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High School Students' and Scientists' Perceptions of a Student-Scientist Partnership

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HIGH SCHOOL STUDENTS' AND SCIENTISTS' PERCEPTIONS OF A STUDENT-SCIENTIST PARTNERSHIP

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2015

Dedication

I would like to dedicate this thesis to my family for their support and guidance throughout my life.

HIGH SCHOOL STUDENTS' AND SCIENTISTS' PERCEPTIONS OF A
STUDENT-SCIENTIST PARTNERSHIP

by

KARLA RENEE SINGH, Bachelor of Science

THESIS

Presented to the Faculty of the Graduate School of

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Abstract

The idea of getting high school students to work with scientists has become a hot topic. There have been many programs that get students involved with scientists to gain experience. Having students work with scientists allows students to practice authentic science. These programs also aim to get more students interested in science and hopefully inspire these students to go into a science career. Researchers have looked at several aspects during these interactions. These aspects include students' interest, students' ability, students' career choice and students' perceptions of the scientific community. However, few studies are known that include trying to understand students' and scientists' perceptions of a student-scientist partnership. In this study 54 students and nine science professionals were interviewed about benefits and obstacles they may face during this program. These interviews will then be analyzed to see similarities and differences between high school students and scientists. The analysis of these interviews can lead to making improvements for future student-scientist partnerships.

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Introduction

Educators are looking for ways to get students more interested in school and go on to college. One major issue in education is students are not performing well in STEM areas and not pursuing careers in these fields (Boscia, 2013). Without the basic knowledge of these areas students will not be prepared for tomorrow's jobs (Kesidou & Koppal, 2004). With the advancing of technology students need to have the knowledge in order to become leaders to keep the US an innovative society. A key element that has been looked at to give students the necessary knowledge to succeed in the STEM fields is the teaching of authentic science. One approach for the teaching of authentic science is having students work with scientists side by side. By having high school students' work with scientists, this can add more diversity in these fields and also create bonds that will only promote scientific progress (Strong, 2005). During these kinds of projects researchers are looking into many components that exist between high school students and scientists. For example, studies have looked at (a) student interest (e.g., Craney, Mazzeo, & Lord, 1996) (b) student knowledge (e.g., Dresner & Worley, 2006) (c) scientist pedagogical knowledge (e.g., Caton, Brewer, & Brown, 2000; Dresner & Worley, 2006) (d) interest and perceptions from women (e.g., Farland-Smith, 2009) and (e) improvement of science instruction (e.g., Brooks, Dolan, & Tax, 2011; Caton, Brewer, & Brown, 2000; Goodnough, 2004).

High school students have not been fully exposed to the scientific world. We believe that Moscovici's (1984a) theory of social representations can provide insight into how high school students perceive a student-scientist partnership. Moscovici (1984a) discusses that our attributions, perceptions and ideas are responses to stimuli from the physical environment we live in. These representations allow us to think about an unfamiliar issue. First, representations conventionalize the persons, objects and events we encounter (Moscovici, 1984a). Second, representations are prescriptive, they impose themselves upon us with force (Moscovici, 1984a). These representations are shared and able to

influence each mind. Representations are developed through examining and interpreting information. The perceptions of a student-scientist partnership studied are social representations from high school students and scientists.

In this study we looked at what the participants think the best relationship would be between a high school student and a scientist. More components to be looked into are the views of students and scientists on the benefits and obstacles of this project. This will give a better insight into the high school students' and scientists' opinions. By looking into the perceptions of students and scientists researchers can possibly understand the interaction of high school students working with scientists. Researchers can also look at the possible ideal relationship between high school students and scientists. If there are any difficulties during a partnership, looking at the perception of student-scientist could address those issues. High school students' and scientists' perceptions can give a personal look into how they think a partnership should work. Analyzing these perceptions can further researchers' knowledge on how to make a partnership between high school students and scientists successful.

1.1 STEM Workforce in the United States

Many educators and researchers are examining the lack of interest and lack of people in the STEM fields. "There is growing concern that the United States is not preparing a sufficient number of students, teachers, and professionals in the areas of science, technology, engineering, and mathematics (STEM)" (Kuenzi, Matthews & Mangan, 2006, p.1). Workers in the fields of Science, Technology, Engineering and Mathematics are major components in the success of the United States. These workers drive the nation's competitiveness and innovations by producing new ideas, new industries and new companies (Langdon, McKittrick, Beede, Khan, & Doms, 2011). Due to the advancement of technology two-thirds of children will have jobs that do not presently exist (Boscia, 2013). The United States is always evolving and needs to have capable citizens who are up for the challenge of these new jobs. In

