ASSESSING THE IMPACT OF A STUDENT-LED SCIENCE CAFÉ ON SCIENCE LITERACY IN THE COMMUNITY

by

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DEDICATION

This paper is dedicated with much love to my parents, Byron and Marjorie. Through their example and throughout their lives, they have given me a love for science, and taught me how to find fascination, joy, and wonder in nature.

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND....1

2. CONCEPTUAL FRAMEWORK....3

3. MEHODOLOGY....7

4. DATA AND ANALYSIS....13

5. INTERPRETATION AND CONCLUSIONS....23

6. VALUE....25

REFERENCES CITED....29

APPENDICES....32

APPENDIX A: Pre-Science Cafe Questionnaire....33
APPENDIX B: Post-Science Café Questionnaire....35
APPENDIX C: Pre-Café Background Knowledge Probe....37
APPENDIX D: Post-Café Background Knowledge Probe....39
APPENDIX E: Participants' Interview Questions....41
APPENDIX F: Participants' Email Survey....43
APPENDIX G: Presenter's Interview Questions....45
APPENDIX H: Presenter's Email Survey....48
APPENDIX I: Informed Consent Form 50

LIST OF TABLES

1. Data Triangulation Matrix..12

LIST OF FIGURES

1. Degree of Participants' Knowledge Before the Science Café.....14

2. How Participants' Knowledge was Gained Before the Science Café.....16

3. Participants' Interest in Becoming More Informed, Following the Science Café 17

4. Participants' Methods for Becoming Informed, Following the Science Café 18

5. Comparison of How Well-Informed Participants Felt Before and After the Science Café Sessions 19

6. Comparison of How Often Reading was Used or Intends to be Used as the Preferred Method to Become More Informed on Science Research 20

7. Comparison of How Often Listening to or Watching Programs was Used or Intends to be Used As the Preferred Method to Become More Informed on Science Research 21

8. Comparison of How Often Reading was Used or Intends to be Used as the Preferred Method to Become More Informed on Science Research 22

9. Presenter's Degree of Challenge in Preparing for the Discussion, and Degree of Interest in Further Pursuit of the Topic 23

ABSTRACT

Among the general population of gifted and talented students, there are some who stay interested in school. Others quickly become bored, beginning as early as kindergarten. Many of them choose to dropout before high school graduation.

Science literacy among the general population of the United States is not keeping pace with the high level of research that is being done across the nation. Many people are fearful of science and have little or no confidence in their ability to understand it. In our schools, it has become commonplace to de-emphasize science education to make more time for math and reading instruction.

This study represents an effort to improve the level of science literacy in the local community by using gifted and talented students to lead discussions on current science research during evening science café sessions. At the same time, this practice provides opportunity for the gifted and talented students to immerse themselves in topics they feel passionate about. As determined by survey results and interviews, those gifted students who chose to become the resident expert and take on this task of discussion leader found greater purpose in school as well as a desire to stay in school. The data also revealed that, within the sample population, levels of interest in science increased, and the degree of science literacy improved, as determined by survey results and interviews.

INTRODUCTION AND BACKGROUND

My current assignment as Gifted and Talented Coordinator for McCall-Donnelly School District began with the fall semester of the 2012-2013 school year. Before this assignment, I had been teaching high school science and math classes for 23 years. As I began contemplating a focus for my research near the beginning of my Action Research class, I thought it should be something which blends my love for science with my fascination for the unique characteristics of gifted students.

Gifted students commonly do not receive enough challenge in the regular curriculum, and thus become bored with school. They have a higher capacity for learning complex material, ideas, and relationships. Compared with the majority of students in school, these students display an asynchronous development of age and mental attributes. It is common for gifted students to be able to comprehend material of a much higher complexity than that designed for their age range. The complex studies done by researchers in the professional and academic settings, normally requiring post-secondary education experience to comprehend, are not out of reach for many gifted high school students. When a gifted student, who is nearly ready to give up on school due to a lack of interest and challenge, finds a passion for a topic of study, that study can be enough to keep him or her engaged in school.

During the summer of 2012 I attended the Physics of Atomic Nuclei program at Michigan State University. I became convinced that more adults than just those teachers attending the program need to know about high-energy physics as well as other scientific research. More adult science education is needed in the United States to overcome the

low levels of science literacy among our population (Miller, 2016). I learned of the concept of science cafés from another physics teacher at Michigan State University, and realized that establishing a science café in my own town could be an effective method for improving informal adult education.

Located in the mountains of central Idaho, McCall is isolated from research facilities and universities. Science cafés are normally organized in areas where science research labs are close at hand, and it is the local researchers that present their projects to the audience at the café. After a brief presentation by the researcher, open discussion is encouraged by all, whether or not they have any background in science. Such an introductory presentation could be conducted by a gifted student after he or she has discovered a research project of interest, read about it, and contacted the researcher in order to become a resident expert.

These gifted high school students come from a variety of economic backgrounds, among a high school population of 283 with 29% on free or reduced lunch programs (Niche). Grades nine through 12 are taught at the school, including students from diverse family backgrounds such as farmers, loggers, ranchers, service personnel, business owners, and wealthy second-home owners. McCall-Donnelly High School draws students from a large geographic area including the resort town of McCall and the surrounding communities of Lake Fork and Donnelly.

Through this research project I hope to achieve the blending of informal adult science education with opportunities for focused research for gifted students. The focus of the study is to measure the success of a student-led science café. The influence of the

science cafes was investigated using the following research questions.

1. What is the impact of the student-led science café on science literacy in the community?
2. Is the development of a student-led science café effective in helping gifted students discover challenging topics they feel passionate about?

CONCEPTUAL FRAMEWORK

From the data gathered by tracking 4000 youth since 1987, researchers concluded that parents who value science in the home have a strong influence on their children's likelihood to pursue a science, technology, engineering, math, or medical (STEMM) career (Miller, 2012). In their study of scientific literacy in the United States, these researchers found that it did not make a difference whether the parents had STEMM backgrounds, or even whether they had been to college. According to the results of this project, called the Longitudinal Study of American Youth, 40% of children who are actively encouraged by their parents in science and math will choose a STEMM major. In comparison, 8% of children who are not encouraged in science or math will choose a STEMM major (Miller, 2012). This five-fold difference suggests that a focus on increasing the science literacy and the enthusiasm for science at home and among adult populations may have a significant impact on the struggle to produce more science and math professionals in the United States. Furthermore, it points to a nation-wide need for increasing the level of science literacy among the general population. As the level of science literacy improves, the degree to which science is encouraged in the home will

also increase. The probability of a higher number of STEMM graduates will therefore follow.

In our nation's schools in recent years, science education has been de-emphasized to make more time for math and reading instruction. Many people are fearful of science and have little or no confidence in their ability to understand it (Goldston, 2005; Center on Education Policy, 2006). A national trend of recent concern to the National Science Foundation has been the lack of efficient communication of technical scientific research to the non-technical portion of our society (National Science Foundation, 2008). Science literacy among the general population of the United States is not keeping pace with the high level of research that is being done across the nation (National Science Foundation, 2004). New information from research that is being done generally does not filter down effectively to the non-scientific community. The level of post-secondary specialized science research is separated by a wide gulf from the level of science education in our pre-college schools. In order to improve science education in our nation and enhance the level of science literacy among our country's population, new methods and ideas are needed to reduce this gulf of separation. By enhancing the level of science literacy in our adult population, the more science-literate parents will carry their enthusiasm and interest in science into their families' homes where they may influence their children to pursue STEMM majors of study (Miller, 2012). Methods of informal science education hold great promise in bridging this gap of knowledge.

