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Examination of a Successful and Active Science Club: A Case Study

Abstract

This qualitative evaluative study explores the views of two science club advisor/educators of an active 122-member rural high school science club program that is thriving in spite of increasingly busy student schedules, decreasing school budgets, and a demanding standardized curriculum. It is essential to understand the teacher-advisors' objectives and how they run science club, to understand why the organization is popular for students. What do the two teachers do to make this science club vital to the students? Why do the students connect to the program? Four emergent categories were identified during analysis: (a) the teachers established goals and a philosophy concerning science club, (b) the science club was based on activities, (c) the social aspects of science club were nurtured, and (d) there was a connection between the informal (science club) learning and the formal (classroom) learning. The results of this study informs our understanding of how an active, strong science club may be structured and managed, and the study tangentially illustrates the benefits that a well-run science club may provide to the student membership as well as the overall science program at the school.

Introduction

Student interest in science tends to decline as the students advance through school (Ipsos Reid, 2010). Once the students reach high school, many do not see science as relevant for their future careers, overlooking the fact that science courses are required to enroll in seemingly non-science career paths such as culinary arts, technical theatre, or fitness (Hurd, 2013). Students also need science literacy to participate wisely and function as a contributing member within society (Martin, Sexton, & Franklin, 2009). At the same time, determined from the Programme for International Student Assessment (PISA) statistics, 15 year-olds in the United States rank 16 out of 26 countries in science literacy (National Science Board, 2010). Gottfried and Williams (2013) recognized that government, industry, and parents are pressuring school systems to respond to the perceived gap of decreased student scientific literacy and stagnant numbers of students pursuing science related career paths. To close the gap, the Next Generation Science Standards (NGSS) provide guidance for the formal classroom setting, but classroom activities alone may not be sufficient. To bridge the divide, Gottfried and Williams (2013) identified an improvement of student achievement in the science, technology, engineering, and mathematics (STEM) areas when students participated in informal learning activities, particularly when belonging to STEM related extracurricular clubs.

This study examined one very active, 122-member rural high school Science Club program that thrives in spite of increasingly busy student schedules, decreasing school budgets, and a demanding standardized curriculum. This study was not about how to set up or run a Science Club, but instead the objective was to explore what the two teacher-advisors did to make this Science Club vital to the students. Why did the students connect to the program?

Keywords: science club, informal learning, experiential learning, field trip

Definition of Science Club

Science Clubs are organizations or programs intended to provide students opportunities to directly explore and participate in science-related activities. The clubs are usually supported and run by a school, educational facility, or parent group; in the case of this study, the Science Club was a sanctioned organization in a high school. Each club is different, defined by its purpose and advisor's philosophy and goals. Looking specifically at school-based Science Club programs, the meetings may take place during school, after school, or during the weekends (Primary Science Teaching Trust, 2014). Activities are usually student oriented to generate and nurture interest in science, to gain science related experiences that are not part of the regular school curriculum, and to simply inspire students to have fun exploring and experiencing new things. Some clubs are general, and some clubs may focus on a specific area of science such as astronomy, technology, or nature (Science Clubs of South Africa, 2014). School based Science Clubs are typically open to the full student body, although some clubs may target subset populations, such as female students (Chandler & Parsons, 1995; Watermeyer, 2012). In some instances, in spite of Science Club being open to the full population, only segments of the student population join. For example, Carter (2012) observed that his Science Club membership consisted primarily of "boisterous boys" who did not necessarily do well academically but enjoyed participating in the activities.

There is minimal recent research illustrating the state of Science Clubs in modern high schools. Anecdotal evidence and personal observations suggest that, in general, Science Clubs are experiencing decreasing memberships or dissolution. In contrast, the benefits of an afterschool Science Club program are

well documented from past and present researchers (Dunbar & Schafer, 1930; Gottfried & Williams, 2013; Hauenstein & Makki, 2012; LeDee, Mosser, Gamble, Childs, & Oberhauser, 2007, Reusser, 1934; Twillman, 2006; Webb, 1931).

