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Why Do Students Attend STEM Clubs, What Do They Get Out of It, and Where Are They Heading?

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Abstract: This research investigated what motivated and sustained the involvement of 376 students in culturally relevant, afterschool STEM clubs at four rural, under-resourced schools. A longitudinal, convergent parallel mixed methods research design was used to investigate participants' participation in and perceptions of the clubs, their motivations to attend, and their future goals, over three years. Situated Expectancy-Value Theory (SEVT) served as a guiding theoretical and analytical framework. Overall, students who attended the clubs were African American (55%), female (56%), and 6th graders (42%), attended approximately half of the clubs (43%), and *agreed* with quality measures on the STEM Club Survey (M = 4.0/5). Students interviewed (n = 131) were most likely (99%) to describe what they enjoyed (*intrinsic value*), what was useful to them (*utility value*; 55%), personally important (42%; *attainment value*), or related to their personal or collective *identity* (40%). Most participants (78%) planned to attend a 4-year university and expressed interest in at least one STEM career (77%); highest attendees (48%) expressed the most interest. Our study reveals that a culturally relevant, afterschool STEM club can motivate underserved students to participate, learn, feel a sense of belonging as a club member, and positively influence their college and career pathways.

Keywords: STEM careers; career exploration; Situated Expectancy-Value Theory; rural; middle school; STEM clubs; underserved; afterschool

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1. Introduction

1.1. Benefits of Afterschool STEM Programs

Afterschool STEM clubs can provide safe learning spaces for informal, non-compulsory learning for students, particularly those from underserved student populations. In addition, afterschool STEM clubs can provide more authentic experiences that help participants better understand STEM concepts, through interesting, enriching activities that engage students [1,2]. Student-centered pedagogies that are prevalent in informal club spaces have also been shown to help develop 21st century skills (e.g., the 4Cs—collaboration, creativity, critical thinking, communication) [3,4].

A large U.S. study found that afterschool STEM programs have three main benefits for participants: (1) increasing interest in STEM, (2) supporting the capacity to productively engage in STEM learning activities, and (3) developing value for the goals of STEM [5]. Participants in STEM clubs often gain exposure to stimulating activities, build new friendships, learn new content and skills, experience a sense of belonging, and find out what areas of STEM about which they are passionate [6]. Afterschool programs have been found to increase students' social skills, work habits, and feelings of self-esteem and self-confidence, as well as decrease negative behaviors [7,8]. The less structured nature of afterschool settings supports the development of students' communication skills [9]. Students who participated in STEM clubs were better able to share their ideas, knowledge, and experiences, take ownership of their learning, develop a stronger sense of belonging [10], and reflect on how the clubs aligned with a personal identity [4].

Ideally, there are links among afterschool activities, family involvement, and school success. Communicating with family members about afterschool activities and finding ways to involve them (e.g., club visits, books, and STEM club materials sent home) [6] can enhance family–school partnerships in support of students' academic development [11]. Epstein [12] created a framework for six types of involvement in school at home and in community partnerships that empower families and school members to use a wide range of practices that promote students' success. These include the following: parenting, communicating, volunteering, learning at home, decision making, and collaborating with community. In a recent at-home study by Author [13], rural middle school students who received social justice-oriented trade books and STEM kits expressed confidence about their abilities in STEM and in shaping the direction of their lives.

Saw and Agger [14] focused on rural students' lack of access to advanced coursework and extracurricular programs and found that demographic inequities led to disparities in STEM career aspirations and relevant coursework. Hill et al. [15] explored differences in informal science experiences between urban and rural youth, while considering the intersection of socioeconomic status, ethnicity, and gender. Rural youth reported a greater desire to participate in afterschool clubs, but had less access, and therefore fewer experiences. The authors recommended that informal educators "focus on the development and implementation of quality, sustainable, after-school learning opportunities for rural youth" (p. 10).

1.2. Equity Pedagogies

Educational equity often relates to issues of access, such as access to quality teachers, books, quality programs, parental support, relevant role models, and relevant experiences (e.g., [16–18]). Equity pedagogies (i.e., culturally relevant, culturally responsive, culturally sustaining) stress the importance of centering students' cultures and identities within "curriculum and practice across content areas and grade levels"(p. 6, [19]) Seminal works in equity pedagogies (e.g., [20–25]) push educators beyond simply integrating equity-related topics into content. Rather, they seek to educate youth in ways that "affirm students' cultural and ethnic identities" in the ways students engage, think, know, and speak (p. 6, [19]). Cultural assets [26] are acquired in school and at home and include students' values, dispositions, and norms and are influential in students' academic and career goals [27].

Role models who are similar in race and gender (e.g., [18,28]) can be influential to encouraging underserved students to participate. Eddy and Easton-Brooks [29] investigated the potential of ethnic matching, in which African American teachers can have positive effects on outcomes of their African American students. They found that having at least one teacher who the students found ethnically matched themselves (from grades K–5) had a significant positive effect on mathematics achievement. A high school study on twelve high-achieving African American male students emphasized the important positive influences of an African American anatomy and physiology teacher and an African American athletic coach [30]. A multiple case study by Author [31] described the important influence of a Black male band teacher to a rural, African American male middle school student. Ladson-Billings [32] promotes culturally relevant teaching that "attend[s] to students' academic needs", leading students to "choose academic excellence" (p. 160). Engaging students who are historically underrepresented in STEM (e.g., gender, SES, race/ethnicity) in relevant activities, ideally led by teachers to whom students feel ethnically connected [29], may increase their motivation to learn [32]. This may translate to increased achievement in their courses and gains in high-stakes test scores [33,34]. Author [35] demonstrated that engaged rural, underserved students with hands-on technologies in classrooms also led to gains in standardized tests.

In order to provide culturally relevant and equitable experiences for students in an informal setting, it requires club leaders (teachers) to gain an understanding of how underserved students use cultural assets [36,37] and to use pedagogical strategies that "tap into the diverse cultures of their students to make learning meaningful and comprehensible" [38] (p. 560). Culturally sustaining or responsive pedagogies for STEM clubs [6] include teachers making the clubs their own through localized changes in the activities [39], linking to STEM career explorations [40], bringing in a diverse group of speakers [28,34], encouraging voluntary attendance [41], designing clubs to be highly interactive and social [39], including novel competitive elements [42], connecting to standards [43], and infusing activities "that can shift the dominant narrative of STEM from white ethnocentrism to one that is more grounded in students' experiences or funds of knowledge" [44] (p. 106). This is challenging if the teachers do not understand that the cultural differences [45] and the cultural backgrounds (e.g., economic, racial, generation) and therefore lived experiences, values, and expectations may be different from those of their students [46,47]. Therefore, it is important to prepare teachers to work with diverse student populations [44,46,48,49] to promote high academic achievement for all students [50].

1.3. Future Goals

Informal academic spaces have also been shown to expand participants' vision of their future, post-secondary educational pathways, and STEM careers [7,19,51]. STEM clubs can help close the opportunity gap [52] for traditionally underserved (e.g., related to race/ethnicity, gender, and/or SES) students. Changes through participation could relate to students' interest, self-efficacy, confidence, and behavior choices and future career goals [33,34]. Participants in clubs ideally gain exposure to potential STEM careers that they may not have even known existed [31,53]. Through career explorations, they can try on different STEM career 'hats' and see if any may fit, such as by searching STEM career information sites, watching related video clips, or meeting STEM professionals (e.g., [53]). As described earlier, representation or mentoring from individuals to whom the participants can relate can also make a difference [18,28,29]. Kricorian et al. [54] found that 56% of women in STEM majors believed that media exposure to STEM professionals with matching gender and ethnicity would be effective encouragement. Researchers of science and STEM clubs and competitions [33,34] also noted changes in students' self-efficacy, confidence, and behavior choices, as well as gains in STEM interest and future career goals. Sahin [42] found that students who had regular STEM club participation were more likely to select STEM majors than the national average. Yet, participants in non-compulsory STEM activities often have variable attendance and motivations to attend [4].

1.4. Focus of Current Study

Taken together, the studies reviewed indicate that there are many potential benefits for underserved, rural students who are offered and able to participate in high-quality afterschool programs. Culturally relevant clubs led by encouraging, relatable role models can promote students' development of new skills, knowledge, and friendships, foster a sense of belonging, and help students to find out about what they are passionate (e.g., [6,10,29,32]). Yet, few studies (e.g., [4,55,56]) have investigated the reasons or motivations for students to participate in afterschool programs. This study sought to document their choices and understand their reasoning through data collected directly from the students and use the lens of Situated Expectancy-Value theory [57] to make sense of these choices.

