RURAL YOUTH'S ENROLLMENT IN A STEM SUMMER CAMP: A COMPARISON BETWEEN IN-PERSON AND TAKE-HOME EXPERIENCES

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Madison Rena Milbrath

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Madison Rena Milbrath

The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

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SUPERVISORY COMMITTEE:

Dr. Lisa Montplaisir
Chair

Dr. Jeffrey Boyer

Dr. Brent Hill

Approved:

4/28/21 — Date

Dr. Kendra Greenlee — Department Chair

ABSTRACT

The utilization of informal STEM education opportunities has been well established as a way to supplement and support formal STEM education learning. Many of the studies confirming this were completed in urban settings. Recently there have been calls to better our understanding of rural populations and their interactions with informal STEM education. This study analyzed the registration records of youth in an informal STEM education experience as well as survey responses from the youths’ parents/guardians. This was done in an attempt to understand if rurality impacts participation in an in-person STEM education experience compared to a take-home STEM education experience. Additional work looking at survey responses attempted to find other predictors or indicators that could be reasons for participation associated with rural populations.

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INTRODUCTION

Informal education experiences are opportunities to expand a student's understanding and growth in regards to a topic beyond what has occurred in a traditional formal education setting, such as a classroom. (Bell et al., 2009; Green, 2005; Meyers et al., 2013). There is evidence that supports the claim that informal education experiences in Science Technology Engineering and Math (STEM) can be beneficial for youth. Participation in short-term STEM summer experiences were shown to increase students' interest in STEM (Bell et al., 2009; King, 2017; Kitchen et al., 2018; Mohr-Schroeder et al., 2014). However, like most research completed on informal STEM education, the student's studied were from an urban setting. This can be problematic because it may lead to gaps in understanding or unfounded assumptions about how rural youth can benefit from informal STEM education experiences.

We know that minority groups can and do benefit from these experiences, but may have different barriers to participation. (Gilliam et al., 2017; Stevens et al., 2016; Todd & Zvoch, 2019). We propose that similar to minority groups based on race and ethnicity or sex and gender, rural youth are members of a minority population based on geographic distance and population size. While one-fifth of all students in the United States are in a rural setting, they are still under-represented in education research (United States Census Bureau, 2019). We set forward in this study with the intention of comparing rural participants to urban participants to better understand how findings concluded in some urban research studies could apply to rural populations. Additionally, we aim to further investigate the unique ideas that occur as a specific result of working with rural populations. Currently, there are assumptions about what existing barriers prevent rural populations from being able to attend informal STEM education experiences (Hartman & Hines-Bergmeier, 2015). We took these into consideration when reviewing what information to gather about participants as well as what questions to ask when creating our survey instruments. This project aims to clarify what may be barriers for rural youth to participate in an informal STEM education experience. The study includes the utilization of two different informal STEM education experience formats, in-person and take-home.

Research Questions

1. Do rural youth participate at differing rates in a take-home informal STEM education experience compared to an in-person instruction experience?
    a. H1: Rural youth participate more in a take-home informal STEM education experience compared to an in-person instruction experience
2. What factors contribute to a rural person's enrollment in an informal STEM summer camp experience?

LITERATURE REVIEW

Informal Education

Informal Education

Informal education experiences are learning events that occur outside the structure and environment of a classroom. Informal learning environments can be categorized into three major settings: 1) everyday experiences, 2) designed settings, and 3) programmed settings (Kotys-Schwartz et al., 2011). These three environments include a wide array of experiences such as reading books at home, visiting museums, zoos, and libraries or participating in after-school programs, clubs, and summer camps. This variety in structure has allowed many people to engage with a multitude of experiences to varying degrees throughout their lifetime. Informal learning experiences have the potential to support students' learning and engagement in a formal learning environment. Informal learning experiences address the limitations of the formal school experience by providing opportunities that build students' awareness of and interest in a field such as science or music (Bell et al., 2009; Green, 2005; Meyers et al., 2013). Without these additional experiences, people often don't have exposure to new and exciting topics which have not yet been integrated into formal schooling.

Formal vs Informal Education

Formal education is traditionally characterized by some kind of institutionalized instruction and then some kind of summative assessment of retention and application of the material presented through grades, performance reports, or some other measure of competency. And, while formal education can be tied to programmatic instruction, informal education embraces the concept of personal, lifelong learning. Stereotypically, in K-12 education it consists of public or private school instruction, although increasingly this also includes homeschool instruction. In contrast, although informal education settings sometimes follow similar frameworks as formal education, a key difference is that participation is a choice rather than a requirement. In informal education a participant may attend repeated events, such as a weekly sketch group, or an after-school robotics club, but the participant may also only be there once such as a visit to a museum. Instruction in informal education may come via a wide variety of conduits: mentor, guide, coach, or peer. Instruction may even be completely self-guided, as visiting an exhibition or reading a book to learn a new skill. Informal learning environments are often composed in a way to promote learning through real-world modeling and examples (Martin, 2004; Meredith, 2010). The aspect of real-world connections makes learning informally very personal and relevant to each learner (Green, 2005; James, 2017). Another way that informal education differs from formal education is freedom of choice. Often times in formal education there is little freedom given to the learner regarding what or how to learn. Contrastingly, informal education is rich with autonomy, and autonomous choices are often a corner stone of the informal education experience. These and other components are compared and contrasted below in Table 1, adopted from (Boustedt et al., 2011).

Table 1

Compare and Contrast Formal and Informal Learning Environments

Component	Formal Learning	Informal Learning
Access to Information	Class time/ In-person	Internet, In-person
Availability of help	Office hours, tutoring hours	Forums, online videos, friends/coworkers
Setting	Classroom	Anywhere
Time	Set hours	Dependent on source and your interest to invest time in learning the specific topic
Quality of Information	Scholarly, comprehensive	Variable, may not be encompassing all ideas, or only shallowly covers topics, alternatively could be thorough
Effort to Learn	Assisted by instructors	May be assisted, or may be on your own
Recognition	Grades, or another formal competency	Satisfaction, interest, self-confidence.