Students may use Science Club as a resource to deepen and broaden their interest in science, to gain knowledge, to develop experience in conducting a meeting, to experience topics and activities that are not part of the regular classroom, and to be given free-choice to explore their personal interests, which may intrinsically motivate exploration and discovery (Reusser, 1934). Depending on the purpose and goal of the Science Club, the teacher might use Science Club as an extension of a class (Hauenstein & Makki, 2012) or as an avenue to science competitions (Twillman, 2006). An effective Science Club program has the ability to develop in students the sense of awe and wonder, to develop "personal interest, experience, and enthusiasm—critical to children's learning of science at school or in other settings— [that] may also be linked to later educational and career choice" (National Research Council, 2011, p. 28).

Students enjoy Science Club because they get to do authentic science and be real scientists, they can conduct science activities that are meaningful and have a purpose, (Hauenstein & Makki, 2012), they feel less apprehensive about science and have a better attitude towards science (Moore-Hart, Liggit, & Daisey, 2004), and they have time to meet and mingle with peers who will not laugh at them for enjoying science (Twillman, 2006). There is no focus on standards or curriculum, rather an afternoon activity may unpredictably change course as students find interest in an unanticipated, peripheral topic that leads to exploration and discovery. Science Club should cultivate the joy of investigating mystery, while having fun (Twillman, 2006).

Design and Procedure

This current study is an emergent extension of a larger study that will be described first, to provide a foundation to the current study. In the original study, six students, four female and two male, ranging from tenth to twelfth grade, were chosen through purposeful stratified selection methods from the Science Club membership pool (Onwuegbuzie & Leech, 2007) to gain understanding of the nature of their experiences during a four-day immersive field trip. Three students self-identified themselves as highly interested in science, and three students self-identified themselves as minimally interested in science. The six students were interviewed on multiple occasions, and participated in photovoice. During semi-structured interviews, each student-participant (all names are pseudonyms) commented on the importance of Science Club to their interest or appreciation of science:

- "With Science Club you get to do things you would never have had the opportunity to do…If I only have one activity to do, I would probably pick Science Club, because of the people in it and [the teacher-advisors]" (Willa, interview, 4/10/2013).
- "We have the Science Club. We do everything from a zoo trip, which is an overnighter, we do a canoe trip, we do Stone Lab. We have many labs after each informational meeting, like blowing stuff up with dry ice, just the fun activities that we do with science." (Tammy, interview, 4/8/2013)
- "I like to see different things all the time. I love to go on the local zoo overnight trip, you get to interact with different kinds of people, you get to learn stuff you don't learn at school" (Logan, interview, 4/9/2013).
- "The trips are fun, and I like doing the odd experiments at the end [of each meeting]" (Lisa, interview, 4/8/2013).

During the initial interviews prior to the field trip, when asked what activities or sports they belong to, each of the students immediately answered "Science Club" before naming any other activity. This particular studied Science Club had 122 members during the 2012-13 school year at a rural Midwestern US high school attended by 550 students. Some students were part-time Science Club members; however, 50 or more students showed up for each meeting and activity. It was evident from the interviews that Science Club was important to all students - those who enjoyed science as well as to those who did not enjoy science classes. What did this Science Club do to connect to so many students?

This current study utilized a qualitative case study research design (Creswell, 2003; Stake 1995) to explore the views of two high school science educators who were also co-advisors for a rural Ohio Science Club. Data from this study included teacher interviews, three full months of classroom and field trip observations, and statements from student interviews from the larger study that sparked this examination. After IRB approval was granted, teacher interviews were conducted using a semi-structured protocol, recorded on digital recorder, and transcribed. Interview transcript analysis involved open coding related to the teachers' views about science education and Science Club membership and activities. Generated codes were compared and merged where appropriate into categories, and then tested against the data (Patton, 2002; Rubin & Rubin, 2012; Stake, 1995).

Participants

Two high school science teachers who were also co-advisors for Science Club participated in the interviews. Mr. Jacobs (all names are pseudonyms) had six years experience, and taught Biology 2, Ecology, and multiple sessions of Biology 1 at the time of the study; Ms. Kay had 28 years experience and taught Physics and multiple sessions of Chemistry at the time of the study. Both teachers had one free period per day for lesson preparation. The two teachers at this specific high school were chosen for this study because the Science Club membership at their school over the past ten years ranged from 122 to 226 members, at a school with on average 550 students.