1.5. Theoretical Framework

Adolescence is a time when students are wrestling with who they are, what they value, and what they want to do with their lives. In order to make sense of students' motivations for participating in the STEM clubs, Situated Expectancy-Value theory (SEVT) of achievement motivation [57,58] was employed. SEVT states that students' academic performance, persistence, and activity choices are most directly linked to their expectancy-related and task value beliefs [57,59]. A student's expectation of success is how well they believe they will do on an upcoming task, which is influenced by their perception of their abilities, how difficult they perceive the task to be, and their interpretation of past success or failures in the task in the particular setting or with particular individuals [59,60] (See Figure 1). The extent to which a student values a task relates to the nature of the task, as well as the student's identity, expectation of success, and values. Historically, the quantitative work performed with the SEVT has not been able to capture or operationalize the views of marginalized and minoritized youth. In this study, the SEVT framework will be used as a qualitative analytical tool to make sense of students' interviews, analyzing their motivations for club participation based on what they have expressed. This approach has been used in some recent studies to highlight the values of underserved rural middle school students (e.g., [4,31]).

Eccles et al. [59] put forth three ways that students can value a task, which can influence the extent to which they are motivated to engage. The three subjective task values are as follows: attainment value, intrinsic value, and utility value. In addition, cost is considered as a fourth (negative) component of value, as students may perform a cost/benefit analysis when making a decision about attending a STEM club [60–62]. All of these aspects will be operationalized through these rural middle school students' responses.

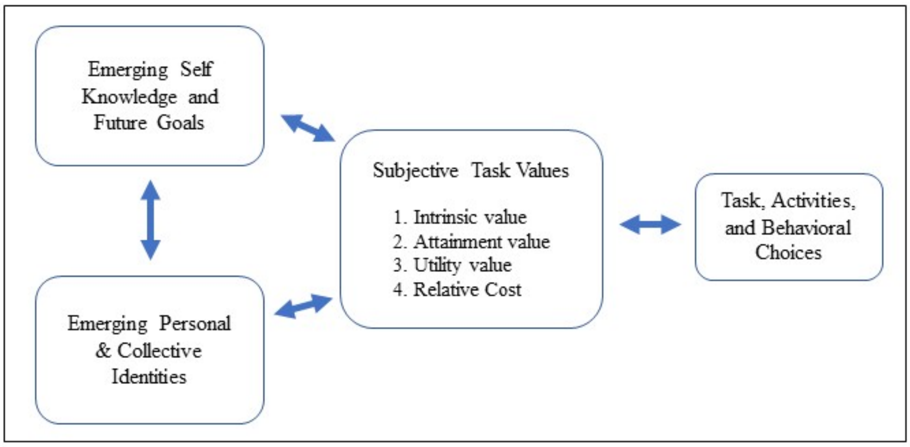

Figure 1. Salient aspects of Situated Expectancy-Value theory (adapted from [58,62]).

1.5.1. Intrinsic Value

Intrinsic value is the inherent interest or enjoyment one anticipates gaining from participating in an activity [60]. Author [63] connected this to Ryan and Deci's [64] definition of intrinsic motivation as being driven by one's inherent satisfaction. Students who value a task because they enjoy it or are interested in it are intrinsically motivated and typically demonstrate better performance, more persistence, creativity, and confidence on the task [65]. In Author [31], a rural, African American middle school student talked about his intrinsic enjoyment while working on a car and playing trumpet. For a STEM club student, this could include the student finding the activity fun, cool, or exciting, enjoying the teamwork or socializing, or finding it enjoyable in other ways.

1.5.2. Attainment Value

Students also can value doing well on a task based on how it fits with their individual identity or their personal values or because they offer opportunities to fulfill their long-range goals [58,66]. Author [4] shared that rural middle school students in climate-oriented STEM clubs learned about weather and climate and helped learn about jobs they might want to do. In a STEM club, students may value the club because they are learning new things that they care about, finding out about careers they may be interested in, or because the tasks align with what they think they are good at, such as science or mathematics.

1.5.3. Utility Value

Utility value refers to the value a task holds because it is believed to be important for teaching a variety of short-range or longer-term goals, even if the task itself does not hold high interest [62]. For example, a STEM club student may believe that a club experience will help them in their math class or teach them how to program a robot, which they may perceive as useful if they imagine becoming a programmer. Although the term "utility value" paints an image of an extrinsic motivator, individuals can accept and endorse the value and perform the task willingly [64].

1.5.4. Cost

Finally, cost is what is lost, given up, or suffered as a result of engaging in the activity [66]. In a STEM club, costs may include having to follow directions, not getting along with team members, finding it boring, or frustration about how to use equipment. Alternatively, it may involve missing a sports practice or getting home late in the day. Both the value factors and the cost will play roles in a student's perception of the relative benefit to them of club attendance and therefore whether they will decide to attend the club.

1.5.5. Identity

Identity [58] encompasses both personal identity, which relates to who a student thinks they are or what makes them feel unique (e.g., I am smart, I am funny) and collective identity, which ties students to others through their social groups or relationships (e.g., we have a lot in common). Nasir [67] focuses on the intersection of race, culture, and mathematics learning for African American students in out-of-school settings. She argues that the formation of goals and identities in practice is related processes that are central to students' learning.

1.6. Summary

Recent literature suggests the potential of after-school STEM clubs to positively influence the experiences of students, particularly those who have been underserved and who are underrepresented in STEM. These non-compulsory experiences allow students to choose to participate, to learn, to find relevance and community, and to consider their future goals. Aspects of SEVT—intrinsic value, attainment value, utility value, relative cost, and identity—offer an analytical framework to better interpret what students tell us about their motivations for attending and participating in STEM clubs. To date, few studies have been published about rural, underserved students' experiences in afterschool settings or how they respond to culturally relevant pedagogical practices (e.g., [4,31]). This study seeks to address this gap by exploring the experiences and perceptions of a diverse group of rural students who participated in afterschool STEM clubs, over a three-year period.

1.7. Research Questions

The overarching research question was *what motivated and sustained students' involvement in the STEM clubs?* Given our focus on the students' perspective, all of our analyses were focused on data we had collected directly from the students, through self-reported demographic and attendance data, surveys, open-ended responses, and individual interviews. The research questions guiding this study are as follows:

1. How can students' choices to participate in clubs and their perceptions of the clubs be characterized?
    a. What were participants' patterns of attendance?
    b. What were participants' perceptions of the STEM clubs?
    c. What did participants believe was the purpose of the STEM club?
2. What motivated students' STEM club attendance and participation?
3. What were students' post-secondary and future career goals?

2. Materials and Methods

2.1. Research Design

To answer the research questions, the authors used a longitudinal, convergent, parallel mixed-methods research design [68,69]. A convergent design involves the collection of quantitative (i.e., attendance, survey) and qualitative data (i.e., interviews, open response) separately over the same time frame. By using a mixed-methods design, the authors were able to focus on the questions they wanted to answer and align the best data sources and methods of analysis to answer the questions [70]. Answering the research questions through both quantitative and qualitative methods provides perspectives that using only one or the other methods would not [71]. Data were collected multiple times over a three-year period and analyzed separately by data source, and the results were compared in order to gain a more comprehensive understanding of the overarching research question by triangulating complementary data sources [68].

2.2. Context

The context of this study was a 3-year, federally funded project that implemented 6 STEM Clubs in year 1 (Spring) and 12 STEM Clubs held over the entire school year, years 2–3. All students in each of the four middle schools were invited to participate in the afterschool STEM clubs. Each club made different decisions about how to organize or assign students and activities, which varied from meeting in one large activity space to meeting in separate classrooms, depending on the nature of the activity and the number of teacher coaches who could be present. Students often chose which students they would work with, and only one school (SMS) tended to group students by grade level with groups meeting in separate teachers' classrooms. Some activities began in classrooms, but supplies might be out in the hallways between classrooms or in the center of the meeting room. For many activities, students went outside to launch rockets or take weather measurements, for instance. Students often would intermingle with other groups and teacher coaches during these parts of the activities, when getting supplies, or when watching short presentations from other students (e.g., whose soundproof booth had the lowest decibel measurement). The structure, strategies, and STEM activities designed for the club used culturally relevant pedagogies and literature-based strategies specific for informal afterschool clubs, such as collaborative peer discussions, collection and analysis of authentic data, and interactions with local and global STEM professionals (face-to-face or virtually) [4,72]. STEM professionals were recruited who mostly were from underrepresented minority groups and—as often as possible—from rural communities, similar to those of the club participants. STEM subject areas were integrated throughout, and activities were clustered in groups of three similarly themed club meetings to provide participants with continuity and to go in greater depth within similar content. For example, in the spring of year 2, a series of three club meetings related to health and medicine was held (e.g., heart basics, health of the heart, respiratory system). In the fall of year 3, a series of club meetings focused on circuits and coding (e.g., Makey Makey®, Using Scratch, Integrating Makey Makey® and Scratch). Additionally, within each club, content was explicitly linked to related careers (e.g., nurse, veterinarian, electrician, electrical engineer) and when possible, activities and guest speakers were specifically connected to the youths' local communities and personal lives [6].

