questions as it occurs to them during the session. These questions are spontaneous and generate stimulating conversation. Youth are encouraged to take notes about what they learned or found interesting concerning the STEM topic. After the first two lessons, youth are invited to take local community pictures before the final lesson.

A culminating project is intended to bridge the previous lesson and provide an opening for action research. The culminating project allows the youth to express local rural knowledge

(Avery, 2013) and their thoughts and reflections on the hands-on experiences and community member discussions. With those thoughts, photos from the community they selected are added to their presentation. Some youth can submit photos for inclusion in the culminating project. The researcher takes some photos. The researcher/facilitator takes requests from the youth for subjects and locations they would like photos. Many youths do not have access to technology to take photos or a way to send them to be integrated into the submissions. Their ideas are incorporated into photo subjects by including youth in photo solicitation. During the culminating project session, draft poster templates in PowerPoint format are provided. The templates include writing heading prompts and space for photos. Youth fill in their interpretation of what they have learned during the program. They also articulate what they think others viewing the poster should know. School and sponsor logos area added during editing for appearance purposes. The extra-large (38-inch by 46-inch) posters are printed and delivered to the youth. See Image 1 for a sample poster.

In some cases, the posters will be displayed by sponsoring organizations. One local sponsor has proposed that the youth present their posters to local community members during a program focused on water. A presentation would be ideal for action research integration within the culminating project but was not within the scope of the current study.

Image 1: An example of a culminating project from the final lesson.

Interest Effects

Harackiewicz et al. (2016, p. 1) defined, "Interest is both a psychological state of attention and affect toward a particular object or topic, and an enduring predisposition to reengage over time." All research questions examined interest effects based on each instructional method. The methodology was accomplished through qualitative methods of non-participant observations, focus group interviews, and self-report surveys. The findings were analyzed through deductive codes, attribute codes, and in vivo quotes. A priori qualitative codes were predetermined and used for observation protocol and coding focus group interview data.

The main findings for each instructional method are as follows. The hands-on instructional method's central theme was based on opportunities for collaboration. One participant stated, “Like sometimes we get things wrong and then it is like, oh, I got it right, you kind of feel like YAY!” The role model instructional method’s central theme was based on discovering new community knowledge. A participant was noted, stating, “Yes, it’s clean for animals now, OK, but it’s not it’s not cool for people. Well, it was farther down, people want that water farther down.” The culminating project instructional method’s central theme was determined to be action research, a component of the place-conscious framework. One participant states, “knowing that like the whole, like a lot of people could see it.” The figure 1. below depicts the overlapping interest indicators by each instructional method and where all three show the same interest indicator.

STEM Interest Major Indicators

Figure 1: The Venn Diagram illustrates the overlap in major interest indicators for each instructional method.

STEM Interest Between Genders

It was also determined that boys (N=16) and girls (N=14) were affected differently. Boys were more interested in the instructional methods due to activity level, sociability, and group work. It was noted that boys wanted to work in groups and be actively engaged in each instructional method. They enjoyed the building, asking questions, and typing their posters. Girls were more interested in the instructional methods due to the personal relevance and awareness of the topic. The girls would make connections to their own experiences and personal knowledge of water. It was also noted that girls expressed they did not like when someone took over during group work and preferred autonomy to working in a group.

Significance and Recommendations

The significance of this study on educational research is essential. In this upper-elementary age group, youth, especially girls, have not been well represented in the literature. Most work in STEM education focuses on middle and high school grade levels. The significance of this study is that peer groups form during these years and could lead to STEM interest that is sustained throughout the middle and high school years. Therefore. One recommendation is for longitudinal studies to follow the more prolonged-term effects of programs such as these at earlier grade levels.

Additionally, the observation of interest could be improved. This study is one of the first interest non-participant observations made in the literature. More information from behavior analysts could improve future findings. The informal STEM program should be implemented in other rural communities, including reservations, to validate these findings further.

Conclusion

This research study examining STEM interest development through an informal place-conscious STEM program for rural youth demonstrates how three different instructional methods can facilitate STEM interest for upper elementary-aged youth and offers insights for differentiating instruction for gender. Specifically, boys were interested in actively interacting, and girls were interested through their awareness and personal relevance to the STEM content. These findings also indicate a desire expressed by younger participants to be actively involved with STEM lessons and not passively watching.

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