Findings and Analysis

The objective of this study was to explore what the two teacher-advisors did

to make this specific Science Club interesting and significant to the students. The analysis resulted in four emergent categories:

1) The teachers' established goals and a philosophy concerning Science Club
2) The Science Club was based on activities
3) The social aspects of Science Club were nurtured
4) The informal (Science Club) learning connected with the formal (classroom) learning.

Goals and Philosophy

In this first emergent category, the teachers reported clear goals for the Science Club: to provide a place where students who enjoy science fit in; to create experiences that students find interesting; and to help students realize that science is around them at all times. The teachers wanted the students outdoors, to experience and recognize that not everything in nature is what they expect, and that science is a process that is always changing:

> Doing pre-field stuff inside makes sense, you get their attention, but if you really want to experience stuff in a creek, you don't grab rocks and bring them in. You can talk about that, look here is what you are going to see, here is the kind of stuff, here is the stuff, now we have to go outside. (Mrs. Kay, interview, 5/31/2013)

The goals are achieved through interesting activities and during at least three field trips, two of which are overnighters. The idea is to break students away from their routine lives and activities, to be surrounded by peers and teachers who are excited about science and to experience science and the natural world.

The teachers explained that all students are welcome in the Science Club, no students are excluded, and no students are compelled to join. Knowing that some students have overwhelmingly busy schedules due to membership in multiple organizations and sports, there is no required attendance except two mandatory times of service during the school year when students worked with the school recycling effort. The goal is to make science fun, to make it a starting point from which students can begin exploring on their own. Science Club is to be non-threatening. There is no homework, and besides an obligation of two service days working with the school recycling program, there are no expectations for members. The teachers' ultimate goals are that the students gain new awareness of the world around them and that students develop and maintain a sense of self-worth.

Activities

In the second emergent category, the teachers described how students planned and ran the Science Club meetings and post-meeting activities. The teachers are involved as advisors and oversee all activities that require equipment or involve potential safety issues. Favorite post-meeting activities that students repeatedly brought up during the interviews included placing dry ice in plastic milk jugs, placing a Peep marshmallow in a vacuum pump, and building gliders.

One trip is planned per season, three per year. The teachers consider the overnight field trips to be integral moments when the students are susceptible to learning and gaining awareness about the world:

> Once you get them away from their regular routine, it becomes special, they are more willing to learn. I think even just an overnighter is enough to make it because it is just enough to make a difference. It is like a trip to any other class-like thing, but they will remember because it is time away from classes, people, their parents, all that, to spend with a group of people. Any time you get a group of people to spend a long time together, you are going to get a close connection. That connection, that tie that brings them together, is going to make a huge impacts, good or bad. (Mrs. Kay, interview, 5/31/2013)

Shortly after the school year begins, the Science Club goes on a Sunday afternoon canoe trip on a local river. The event unites the membership and builds a commonality among the students. Although primarily a social event, the teachers talk science to any nearby students with each teachable moment. The winter overnight trip at the local zoo is a favorite annual activity. This activity is more social than educational, but the students learn about zoo operations. Additionally, the students experience a one-night field trip away from home. In the spring, there are two possible extended trips, alternating each year. During the first option, the students spend three days and two nights at a rural state park, where they hike, explore and discover the local biology and geology. During the hikes, the teachers stop to explain and add relevance to what the students are seeing. One highly anticipated activity during each state park trip was the night hike, an experiential activity in which students learn about nocturnal forest life. In a moment of awe and wonder, after hiking for a while the group stops to listen to the night, and then the teacher makes a barred owl call, which causes the barred owls within hearing range to respond. The most anticipated of all the field trips is the biennial biological field station trip, when the students spend four days and three nights immersed in science, as explained in this powerful description:

> It is science, hands on, the whole time. [The students] are surrounded by adults going, isn't this cool? Did you see this bug sitting here on the wall? Have you gone out and looked around? And it is not just in the class. It is complete total immersion…We have had kids go to Stone Lab and come back and go, that's what I want to do. I know what I want to do now. It is really important. It is something that they would not have seen anywhere else." (Mrs. Kay, interview, 5/31/2013)

Students prepare up to two years in advance to attend the biological field station trip. Expenses are covered through money-making activities through Science Club. After the field trip, students share their excitement and passion with those who did not attend, which sets up the anticipation for the next field station trip.