One type of informal science education that offers hope in linking science researchers with the general public is the establishment of science cafés. One example is

a science café in Florida, where meetings are held at the local high school once per month after school. Scientists from industry as well as academic researchers present their projects to the high school students. These café sessions add credibility to the equations and lessons kids learn in the classroom. Students have learned that science is used by ordinary people in a variety of different settings (Parker-Burgard, 2009). Another science café in New Mexico also focuses on communicating science research to a high school audience. By engaging the teens on a personal level, the scientist-presenters have developed an effective method of science communication that connects with the daily lives of their audience and at their own level of knowledge and social context (Mayhew & Hall, 2012). In other science cafés around the world that have been organized for adult audiences, scientists present their research to the audience for five to 10 minutes in order to start a discussion on the topic of their research. Through the process of discussing science, the attendees learn from each other's knowledge as well as from the scientist-presenter (Giles, 2004).

Recent studies announced by the National Academy of Sciences have raised the concern of an upcoming shortfall of technical and professional scientific workers in the United States (Congressional Research Service, 2009). With this predicted shortfall, industries in the United States will continue to rely more heavily on foreign-made technology in the future. This unfavorable outlook in our labor force and technological competitiveness is compounded by a growing population of school drop-outs in the United States (Center for Labor Market Studies, 2003; Rumberger, 2011). Gifted children represent a large portion of these school drop-outs (Renzulli & Park, 2000). For

many of the gifted children who drop out of school, the school curriculum does not offer anything of sufficient challenge and complexity to interest them. They find that they are unable to pursue the topics they are passionate about. The school setting tends to become a burden with its repetitious lessons and shallow content. Many of our society's greatest minds are lost from our educational system when gifted kids give up and drop out of school. Our nation's potential to become more competitive in technological advancement is apt to decline.

Gifted students have a high capacity for learning complex material. The role of gifted education is to provide for the unique needs of gifted children. One of the methods used by gifted educators is to help the gifted student find his or her passion. Once that has been determined, a program of individual study can be established for the gifted child. Such a program can satisfy the gifted student's need to indulge in the study of complex and challenging material of his or her own choice. Such an arrangement is often enough for the gifted child to remain in school because he or she has that complex, challenging project to look forward to. The project attempts to encourage engagement by giving the student something interesting to occupy his or her mind while performing more mundane, less challenging tasks in school (Renzulli & Park, 2000).

Establishing a student-led science café could possibly contribute to serving the need of increasing the level of science interest in the home, keeping students interested in school, and providing appropriate accommodations for gifted children. In a student-led science café, the students become the resident experts by studying the findings and methods of the research they are interested in. The researcher’s role could be that of a

tutor to the student, helping the student to gain sufficient knowledge and understanding of the topic of research to be able to introduce the research in a science cafe setting. If the researcher is able to attend the café session, the student would still take on the role of presenting the research. The researcher would then be available to assist with his or her greater depth of understanding of the topic during the discussion.

METHODOLOGY

In the study involving a student-led science café, the primary focus was to measure whether the implementation of the café improved the level of science literacy in the community. To address this focus, two research questions were investigated, namely, "What is the impact of the student-led science café on science literacy in the community?", and "Is the development of a student-led science café effective in helping gifted students discover challenging topics they feel passionate about?" These questions were measured among the participants of the café sessions by the use of questionnaires, background knowledge probes, interviews, and email surveys.

Treatment Description

Science cafes were held every Thursday from February 23rd through March 23rd. A restaurant in downtown McCall, The Pancake House, provided a table large enough for a dozen people in the back corner of the dining room. Restaurant staff were prepared to expand our meeting area to include more tables and a room divider in case more than twelve people might show up. Each session started at 7:00 and lasted between one and two hours.

Twelve participants, including myself and the presenter, filled the table for the first session. While people were still arriving, one of the participants started a discussion on planet exploration. He had read the newspaper article announcing the science café, and had prepared for the topic mentioned in the article. When it appeared unlikely that more people would be coming, I began explaining my role as a teacher of gifted and talented students, as well as my role as researcher in the investigation. I then introduced the student-presenter, a seventh grade gifted girl. I had approached her two weeks prior to the event, and offered the opportunity to present a topic of recent science research at the first student-led science café. She enthusiastically accepted the offer, and every two or three days I checked on her progress in preparing for the presentation. She had expressed frustration with narrowing the topic down to something manageable, so I helped her through that process. She has had a keen interest in astronomy for many years, and settled on the topic of recent exoplanet discoveries.

In addition to the newspaper articles that I wrote each week to announce the topic and invite the general public to attend, an email was sent to every family of the 50 K-12 identified gifted and talented students in the school district. The email contained an invitation to attend, the topic of discussion, and a request for volunteer presenters. Two fifth grade boys eagerly accepted the invitation for the second week, and knew the specific topic they wanted to present. For their session on Mars explorations, there were eleven people including myself and the presenters.

An 11th grade boy responded to the email invitation to be the presenter for the third week, and I helped him narrow down his topic over the course of the first few days.

He settled on cryo-research aboard the international space station. There were eight people in attendance.

For the fourth week, I asked a high school senior boy to present a topic that I knew he had been fascinated with for years and had studied extensively. He presented research on space propulsion systems, including theoretical warp drive propulsion. The total number of people for the fourth week was ten.

Deep-sea squid and other mollusk research was the planned topic for the fifth week. The presenter who had been studying this research was an 11th grade boy from the alternative school, but he did not show up for the science café in spite of the frequent contact I had made with him to be certain he was well-prepared. The group discussed other research topics they were interested in while we waited for the presenter to arrive. When I decided he was not going to show up, I asked a fifth grade boy to lead a discussion on deep-sea nautilus research. I knew he had a fascination for that topic, and that he had read a lot about it. There were six people attending that week's science café.

Instrument Description

The focus questions were measured among the participants of the café sessions by the use of questionnaires, background knowledge probes, interviews, and email surveys. A questionnaire that was given to the café participants before they attended the first science café provided baseline data on the level of science literacy for a sample of the community's population (Appendix A). This Pre-Café Questionnaire consisted of a Likert Scale of *strongly agree* (4), *agree* (3), *disagree* (2), *strongly disagree* (1) to determine the degree to which respondents felt they are engaged in science on a day-to-day basis.

Other questions probed respondents' level of awareness of current research in science. Following each science café session, a Post-Café Questionnaire was administered (Appendix B). This was a Likert Scale questionnaire similar to the Pre-Café Questionnaire. The Pre-Café Questionnaire and Post-Café Questionnaire results were then compared. The mean difference for each item was analyzed for trends of growth.

To provide a measure of topic-specific improvements in science literacy, the science café participants were asked to complete a Pre-Café Background Knowledge Probe before each session (Appendix C) and a Post-Café Background Knowledge Probe after each session (Appendix D). Each of these was a simple, two-item questionnaire. The Pre-Café Background Knowledge Probe and the Post-Café Background Knowledge Probe results were then compared. The mean difference for each item was analyzed for trends in levels of knowledge.

From one to three of the participants were then asked to participate in a Participant's Interview session. The interview questions were designed to ascertain both topic-specific improvements in science literacy and more general improvements in enthusiasm for science and science discussions (Appendix E). As a follow-up measure of the effectiveness of increasing science literacy in the community, Participants' Email Surveys were administered during the week after the science café session. The questions in this survey were open-ended questions concerning the level of excitement for science that the participants may still have, several days after the café session, and the degree to which they may have continued to engage in or initiate science conversations (Appendix F). After grouping the responses by common theme, they were categorized according to

whether they reflected improvement in science literacy and in enthusiasm for science and science discussions.

The secondary focus of study was to determine whether the implementation of a student-led science café is effective in helping gifted students discover a topic they feel challenged by and passionate about studying further. The data was gathered through the use of teacher's journal notes, presenter interviews, and presenter email surveys. Gifted students in the McCall-Donnelly school district are identified primarily by cognitive test scores (IQ testing) or achievement test scores. This testing is done by the school psychologist following referral by teachers, other staff members, or parents. In general, a test score of 130 on an IQ test or an achievement test qualifies a student for identification as gifted. Students may also be identified by a body of evidence that demonstrates superior ability in creativity and the arts. Gifted students became the resident experts on a science research project of their choosing by reviewing the literature, writing to the researcher, conducting interviews with the researcher, and studying the background information surrounding the research. After becoming a resident expert, a gifted student presented the research at one of the science café sessions.