2.3. Participants

2.3.1. Middle School Participants

This study investigated the experiences of adolescents aged 11–14, who participated in afterschool STEM clubs in four high-need, rural middle schools in the southeastern U.S. over the span of three academic years. The nature of the multiple-year STEM club design meant that 5th graders (at one middle school only) would become 6th graders (the next year), 6th graders would become 7th graders, and 7th graders would become 8th graders. Students who were 8th graders in year 1 of the study moved on to high school. Therefore, the students flowed through the clubs as they were willing and able to participate, and approximately 29% of the students participated multiple years. Participants were required to submit a signed informed consent form (parent) and assent form (student) in order to participate in STEM club activities. Survey and interview data included in this study were only from participants who assented and whose parents consented to use of the participants' anonymized data.

On average, the ethnicities of students in the four participating STEM club schools were 62% Black, 30% White, 5% Latinx, and <2% Native American. These percentages were different from the state average of White students (72%). Most students (98%) in three out of four of these schools (one school was a district-wide STEM school and therefore demographics differed somewhat) received free and/or reduced-price lunch as compared to the state average of 52.8%. Students attending the four STEM club schools in this study often underperformed statewide in STEM content areas. Approximately one quarter (24.7%) of students scored *minimally proficient* in mathematics (state 46.2%) and 57.7% scored *minimally proficient* in science (state 72.6%), which is common in schools with high levels of poverty [17] (specific attendance and demographic data for STEM club participants will be examined in more detail in the findings). Therefore, the students were more diverse, lower SES, and less academically successful than most students in the state.

2.3.2. Teacher Coaches

At each participating school, a team of six teachers comprised the teacher coach team for a total of 24 teacher participants. Of these individuals, 80% identified as female and 20% male. Eleven of the teachers self-identified as Black, nine as White, two as Asian Pacific Islander, and two as 'multiracial/other.' The majority (54%) of teachers were science or math specialists. Twelve of the teachers held a Bachelor's degree, eleven held a Master's degree, and one had advanced certification. Additionally, most of the teachers had over ten years of teaching experience (66%). All teacher coach teams seemed to be relationship-oriented, behaving more like friends working toward a shared goal, than co-workers. This translated into a relaxed club feel of a fun, interactive environment where students were actively talking and working with each other.

2.3.3. Comparing Teacher Coach and Student Demographics

The demographic match between the students in the four clubs (N = 742) and the teacher coaches in the four clubs (N = 24) over the 3 years is shown in Table 1. Student attendance varied from club to club by the students and, to a lesser extent, the teacher coaches. The largest percentage of student participants at each of the schools was African American. At all four of the schools, there were ethnic matches [18,28,29,54] for African American students with male teachers, female teachers, or both. All but one club had at least one White teacher coach. Two of the teachers identified as 'Multiracial/Other,' one of whom was a Spanish teacher and spoke Spanish fluently, likely providing a perceived ethnic match for some of the Latinx students in that club (SMS). There were no teacher coaches who identified as Native American at WMS; however, 11% of students attending the club did identify as members of this population.

In addition to the students and teachers in the clubs, there was also a diverse group of STEM professionals who were recruited to visit clubs, and students engaged with career videos from the project website that were purposefully selected to include a diverse representation of STEM professionals from historically underrepresented groups (e.g., females, people of color). Moreover, other school personnel routinely would stop by, such as an African American principal. At times, parents of students also stopped in before parent events or simply because they wanted to see what was happening in the clubs.

Table 1. Comparison of STEM club teacher coaches and student demographic characteristics.

		African American		White		Latinx		Asian/PI		Native Am		Multiracial/Other	
School		**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
1 (NMS)	Teachers	17% *	33%	-	50%	-	-	-	-	-	-	-	-
	Students	31%	23%	10%	19%	7%	-	2%	-	2%	2%	2%	3%
2 (SMS)	Teachers	-	33%	33%	-	-	-	-	17%	-	-	-	17%
	Students	22%	29%	12%	19%	5%	5%	1%	1%	1%	-	2%	3%
3 (WMS)	Teachers	17%	50%	-	-	-	-	-	17%	-	-	-	17%
	Students	21%	33%	1%	11%	2%	11%	-	1%	3%	8%	5%	4%
4 (EMS)	Teachers	-	33%	17%	50%	-	-	-	-	-	-	-	-
	Students	33%	35%	10%	9%	1%	6%	1%	3%	2%	-	-	-

Note: * Percentages were rounded down or up to whole numbers. A (-) indicates 0%. Teachers are used for the teacher coaches who ran the clubs.

2.4. Data Collection and Analyses

2.4.1. STEM Club Attendance

Attendance for all participants was taken at each of the Club meetings, by students using a computer to enter their information on a Google Form during pre-club snack time. Demographic information was collected on one of the project surveys, in which students entered open responses for their name, school, grade level, race/ethnicity, and gender identity.

2.4.2. STEM Club Survey

STEM club participants participated in a survey exploring their perceptions of STEM clubs at the beginning of each year (pre-club) and at the end of the year (post-club). The survey items were developed by the research team based on aspects of Epstein's framework for Six Types of Involvement [12]: parenting, communicating, volunteering, learning at home, decision making, and collaborating with the community. The item development was needed because there were no survey items connected to Epstein's framework, and the research team wanted to understand students' perceptions of how the clubs were translating from the desired club to home and community outcomes. In addition, the research team wanted to ask students about their perceptions of the club quality and about STEM careers (e.g., knowing about STEM careers). The grant team (evaluator, PIs, and graduate students) independently went through multiple rounds of revisions of the proposed survey items, based on face and content validity, by trying to match the items to each of the Epstein constructs (e.g., collaboration, communicating) and developing clearly worded items. An open-response item was also included at the end of the survey that asked students, "What do you believe is the actual purpose of the STEM Club/Program?"

Exploratory and Confirmation Analysis. The survey responses were divided into two groups, pre-club and post-club. The data involved surveying the same individuals at two timepoints as a repeated measures design [73]. The pre-club data were collected at the beginning of the school year and were composed of all students who initially attended club meetings. The post-club data were collected at the end of the school year, approximately 6 months past the original administration of the pre-club survey. In consideration of the time between survey administrations, the pre-club survey and post-club survey were treated as two individual data sets and used independently for exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), respectively.

It is likely that the two data sets are composed of students who participated in one survey but not the other, as well as students who participated in both surveys. If the pre-club and post-club survey data were combined and then randomly split for factor analysis, it would be likely that some students would be present twice in one set and absent from the other and therefore not fully represent the students' responses. However, this conflict was eliminated by treating the pre-club survey and post-club survey as two data sets.

Testing for construct validity, EFA was conducted to identify latent constructs and the variables that represent them in the instrument with the pre-club survey results. The software package Statistical Package for the Social Sciences version 27 (2020) was used for EFA. The Shapiro-Wilk test of normality revealed that the data were not normally distributed; therefore, principal axis factoring (PAF) was selected as the method of factor extraction, with maximum likelihood (ML) selected as the preferred method [74,75]. PAF was performed on the 22 items, followed by Promax rotation, a well-established oblique rotation that permits correlations among factors [75,76]. Though parallel analysis suggested that the survey had one factor, the EFA was conducted with two factors, as determined by the MAP (minimum average partial) analysis. Through an iterative process, items with communalities less than 0.200, cross-loading greater than 0.32, and covariances less than 0.4 were eliminated [74–77], resulting in the removal of 3 items. The suitability of EFA for the data set was evaluated for the 19-item, 2-factor model; the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity were 0.853 and $p < 0.001$, respectively [76,77]. The 2-factor model explained 41.74% of the variance in the data, and the two factors had a correlation of 0.329. The Cronbach's alpha values for Factor 1 (10 items) and Factor 2 (9 items) were 0.877 and 0.845, respectively.