Adopted from (Boustedt et al., 2011).

Benefits of Informal Education

While many of the benefits of formal learning environments are cognitive, informal environments can lend themselves to both cognitive and affective benefits. Furthermore, informal learning environments can provide opportunities for multiple affective components that build upon one another, creating a synergy that both supports and enriches cognitive and affective development. For instance, participants in informal education experiences have reported feeling a personal sense of accomplishment (Denson et al., 2015; Green, 2005). This sense of personal accomplishment allows students to have more positive attitudes towards a topic and greater self-efficacy. In turn, these positive affective learning facets of attitude and self-efficacy are valuable for developing intrinsic motivation. In another example, self-efficacy and encouragement are correlated with personal interest (Venville et al., 2013). This personal interest plays a role in developing life-enriching and sometimes life-long pursuits. Additional benefits include increased confidence, developing a sense of camaraderie, and having exposure to new opportunities (Denson et al., 2015). Again, these affective components can support rich learning environments that encourage autonomous student learning.

Camps as Engagement

One particular question arises about the length of informal education: How long must someone be a part of an informal experience to benefit from it? For example, camps can be week-long, one day, or even just a few hours. Although the literature shows that ongoing informal experiences such as weekly book clubs or monthly sketch groups have a positive impact on curiosity about the focus topic (Bonnette et al., 2019; James, 2017), the literature also shows that even short, one-time experiences can be beneficial. For example, participation in short-term STEM summer experiences have been shown to increase students' interest in STEM (Bell et al., 2009; King, 2017; Kitchen et al., 2018; Mohr-Schroeder et al., 2014). Support for the inclusion of brief engagement activities include work by George and Kaplan in 1998 which found that science-related activities, such as science fair participation and museum and library visits, positively affects student attitudes toward science. These short-term opportunities for engagement can increase someone's awareness of topics and opportunities in various fields. Similarly, engaging music learners in reflecting on their informal music learning practice is also a form of music learning that contributes to the process of developing and clarifying their understanding of music making (O'Neill, 2014). These work as a short-term point of engagement to increase someone's growth or awareness of other opportunities in various fields. Therefore, whether it be an afternoon at the museum, or a daily attendance in a year-long club, both prove to be beneficial in supplementing someone's understanding and interest in specific fields.

Youth and Informal Education

A particular group that is important to study is youth (8-16). During their formative years, youth are still developing interests and identities that will play a role in deciding what career paths they take. Previous research has found that middle school experiences have the potential to reinforce or redirect a student's cognitive and affective outcome (Reynolds, 1991). Therefore, a focus is on youth around ages 10-14. After that age youth have stronger ideas about who they will become and set limits on who they think they cannot become. For example, STEM education research suggests that a child's intention to be a lifelong scientist is heavily influenced by experiences in middle school. (Maltese & Tai, 2011; Tai et al., 2006). Similarly, music education research identified that persuading more youth to continue with music beyond the age of 14 is particularly challenging. (Hargreaves et al., 2003). Thus, it is a pressing matter to ensure youth have access to opportunities for growth in all fields prior to the end of middle school. However, despite spending time from each weekday in a classroom, it is estimated that during their schooling years 86.7% of students' time will be spent outside of a classroom (Gerber et al., 2001). Therefore, it is important to supplement a student's formal schooling with informal education. This creates room for opportunities where a child can explore topics of interest beyond the classroom.

Rural Education

Rural Education

Approximately 80% of children in the US live in urban regions, while the remaining 20% live in rural regions (United States Census Bureau, 2019). This means that approximately 1 out of 5 children are living in a rural region, and in coming years it is projected that the number of children living in rural areas will grow more rapidly than those in urban areas (Johnson et al., 2014). With this growth it is imperative to allocate more time and energy towards researching and understanding the education of rural youth. Nationwide, half of all school districts are rural and tend to have lower funding per student than most urban areas (Johnson et al., 2014). This can create unique challenges for a district which often results in the reduction or elimination of extra curriculars and courses beyond the standard curriculum. While rural education areas benefit from rich natural environments which could support learning experiences with strong connections to social studies and science, the limited funding becomes a barrier. Rural schools often lack the resources to access them and rural school teachers have limited opportunities for professional development that could develop such experiences (Hartman & Hines-Bergmeier, 2015; Monk, 2007). Whether the funding shortages impact courses or professional development, both ultimately negatively impact students' opportunity to learn.

Along with challenges of funding, rural schools continue to report teacher shortages for numerous reasons. Despite teachers in rural settings reporting high levels of job satisfaction from close communities and supportive staff structures, (Berry & Gravelle, 2013) there are still issues related to inadequate funding, lack of amenities, social and geographic isolation, and limited access to professional development opportunities which deters teachers away from rural settings (Aragon et al., 2016; Barton, 2012; Berry & Gravelle, 2013). Because of this, rural regions regularly are taught by inexperienced teachers who often times plan on eventually leaving the region and invest less in the community. For these reasons, rural education does not provide the same experience as urban education and should not be considered equitable comparisons.

Rural Youth and Informal Education

Collectively the context in which urban youth participate in informal education experiences has been well researched to develop a better understanding. Because urban students are both a large population and convenient population to access, most studies to date done on informal education utilized urban populations. From this we have been able to draw conclusions about the benefits of informal education and how opportunities influence students. But it is not well understood how these same conclusions apply to rural students for a variety of reasons. For starters, access to high-quality informal (out-of-school) learning experiences in rural areas is often limited in early childhood settings (Monk, 2007). As previously noted, early exposure is crucial in development of interests, particularly before the end of middle school. With limited early childhood informal learning experiences, rural students may be unintentionally limited in their scope of interests due to a lack of exposure before entering middle school. And while approaches for addressing and closing opportunity gaps in rural areas are emerging, considerably more work to identify strategies through research-based practices is needed (Harris & Hodges, 2018). Without the development of research-based practices, as a field we neglect the academic growth of rural students. Nationwide this results in 1 out of every 5 children missing chances to explore the full range of opportunities available for academic growth and career development.