2010, there were 7.6 million STEM workers which amounts to 1 in 18 workers. According to the academic year of 2002-2003 the United States had more than 2.5 million degrees awarded from different universities. Of that the number only 16% of those degrees were in the STEM fields. “All STEM degrees comprised 14.6% of associate degrees, 16.7% of baccalaureate degrees, 12.9% of master’s degrees, and 34.8% of doctoral degrees” (Kuenzi et al., 2006, p.10). In a recent assessment of sophomore students the US ranked 28th in math literacy and 24th in science literacy. The US is called the leader of scientific innovation and yet these numbers do not show that. In looking at recent graduates, the US ranks 20th for people who earned a degree in science or engineering (Kuenzi et al., 2006). In comparison with the amount of STEM degrees awarded to foreign students the United States are falling behind. The international average for STEM degrees were 26.4% in 2002. Also there is a significant amount of foreign university faculty in the scientific disciplines.

This raises a question as to why the United States is not producing more people in the STEM fields. According to Langdon et al. (2011) STEM careers are expected to grow by 17% from 2008 to 2018. Non-STEM careers are expected to have a 9.8% increase. The statistics reveal STEM careers are outnumbering the need for non-STEM careers. One reason this is happening is because many jobs are being eliminated due to the advancement in technology. “Duke University professor Cathy Davidson, an expert on the history of technology, estimates two-thirds of children in US schools today will eventually work in careers that haven't been imagined yet, in jobs far different from what their parents know” (Boscia, 2013, p.1). There is much certainty that the careers that will remain and that are needed are in the STEM fields. “Indeed, President Obama's Council of Advisors on Science and Technology in 2012 predicted that it would take 1 million STEM graduates in the next decade to fill the high-tech jobs of the future” (Boscia, 2013, p.1). It is clear that we need more capable people to fill these job requirements. Much research takes a look at the quality of teachers and the curriculum. There have been studies on students in elementary and middle in the United States that are being compared to other countries. An

assessment was shown that the majority of students did not meet the proficiency level. Only one-third of fourth and eighth graders performed at the proficiency level in mathematics (Kuenzi et al., 2006). About two-fifths of students continue to achieve only partial mastery of mathematics. When high school seniors were tested, only 12% performed at the proficient level or higher level of mathematics. In the case of science less than one-third of 4th and 8th graders and less than one-fifth of 12th graders scored at the proficient level or above.

Due to the fact that the United States is behind in the STEM areas, foreign people are being hired to full those jobs. In comparing with other nations, the US is not meeting the international average. The US scores of 4th and 8th graders did go above the international average in the 90's but now the scores have dropped (Kuenzi et al., 2006). STEM workers play a vital role in sustaining the nation's economy and a critical component in helping the US win the future (Langdon et al., 2011). STEM jobs are the jobs of the future and something must be done so the US can provide enough STEM workers to fill those jobs.

1.2 Authentic Science

One of the most common features in school right now is skills and knowledge has become abstracted from their uses in the world (Barab & Hav, 2001). Students are not able to develop research questions on their own, they follow a set of procedures given to them instead of utilizing a plan they created and are taught classroom inquiry to learn scientific concepts (Burgin, Sadler & Koroly, 2012). The pressure to teach for high-stakes standardized tests has led teachers to stay away from laboratory investigations. As a result students are not exposed to the mature field of practice that is commonly used in the real world. Due to this the content is looked at as not valuable and the students are only taught what the schools think is appropriate. In the US the classroom inquiry is "hands on" but the students are told what laboratory activities they will be doing. The students are not given the freedom to work on a

project that they want to do. One key element that science educators are interested in is the teaching of authentic science. “Authentic science learning is commonly thought to involve students in practices resembling those of scientists, such as asking scientific questions, designing and conducting research, generating and testing hypotheses, and communicating results” (National Research Council, 2000). Dolan, Lally, Brooks and Tax (2008) affirm that this type of research is usually done in research laboratories or field sites and requires access to supplies, knowledge, and equipment that is not usually available in the classroom. By having access to these tools students will be able to see and do real science. Dolan et al. (2008) explain that students wanted opportunities to collect real data. These students wanted more than just lab demonstrations and science fairs.

In order for students to do authentic science, educators have been creating student-scientist partnerships through the use of internships. This has become a popular source for authentic science. Research internships offer an outstanding way for high school students to take part in authentic research (Barab & Hav, 2001). Students are able to engage in the collection, analysis and modeling of data from active research programs guided by unanswered questions. These research internships are usually held in institutions which are structured and can guide and influence students through the whole process. Research has shown that involvement in authentic activities is crucial to build significant learning and interest in science. The students have control in what they want to research and they own their learning through the process of the internship. They get to see what is being researched now and why it is important. In the classroom, the material is extremely limited due to the lack of time. Actual research can take a couple months to a couple of years. Since students are not given the tools to really understand how science is conducted they miss out on some vital knowledge that could possibly lead to an interest in the science field.