Using the post-club survey result, CFA was performed with Stata Version 17. This analytic procedure was used to verify the model established in EFA, a measure of the survey's reliability (Table 2). With the addition of several covariances, the model was found to have an acceptable fit. The Chi-square test results indicated a poor fit (χ^2 (145, n = 131), = 219.28, $p < 0.000$). The results of the other goodness-of-fit indices indicated a good model with a comparative fit index (CFI) at 0.95 [78]. The root mean square error (RMSEA) revealed an acceptable fit, at 0.063, and the standardized root mean square residual (SRMR) was considered a good fit at 0.053 since it fell between 0.05 and 0.08 [78]. Factor loadings had a range from 0.86 to 0.61, with the exception of one item that had a value of 0.40 (Table 2).

Table 2. Factor loadings for confirmatory factor analysis.

Category	Factor 1: Negatively Worded	β	Factor 2: Positively Worded	β
Volunteering	I do not feel involved in the STEM Career Club Project.	0.86	I participate in the STEM Career Club activities as much as I can.	0.69
Learning at Home	I do not talk about the STEM Career Club Project at home.	0.74	I think parents should talk to their children about what they learned during the STEM Career Club meetings.	0.81
Communication	I do not feel able to talk to other people about the STEM Career Club Program.	0.77	Students and parents are discussing STEM careers and/or STEM ideas more now.	0.65
Communication	I am not aware of what is happening during the STEM Career Club meetings.	0.75	I will be able to select the math and science classes needed by a student for a future career, possibly in STEM.	0.77
Decision Making	When I come to a STEM Career Club activity, I am not sure what I am supposed to be doing.	0.84	STEM Career Club leaders seem open to my ideas or feedback about the club.	0.64
Collaborating	I do not think the activities of the STEM Career Clubs Program will help students to consider STEM careers.	0.69	I am learning new skills from the STEM Career Club Program.	0.72

Table 2. *Cont.*

Category	Factor 1: Negatively Worded	β	Factor 2: Positively Worded	β
Collaborating	The STEM Career Club does not involve any people outside of the school to support the STEM Career Club activities, such as people who work in local businesses or in STEM careers.	0.61	I think that the STEM Career Club Project will make a positive difference outside of school, in my community.	0.69
Collaborating	I am not sure which jobs are considered STEM jobs.	0.65	I am becoming more aware of minority role models in/STEM fields.	0.75
Club Leadership	NA		I think the staff involved in the STEM Career Club truly have the interest of the students and their futures in mind.	0.70
STEM Careers	I do not think that/the emphasis on Science, Technology, Engineering, and Math (STEM) in the careers students learn about is important.	0.40	NA	
Parenting	It is not important for parents to participate in STEM Career Club activities.	0.72	NA	

The STEM club survey items were purposefully worded both positively and negatively, in order to try to confirm students were responding meaningfully to the items [75,79]. However, the wording led to the items being distributed into two factors, with Factor 1 being composed entirely of negatively worded items, whereas Factor 2 was composed of positively worded items (Table 2). Prior research has shown that negatively worded items will cause the appearance of an artificial factor composed entirely of negatively worded items and that negatively worded items often load on one or more separate factors [80,81]. In consideration of the idea of an artificial factor and the parallel analysis suggesting one factor, the survey items were collectively considered as one factor for the STEM club survey. The items are organized in Table 2, aligned with the category linked to Epstein's framework [12], STEM Careers, and club leadership.

2.4.3. Student Interviews

At the end of each of the three academic years of the project, approximately 43 STEM club participants were interviewed for about 15 min each. In total, about one third of the students who attended each school's Club that year were interviewed from a purposeful sample, based on club attendance (i.e., rarely attended to attended often) and grade level. A team of trained staff (usually 3–4 interviewers, total 8) conducted the interviews on one day each spring at each of the four middle schools. Interviews were recorded and transcribed verbatim by a professional transcriptionist. In total, the data for this paper totaled 917 pages of double-spaced transcripts from 131 student interviews over three years. At the time of interview, six of the students were in 5th grade (only one school), 35 students were in 6th grade, 38 students were in 7th grade, and 52 students were in 8th grade.

Interview questions were developed based on constructs of the Situated Expectancy-Value Theory of Achievement Motivation [57,66]. They were developed by the research team to be appropriate for middle school students, connect to the SEVT constructs, and be relevant to Club experiences and for the interview to last 10–15 min, on average. Interview questions were semi-structured, with an initial list, asked in order, but with the latitude to follow up with questions based on how the students responded to the questions. Students were asked a wide range of questions, including what they liked and did not like about the clubs and the specific activities, its usefulness, whether it was similar to or different from school, whether they saw themselves as a scientist, technologist, engineer, or mathematician while at STEM club or in the future, their plans after high school, and how they imagine their lives at age 25.

A codebook for interview responses was developed by the authors and was mapped onto the SEVT constructs, specifically those specific to identity and Subjective Task Values. Exemplars from the codebook that were used to code the student interview data were included for the following SEVT constructs: goals (i.e., college, careers, personal, making money, and providing for family), identity (i.e., we were just alike, had the same ideas, liked the same things, did/did not have a lot in common), intrinsic value (i.e., it is fun, it was cool, it was a great experience), attainment value (i.e., helped me learn more, know more, make things, introduce new content and careers), utility (i.e., working toward a goal, was useful, helped outside of the STEM club in their classes), and relative costs (i.e., have to follow directions, did not get along with other students, transportation issues). See Section 3.4 for examples given by students and sample quotes.

Additionally, a priori categories were established for post-secondary (i.e., community college, 4-year university, military, job) and career goals (i.e., business, engineering, professional, arts). Authors co-coded approximately 25% of the sample together, using the codebook as a guide. Following this protocol, the authors completed coding the remainder of the interviews independently; all codes were reviewed, and differences in interpretation were negotiated to 100% agreement [82].

3. Results

This section responds to the specific research questions and subquestions for this manuscript. Each research question was examined through qualitative or quantitative methods, as appropriate to answer the question. The results from the mixed-methods approach are then discussed together in the discussion section that follows.

3.1. Patterns of STEM Club Attendance

In response to the research question (1) how can students' choice to participate in clubs and their perceptions of the clubs be characterized?, we first addressed (1a) "What were participants' patterns of attendance?" Student attendance records were analyzed to understand who attended the club meetings, how often they attended, and if there were differences based on demographic factors and grade level. There were a total of 740 students, which included repeated records of students who participated for several years; a total of 376 unique students attended the STEM clubs over the three-year period. For club meetings, 6th-grade students had the highest attendance (41.8%), followed by 7th-graders (28.7%). Only one of the schools had 5th-grade students. A higher percentage of females attended club meetings than males for all grade levels except for the 8th grade (Table 3).

Table 3. Characteristics of STEM club students by grade and gender.

Grade *	Male * (%)	Female * (%)	Total (%)
5th **	3.1	3.3	6.4
6th	17.5	**24.3**	**41.8**
7th	11.3	**17.4**	28.7
8th	**12.3**	10.8	23.1
Total (%)	44.3	55.7	

Note: * Students self-identified grade level and gender. ** Only one middle school had 5th grade students.

A higher percentage of African American students (55.0%) and White students (23.4%) attended club meetings compared to other racial and ethnic groups. The composition of the student club participants is reflective of the racial/ethnic composition of the schools (Table 4).

Table 4. Characteristics of STEM club students by race and ethnicity.

Race *	African American	White (Non-Hispanic)	Hispanic	Asian or Pacific Islander	Native American	Other
Students (%)	55.0	23.4	8.9	2.0	4.5	6.2

Note: * Students' self-identified race.

Students were grouped into three attendance categories to understand trends: low, medium, and high. The low group consisted of students who attended $^1/_3$ or fewer of the club meetings, whereas the high group consisted of students who attended $^2/_3$ or more of the club meetings. The medium group consisted of students who attended between $^1/_3$ and $^2/_3$ of the club meetings. Most students had medium attendance, followed by high attendance, for all three years (Table 5). In the first year of the club, most students had medium participation. Over the three years, the percentage of students who attended at a high level of involvement increased from 30.7% to 36.1%.

Table 5. STEM club involvement by year.

Year	Low (%)	Medium (%)	High (%)
1	23.4	**45.9**	30.7
2	26.4	44.8	28.8
3	26.2	37.8	**36.1**

Attendance patterns were analyzed for the level of involvement by grade and gender to understand which students attended more meetings. Student data were analyzed to determine what type of involvement students displayed by assigning a value of 1 for low participation (attending $^1/_3$ or fewer of the meetings), 2 for medium participation (attending $^1/_3$-$^2/_3$ of meetings), and 3 for high participation (attending $^2/_3$ or more meetings) for each year of participation. The level of participation was compared across grade levels and students' genders by calculating the percentage of students in each category (Table 6).

Table 6. Summary students' involvement over three years.