STEM Education

STEM Exposure by Middle School

Some researchers have questioned why students choose to pursue or not pursue a life path that involves STEM. A question arose that perhaps certain children didn't like STEM related learning in the first place. However it was found that young children tend to start out highly motivated in science, regardless of gender, race, or even academic achievement (Patrick et al., 2009; Reynolds, 1991). A natural curiosity exists in children that as educators we have a responsibility to encourage. Yet that doesn't seem to be what happens. We have chosen to explore this this idea by researching the science content standards for the population of our study. From this we aimed to understand what formal education experiences in STEM are children receiving to support their natural curiosities.

The formal education experience of students across the state of North Dakota (ND) are largely dictated by standards for content, standards for education (*K-12 Education Content Standards*). More focused to set guidelines for STEM education are the ND Science content standards. In ND according to the ND Science Content standards, grades K-5 average a total of less than 15 science lessons per grade level (*K-12 Education Content Standards*) That means in the approximate 35 weeks of school, students approximately receive a new science lesson once every other week. We want to acknowledge that some educators will choose to include more science curricula but are not required to. As these students grow older and enter middle-school they will take 3 classes dedicated to science: Earth and Space science, physical science, and life science. It is from this K-8 educational experience that the students enter high school and begin to choose what classes they take. At this point, for many students it is too late to open their mind to additional science engagement. There is evidence showing that as children get older, particularly between ages 10 and 14, children's intentions to maintain a lifelong relationship with science solidifies (Johnson et al., 2014; Maltese & Tai, 2011; Tai et al., 2006). This leaves the need for intervention and additional STEM engagement to occur prior to high school. The role of informal education is understandably not outlined by the state's standards but is an avenue that can be employed to further our K-8 and further K-12 STEM education.

How Informal STEM Can Aid

Understanding and increasing STEM proficiency, interest, identities, and inclusivity among adolescents has become a major goal of researchers, educators, policy makers and employers. However, knowing the limited time that students have in classroom, informal STEM education opportunities have grown in popularity as a way of achieving these goals. Informal science has been advocated for since the 1990s as a means to support school curriculum, student interest, and academic success (Advisory Committee to the National Science Foundation, 1995; Eccles & Barber, 1999) and has been deemed an effective tool for advancing science interest and learning. (Hofstein & Rosenfeld, 1996). More recently this notion has received continued support (Barker, 2014; Fallik et al., 2013). One instance of this is evidenced in work by Patrick et al. who found "…additional evidence that sustained and meaningful participation in science activities is related significantly to children's beliefs about their competence in science processes and skills, their liking of science, and their views of what learning science encompasses" (Patrick et al., 2009). These benefits of developing a child's beliefs, likings, and views allow that child to more meaningfully interact with science over time. Potential for adolescents to engage with science activities during out-of-school times is an important element for developing and maintaining a science identity (Afterschool Alliance, 2013). This is valuable because science identity is an indicator of a greater likelihood that youth will persist in science through high school, college and beyond (Hill et al., 2018; Stets et al., 2017). Additionally, informal experiences with science enables children's motivation and ability to engage with and excel in science and stay on a pathway to STEM careers (Archer et al., 2014; Bell et al., 2009; Green, 2005; Meyers et al., 2013). Therefore, access to informal STEM education experiences not only creates an avenue for assisting K-12 formal education but supports long term science learning.

Rural Engagement

The current literature indicates that all groups of underrepresented minorities can and do benefit from informal STEM engagement (Gilliam et al., 2017; Stevens et al., 2016; Todd & Zvoch, 2019). Yet only a few of these works explore what this means for rural populations. The

Afterschool Alliance report from 2013-2016 identifies that while a growing number of children from rural communities want to participate in a program, 3.1 million children still cannot. Parents were asked about this and the following was reported:

> "….. challenges including the affordability, availability, accessibility and lack of knowledge of programs emerge as the primary obstacles preventing parents from enrolling their child in a program" (Afterschool Alliance, 2016).

Some programs that are already in place in rural communities are working to increase the number of STEM education opportunities they provide. Examples of this are 4-H expanding to include Robotics, Tech Wizards, and STEM Labs (Phillips, 2018) or FFA hosting an Agriscience Fair and Innovation workshops (Dryden, 2018) However, these programs are not available everywhere. There is still a gap in the amount of, and diversity in, opportunities presented to urban students compared to their rural counterparts.

Barriers

Informal education opportunities, as demonstrated by the growth in FFA or 4H for example, are evolving to better meet the needs of all youth. Yet, there are many challenges and barriers unique to the rural setting. In fact, these barriers are not only unique to the rural setting, as a whole but also unique to the specific kinds of rural setting.

Gjelten's Rural Typologies

Gjelten (1982) developed a rural typology: stable rural, isolated rural, reborn rural, depressed rural and high growth rural. It is valuable to recognize that every rural community does not have the same attributes and may experience education differently. For example, in a stable rural community, the quality of education is generally good. Students tend to graduate high school at higher rates than their urban counterparts and frequently score well on standardized testing. These schools are predictably stable in their operations but are most at risk to lose quality education when statewide alterations in school funding occur.

Then a different type of typology is high growth rural. This community is managing a rapid influx of people and income often facilitated around the development of new jobs in a region. These regions are financially well equipped to handle the new growth. But there is a struggle to adequately plan for new incoming students and alter old ways to teach new skills and knowledge. Additionally, a high growth rural community lacks the close-knit feel and familiarity that many rural communities identify with. In contrast, a depressed rural community is one that is struggling financially, and many people are moving away from it. The challenge in these communities is recruiting quality educators to serve the students.

Isolated rural can be any combination of the above characteristics. It may be rich or poor, it may have people coming or going, but the largest identifier is that geographically, it is removed from others. And, while Gjelten (1982) described these rural communities well before the advent of the internet and advancements in technology which provides better communication, all types still exist. While this paper will not specifically investigate the effects of each rural typology, it is important to recognize that not all rural settings are created equal. We want to acknowledge that each rural community has its own diverse interests, needs, and challenges.