Evaluation of the success in accomplishing this secondary goal was determined by Journal Notes kept by the gifted and talented coordinator. In these notes, the coordinator monitored preparations on the part of the gifted student prior to his or her presentation at the science café. Conversations with the gifted student were summarized. These conversations yielded insight to the degree of passion the student felt for the topic he or

she chose. Further data for evaluating the student's level of passion and feeling challenged was provided by the use of Presenter Interview sessions following the science café presentation (Appendix G). After grouping the responses by common theme, the responses were categorized according to whether they reflected improvement in science literacy and in enthusiasm for science and science discussions. The Presenter's Email Survey was administered during the week following the science café (Appendix H). Data was analyzed in the same way as the interview data. Specifically, after grouping the responses by common theme, the responses were categorized according to whether they reflected improvement in science literacy and in enthusiasm for science and science discussions.

The methods described are summarized in Table 1, the Data Triangulation Matrix. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained. No student names were used in the collection of data, and consent was sought from persons under the age of 18 to participate in the study (Appendix I).

Table 1
Data Triangulation Matrix

Research Questions	Data Source 1	Data Source 2	Data Source 3
To what degree does a science café improve the level of science literacy in the community?	Pre and Post Café Questionnaire	Pre and Post Café Background Knowledge Probe	Participants Interview and Participants Email Survey
Does a student-led science café help gifted students dis-	Journal Notes	Presenter's interview	Presenter's Email Survey

cover a topic they are challenged by and feel passionate about?			

DATA AND ANALYSIS

To measure the degree to which a science café improves the level of science literacy in the community, a questionnaire and a background knowledge probe was given to the participants before the discussion began in each science café session. Following the discussion, a similar questionnaire and background knowledge probe was given. The responses before and after the discussion were analyzed for indication of growth in science literacy.

Individuals Attending Science Cafes Possess Existing Curiosity and Expertise

Of the 42 people who attended the science café sessions, more than half of them (57%) thought of themselves as well-informed on science research before the discussion began, and more than half (also 57%) of them were engaged in understanding the details of science research. One of the respondents stated "I am a regular reader of Scientific American and Smithsonian Air and Space Magazine, and listen regularly to Star Talk." Another wrote "I am well-versed on this topic. I have studied the topic and discussed it with family" on the Pre-Science Café Background Knowledge Probe (Appendix C). For question number one of the Pre-Science Café Questionnaire (Appendix A), 44 % of the respondents over the course of four science café sessions agreed that they were well-informed on current science research in a wide variety of topics, (*N=33*). See Figure 1. Thirteen percent strongly agreed with this statement, 38% disagreed, and 5% strongly

disagreed. One of the respondents wrote “I am not very well versed in tonight’s topic. Been out of school for 30 years so not up to date on quantum stuff.” For question number 2 on the pre-café questionnaire (Appendix A), 45% of the respondents agreed that they were engaged in understanding the fine details of current science research topics, and 12% strongly agreed with this statement (Figure 1).

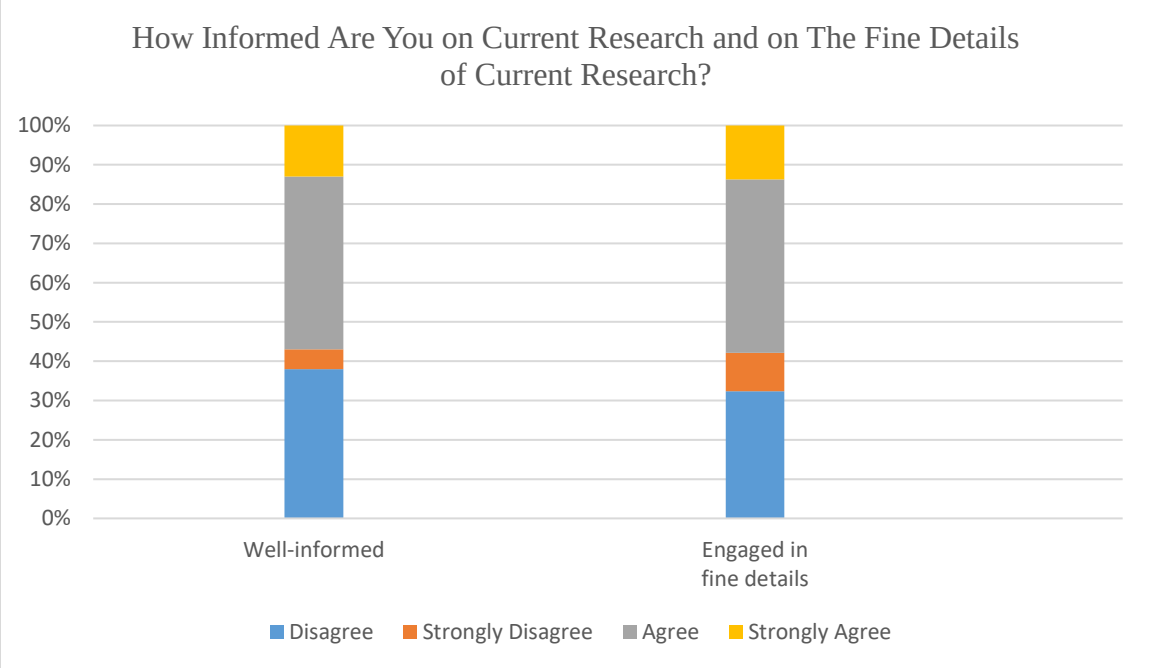

Figure 1. Participants’ knowledge before the science café, (*N*=33).

Before the discussion on exoplanets began, one person wrote “I have read the recent press release about the newly discovered planets in the Trappist system.” One third (33%) disagreed that they were engaged in understanding the fine details, and 10% strongly disagreed. One participant indicated a limited background stating he was “…not exceptionally well-versed” and “[knew] the basics, but [had] never gone into depth.” He concluded with the statement A comment written on one of the background knowledge probes (Appendix C) was “Not exceptionally well-versed. I know the basics but have

never gone into depth. I have sufficient knowledge."

Although over half of the respondents considered themselves well-informed as well as engaged in understanding the fine details of science research, only half of them maintained a regular routine of keeping up with research results. For question three in the Pre-Café Questionnaire (Appendix A), which was focused on journal-reading, 50% of respondents said that their personal routines rarely include reading science journals to update their knowledge of current science research, (*N=36*). See Figure 2. Twenty-five percent of participants stated that they maintained monthly routines, and 25% stated that they maintained weekly routines. None of the participants stated that they maintained daily routines, although some of the written comments seemed to indicate otherwise. One such comment was "My educational background is scientific (BS physics/MS Aerospace engineering) and so read daily news (BBC.com mostly) on science advancements."

Similarly, 42% rarely maintained a personal routine which includes listening to or watching a broadcast or program that informs them of current science research, while 9% maintained such a routine on a daily basis, (*N=33*). Between these extremes, 12% maintained a monthly routine, and 37% a weekly routine. One comment to the background knowledge probe (Appendix C) was "Mostly online and in the news. Some of it was learned through friendly discussion with peers/teachers." Another was "I watch science related programs on TV and enjoy increasing my knowledge."

When asked about the frequency of conversation with others to stay informed about current science research, question five in the Pre-Science Café Questionnaire

(Appendix A), weekly routines (39%) were reported with higher frequency than the 32% who reported "rarely," (*N=31*). Responses for "monthly" accounted for 29%, and 10% replied "daily" to this statement (Figure 2).