Participant Level of Involvement	Grade				Gender	
	5th	6th	7th	8th	Male	Female
Low	1.5%	7.4%	6.4%	5.4%	8.3%	12.2%
Medium	1.8%	19.1%	14.8%	10.8%	21.7%	24.7%
High	3.3%	15.4%	7.4%	6.8%	14.4%	18.6%
Total	6.5%	**42.0%**	28.6%	23.0%	44.5%	**55.6%**

Per grade level, 6th-grade students were those who attended the most meetings with a medium level of participation. Female students were more active participants than male students with the greatest number of students at a medium level of participation.

3.2. STEM Club Survey Item Analysis

In response to research question (1) How can students' choice to participate in clubs and their perceptions of the clubs be characterized?, we next addressed (1b), "What were participants' perceptions of the STEM Clubs?" The STEM Club Survey was intended to capture the students' perceptions regarding relevant aspects [12], such as their learning, skills, decision making, careers, and collaborating with their community. In addition, one item asked about club leadership, and another asked about the importance of learning about STEM. An open-response item asked students what they thought was the purpose of the STEM clubs. All survey items were evaluated with a 5-point Likert scale, with 1 representing "strongly disagree" and 5 representing "strongly agree". Negatively worded items were unreversed for item analysis. Higher scores, closer to 5, represent positive perceptions toward the club, whereas lower scores, closer to 1, represent negative perceptions toward the clubs.

Although STEM Club Surveys were administered both in the fall (pre) and in the spring (post), only post-club responses were used in item analysis. The "pre" surveys may have been at the beginning of a student's second or third year in the club and therefore not a true measure of their initial perceptions. In addition, the clubs were all quite different from one another, stressing different content and skills. Therefore, the research team made the decision that the survey taken toward the end of the school year would be better able to capture students' perceptions of the nature of the clubs and what they were getting out of it after they had participated in clubs over many months.

Before item analysis by subgroup, the survey items were tested for normality with the Shapiro-Wilk test and the Kolmogorov-Smirnov test, and all items failed to reveal normality. Consequently, a one-way, nonparametric ANOVA test, the Kruskal-Wallis test, was utilized to determine item means and potential differences between student subgroups. The mean scores for sample items are displayed in Table 7. Most scores represented *Agree* to *Strongly Agree*. The mean scores for the categories ranged from 3.9 to 4.2. The lowest category score was for *Collaborate* (M = 3.61). Even though this represents the lowest scoring category, it still indicates *Agree* on the Likert 5-point scale. Overall, the category values indicate that students generally agreed with the survey items (>3.5–5.0), revealing positive student perceptions toward the STEM club (average score of the survey, 4.0).

Table 7. Sample STEM Club Survey items.

Category	Item	*Mean*	*SD*
Collaborate	I am learning new skills from the STEM Career Club Program.	4.4	0.7
Collaborate	I think that the STEM Career Club Project will make a positive difference outside of school, in my community.	4.3	0.8
Communication	I will be able to select the math and science classes needed by a student for a future career, possibly in STEM.	4.2	0.8
Decision making	STEM Career Club leaders seem open to my ideas or feedback about the Club.	4.0	0.9
Learning at home	I think parents should talk to their children about what they learned during the STEM Career Club meetings.	4.1	0.9
Volunteering	I participate in the STEM Career Club activities as much as I can.	4.4	0.8
Club Leadership	I think the staff involved in the STEM Career Club truly have the interest of the students and their futures in mind.	4.3	0.9
Overall mean for all survey items (22)		4.0	

Item means were analyzed in comparison to students' grade levels, racial/ethnic identity, and gender identity. No significant differences in their perceptions of the STEM Clubs were found, with one exception. For the items *STEM Club leaders seem open to my ideas or feedback about the club*, African American students were significantly more likely to agree (M = 4.2; SD = 0.7) than Hispanic students (M = 3.6; SD = 0.6) and White students (M = 3.8; SD = 1.1). Hispanic students (M = 3.6; SD = 0.6) had a significantly lower score than Native American students (M = 4.5; SD = 1.0) and those students who identified as other (M = 4.3; SD = 1.0).

3.3. Purpose of STEM Clubs

In response to (1) How can students' choice to participate in clubs and their perceptions of the clubs be characterized?, we next addressed (1c) "What did participants think the was purpose of the STEM club?" The STEM Club survey included an open response item asking participants what they believed was the purpose of the STEM Career Clubs. These responses were coded within the relevant constructs of Situated Expectancy-Value theory [57,66]—cost, intrinsic, attainment, and utility. There were 149 statements coded. Some statements were double coded as some students included multiple ideas that spanned theory constructs within their responses. Statements that were coded as intrinsic represented personal enjoyment, including "to have fun" or "I think STEM is a fun way to let kids learn". Items that represented the importance of doing well or self-image were coded as attainment. Example attainment items included "to help educate us" and "give knowledge to students [about] science technology, engineering, and mathematics". Statements relating to long- and short-term goals were coded as utility. For utility, students shared "to help kids with their future careers and to encourage kids to do better in school", along with "to inform kids about different careers". The cost code was used to identify aspects of the clubs that students perceived to be competing with their other goals. From the data analysis, the only cost statement shared was, "it's a good club for someone who got time for". This statement was dual-coded as intrinsic because the *good club* implied enjoyment, but the *time for* depicted the cost of time to participate.

The percentage of codes for each value category was calculated for the four grade levels (Figure 2). For 5th grade students, reasons for attending the clubs related to attainment value (63.2%) were much higher than other value categories and those for other grade levels. Attainment and utility values were the highest with similar representation for 6th, 7th, and 8th-grade students (ranging from 37.1% to 50.0%). As the students increased in grade level, utility statements had a higher frequency than those related to attainment, representing a greater focus on careers and reaching their future goals. The intrinsic value of the club was of lower importance for students but had the highest value for the 8th-grade students (17.1%). The only presence of a cost statement was from an 8th-grade student sharing about the time requirement to attend club meetings, representing 2.9% of the codes from the 8th-grade students.

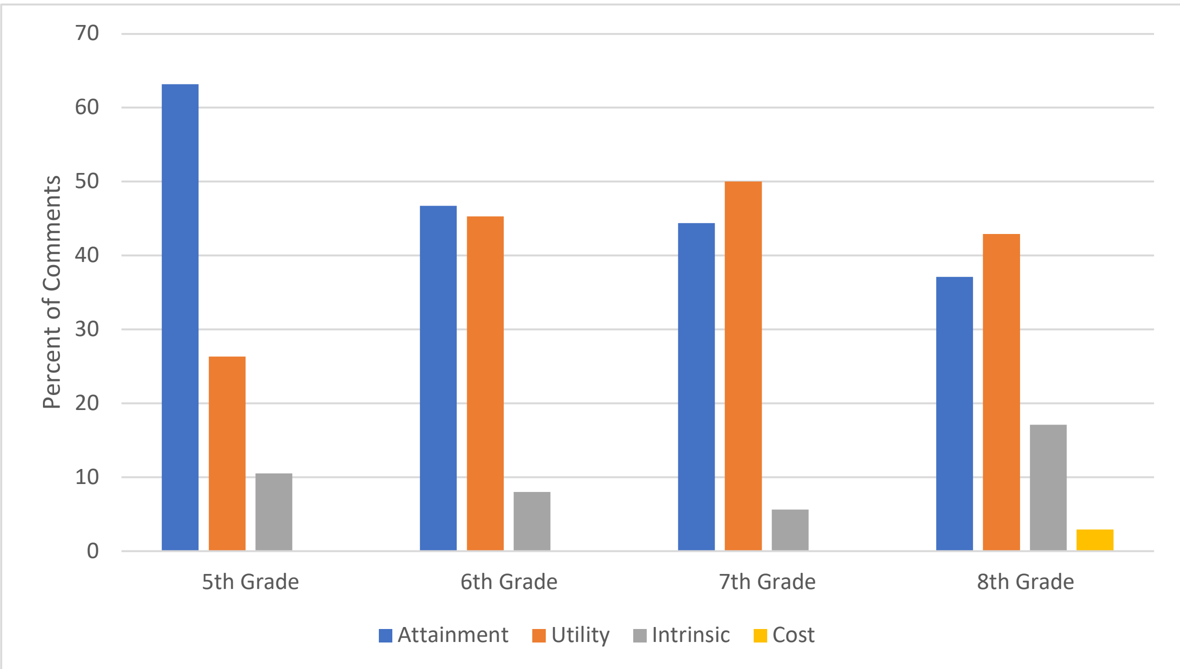

Figure 2. Analysis of students' responses to the purpose of STEM clubs.