Funding

Considering the various kinds of rural settings, regions that are likely to have financial difficulties would understandably struggle with adequate funding for what is considered a non-essential educational program. In the instance of informal STEM education, all of it is non-essential and therefore is not guaranteed any funding. With scarce income, it is challenging to sustain let alone expand a program. In order to secure more income, some programs consider raising attendance costs. However, that may directly prohibit the exact people who were intended to be recipients or participants in the program. For example, in the southeastern region of Ohio, 20 percent of its residents live at or below the poverty line.(*U.S. Census Bureau QuickFacts*, 2021.) The Ohio Valley Museum of Discovery, located in southeastern Ohio, regularly hears that even though the museum is regionally accessible, schools are not able to pay for even a short bus ride. Charging admission fees in this impoverished region also presents accessibility issues, as many families and school districts are unable to afford even a modest admission fee (Hartman & Hines-Bergmeier, 2015). Therefore, despite having available opportunities such as a local museum, there are still barriers in place that prevent the community from being able to engage with these resources. This supported by The Afterschool Alliance (2016) which reported youth in rural areas have less access to STEM role models and informal STEM learning resources such as science museums and zoos. These barriers may be challenging to overcome; however, we acknowledge that does not mean without zoos, museums and libraries rural youth have no STEM education opportunities.

Daily STEM in Rural Settings

Rural youth may not consistently have access to additional STEM education programs or venues such as museums and zoos. But many rural youths do have rich experiences grounded in STEM everyday due to their natural surroundings. They have experiences with agriculture, and access to nature that connect them to science and engineering in their daily lives. However, these may go underrecognized as a source of STEM due to a lack of models creating this connection for youth. We have established that rural families often must travel considerable distances to access science resources that are available in urban communities. Urban researchers, however, may underestimate the capacity in rural areas to foster community connections and close links that can foster local science ecosystems (Avery, 2013; Dusenbery, 2016; Johnson et al., 2014). As a research team, we have a background in both rural and urban contexts. We aim to minimize bias and deficit thinking about rural communities by acknowledging the rich connections in the community.

METHODOLOGY

Context

Our study utilizes information of enrolled youth in a midwestern university STEM summer program and parent/guardian/community workers of the aforementioned youth.

Years 2014- 2019

The midwestern university STEM summer program was offered for 2 weeks in Mid-July. This voluntary program offered multiple half day courses ranging in topics such as electrical engineering, coding, and biology. Courses were designed to be offered by grade levels with the courses being divided K-2, 3-5, and 6-8. Youth were able to participate in more than one course, but no more than four courses, due to the camp running weeklong morning and afternoon courses for two weeks. While some courses offered were similar year to year, new ones were also introduced. The summer camp was advertised to the state in a variety of ways including TV, email, flyers, radio ads, school announcements, Facebook and Twitter posts, and on the university's website.

Summer 2020

Due to a global pandemic as a result of the Coronavirus' spread, nationwide shutdowns occurred in the summer of 2020 and the STEM summer program did not take place in-person. Instead, a take-home kit of supplies was created for each course offered. There was a website created that had instructional videos which walked through various lessons accompanying the take-home kit's contents. Youth were able to purchase and participate in an unlimited number of courses. A few new course topics were introduced. The summer camp was advertised to the state in a variety of ways including TV, email, radio ads, school announcements, Facebook and

Twitter posts, and on the university's website. Additionally, emails were sent to people across the state who may have links to rural youth such as 4-H and FFA instructors.

Population

The targeted population was parents/guardians/community workers involved with rural youth grades K-8 who enrolled in a midwestern university STEM summer program for the years of 2014, 2015, 2018, 2019 and 2020.

In 2020, these participants were recruited via an email that had been initially provided to register the youth for the STEM summer program and through a link on the STEM summer programs website. Of the 209 targeted participants contacted, 34 individuals (16.3%) completed the study and an additional 28 participants completed only the initial survey totaling 61 participants (29.9%) for the initial survey.

Data Collection

2014-2019

Existent historical registration records from the 2014, 2015, 2018, and 2019 STEM summer camp were utilized because these were the years with accessible records. The registrations provided information about zip code, grade level, and course enrollment. After the summer camp was over, a digital Qualtrics feedback survey was sent via the original registration email address to all participants. Due to the data from each year being deidentified, it is impossible to tell whether or not there are participants who responded over multiple years.

2020

After IRB approval, we accessed the 2020 registration records from the STEM summer camp. These registration records provided information about zip code, grade level, and take-home kit selection(s). In contrast to previous years when youth attended in-person courses, the STEM camp organizers sent a take-home kit with activity supplies to every youth in mid-July.

The take-home kit included an informational sheet that contained the link to the camp's website where an initial, voluntary Google-form survey was posted for parents/guardians/community workers to complete before the youth began working on their take-home kits (Appendix A). Then, a link to the feedback survey was sent to respondents approximately two weeks after the completion of the initial survey (Appendix B).

The feedback survey instructions stated that it should be filled out after the youth completed the take-home kits. Participants were sent a reminder email for the initial survey in early August and another reminder email for the feedback survey at the end of August.

Analysis

Our first research question was "Do rural youth participate at differing rates in a take-home informal STEM education experience compared to an in-person instruction experience?" To best answer this, a hypothesis was formed "H1: Rural youth participate more in a take-home informal STEM education experience compared to an in-person instruction experience." For the initial step of data analysis to address this hypothesis, we compared information about grade levels, available course topics, and zip codes from the years 2014, 2015, 2018, 2019, and 2020. The data were organized into three tables: grade levels, course topics, and zip codes.

Grade level was analyzed using descriptive statistics. The intention was to ensure that there were not vast differences between the 2014-2019 sample and the 2020 sample. We looked at the maximum, minimum, and average enrollment for grade levels over the years.