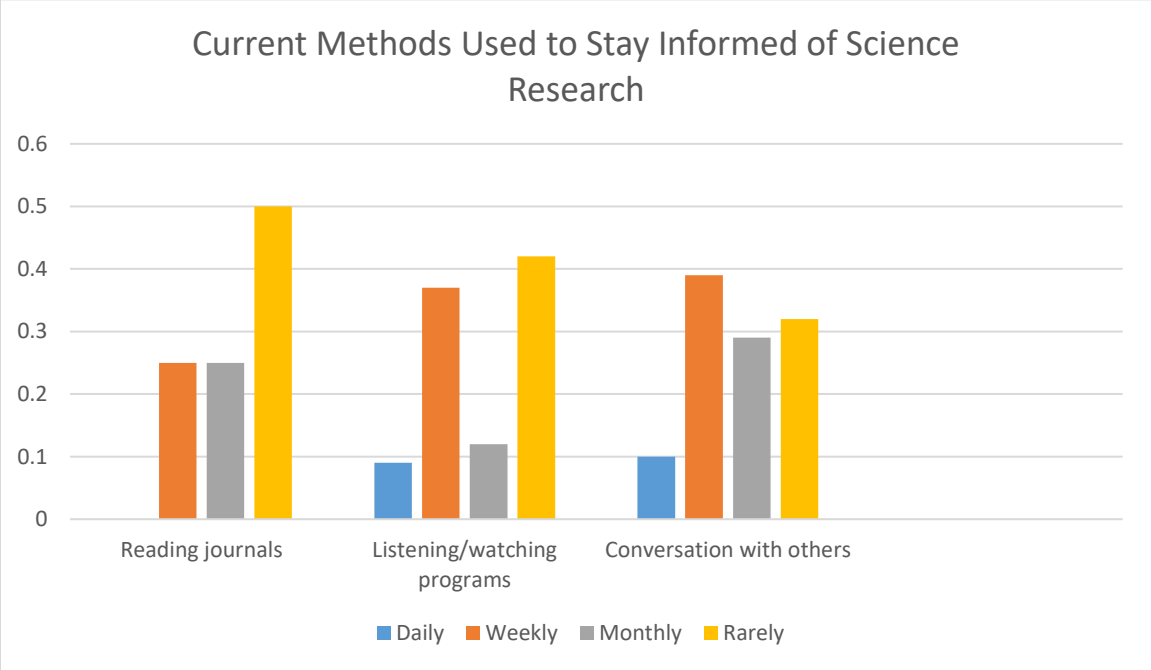

Figure 2. How participants' knowledge was gained before the science café, (*N*=31).

Attendance at Science Cafes Increases Engagement with Scientific Ideas and Content

Results of the Post-Science Café Questionnaire revealed that nearly all of the participants had the desire to become more informed on current science research, after the science café session was over. In response to Question One in Appendix B, 95% of respondents either agreed (67%) or strongly agreed (29%) with the statement "I would like to become more informed on current science research in a wide variety of topics," (*N=21*). One person strongly disagreed, and zero respondents chose "disagree" for that statement. Furthermore, 55% agreed they would like to become more engaged in

understanding the fine details of a wide variety of current science research topics, after the session was over, while another 22% strongly agreed. The written comments included "I understand more now and am more curious about what they are planning in going to Mars." Nine percent disagreed and 4% strongly disagreed (Figure 3).

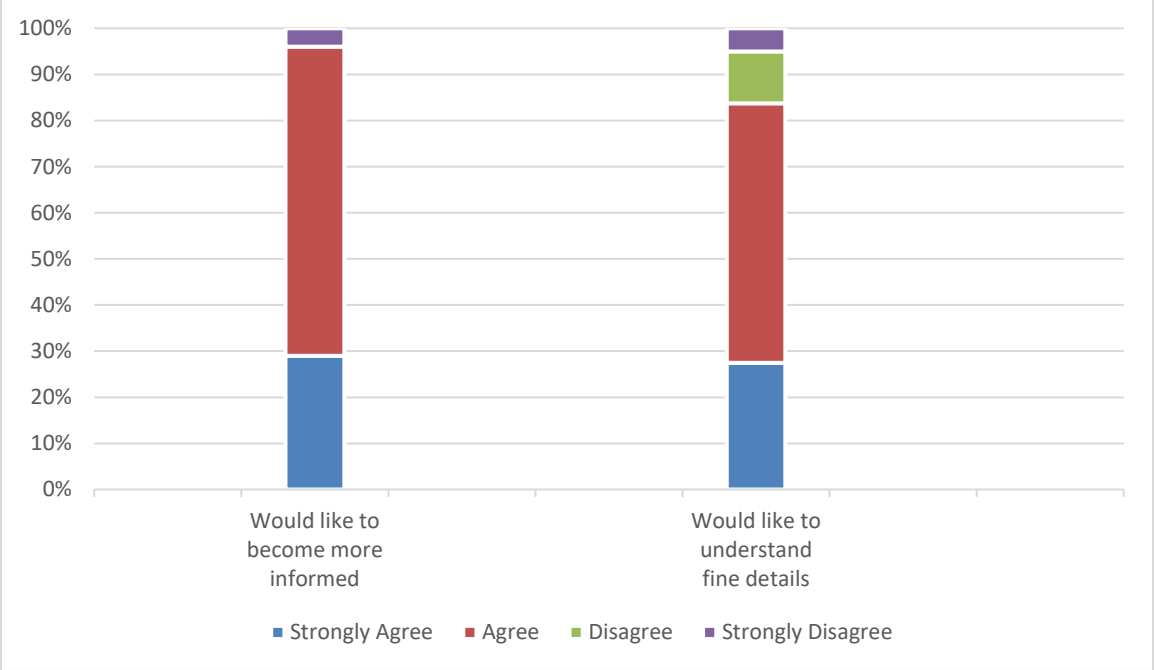

Figure 3. Participants' interest in becoming more informed, following the science café, *N*=21).

In order to become better informed on current science research, 38% of the respondents stated their intention to spend more time reading science journals on a weekly basis, and 44% chose to do so on a monthly basis. Nobody indicated a daily basis for this statement, and 19% stated they had no such intention at any frequency. The intention to listen to or watch a broadcast or program to become better informed proved somewhat better, with 14% stating a frequency of daily, 45% weekly, 32% monthly, and 9% having no such intention. The responses to the statement "I intend to modify my

personal routines to include more time in conversation with others to stay informed of current science research" included 45% monthly, 32% weekly, 18% daily, and 5% no such intention, (*N=22*). See Figure 4. In response to the Participants' Email Survey, one of the respondents wrote "As a husband and wife, we've talked together about the space program and other science related subjects. That has increased over the week." Another response to the email survey was "I'm more aware of science and seek out science related programs on TV to watch."

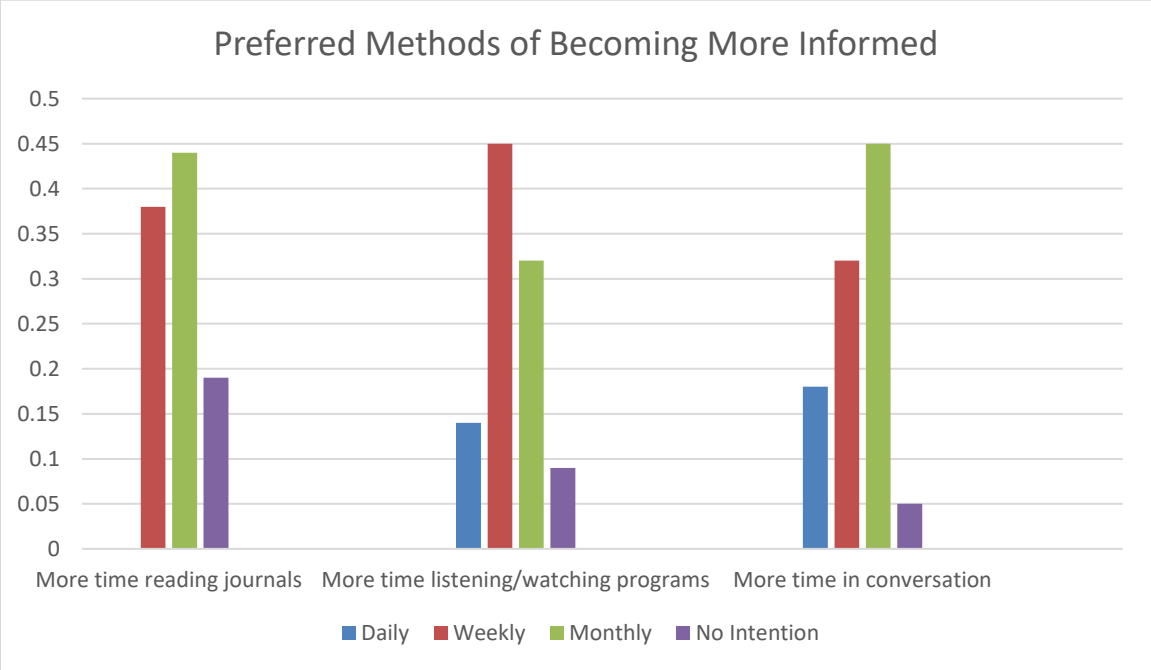

Figure 4. Participants' methods for becoming informed, following the science café, (*N*=21).