3.4. What Interviews Revealed about Students' Motivations for Attending STEM Clubs

In response to research question two, "What were participants' motivation(s) for STEM club attendance and participation?", interviews were also utilized as a source to help determine students' motivations for attending the STEM club. The student interviews (n = 131) that were conducted and transcribed from each year were analyzed based on relevant Situated Expectancy-Value theory constructs (Table 8) expressed by students. Overwhelmingly, interviews revealed that students (99%) found the club intrinsically rewarding. They expressed this in a range of ways, calling clubs "fun", indicating enjoyment of "hands-on" activities, and finding the clubs "exciting".

Table 8. Key Situated Expectancy-Value theory constructs from student interviews (n = 131).

Intrinsic Value	**% of Students who Expressed Value**	**Examples Given by Students**
Interest/enjoyment	99%	Fun, interesting, enjoyable, exciting, hands-on

Sample Quotes

- It's exciting. It's fun. The disease and pandemic, then the natural selection and evolution, then the physiology. Favorite from all three years- making ice cream.
- It's fun, usually. It's funner than school. Because there are no grades.
- Because I like learning more about the earth and how we were made and how we came together and what do we do in more of an in depth way. [why is science your favorite?] I like that we do more experiments to learn more about the aerospace and stuff. We made a rocket out of Alka-Seltzer and a beaker and a stopper and it flew up to more than two feet.

Utility Value	**% of Students who Expressed Value**	**Examples Given by Students**
Valued because it helps to reach a variety of long- and short-range goals	55%	Good opportunity, helped with class work, developing new skills

Sample Quotes

- Well, sometimes we learn things in STEM that we learn before we learn in class, so that helps me on tests, and sometimes I already know. Like, I don't have to copy the notes.
- [Guest speakers] It made me think about what to be, even though my dream goal was to be a doctor . . . .I normally thought it was, like, about 50 jobs out there. But then, I just realize there's more and more and more. It's different. It's a lot of engineers. So, it just made me realize. It just made me think. But I'm still trying to be a doctor, but I'm-if I don't make it there, then I just have to think about some other things and try to think about one of those.
- There's been so many things that we would use in the real world especially since I want to be an engineer. It really affects how my perception on what I want my job to be.
- I'm not going to tell you like the whole reason I went to STEM was like to have fun. I originally just went because I wanted to learn, and I thought that it would look really, really good on my college application to say that I was in that club and the [unintelligible] originally for a good look at a college application, but as I got to it, I'm like, "Oh wait, this actually really fun and really things I would do".

Attainment Value	**% of Students who Expressed Value**	**Examples Given by Students**
Important due to core personal values	42%	Found out about new careers, learn more and know more, do things that add to who you think you are

Sample Quotes

- Last year when I came it introduced me to some new stuff. Like forensic anthropology. And now I want a career with forensic anthropology. So they just introduced me to my career.
- I really like helping people. And I also like making things, at home I have a whole section just to make stuff that's mine to draw, so I thought that would come in handy in engineering because I might be able to come up with things that could help other people and I think I'd really enjoy helping other people.
- I thought it would help me with what I wanted to do when I grow up; Engineering...Because I can use my creativity to build and come up with new technology.

Table 8. *Cont.*

Identity Personal and collective characteristics	% of Students who Expressed Identity 40%	Examples Given by Students Being smart, funny, creative; having a lot in common with the group
Sample Quotes • Yeah, because I already wanted to go [to college], and actually being on campus it teached me that seemed like... I can see myself being there. • [How do you feel at the club?] Like at home.		
Cost What is lost or given up/suffered as a result of engaging in the activity	**% of Students who Expressed Identity** 21%	**Examples Given by Students** Boring, teachers did not listen, fighting, confusing, too much or not enough time, had conflicts with attending
Sample Quotes • At first [I felt] bored. • I get home about 7 [long bus ride] • [I felt] nervous • I didn't like the little sign off sheet at the end. I actually did not like that.		

Note: Students may have expressed multiple examples for some of the SEVT constructs during an interview, but it was only coded one time for each student, to obtain an overall sense of the prevalence of the SEVT construct in the group.

Most students described many things they liked about the club, sprinkled throughout the interviews. As with all of the coding, *intrinsic value* was only coded once per student, regardless of how many things students described as enjoying. Students often discussed how much they enjoyed the activities in the club because they were different (e.g., hands-on, working in groups, encouraged to talk and share ideas) and considered them to be more fun that what was traditionally done during the regular school day. A few students noted that the clubs were not connected to testing.

Next, students (55%) were most likely to talk about how they found the club activities useful to them (*utility value*), either currently, while in middle school, and how these would provide skills and content knowledge that may help them in the future (e.g., high school, college, careers). *Attainment value* was the next most often coded category. Students (42%) described learning new things and connecting those experiences to what they cared about and career possibilities (all activities were linked to related careers).

Additionally, students (40%) talked about *identity*-related constructs, such as feeling how they felt comfortable and a part of a group in STEM clubs and how they had a lot in common with their team (*collective identity*). In addition, students also talked about being smart, funny, and someone who was kind or good in math (*personal identity*) and similar identity expressions. Many students described feeling as though they belonged in the club, with students who shared many of their goals and interests. The highly interactive structure of the clubs allowed students to get to know each other and help each other while they tried to develop biomathematical models for how high they could jump, take measurements on the weather, learn about climate change, or consider careers they explored [4,6,31].

3.5. Post-Secondary Education and Future Career Goals

The student interview data were analyzed to answer research question three, "What were participants' post-secondary and future career goals?" The results for this question are divided into the two subsections below.

3.5.1. Post-Secondary Education

Over 78% of participants in all grades (5th = 100%; 6th = 85.7%; 7th = 78.9%; 8th = 90.1%) indicated that part of their future educational goal included attending a 4-year college or university. While most participants primarily focused on 4-year institutions, a few participants (5th = 1; 6th = 0; 7th = 4; 8th = 2) spoke either exclusively about attending a 2-year college or technical school or attending, as part of their pathway, a 4-year institution. For example, when asked what he wanted to do after high school, a 6th grader said, “go to college [... to] [Name] Community College. I was planning on going to the Early College Program [...] and then the college is free. [After that . . .] I might go to four years of college, maybe . . . probably [University name]”. Similarly, most other participants named at least one specific college or university they wanted to attend, with this percentage of participants increasing as they progressed through middle school (6th = 74.3%; 7th = 76.3%; 8th = 82.7%). Participants often named local universities, such as a 7th grader who said, “I was planning on going to [University name] because that was my favorite college team and I wanted to play basketball for them”. However, participants, including the young man quoted previously, also pushed boundaries toward out-of-state ivy league institutions, “I was thinking if I don’t make it to Yale, Princeton, Stanford, or Harvard, I would go to [University name]. I just wanted to go to a higher one to see, because my grades are good enough”. Overall, participants generally intended on going to college to complete an undergraduate degree, but a few participants, particularly those in 7th and 8th grades, talked about completing either a masters (7th = 3; 8th = 3) and even doctoral (7th = 3; 8th = 4) graduate programs. Additionally, a couple of participants in 7th and 8th grades mentioned either entering the armed forces or attending an early college as pathways to pay for and attain their college degrees, while students in earlier grades did not mention these as possible routes to help reach their educational goals. For example, an 8th grader had a solid educational pathway planned: first, to go to the “early college program and the [Name] Community College [...] so then I can have my associate’s degree when I go to college. Then I can get another degree. Then go to get a DMV, which is a Doctorate of Veterinary Medicine”.

3.5.2. Future Careers

Overall, the majority of STEM Club participants (5th = 83%; 6th = 71%; 7th = 68%; 8th = 84%) expressed interest in pursuing at least one STEM career for their future career.

Figure 3 shows the raw numbers of interviewed participants who shared specific career goals. Some participants mentioned multiple career goals; thus, participant responses were coded into multiple categories, as needed. The named careers were coded into the categories listed in Figure 3 and then split between either STEM or non-STEM careers. Non-STEM careers within the sub-code artists/entertainers/athletes included participants who said they wanted to be singers, basketball players, or dancers; professional careers included lawyer, teacher, or tax collector; service industry careers included chefs, hair stylists, or truck drivers; and business included restaurant owners, hair salon owner, or CEO of a company. Of the participants who indicated they wanted to pursue a STEM career, the greatest number said they wanted to pursue a career in medicine (e.g., veterinarian, pediatrician, nurse). This was followed closely by those participants who were interested in engineering (e.g., mechanical, aerospace, civil, chemical), science (e.g., scientist, biologist, chemist), and technology (e.g., game designer, technologist, computer technology). Participants often were vague when they talked about the type of science or technology career they wanted to pursue but were more specific when they explained the type of engineering or medical professional career that interested them. Both those who expressed interest in STEM and non-STEM careers often indicated that they chose their future career not only because of their interest in the field and the content of their career but also because they saw that career as a career of caring, empathy, and helping others. One 8th grader explained that she “really likes helping people . . . so I thought that would come in handy in engineering because I might be able to come up with things that could help other people and I think I’d really enjoy helping other people”. Participants also talked about how their career goals changed over the course of the year(s) involved in the STEM club. For example, one 6th grade student expressed that “last year I was thinking of being a policeman and now I want to be something that is involving engineering”.