Course topic was investigated to establish if there was a large difference in the type of courses offered each year which could have contributed to enrollment variation simply based on course topic interests. To determine which category a course topic belonged to we looked at the original description for the course on the course enrollment page. If the course description was too general or was partially unclear, follow-up was conducted with the STEM summer camp program coordinator about what types of activities and materials were covered in the course. As a result, some courses were given one topic, while others were made a hybrid. For example, a course titled “Jr. biologist” focused exclusively on biology, and thus was categorized as a Biology course topic. However, a class titled “Rocking Robots” focused on utilizing both engineering and coding in the course and would have been categorized as a Coding/Engineering Combo course topic. Each class was only counted under one topic. After each course was categorized, enrollment data was used to determine the number of students that attended each course. The data was analyzed using descriptive statistics. We looked at the maximum, minimum, and average number of students based on the number of courses offered for that topic.

Enrollment Data containing zip codes from the years 2014, 2015, 2018, 2019, and 2020 were utilized to determine if a youth summer camp participant was from an urban or rural region. Over the years there were a total of 112 different zip codes on record. Of the 112 zip codes, 6 zip codes could not be included due to a lack of information regarding the population surrounding the zip codes, such as a zip code attributed to a P.O. box. The remaining 106 zip codes were classified as either urban or rural based upon having 1000 people per square mile (PPSM) (United States Census Bureau [USCB], 2020). This is in accordance with the USCB classification of urban and rural regions. All zip codes PPSM numbers came from *United States Zip Codes*, which accessed data from the United States Postal Service, U.S. Census Bureau, Yahoo, Google, FedEx, and UPS. (United States Zip Codes, 2020) The 106 zip codes were also classified by state.

Additional information about the zip codes not depicted in Table 4 is whether or not part of the zip code is within 25 miles of the in-person summer camp location. The years 2014-2019 all participation took place in-person whereas in 2020 all participation was take-home.

To analyze the zip code data several likelihood ratio chi square tests were conducted. All of the likelihood ratio chi square tests were completed in STATA and were analyzed at a significance level of 0.05. The first analysis utilized data only from ND and MN for 2014, 2015, 2018, 2019, and 2020. The specific inclusion of only ND and MN is due to the in-person summer camp experience being located within 2 miles of the state border. Therefore, attending youth were likely to be from either state. The second analysis was again only ND and MN, but this time for the years 2019 and 2020. The decision was made to compare just 2019 and 2020 after looking at enrollment numbers and noting that 2019 and 2020 were most comparable regarding the number of youths enrolled. A third analysis compared data from all states for all years. Following up on the previous, an analysis of all states for only the years 2019 and 2020 was conducted. Finally, likelihood ratio tests were also conducted on only the zip codes where at least a portion of their region is within 25 miles of the in-person camp. This created a 50-mile diameter circle of included zip code regions.

The second portion of our data analysis utilized two ways of understanding our data. The participant responses from the initial survey were assessed in two ways. The first was using likelihood chi-square ratio test to determine if a particular response occurred in differing rates amongst rural versus urban respondents and to determine if any patterns in reason for attending were more common amongst rural respondents. The survey question stated, “Please share what led you to participate this year.” Following this, a qualitative approach was employed to look at open ended questions in the initial and feedback survey. All responses were coded and reviewed for emerging themes. These responses may provide insight as to how take-home kits may or may not be a viable solution for meeting the needs of rural informal education.

FINDINGS

Research Question 1

Grade Level

The initial results we looked at were a simple comparison of the participation based on grade level over the years (Table 2). In 2020, 244 youth specifically had the grade level of the youth participant listed. There were a portion of the participants who did not indicate a grade level. Those participants were left out of the total for Grade Levels. In 2014 and 2015 there were no courses offered to grades K-2. With the exception of 2014, through the years grades 3-5 consistently had the most enrollment. We are uncertain about what occurred in 2018 that caused a large drop in enrollment for grades 6-8. It perhaps could be attributed to the course offerings available to that grade level. Alternatively, the promotion for the STEM summer camp may not have been as clear to that age demographic, who would have been in different schools than the K-2. These are both speculations that can neither be confirmed nor denied. The lower enrollment of K-2 in the 2020 take-home version raises questions that are not particular to rural engagement but rather informal education in general. A few ideas about what may be occurring here include the thought that parents/guardians are uncertain in their ability to guide their child(ren) through the activities. Therefore, needing to be the “resident expert” at home, a parent may be less likely to enroll a younger child in STEM based activities. This is in comparison to a parent feeling more confident with sending their child to an in-person experience where there would have been on-site instructors for their child(ren). Alternatively, there may have been a drop in enrollment because there were fewer course options available to K-2 compared to previous years. 2020 despite being a new format saw continued growth for both grades 3-5, and 6-8. From this, we must assume that there are a portion of the youth who are new to the STEM summer camp and were able to participate in the take-home format. In future years, it would be valuable to investigate if there can also be growth in the K-2 grade level, or if this is more exclusive to the older grades of 3-5.

Table 2

Youth Enrollment by Grade Level

Grade Level	**2014**	**2015**	**2018**	**2019**	**2020**
K-2			70	92	43
3-5	47	89	57	102	115
6-8	67	60	25	62	86
Grade Level Totals	114	149	152	256	244

Course Topics

Following the condensing of multiple classes for in-person or kits for take-home into categories based upon topic, we concluded there were 8 distinct topics. The general trend is from 2014-2019, youth enrollment grew, as did the diversity of courses offered (Table 3). In 2014, only computer science, engineering, and coding/engineering combo courses were available. In 2015 additional classes were offered in engineering/coding combo, and the new topics of physical science and general STEM exploration were introduced. In 2019, the most recent in-person year, there were courses available across all 8 topics. In 2020, the first year of take-home kits, there was not a need to have as many courses since there were no constraints of classroom sizes or instructor to student ratios. Similar to 2019, a wide variety of course topics were available to choose from with the absence of courses in computer science and general STEM exploration. In the years 2014-2019 there is constant growth in the total number of courses/kits enrollment. This number is greater than the total number of youth participants because a child was able to enroll in up to 4 different classes. In 2020, we see a large increase in the total number of courses/kits enrollment. Since there are a comparable number of youths enrolled in 2019 and 2020, we can infer that children are getting to experience more course topics with the take-home kit format. There are two main primary reasons that we are able to predict for this large increase. The first prediction is a simple scheduling issue. Youth may be able to do more take-home kits than they could in-person courses if their schedule doesn't align well with when the in-person classes were offered. A second prediction is related to cost. The cost for each class in 2014-2019 was $90 per camp, whereas the cost for each kit was $25. With the kit costing nearly ¼ as much, it would be reasonable to conclude families could afford more kits than courses.