1.3 Lack of Research on Perception of Student-Scientist Partnership

In this section I will illustrate that research does not commonly look at the perception of student-scientist partnership as a topic. In order to research this topic I used the database in education called Educational Research Information Center or ERIC. Two keywords “scientists” and “students” were used first to see how many articles there are related to these words. This received 1,124 hits out of the database. These many articles can include research looking at the professional development of teachers, student’s knowledge of science, student’s interest in science, women in STEM, the role of a scientist and student career choices. This is what constitutes as my 100%. To further condense my search I added one more word “partnership”. My results showed 72 hits which consists of only 6% of the original broad topic. This clearly shows a dramatic drop of articles from the previous search. I then started using more words that I thought were frequently researched. The words that were chosen are interest, career, knowledge, confidence and lastly perception. These results can be seen in Table 1.

Table 1 Result of a student-scientist partnership using ERIC database

Keywords entered in the category of “Topic”	Hits	Percentage
“Scientists” and “students”	1124	100%
“Scientists” and “students” and “partnership”	72	6%
“Scientists” and “students” and “partnership” and “interest”	3	0.3%
“Scientists” and “students” and “partnership” and “career”	11	0.97%
“Scientists” and “students” and “partnership” and “knowledge”	20	1.77%
“Scientists” and “students” and “partnership” and “confidence”	2	0.17%

“Scientists” and “students” and “partnership” and “perception”	4	0.35%
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By using the extra word perception only four hits were shown out of 1,124 hits. The percentage of the words “scientists”, “students”, “partnership” and “perception” is 0.35%. This shows that studies on perception are not thoroughly researched. There have been few studies done on what I want to research. This research should become more important and necessary for science education. By looking at the perception of high school students and scientists this could add another layer into understanding why a partnership is successful and why another partnership is not successful. Analyzing these perceptions is another dimension that can be taken in consideration when observing a student-scientist partnership. For example, if the students feel intimidated by working with a scientist there could be an intervention created to transform this perception. An intervention can include a new curriculum or materials to promote a healthy relationship between a high school student and a scientist. By incorporating materials or a new curriculum this can help other students who maybe would not consider working with a scientist because they feel intimidated by a scientist. In turn if looking at the perception of high school students can possibly promote a positive perception of scientists, this can attract more students to want to be a part of a partnership. By learning about authentic science students could want to go into a STEM career. Understanding high school students’ perceptions of a student-scientist partnership is a small area to look at but it can impact the US STEM workforce. In the next section what has predominately been researched in student-scientist partnerships will be discussed.

2. Literature Review

This section discusses what research has been done on student-scientist partnerships. The most frequent research topics will be conferred in detail. It will be apparent that many articles articulate the same ideas when it comes to student-scientist partnerships. The perceptions of high school students and scientists have not been taken into account in these studies.

2.1.1 EXTENDING PARTICIPANTS INTEREST IN SCIENCE

An important aspect that has been shown from a student-partnership is that student's interest in science increases. "One model suggests that involving students in authentic research projects and allowing them the opportunity to engage in scientific work alongside practicing scientists leads to increased excitement about science, as well as increased retention of students in science courses" (Abraham, 2002, p.1). Abbott and Swanson (2006) support this aspect by describing the benefits of students working with scientists. They state that having science connect to a student's everyday life gets the students more interested in the subject. This experience can be rewarding and students who normally don't take pride in their work will suddenly be drawn to science (Abbott & Swanson, 2006). The material that the students are working with is more exciting than what they have been doing in their classroom so they are more interested in the subject. The authors also point out something very interesting. They mention that since the students are helping a scientist with their research it becomes more important to them. The students know that their results are going to be used beyond the classroom. Since the research is taken more seriously by the students they feel important and so their interest of the subject increases.

A scientist is a role model of authentic science to the students (Hughes, Molyneaux and Dixon, 2011). The scientist is able to guide the students into real-world science and move beyond the classroom. Students will be taught new and different concepts and they will see that science is

important. A student could change their mind about science if they are offered a chance to work with a scientist. By being taught in a different way the students can become more interested in science. Through this experience, students gain knowledge about how scientists work and about the scientific community.