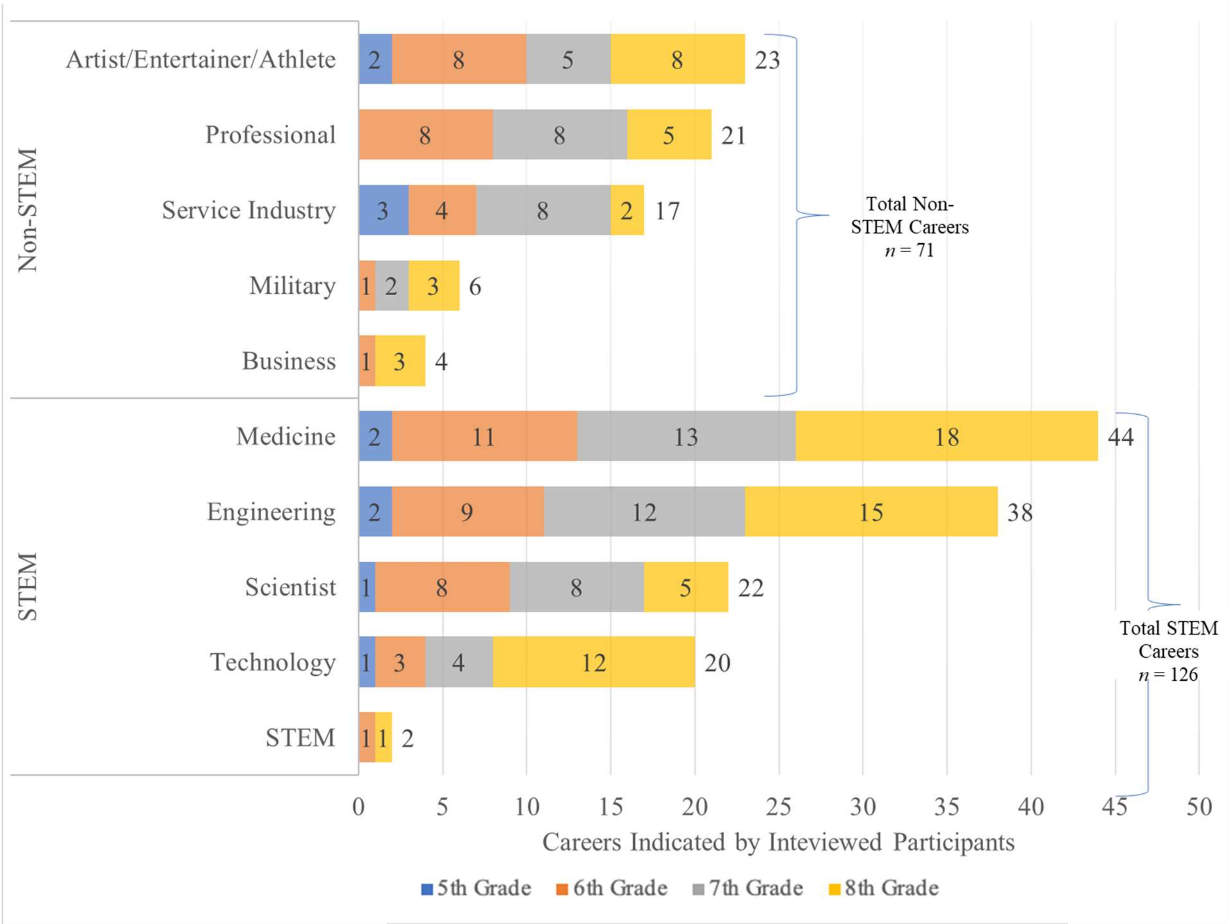

Figure 3. Number of interview participants who indicated STEM (n = 126) vs. non-STEM (n = 71) future career goals.

After analyzing students' career goals, the percentage of STEM-career-focused responses was compared to the students' attendance trends for the year the interview was conducted (low = $^1/_3$ or less meeting attendance, medium = between $^1/_3$ and $^2/_3$, and high = $^2/_3$ or more). As shown in Figure 4, for all grade levels, the highest attending students had the highest percentage of STEM-focused-career goals (5th = 68%; 6th = 46%; 7th = 40%; 8th = 39%). For medium attending students, the percentage of STEM-focused careers did not seem to change by grade level, but the overall percentage was lower than the high-attending group. For the low-attending students, there was an upward trend in STEM-focused-career goals as they progressed through middle school.

Additionally, the number of different careers (all categories) mentioned by the students as potential future career goals was analyzed compared to their grade level. Generally, most students (82%), regardless of grade level, mentioned 1–2 potential future careers. There was no clear trend between the total number of careers mentioned and the students' grade level.

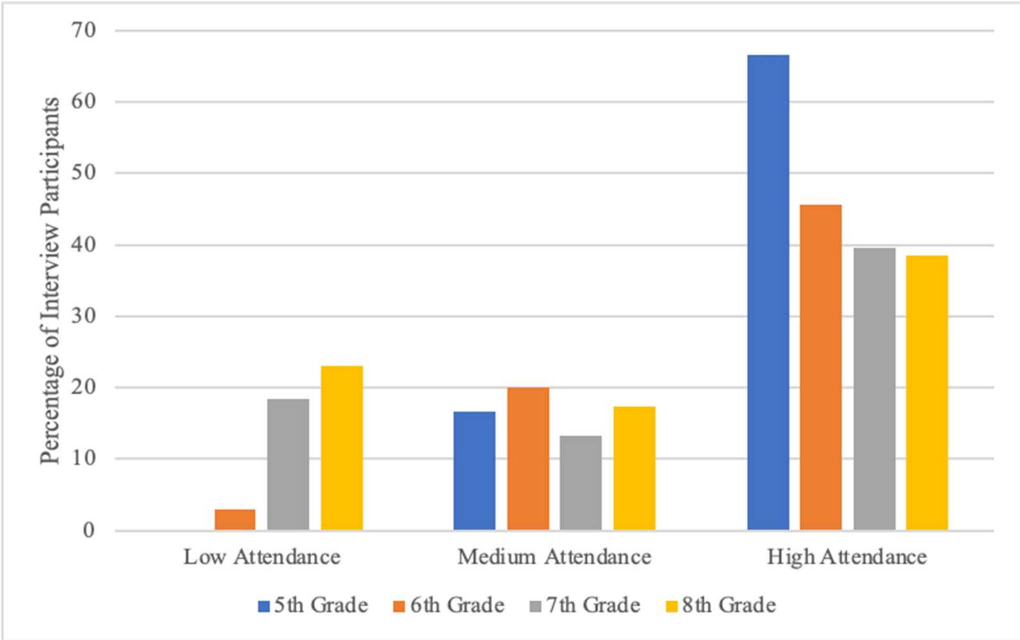

Figure 4. Level of attendance for students with future STEM career goals.

4. Discussion

In this study, we wanted to gain a holistic understanding of what motivated and sustained students' involvement in the STEM clubs. That is, what were they gaining from the experience that kept them coming back? This study was logistically difficult: we had clubs at four rural middle schools with variable, non-compulsory attendance. Eighth grade students matriculated into high school and 5th (one school) or 6th grade students entered from elementary school, meaning that the population of students in the club shifted every year. High-quality afterschool programming (e.g., [4,6,18,39]) allows students the freedom to choose to attend. Their choice to attend was enhanced by providing the clubs at no cost to students, a snack, and free bus transportation home available to anyone who needed it.

The current study was unique in that literally all of the data collected and analyzed for this manuscript were provided by the students. The population of participants in the current study has not been well represented in the literature (e.g., [4,14,83]). Overall, these were rural, minority (predominantly African American) students from low-SES households who had moderate participation in the clubs. Analyses of the students' interviews and open responses provided insight into their thinking and what they valued, through their own words, adding to what we know about these marginalized and minoritized youth. The female students were more likely to attend, as were 6th grade students. Despite the non-compulsory nature of the club, students chose to attend and—despite the necessary turnover due to matriculation to high school—about one third of the students participated for multiple years.