Table 3

Course/Take-home Kit Topic Offerings and Enrollment

Course/Take-Home Kit Topics		**2014**	**2015**	**2018**	**2019**	**2020**
Computer Science	# of courses/kits offered	1	1	1	1	-
	# of Students enrolled	19	18	29	26	-
Engineering*	# of courses/kits offered	5	4	7	7	2
	# of Students enrolled	73	39	110	125	146
General STEM Exploration	# of courses/kits offered	-	1	-	1	-
	# of Students enrolled	-	11	-	20	-
Chemistry	# of courses/kits offered	-	-	1	2	1
	# of Students enrolled	-	-	20	38	72
Biology	# of courses/kits offered	-	-	-	2	1
	# of Students enrolled	-	-	-	51	48
Physical Science	# of courses/kits offered	-	1	-	1	2
	# of Students enrolled	-	26	-	7	128
Coding/ Engineering Combo	# of courses/kits offered	1	5	2	6	1
	# of Students enrolled	33	86	40	127	92
Forensics	# of courses/kits offered	-	1	1	1	2
	# of Students enrolled	-	20	29	18	213
Total Courses/Kits offered		7	13	12	21	9
Total of the courses/kits enrollment**		125	200	228	412	699

*Engineering includes computer, civil, industrial, mechanical, electrical engineering
**Total enrollment may be greater than the total number of participants because youth were able to attend more than 1 course or purchase more than 1 kit.

Zip Codes

We looked at the range of zip codes to determine the reach of participation of students in the years 2014-2019 compared to 2020 (Table 4). Zip codes were classified as Urban or Rural, based on the 1000 PPSM classifier. Within urban and rural we looked at both the number of unique zip codes and number of youths enrolled in the STEM summer camp broken down by year for the informal STEM summer camp. The total number of unique zip codes with participants enrolled in STEM summer camp numbers showed that the camp had already begun expansion in the year 2019 with a total of 31 unique zip codes. However, it more than doubled that reach in 2020 with a total of 82 zip codes.

Table 4

Zip Codes by State and Their Number of Participants

State	Classification		2014	2015	2018	2019	2020
ND	Urban	# of zip codes	2	2	2	2	2
		# of youth enrolled in STEM summer camp	25	27	53	80	50
	Rural	# of zip codes	9	8	10	13	32
		# of youth enrolled in STEM summer camp	70	86	77	146	147
MN	Urban	# of zip codes	1	-	-	2	7
		# of youth enrolled in STEM summer camp	1	-	-	3	8
	Rural	# of zip codes	4	5	5	11	21
		# of youth enrolled in STEM summer camp	16	36	21	21	50
Other	Urban	# of zip codes	-	-	-	1	12
		# of youth enrolled in STEM summer camp	-	-	-	2	12
	Rural	# of zip codes	-	-	1	2	8
		# of youth enrolled in STEM summer camp	-	-	1	3	9
Total # of unique Zip codes with participants enrolled in STEM summer camp			16	15	18	31	82
Total # of youth participants enrolled in STEM summer camp			112	149	152	255	276

The result from the first analysis comparing ND and MN for 2014, 2015, 2018, 2019, and 2020 revealed a statistically insignificant relationship for zip code classification and mode of participation, $G^2(1) = 3.4790$, $p = 0.062$ $n = 915$. The first result is not significant and does not provide support for the hypothesis that rural youth participate more in a take-home informal STEM education experience compared to an in-person experience. This does not align with what we hypothesized as it is not fully cohesive with the notion that urban youth are more likely to gain access to STEM education opportunities compared to rural students (Avery, 2013). Instead, we found that a child was no more likely to have been from an urban than rural zip code. This might indicate that in ND and MN there may be already established systems where rural regions are able to reach STEM education opportunities more readily. Or conversely, it may indicate that urban youth are not as able to access STEM education outreach opportunities as previously believed.

The second analysis comparing ND and MN for only the years 2019 and 2020 revealed a statistically significant relationship for zip code classification and mode of participation, $G^2(1) = 6.7311$, $p = 0.009$ $n = 506$. The second result which compares only 2019 and 2020 for a more comparable enrollment number being analyzed, there is a significant relationship and would lend support for the hypothesis. This finding contradicts our previous one. Therefore, we are uncertain whether the variation is attributed to a matter of sampling, and which years are included, an issue of sample size, or if our results are due to random chance. If we support the hypothesis, this will mean that rural youth are not as likely as urban youth to attend an in-person experience compared to a take-home experience. From this we reflect on the previously mentioned barriers that rural students have when it comes to engaging in informal STEM education. Geographic isolation (Gjelten 1984) or lack of funding (Hartman & Hines-Bergmeier 2015) could each be factors that inhibit rural youth from coming to an in-person experience. The support for a geographic isolation factor would be from the belief that youth were not able to participate in-person due to the physical distance from their home to the location of the STEM summer camp, whereas with a take-home kit, which could have been mailed directly to the youth, physical distance is entirely eradicated as a problem. The other consideration that funding, or cost, may have been a factor is supported from the growth in rural participants who purchased a $25 take-home kit, compared to enrolling in a $90 in person class.