As a visual comparison of the data, changes from the Pre-Science Café Questionnaire responses to the Post-Science Café Questionnaire responses are summarized in the following two graphs. Specifically, the pre-café response in the first graph applies to the Appendix A question "I am well-informed on current science

research in a wide variety of topics,"(*N*=21). See Figure 5. The post-café response in the first graph applies to the Appendix B question "I would like to become more informed on current science research in a wide variety of topics". The pre-café response in the second graph applies to the Appendix A question "My personal routines include reading science journals to update my knowledge of current science research (daily, weekly, monthly, rarely)," (*N*=21). See Figure 6. The post-café response in the second graph applies to the Appendix B question "I intend to modify my personal routines to include more reading in science journals to update my knowledge of current science research (daily, weekly, monthly, rarely)".

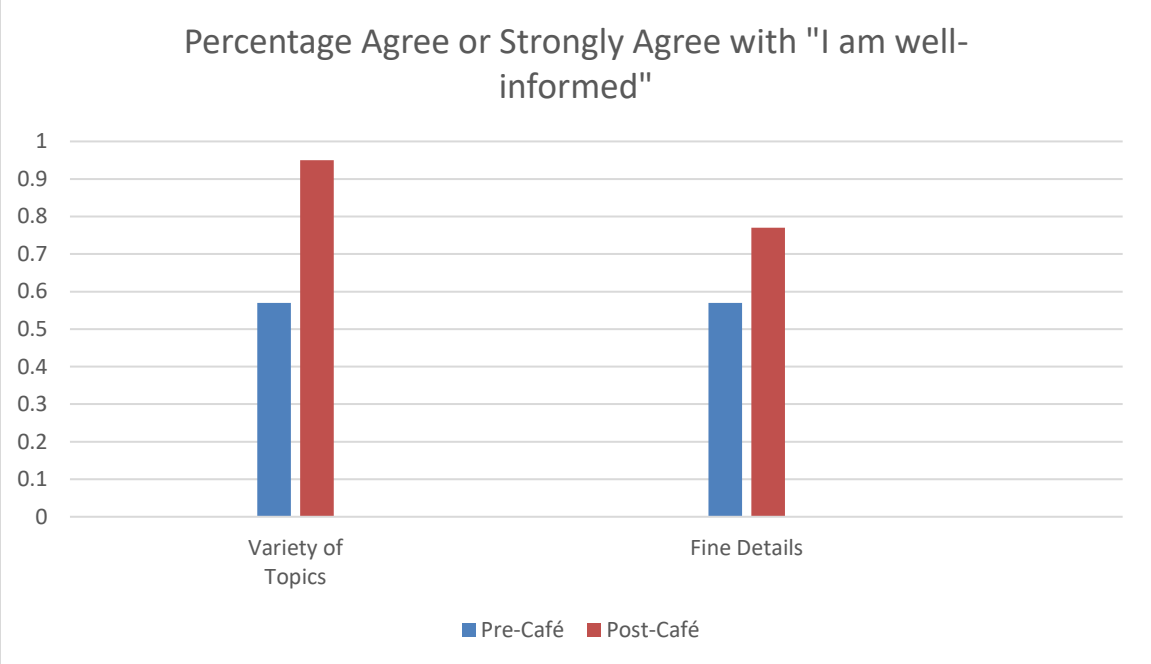

Figure 5. Comparison of how well-informed participants felt before and after the science café sessions, (*N*=21).

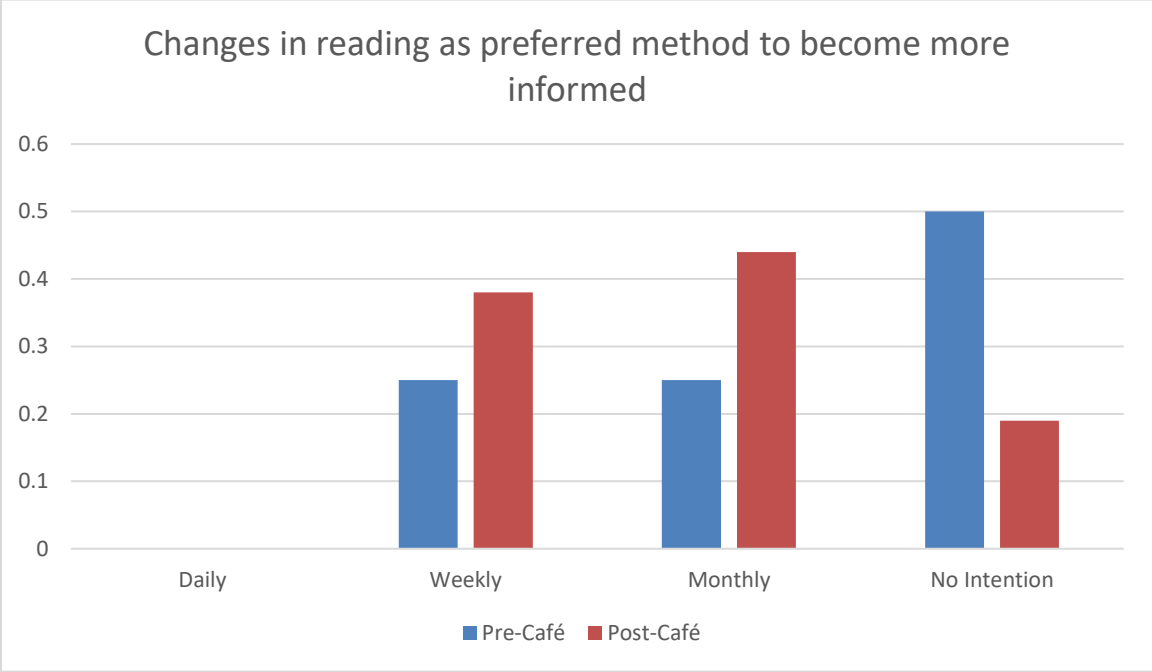

Figure 6. Comparison of how often reading was used or intends to be used as the preferred method to become more informed on science research, (*N*=21).

The pre-café response in the first of the following two graphs applies to the Appendix A question "My personal routines include listening to or watching a broadcast or program that informs me of current science research (daily, weekly, monthly, rarely)," (N=21). See Figure 7. The post-café response in the first graph applies to the Appendix B question "I intend to modify my personal routines to include more time listening to or watching a broadcast or program that informs me of current science research (daily, weekly, monthly, I have no intention)." The pre-café response in the second graph applies to the Appendix A question "My personal routines include conversation with others to stay informed of current science research (daily, weekly, monthly, rarely)," (N=21). See Figure 8. The post-café response in the second graph applies to the Appendix B question "I intend to modify my personal routines to include more time in

conversation with others to stay informed of current science research (daily weekly, monthly, I have no intention)."