Social Interactions

In the third emergent category, the teachers reported the impact of students building social connections with peers and teachers through Science Club.

Social interactions with students. For some students, Science Club is a time to meet and talk with friends. For other students, they are able to enjoy science without the fear of being laughed at, knowing that everybody in Science Club likes or accepts science to some extent. Students who are awkward and with few friends are welcomed and are accepted for who they are. The club provides the venue for this diverse group of students to gather and share a common interest or curiosity in science.

The membership drive occurs during the first few weeks of school. All it takes is one student excited about Science Club to "change the complexion of the entire class; they will get other students interested" (Mrs. Kay, interview, 5/31/2013). It may be the trips, the activities, or the idea that the club is just fun, but students want to join Science Club. The first year that the teachers were Science Club advisors, there were 226 members, roughly half the school population; however during the past year the membership was down to 122, mostly because the teachers imposed a $5 fee for the year. (The fee paid for supplies for the meetings and post-meeting activities. Each student was expected to pay for his or her own field trip expenses.)

Social interactions with teachers. The teachers cited the importance of positive interactions between students and teachers in the informal Science Club setting. During the meetings, teachers are seen as teachers. However, on field trips, students observe the teachers having fun, laughing, joking, and eating s'mores at the campfire. Students develop a new perspective of the teachers:

> In a classroom, the teacher is up front or the teacher is working the groups, whatever. If you are doing an overnighter or field trip, you are eating with your teacher, you are sitting down and listening to whatever with the teacher, the teacher is more of a person, and so you gain a different look at them, a different feel, and that makes a closer connection. You are not that weird person that, when they see you out of school, they say, who are you? Even in class, you are a real person. (Mr. Jacobs, interview, 5/31/2013)

The teachers sometimes bring family members on the trip, surprising some students that teachers have families like "real people." The field trips allow the teachers and students to casually talk, helping to develop adult/student bonds. Both teachers identified an added benefit:

> It also lets me see [the students] in a different way. I get to see how they are interacting outside. Oh, I didn't know they were friends, because I never see them together… that explains a few things. Now I understand. (Mrs. Kay, interview, 5/31/2013)

Science Club versus Classroom

In the fourth emergent category, the teachers acknowledged the similarities and differences between Science Club and the classroom. Science Club is about fun, of being alongside peers who also find science interesting, of becoming excited about science, and about awareness of the world around each student. The students drive the conversations and discussion during the meeting, activity, and post meeting social time. Students decide what is interesting and pursue it through the activities following the meetings. In comparison, the classroom is teacher-directed, follows a rigid curriculum that is enveloped with assessments for learning. The formal classroom has a level of anxiety, and allows little peer social interaction (National Research Council, 2009). Many students come to high school with no interest in science, and take required science classes with little motivation other than to pass (Ainley & Ainley, 2011).

Science Club is an avenue in which students may realize that science can be fun and interesting when energized by two passionate and excited science educators. As Mrs. Kay exclaimed, "Students have fun and no anxiety about the learning, so they learn the concepts better."

Mrs. Kay compared Science Club to classroom learning that defined this particular school's Science Club:

> We have a chance to kind of pick and choose things that we want to do and we don't have to stick to common core, we don't have to follow a definite progression. With our labs, we can go out and do the dry ice experiment one time, we can come in and do the vacuum the next time. We have done some different things, it is stuff that amuses us and it amuses the kids, and we do it because it is cool, because it is something that we talk about…we are not lecturing on it or not testing on it. They are not sitting there, how is she or he going to put this on a test? That is not even a question! This is really cool, I like this! So it is a chance to see something different and do something different. (Mrs. Kay, interview, 5/31/2013)