Situated Expectancy-Value theory (SEVT) was used to frame the study around motivation and as an analytical tool to make sense of students' reasons/motivations for participating in the clubs [57]. Students shared the ways in which the club tasks were important to them (*attainment value*), the reasons they found it useful (*utility value*), and what about the tasks most interested them (*intrinsic value*); occasionally, they shared *costs* that came with club attendance.

Students' responses to the STEM Club Survey indicated that overall, participants' perceptions of the STEM clubs were generally positive, responding that they *agreed* with a range of statements about the club's usefulness/qualities. The only difference found between groups was that African American students, who made up the majority of the club members, were more likely to agree that *STEM Club leaders seemed open to their ideas or* *feedback about the club*. This speaks to the successful efforts of the professional development of the teacher coaches to be receptive to students' ideas and listen and [6] students feeling the ability to express themselves [54] and feel that they belonged [4]. In looking back on the ethnic and gender [18,28,29] matching of the African American teacher coaches and the students (Figure 2), it seems likely that identifying with the teacher coaches played a role in their positive perceptions of their interactions with the STEM club leaders.

When asked to write what they thought was the purpose of the STEM clubs, younger students were more likely to stress the importance of the STEM club for their future goals. The older students were more likely to stress the *utility* of the clubs [61], mainly focused on learning about careers. This suggests that the STEM career focus of the clubs—exploring STEM careers that featured many minority and female role models and club/Zoom visits from a diverse group of STEM professionals—was being noticed as a useful and clear focus of this club. When Shin et al. [84] began to examine motivation for STEM content areas in 5th and 6th grade students in Korea, they also found that providing an intervention to help increase students' utility value helped to increase student motivation for STEM. Changes in what students value have been found to occur throughout their academic pathways, but particularly when transitioning from one grade band to the next (i.e., elementary school to middle school and then to high school) [61,85]. Given the (up to) four-year grade span of the STEM club participants, there was an opportunity to see some differences emerge based on grade level. Eighth grade students expressed the most interest in STEM careers (Figure 3).

When comparing students' written responses on the goal of the STEM clubs to the individual interview data analyses, students were much more likely to describe interest and enjoyment as driving factors for their participation, regardless of how much they participated. This resonates with prior studies indicating that even short-term interventions can be meaningful [31,86]. Although they may have thought that the *purpose* of the clubs was to learn and to help them with their current and future goals, in reality, they were coming back because of how they felt at the clubs and the inherent enjoyment they experienced, what the research team referred to as "voting with their feet". This suggests that, by choosing to attend, students were gaining many of the benefits documented in the literature with high school students or in weekend programming [51,87].

These experiential aspects of the clubs came out in the individual interviews; participants' motivation(s) for STEM club attendance and participation were dominated by the *intrinsic value* it held for them [60]. The novel activities and teamwork in groups were pivotal for their participation, providing a very different kind of experience than the typical school day. The casual club atmosphere allowed them to meet new students, gain a sense of belonging and ownership in the club (*identity*), and for students who participated in a weekend, residential experience on the university campus, a feeling of belonging on campus. Students described the experiences as useful (*utility value*) for their short- and long-term goals and developing career interests and goals. Given that the clubs were mostly attended by underrepresented minority students, this suggests that the students were finding them to be culturally relevant [32] and allowing them the space to form their goals and identities in practice during club sessions [67]. In this study, those personal and collective identity aspects included such things as feelings of 'being smart", "creative", "having things in common with their group", and feeling "at home" in the clubs.

Students' interview responses were consistent with the data collected from students on the STEM Club Survey. They perceived the club positively, feeling that they were heard, that it was contributing to their awareness of minority role models and STEM careers, and that it was translating to home discussions, consistent with goals for afterschool STEM interventions (e.g., [5,10,12]). Most noteworthy, there were no differences on what students experienced based on their race/ethnicity or gender. Any differences found seemed to be driven by developmental aspects, which could have been from maturity or greater exposure to club or other life experiences. What stood out was that the students felt listened to by the teachers, in stark contrast to what has been documented in classroom studies of underserved students (e.g., [31,88,89]).

More than three-fourths of the interviewed STEM club participants indicated that they intended to attend a 4-year college or university. In the United States in Fall 2020, 63% of high school graduates enrolled in either a 2-year or 4-year institution [90]. A greater percentage of students in our study indicated their aspiration to attain a 4-year degree than the national average. It is particularly important to note that 55% of the STEM club participants identified as African American, and in the US in Fall 2020, only about 12% of those who enrolled in 2- or 4-year colleges identified as Black. Even as early as 5th grade, STEM club participants in this study were mapping out their college and career pathways, some of which included plans to complete early college and/or community college as a steppingstone to their undergraduate institution. This suggest that the exposure they had to career professionals and explorations taught them about new careers [31,53] and expanded their vision for their future educational pathways and STEM careers [7,19,51], consistent with what has been found in other high-quality informal programming. Participants in 8th grade named more potential post-secondary institutions that they were interested in attending than those in earlier (i.e., 5th/6th grades). Given the needs of the students served, this exposure could help to close the opportunity gap [52] for these students.

It would be difficult to establish a cause-and-effect relationship of a monthly STEM club meeting, given the complexity of a student's life and the many factors that were not measured. However, our data indicated that the most frequent STEM club participants (high attendance group), were more likely to indicate their interest in pursuing a STEM career in the future than those students who were in the medium or low attendance groups, consistent with the findings of Sahin [42]. It is unclear whether the students came to more of the club meetings because they were more interested in future STEM careers or if their experiences in the STEM club increased their desire to pursue a college major or career in a STEM field. Prior literature [91,92] examining STEM education programs, such as those in this current STEM club study, have been found to increase student attitudes and interest in STEM and STEM careers.

Limitations

Our findings should be viewed in light of several limitations. First, since the study took place over three years, the group of students in each school and each year was not the same. Second, the outcomes we measured no doubt give a limited picture of what the students gained during the 1–3 years of STEM club activities that they attended. Third, our interviews were with a subset of the population in our study. Middle school students' interviews expressed a mixture of ideas that were coded into different SEVT categories. Different interpretations of the categories may have led to different findings. The views of this subset of the overall population of students may not be generalizable to the whole group or to other populations of students. With these limitations in mind, we will now make conclusions and recommendations based on our findings and the discussion.

5. Conclusions and Recommendations

In this study, students attended the afterschool STEM clubs because they *wanted* to attend, and they were motivated to attend the club as evidenced through the various SEVT constructs that the students shared. The findings show that students' perceptions were that the clubs were fun, social, novel, and valuable to students in many ways, and students felt they were getting a lot out of the clubs. They had exposure to new career pathways at every club and met a diverse group of professionals, and this led to their expectation of attending a four-year university and considering career pathways.

5.1. Conclusions

A number of conclusions and implications related to students' motivation for club attendance are drawn from the findings of this study:

1. The group work met the social needs of students and also developed many personal skills and a sense of identity as a club member.
2. Students talked in depth about education and career pathways and future goals, suggesting the value of linking careers and pathways to each of the activities.
3. The culture of the club and its leaders seemed to resonate with *all* students, based on strong continued attendance and the high participation of African American students.
4. Students clearly differentiated between their club experiences and regular school, describing the clubs as more valuable and their interactions with teachers as more positive.

5.2. Recommendations

For those who plan to organize afterschool clubs, we recommend that teachers participate in culturally responsive professional development to learn how to provide a welcoming and supportive environment for all students. We recommend providing transportation home, free access, snacks, and novel, stimulating activities. All of these require a clear commitment (and probably a memorandum of understanding (MOU)) with schools to ensure continuity when leadership changes.

For those who plan to conduct research in these settings, we recommend collecting pre- and post-data on career interest to better gauge the influence of the club participation on career interest. Researchers should consider using the SEVT framework as an analytical tool to better understand the voices of marginalized and minoritized youth in formal or informal settings. It would also be enlightening to be able to follow up with students to see what decisions they ultimately made, which requires collecting their names and as much contact information as possible. We encourage researchers to collect demographic data on the student participants and the club leaders, with a focus on providing relevant role models for the participating students.

For policymakers who are interested in broadening participation and learning in STEM, it is important to consider key elements of motivation and participation of youth in informal spaces. One way in which policymakers can successfully broaden participation of youth in STEM is to create and support STEM-focused clubs in out-of-school settings [14]. In this manuscript, essential components of afterschool STEM clubs in four rural middle schools, held over the course of 3 years, were explored and discussed, based solely on research data provided completely by the participating students (for a more detailed description of the entire project, see [6]). Policymakers and funders of informal STEM learning opportunities for youth should realize the importance of empowering youth to share their feedback as we seek to motivate and sustain the involvement of underserved students in new, informal STEM initiatives.

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