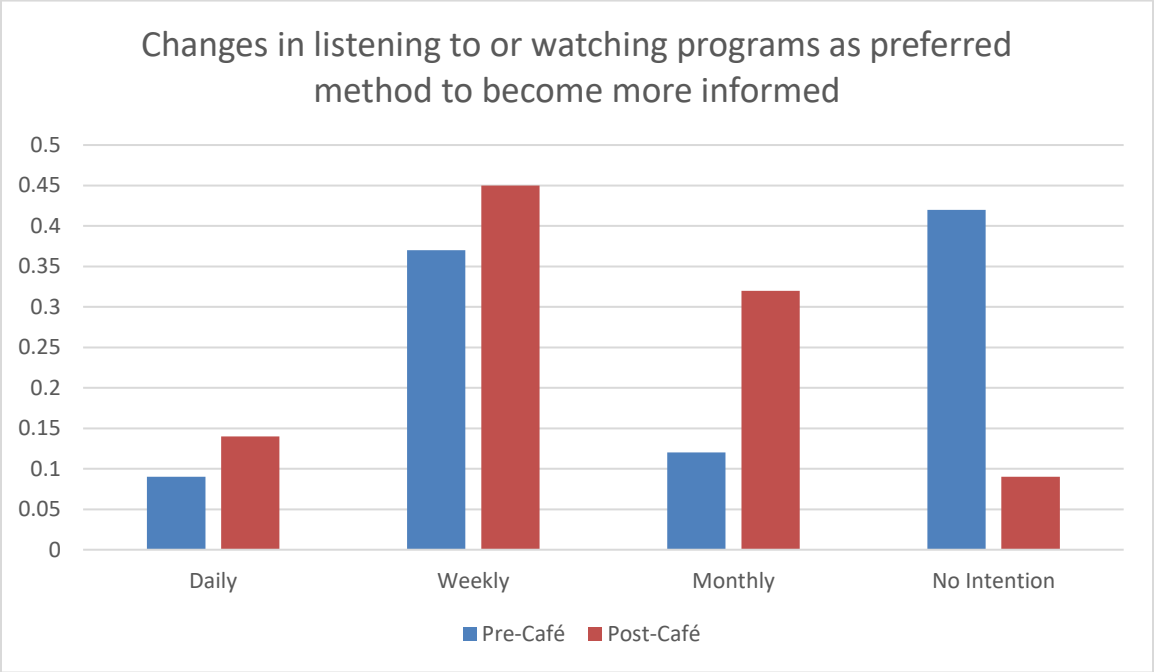

Figure 7. Comparison of how often listening to or watching programs was used or intends to be used as the preferred method to become more informed on science research, (*N*=21).

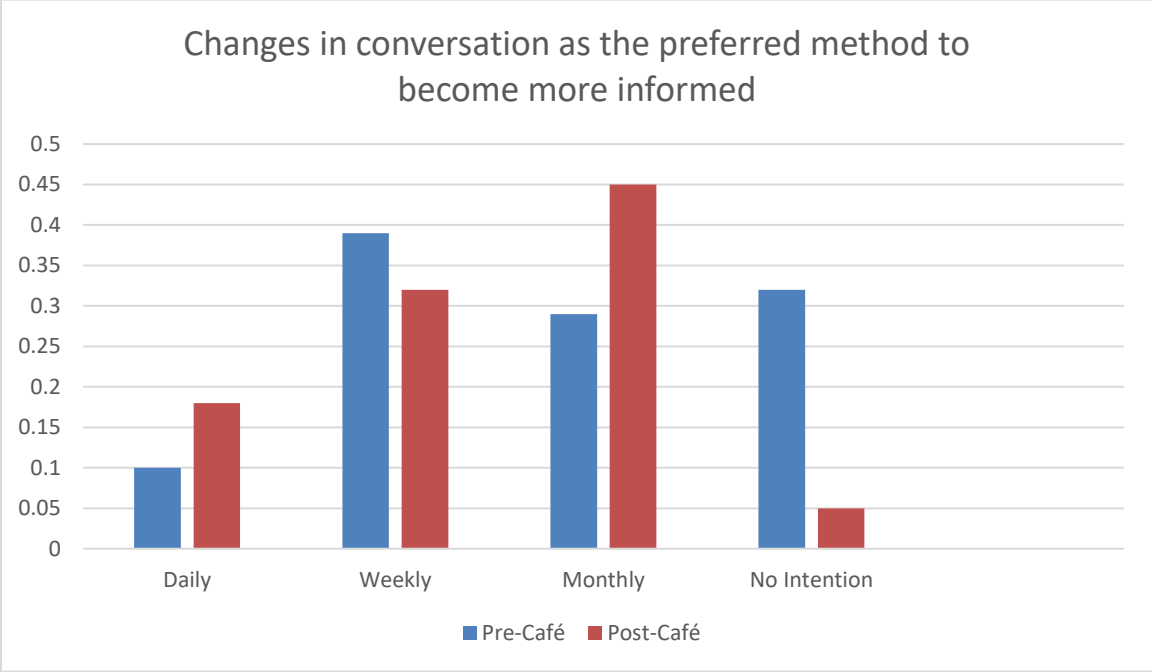

Figure 8. Comparison of how often conversation with others was used or intends to be used as the preferred method to become more informed on science research, (*N*=21).

In response to the interview questions asked of them after each science café session was over, the gifted students who had conducted the discussions overwhelmingly stated that the topic of discussion was one that they wanted to pursue further study of, (*N=4*). See Figure 9. When asked the question "Is the topic that you chose for the science café discussion one that you are interested in pursuing further?" the student who led the discussion on exoplanets replied "Yes. It's a very new subject and I'd love to research the new information". The pair of students who led the discussion on Mars missions replied "Yes, and we want to build a model rocket." Similarly, the student whose topic was advanced space propulsion systems replied "Yes." The gifted student who presented the topic of cryo-research said "not specifically Bose-Einstein, but yes to quantum jitters."

When asked the question "Did you feel challenged in your preparation for leading the science café?" the gifted students' responses were not all affirmative (Figure 9). One of them said "No, it was not challenging to prepare for the science café. I have been reading about this and discussing it with others for years."

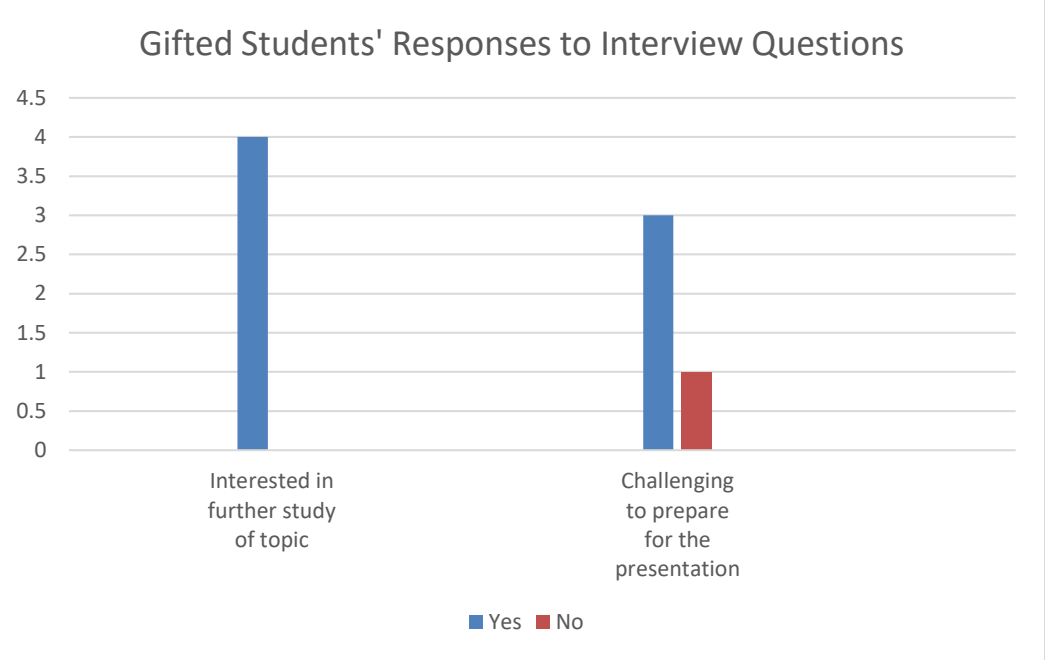

Figure 9. Presenter's degree of challenge, and of interest in further pursuit of the topic, (*N*=4).