Discussion

Science Club activities should involve hands-on experiences as described by the teachers in this study. It is equally important that the teachers focus on social activities that build a preliminary foundation of interest and excitement about science among students. By enabling student control, providing a socially safe environment, sanctioning student-centered fun, and providing experiential field trips, the students share and develop interests with other students, creating personally relevant interest in science. These personal connections are important in science and environmental curricula, helping students develop emotional connections to the subject matter. Increasing awareness and care about a subject lead to increasing passion for that subject matter, no matter whether it is the environment, animals, or a social situation (Tal, 2004; Tal & Morag, 2009; Variano & Taylor, 2006). This cascade of involvement to interest, to awareness and care, enabled by Science Club, has the ability to positively

affect formal classroom learning. With increased interest or passion, learning is promoted as students construct more abstract connections, gain more experiences, develop deeper observations, give in to curiosity, conduct simple investigations, and discuss the subject matter with peers and teachers (Falk & Dierking 2000; National Research Council, 2009).

Informal science educators, including Science Club advisors, have the potential to inspire interest and passion for science among high school students. An emotional connection may inspire the learners to pursue a career in the sciences (Cwikla, Lasalle, & Wilner, 2009). A strong Science Club in association with an effective formal education program has the potential to be life changing for students.

This study was limited through its examination of one specific Science Club program whose membership consisted of one-quarter of the high school's population, its two teacher-advisor participants, and three months of classroom and field trip observations. In spite of these limitations, the insights in this study provide evidence that science educators can build a strong, successful Science Club program that will incorporate regular and significant informal experiential opportunities for students to encounter science and the natural world, in an environment where all students are comfortable exploring science without fear of rebuke or mockery from their peers. Such a program would connect to formal classroom learning through intrinsically motivated students developing interest in science (National Research Council, 2009).

The benefits observed in the described Science Club program suggest that teacher education programs should consider stressing the benefits of informal learning and demonstrate how to utilize informal learning to better prepare future science education professionals, to ensure that coordinated informal learning experiences, including Science Clubs, are designed to promote student interest and involvement in the sciences. The statements by the two teacher-participants illustrates the passion and excitement they have towards introducing their students to informal learning, an example of how preservice science teachers might create interest and student involvement in their future classrooms.

Future Research

There is minimal research available specifically investigating Science Clubs or STEM clubs. New research needs to be performed to understand the interaction between Science Club and the formal classroom, career paths of club members, attitudes and scientific literacy of non-science career students, and standardized test scores. Research might also examine teacher education to explore if and how informal learning is being introduced to preservice teachers. A study is needed to illustrate the state of Science Clubs in modern high schools. Are Science Clubs thriving? What are student memberships? How involved are the teacher advisors? What sort of activities are students experiencing in a Science Club? What support are Science Clubs receiving from their school systems?

Conclusion

Children have an innate interest in science, but interest wanes as they mature and progress through school. In this competitive world, students need to be scientifically literate and possess knowledge of the STEM subjects as well as an understanding of the natural world (Falk & Dierking, 2000; National Research Council, 2009). Students are more apt to learn about subjects in which they have interest. Educators need to find ways to generate student interest in science, which may then lead to deeper, more significant learning and understanding. Science Clubs are one type of informal learning activity that connects students to science through hands-on, participatory activities not encountered in the classroom.

This study examined one specific high school Science Club organization that maintained a student membership that ranged from a quarter to half of the school population. The teacher-advisors established goals to make Science Club an activity-based place where all students could explore and discover science concepts in safe, non-threatening environments. Monthly afterschool activities were augmented with daylong and overnight Science Club trips that developed deeper science interest among the participants. Students were encouraged to socially connect with their friends and peers, and developed deeper and broader relationships with their science teachers, creating connections that energized the formal classroom interactions and learning.

In spite of all the barriers that threaten to prevent students from being involved in Science Club, the advisors have the ability to make the Science Club successful with strong, student-oriented goals, open minds to activities and student social interactions, and commitment to provide occasional field trip opportunities that develop student interest in science - aspects that will pay dividends with student engagement in the formal science classroom.

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