Our third analysis compared data from all states for all years. This resulted in a statistically insignificant relationship for zip code classification and mode of participation, G^2 (1) = 1.1.12, p = 0.277 n = 942. We did not expect to see a major change all states, all years. This is because the new zip codes added in for the "Other" states (meaning zip codes that are not from ND or MN) were fairly evenly distributed amongst the rural and urban zip codes. Following up on the previous, a fourth analysis of all states for only the years 2019 and 2020 was conducted. This analysis did in fact produce a statistically significant result, G2 (1) = 3.9559, p = 0.047 n = 532. This means that we did find urban youth were able to participate in the in-person experience more than rural youth when compared to the take-home experience's enrollments for urban and rural youth. We acknowledge that this is a similar finding to the second analysis. We also acknowledge that physical distance is likely to have played a major role in the ability for rural and urban students from other states being able to participate. What we would like to focus on is how the new expansion into other states was more than anticipated despite the heavy focus still lying in ND and MN. Reaching 20 zip codes beyond the state of ND and MN leads us to believe that take-home kits are a viable solution to informal STEM education experiences where physical distance, regardless of rurality, has been a barrier.

The final analyses that looked at zip code classification and mode of participation with special regard for being within 25 miles of the in-person location. If a portion of the zip code was within 25 miles of the in-person experiences location, all participants for that zip code were included. None of these analyses were significant. This would have helped to support our belief that geographic distance played a role in the inability of rural youth to attend the in-person experience. Since this was not found to prove significant, we must acknowledge that perhaps in ND and MN, distance does not play as large, if any role as a barrier in stopping students from attending a STEM education experience. We acknowledge that 25 miles may have been was the incorrect distance to have checked, and that rural communities may be willing to commute further than the approximate 30-minute drive established by our 25-mile radius.

Research Question 2

Research Question 2 asked "What factors contribute to a rural person's enrollment in an informal STEM summer camp experience?" To best answer this we examined the responses to the initial survey. In particular we looked at the question that asked, "Please share what led you to participate this year." Instructions stated to select all that apply and included the following seven options.

- At home convenience
- Age appropriateness for child(ren)
- Child(ren) has specific interests in a kit/course offered
- Cost of participation
- Lack of other Science, Technology, Engineering or Math (STEM) opportunities
- Lack of other Non-STEM opportunities
- Other (If other please specify: ____________________)

There was a total of 66 completed initial surveys, presumably completed by a parent, guardian, or community worker responsible for the youth participant enrolled. The completed surveys were divided into either being a rural or an urban response based upon zip code. We had a total of 22 urban responses and 41 rural responses. These were evaluated using a likelihood ratio chi square to determine if any particular response was more prevalent amongst rural respondents (Table 5). We found that no likelihood ratio chi-square comparisons proved significant.

Table 5

Likelihood Ratios for Reasons for Participation

Reason for Participation	Compared with Location	p-value
At home convenience		0.347
Age appropriate for child		0.760
Interest in course/kit offerings		0.530
Cost of participation		0.760
Lack of other STEM opportunities		0.819
Lack of other Non- STEM opportunities		0.413

Following the insignificant chi squares, we thought it would be valuable to evaluate if any response pattern(s) was unique to rural respondents. Only four people utilized the other category, and of those four the reasons entered were different, so for investigating patterns the other option was left out. This left six remaining responses to be evaluated for patterns. When evaluating all possible combinations of the remaining six responses, there is a total of 64 possible response patterns of which 28 different ones actually occurred. Below we have listed the top four most common response patterns, which accounted for over one-third of the total responses. (Table 6). The most common response was selecting only one reason for participation, which was “At home convenience.” This was selected by four rural respondents, and one urban respondent. The remaining three most common response patterns were combinations of three or more survey options and were fairly equally selected between urban and rural respondents. Looking at the responses to reasoning to participate led to no significant result. Of the 28 different patterns none of them led to a significant result. This does not mean that the patterns indicated may not be true, but we had insufficient data to make supported claims.

Table 6

Top 4 Most Common Response Patterns

Pattern Number	Reasons for participation selected	# of Rural Respondents who had selected this	# of Urban respondents who had selected this
1	-At home convenience	4	1
2	-At home convenience -Interest in course/kit offerings -Lack of other STEM opportunities	3	2
3	-At home convenience -Interest in course/kit offerings -Age appropriate for child	2	3
4	-At home convenience -Interest in course/kit offerings -Age appropriate for child -Cost of participation	4	3

Our final line of evidence that we analyzed were the responses to the feedback survey. The feedback survey only had 34 responses, six of which were from urban respondents and the remaining 28 were from rural respondents. There is insufficient data to attempt and quantitatively analyze, however we found a qualitative description still fruitful in informing us about how take-home kits as a mode of informal STEM education may be better utilized. When asked "Would you sign your child(ren) up for STEM Kids again?," referring to this particular STEM summer science camp, 25 people said yes, and 4 said maybe (Table 7). We then had a follow-up question for anyone who had answered "yes" and "maybe." Those respondents were asked "Next year, would your family prefer to attend an in-person or do a take-home kit?" From this question we found a clear divide in feelings. About half of the rural responses indicated they would prefer an in-person experience, and half indicated they would prefer a take-home experience (Table 8). We look to their open response “Why?” responses to gain insight about the divide seen in Table 8.

Table 7

Responses to “Would you sign your child(ren) up from STEM Kids again?”

	Yes	Maybe	No
Urban Respondent	6	0	0
Rural Respondent	19	4	1

Table 8

Responses to “Next year, would your family prefer to attend an in-person or do a take-home kit”

	In-person	Take-home	No preference
Urban	2	4	0
Rural	10	11	1

For those who said they would prefer a take-home, five respondents answered something to the effect of “we live too far away.” Three respondents said their child had special needs which could be accommodated at home but would be more challenging or impossible in an in-person setting. Another three favored a take-home kit experience because of the child’s pacing. An example of this is from the parent who responded “My child is shy and easily overstimulated. Loved doing the activity at his own pace and no pressure.” Another three parents said they would prefer the take-home kit because as a parent they enjoyed getting to interact with their child(ren) through the exploration of the kit’s contents. Other responses also included personal scheduling, homeschooling, and the convenience of at home. As educators and members of STEM education outreach, this could provide insight that more parents are looking for activities they can do with their child at home for a variety of reasons. These include but are not limited to adapting to meet the cognitive or physical capabilities of a child or wanting to have an activity the whole family can enjoy.