INTERPRETATION AND CONCLUSION

In a small, rural community such as the one I live in, the data as applied to the primary question, *To what degree does a science café improve the level of science literacy in the community?* indicates that a science café could have a significant impact on science literacy in the community. As shown in Figure 5, the degree to which participants felt they were well-informed increased as a result of the science café sessions. This is true both for a wide variety of topics in science research as well as for understanding the fine details of science research topics. As shown in Figures 6, 7, and 8, the participants' notion

of having no intention to become better informed dropped significantly from before the science café session to after the session was over. This was true regardless of the method by which they preferred to become better informed. In the journal notes, it was recorded that there was a feeling of exhilaration for understanding what is going on in fields of science research at the conclusion of each of the five sessions. With consistency, as each session concluded, more than one of the participants was heard to remark on how much he or she looked forward to the next science café session. The question of whether these science cafes would continue after this study is concluded was frequently heard while those around the table stood up to gather their belongings and return home. Each time this question arose, several people commented that they would like to see it continue. For the purposes of this study, a science café was held each week for 5 weeks. Those who expressed interest in continuing the café sessions generally agreed that once per month would be a more sustainable frequency.

In answering the secondary question, *does the student-led science café help gifted students discover a challenging topic they feel passionate about?* the data from the Presenters Interview Questions indicates that some may find it challenging to prepare for leading a discussion, while others do not. In the Journal Notes, it was recorded that the gifted student who presented the topic of exoplanet research struggled for several days with deciding which topic of space exploration to focus on. While gifted students often have a general area of study they feel passionate about, it is common for them to have trouble narrowing their focus to a single topic of research within that area of passion. The gifted student who replied that he did not feel challenged in preparing for leading the

discussion added the explanation that this (advanced space propulsion systems research) is a topic he has long been fascinated by. The conclusion could therefore be drawn that a student-led science café does help gifted students discover a focused topic they feel passionate about, for individuals who have not yet identified their specific passion.

VALUE

There is value in science enthusiasts taking the time to get together in an activity oriented toward their common interests. Such opportunities can provide rest in an otherwise hectic schedule, and the participants tend to leave the gathering feeling rejuvenated and energized. The sense of camaraderie causes them to eagerly look forward to the next such encounter. Science cafes serve this purpose, but the potential also exists for science café sessions to improve the levels of science literacy beyond the group of science enthusiasts who are automatically attracted. Each of the science café sessions in this study were announced in the local weekly newspaper, and these stories attracted some attention from people who would not be categorized as science enthusiasts. In one of the science café sessions, a middle-aged man attended who told me that he read the story in the paper and did not have anything else to do that evening, so he came to our meeting. In another instance, friends of the high school student who was the presenter that week attended the meeting because they had heard their friend would be leading the discussion. One of these teenagers was interested in science, he told me, but the other was not interested in the subject before the meeting. At the conclusion of the meeting, however, the disinterested student announced that she would like to learn more. The addition of scientific

novices to a meeting of more scientifically literate individuals has the potential to increase science literacy in a community.

The student-led version of science cafes serves its purpose well in small, rural communities where there are no readily-available university or industry researchers who may be eager to educate the general public on their research. Turning the task of presenting over to the population of gifted students is valuable for all who attend the café sessions, because of the ability of gifted students to comprehend complex material they become interested in. This practice could be successful in larger, university and industrial communities as well, where researchers are available and could be the discussion leaders. By turning that responsibility over to students, under the tutelage of the researchers, a wider field of younger people may be attracted. When those youth leave a science café session to return home and discuss the topic with their parents and siblings, the chances of more youth being attracted to future STEMM fields is greater. Gifted students often have a tendency to hyper-focus on a topic that appeals to them. This can lead to feelings of isolation when they cannot find an audience who is interested in hearing about and discussing topics they are passionate about. For such students who hyper-focus on STEMM topics, they may find such an audience in a science café setting. This advantage would be true regardless of the size or demographics of the community in which the gifted students live.

As a result of conducting this study, I look forward to establishing an ongoing student-led science café. The groundwork has been laid during the weeks of data-gathering, and a core group of science enthusiasts has been identified. In the study I conducted, I

solicited interested gifted students to take on each science café, a week or two before the date of the café session. One change I would make is to plan for an entire year of sessions (12 sessions in all, once per month), and assign each interested gifted student to a particular month. I would also give each student a timetable to operate by, including dates by which the topic should be narrowed down, the first contact made with the researcher, and so forth. Researchers would be informed of the date and location of the science café in which a student would present his or her work, and they would have the option of attending if possible.

This experience with organizing and conducting student-led science cafes in the community has given me the boost I needed to do what I have dreamed of doing for many years. Prior to this project, I had organized lunchtime science cafes in the high school on a sporadic, inconsistent basis. Some of these were student-led, others were teacher-led or guest speaker-led. Each one has left me feeling re-energized about digging into current science research, and many of the students who attended have reported the same exuberance. I have witnessed an enthusiasm for science rubbing off on others who do not consider themselves science-types, and that has been exciting to me. It has been a goal of mine to establish a regular routine of science café sessions, and now I have found support within the community and within the families of gifted and talented students to do this. My goal for next school year is to organize and plan for 12 months of student-led science cafes in our community. Whether the impact is dramatic, attracting more and more people as the months go by, or each month the same group of people participate, science research will gain new exposure through newspaper articles and by word of

mouth. Science literacy is bound to improve, either for the same small group of people each month, or for increasing numbers of people who show up because of the exposure. A trend toward improved science literacy in the schools might be realized as students who attend or present at science cafes share their experiences with their friends at school. If this practice were to extend to other communities and other states, there is potential for a resulting rise in science literacy on larger scales.

REFERENCES CITED

Carlson, W.S., & Monk, D.H. (1992). Differences between rural and non–rural secondary science teaching: Evidence from the longitudinal study of American Youth. J*ournal of Research in Rural Education*, 8(2), 1–10.

Center for Labor Market Studies (2003). The Hidden Crisis in the High School Dropout of Young Adults in the U.S.: Recent Trends in Overall School Dropout Rates and Gender Differences in Dropout Behavior, Northeastern University, Boston, Massachusetts.

Center on Education Policy. (2006, March). *From the Capital to the Classroom; Year 4 of the No Child Left Behind Act.*

Congressional Research Service (2009, June 30). The U.S. Science and Technology Workforce.

Dijkstra, A., Van Voorthuizen, H., & Van Zijtveld, M. (2011). Café science for kids. *Nature*, *475*(7356), 296. doi:10.1038/475296c. Retrieved February 12, 2013, from EBSCOhost database.

George, R. (2000). Measuring change in students' attitudes toward science over time: an application of latent variable growth modeling. Journal of Science Education and Technology 9(3), 213–225.

George, R. (2003). Growth in students' attitudes about the utility of science over the middle and high school years: Evidence from the Longitudinal Study of American Youth. 12.

Giles, J. (2004). Pop science pulls in public as café culture goes global. *Nature 429* (6990), 333.

Giunca, M. (2009, May 12). Science Cafe lets people, scientists talk about ideas: It's an informal forum for discussion, and it's here in Winston-Salem. *Winston-Salem Journal (NC)*. Retrieved February 14, 2013, from EBSCOhost database.

Goldston, D. (2005). Elementary Science: Left Behind?, *Journal of Science Teacher Education* 16, 185-187.

Mayhew, M. A., & Hall, M. K. (2012). Science Communication in a Café Scientifique for High School Teens. *Science Communication 34*(4), 546-554.

Miller, J. D. (2016, October 28). Civic Science Literacy in the United States in 2016. Retrieved June 29, 2017, from http://home.isr.umich.edu/files/2016/10/NASA-CSL-in-2016-Report.pdf

Miller, J.D. (1999). The Development of Civic Scientific Literacy in the United States. In D.D. Kumar and Chubin, D. (Eds.), Science, Technology, and Society: Citizenship for the New Millennium. New York: Plenum Press.

Miller, J.D. (2012). The Value of Bringing Science Home. *Scientific American* 307(2), 64-65.

National Science Foundation, Division of Science Resources Statistics. (2004, May). NSB 04-01

National Science Foundation. (2008) Science, Technology, and Sustainability: Building a Research Agenda

Niche: Discover the Schools and Neighborhoods That are Right for You (n.d.). Retrieved from https://www.niche.com/k12/mccall-donnelly-high-school-mccall-id/

Parker-Burgard, D. (2009). Science Cafés: Real Science, Plus Cake. *District Administration*, *45*(8), 26. Retrieved February 13, 2013, from EBSCOhost database.

Renzulli, Joseph S. and Park, Sunghee. (2000, fall) Gifted Dropouts: The Who and the Why, *Gifted Child Quarterly* vol. 44 no. 4.

Russell W. Rumberger (2011, October). Harvard University Press

Silverstein, S. et al. (2009, October). Teachers' Participation in Research Programs Improves Their Students' Achievement in Science. *Science*, 440-442.

The Accent Is On Science at Staff Member's Tilde Cafe Lecture Series (2010). M2PressWIRE. Retrieved February 14, 2013, from EBSCOhost database.

APPENDICES

APPENDIX A

PRE-SCIENCE CAFÉ QUESTIONNAIRE

Pre-Science Café Questionnaire

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. I am well-informed on current science research in a wide variety of topics.

(1) strongly agree *(2) agree* *(3) disagree* *(4)strongly disagree*

2. I am engaged in understanding the fine details of current science research topics.

(1) strongly agree *(2) agree* *(3) disagree* *(4)strongly disagree*

3. My personal routines include reading science journals to update my knowledge of current science research.

(1) daily *(2) weekly* *(3) monthly* *(4) rarely*

4. My personal routines include listening to or watching a broadcast or program that informs me of current science research

(1) daily *(2) weekly* *(3) monthly* *(4) rarely*

5. My personal routines include conversation with others to stay informed of current science research.

(1) daily *(2) weekly* *(3) monthly* *(4) rarely*

APPENDIX B

POST-SCIENCE CAFÉ QUESTIONNAIRE

Post-Science Café Questionnaire

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. I would like to become more-informed on current science research in a wide variety of topics.

(1) strongly agree *(2) agree* *(3) disagree* *(4)strongly disagree*

2. I would like to become more engaged in understanding the fine details of a wide variety of current science research topics.

(1) strongly agree *(2) agree* *(3) disagree* *(4)strongly disagree*

3. I intend to modify my personal routines to include more reading in science journals to update my knowledge of current science research.

(1) daily *(2) weekly* *(3) monthly* *(4) I have no such intention*

4. I intend to modify my personal routines to include more time listening to or watching a broadcast or program that informs me of current science research

(1) daily *(2) weekly* *(3) monthly* *(4) I have no intention*

5. I intend to modify my personal routines to include more time in conversation with others to stay informed of current science research.

(1) daily *(2) weekly* *(3) monthly* *(4) I have no intention*

APPENDIX C

PRE-CAFÉ BACKGROUND KNOWLEDGE PROBE

Pre-Café Background Knowledge Probe

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Please answer each of the following questions succinctly, in two or three sentences if possible.

1. How well-versed are you on the topic of tonight's science café discussion?

2. Describe the methods by which you have obtained your current level of understanding of the topic of tonight's science café discussion.

APPENDIX D

POST-CAFÉ BACKGROUND KNOWLEDGE PROBE

Post-Café Background Knowledge Probe

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Please answer each of the following question succinctly, in two or three sentences if possible.

1. How well-versed are you on the topic of tonight's science café discussion?

2. Describe the high points or major big ideas of the topic as you understand them, following this evening's science café discussion.

APPENDIX E

PARTICIPANTS' INTERVIEW QUESTIONS

Participant's Interview Questions

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. Was your interest piqued by today's science café?

2. What specific topic or point in the discussion piqued your interest the most?

3. In what ways did your participation in the science café improve your understanding of the topic discussed?

3. How did your participation in the science café improve your enthusiasm for science and science discussions?

APPENDIX F

PARTICIPANTS' EMAIL SURVEY

Participant's Email Survey

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. In the time since you participated in the science café last week, how has your level of excitement for science changed?

2. In the time since you participated in the science café last week, how has the degree to which you have continued to engage in or initiate science conversations changed?

APPENDIX G

PRESENTER'S INTERVIEW QUESTIONS

Presenter's Interview Questions

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. Did you feel challenged in your preparation for leading the science café?

2. Is the topic that you chose for the science café discussion one that you are interested in pursuing further?

3. Approximately how much time did you spend preparing, in order to lead the discussion in this science café?

4. Describe the ways in which you gained your knowledge required to lead a good discussion on the topic that you chose.

5. How did the discussion go, in your estimation; were the participants well-enough informed?

Were you well-enough informed?

6. What, if anything, would you have done differently in your preparations to lead the science café discussion?

7. What, if anything, would you have done differently in the manner in which you led the discussion for the science café?

APPENDIX H

PRESENTER'S EMAIL SURVEY

Presenter's Email Survey

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. During the week following your presentation of the topic you chose for the science café, rate how interested you have been in the topic.

(1) I can't stop studying it *(2) I have read a little more about it*

(3) I have thought about it occasionally *(4) I forgot all about it*

Choose the level at which you agree with the following statements.

2. Through the process of preparing for and presenting the science café discussion on the topic that I chose, I have developed a passion for learning more about my topic.

(1) Strongly agree (2) Agree (3) Disagree (4) Strongly disagree

3. In the week following the science café that I presented, I have felt challenged by the topic while I have reviewed the discussion in my mind.

(1) Strongly agree (2) Agree (3) Disagree (4) Strongly disagree

4. In the week following the science café that I presented, I have felt challenged by the topic while I have conducted further research to better understand the questions that were raised, and the observations and comments that were made.

(1) Strongly agree (2) Agree (3) Disagree (4) Strongly disagree

5. I would eagerly welcome another opportunity to do further preparation and lead another discussion on the same topic that I chose for last week's science café.

(1) Strongly agree (2) Agree (3) Disagree (4) Strongly disagree

APPENDIX I

INFORMED CONSENT FORM

SUBJECT CONSENT FORM FOR PARTICIPATION IN HUMAN RESEARCH AT MONTANA STATE UNIVERSITY

The purpose of this research project entitled "**Assessing the Impact of a Student-led Science Café on Science Literacy in the Community**," examines the effect of having a gifted and talented student become a resident expert on a topic of science research, and lead a discussion on the topic at a science café. For this project, students will be asked to complete questionnaires, surveys, background knowledge checks, and interview questions. All of these data collection instruments fall within the area of common classroom assessment practices.

Identification of all students involved will be kept strictly confidential. Most of the students involved in the research will remain unidentified in any way, and their levels of environmental interaction will be assessed and noted. Ten students will be selected for interviews, including those who have led a science café discussion, and others who will be randomly chosen. Nowhere in any report or listing will students' last name or any other identifying information be listed.

There are no foreseeable risks or ill effects from participating in this study. Furthermore, participation in the study can in no way affect grades for this or any course, nor can it affect academic or personal standing in any fashion whatsoever.

There are several benefits to be expected from participation in this study. The students who lead the discussions will gain valuable experience leading a discussion involving technical aspects of current scientific research, as well as a better understanding of current issues in science. Those attending the science café sessions will gain a better understanding as well, in addition to exposure to differing points of view on issues. The principal investigator, Mr. Cochrane, will gain an understanding of how to help gifted students find interests and passions to pursue, as well as how to advance the level of scientific literacy among the general population of the community.

Participation in this study is voluntary, and students are free to withdraw consent and to discontinue participation in this study at any time without prejudice from the investigator.

Please feel free to ask any questions of the investigator, Andrew Cochrane, via e-mail (acochrane@mdsd.org), phone (208-634-2219, ext. 3351), or in person before signing the Informed Consent form and beginning the study, and at any time during the study.

Parent signature: _____

Student signature: _____

Date: _____