In contrast, there were a number of people who indicated they would want their child(ren) to attend an in-person experience the next year. One of the most popular reasons with four respondents was the idea that an in-person experience had more guided instruction. This can help to alleviate the stress of a parent needing to do the activity with a child, or the confusion and frustration a child may experience attempting to learn on their own. The other most popular choice for preferring an in-person experience was the idea that the child(ren) would or could learn better with more social interaction. It was not specified if this meant with an instructor or peers. Other reasons included “It’s more fun,” wanting their child to have the instructors serve as positive STEM role models, and one response where a parent indicated they didn’t have time.

So, there is a myriad or reasons why in-person was favored amongst several rural respondents and indicates that although take-home kits may have at first seemed like an ideal option, there may be some elements of the informal STEM education experience that can’t be duplicated when at home.

LIMITATIONS

One limitation we encountered was using deidentified records of enrollment. We were unable to track enrollment over the years to see if it was new youth or returning youth. Additionally, we were not able to determine which youth enrolled in which courses, so we don't know if rural youth were equally dispersed throughout our grade levels and course types. Determining this in future years could provide more information about the type of experience that is sought out by rural youth and at what age they are most likely to participate in an informal STEM education experience. Another limitation was the utilization of zip codes as an indicator of rurality. Although it is well documented by the US census Bureau that 1000 PPSM or less should be classified as rural, we found that zip codes may not be able to accurately portray urban centers in a setting such as ND and MN. Many zip codes would partially include a city, and partially include the surrounding uninhabited areas. The cities were well over the 1000 PPSM indicator but were not squarely centered in a zip code to reflect this population center. We made attempts to reclassify what was considered urban or rural based upon an established healthcare definition but found it was not likely to provide different results, and thus allow us to gain no further insight.

CONCLUSIONS AND FUTURE WORK

From this work we were able to begin thinking about how rural and urban youth in our region interact with opportunities in informal STEM education. It is not a comprehensive understanding of the way rural communities perceive in-person experiences compared to take-home experiences but rather an introduction to the idea that our expectations or assumptions about what may be the most effective for different communities needs to be better informed and researched. The qualitative work from research question 2 revealed that despite many possible barriers from being able to attend an in-person experience, many still favored it for benefits and elements of the experience that simply cannot be duplicated at home.

Future work may be able to investigate the efficacy of moving to a hybrid of online format with in-person. This could be an expansion to understand how to create connections and foster relationships between peers and instructors, typically found in an in-person experience, and find ways to create the same rapport with a distance learning context. Other recommendations are to research how take-home compared to in-person in terms of engagement and learning or see if people were likely to still engage in the informal experience dependent on format.

Another suggestion would be to engage more deeply with the rural communities that our participants come from to better understand their typology according to Gjelten's classifications. This could inform us better about the type of community established, and how that may foster science community connections within a local context. Along with this comes the consideration that there may be better ways to assign rural or urban status other than zip codes and PPSM classifiers, yet a consistent source with multi-state approval that fit the scope of our work is yet to be found.

A final note would be to consider the possibility that rural and urban are not necessarily variables that can simply be measured with geographic distance from other populated areas, or the number of persons who live in a region. Through conversation and consideration, “ruralness” seems to instead be a proxy for a variety of variables. These may include physical distance from other cities or the number or persons in a region, however it may also be a sense of community, the connectedness of people, the economic resources, or the values of the people. In some instances, we found ourselves through dialogue identifying larger populated areas that had a “rural feeling” to them. This would indicate that perhaps rural and urban are not opposite ends of the same scale, but perhaps entirely different variables and scales to be considered.

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APPENDIX A. INITIAL SURVEY

Is this your first year participating in STEM Kids?
<>Yes <> No

If yes, How did you hear about us?
<>School flyer
<>Email
<>Through an acquaintance
<>Website
<>Other
If other please specify: ____________________

Please share what led you to participate this year
Select all that apply:
<>At home convenience
<>Age appropriateness for child(ren)
<>Child(ren) has specific interests in a kit/course offered
<>Cost of participation
<> Lack of other Science, Technology, Engineering or Math (STEM) opportunities
<> Lack of other Non-STEM opportunities
<>Other
If other please specify: _____________________

Which kits did your child(ren) choose?
Select all that apply
<>Anatomy action
<>Aerodynamics
<>Coding and Electronics with Microbit
<>Makerspace
<>Slime!
<>Physics
<>Crime Scene Science
<>Crime Scene Science Jr.
<>Electrical Engineering

What is your Zip Code?
____
What is your County
____
Please indicate the email you would like our follow-up survey to be sent to. Your responses will help us make STEM kids a better experience in future years

APPENDIX B. FEEDBACK SURVEY

What is your zip code?
____

What county do you live in?
____

Would you sign your child(ren) up for STEM kids again?
<>Yes
<>No
<>Not certain yet

If yes,
Next year, would your family prefer to attend an in person or do a take home kit
<>In Person
<>Take Home
Why?_______________________

Is there something we can do to make your experience better?
____

How clear was the online registration process?
<> Clear
<>some confusion, but mostly clear
<>Not clear
Was Communication related to STEM Kids clear and sufficient?
<>Yes! Clear and sufficient
<> Some confusion, but mostly clear and sufficient
<> not clear or sufficient
Do you have any specific comments about registration, procedures, or communication?
____

Please answer the following questions
If you had more than 1 child, or more than 1 kit, please answer the following with only one child and kit in mind at a time. Followup for other kits and/or other children can be added at the end. (it does not matter which are done first)

*****
Which class did your child participate in?
<>Anatomy action
<>Aerodynamics
<>Coding and Electronics with Microbit
<>Makerspace
<>Slime!
<>Physics
<>Crime Scene Science
<>Crime Scene Science Jr.
<>Electrical Engineering

Was your child happy with the content of the course?
<>Yes
<>No
Why?______________________________

Was your child happy with the instruction?
<>Yes
<>No
Why?______________________________

What went particularly well with this course?
____
What could have been improved with this course?
____
Would you also like to comment on another course for a different child or different kit?
<>Yes
<>No
*****If yes, from here down is repeated