Some studies have shown that there was no effect or no decrease of interest in science after a partnership (Shell, Snow & Claes, 2011). After being exposed to a partnership there is a possibility that a student's interest has not changed. Some students who go through an internship experience can decide that science is something that they do not want to pursue in the future (Abraham, 2012). The students learn that they do not like the process that is involved in being a scientist and their interest actually decreases. A major part of having students work with scientists is to have the students' interest in science increase but that is not always a guarantee.

The scientist plays a crucial role because he/she directly influence the students. Hughes et al. (2011) claim that a scientist acts as a role model of authentic science and can guide students to cross the boundaries from classroom science to real-world science. Many of these students have not been introduced to real-world science in their classrooms. This will be a new experience and it will make them think about science in a new way. If students can see how science is used in the real-world they can be more interested in the subject. Now they are able to see that science is useful and it has become tangible to them. Once students are more intrigued by the subject they put more effort into their learning. A student-scientist partnership can make a huge impact on student's motivation to learn more.

2.1.2 EXPANDING PARTICIPANTS' KNOWLEDGE

One benefit of having students work with scientists is that the students' knowledge of science will grow. Abraham (2002) confirms this benefit by explaining the results of having students working with scientists. The students stated that they had learned more about the nature of science, science

content and scientific process. Scientists direct the students in their learning about the scientific community and the skills in order to conduct scientific investigations. Due to this students are now able to distinguish the difference between a research project and an experiment in the classroom (Abraham, 2002). The students are given the knowledge to understand what it takes to create a research project and follow through. Clendening (2004) also has similar findings of students working with scientists. The author explains that the students not only learned more knowledge of science but also about the realities of the research process. The students are exposed to the process of scientific inquiry as it takes place in a research setting. A scientist can expand a student's content knowledge and broaden their understanding of scientific inquiry (Pegg, Schmook & Gummer, 2010). Science teachers do not have as much knowledge as scientists. Scientists' college years are focused on science content while science teachers are more focused on the education aspect of it. By allowing students to be exposed to scientists they can learn a tremendous amount of material and learn new procedures.

Shell et al. (2011) allege that partnerships between students and practicing scientists improve students' understanding of scientific inquiry and content knowledge. "Student scientist partnerships also are seen as effective methods for engaging students in inquiry based science as proposed in standards such as the National Research Council" (Shell et al., 2011, p.1). Students are given guidance on how to conduct the scientific method and how to use modern research techniques. These skills are essential to future scientists to learn before they enter the college setting. Without having this opportunity the students would not gain knowledge about the scientific method and research techniques through the classroom. Students are able to learn in detail about the scientific process (Bollman, Rodgers & Mauller, 2001). The scientific process requires the students to think like a scientist by asking good questions, to consider all possibilities, to not become frustrated when data is challenging and to continue to press on until an answer is found. The authors also say that students often do not take this journey because the students are not exposed to it in their classrooms. Marx, Honeycutt, Clayton and Moreno (2006)

illustrate that students gain more knowledge when working with scientists. This was shown through a benchmark test which demonstrated that more students were passing this test after the partnership. With all this new knowledge students could possibly want to go into a science career.

2.1.3 ILLUMINATE NEW CAREER POSSIBILITIES

Another important aspect of the partnership of students and scientists is that it can likely bring students into a science career. Students with great science and math might not know what careers they can go into (Waltner, 1992). By having students being able to work side by side with a scientist they are able to learn about the different careers and what is done in those careers. Abraham (2002) claims that students who were not thinking of a science career were now open to studying science in the future as a result of the partnership with scientists. The author also stated that the students who were already interested in a science career had confirmed their decision after the partnership. Shell et al. (2011) had similar findings about student's scientist partnerships. The authors reported that a number of students have increased motivation to study a science related major. "It appears that participation in authentic research activities can not only stimulate students toward science but also can help students clarify their non-interest" (Shell et al., 2011, p.172). Non-interest can be classified as students who already have no interest in science. During the experience of a partnership the students' non-interest can be remain the same or possibly change. Being exposed to new things such as new concepts, equipment and technology can spark a new interest in science. This new interest can lead the students to want to pursue a career in science.

Parker (2005) confirms that students can contemplate a career in science after working with a scientist. The students are exposed to careers and opportunities that they didn't know existed. A student could only be interested in one subject of science but if they are put into a different lab this could change the students' mind. For an example, a student can be exposed to an engineering lab. The student may not

have had an interest in engineering before but by being in a new lab this could generate a new interest in this career. The student might find a new love for that subject and want to pursue to it in college. Seraphin (2010) reiterates the fact that students can change their mind about a science career by being involved with scientists. It was shown in their study that after working with scientists who studied sharks, some students wanted to pursue a career in marine science. Giving students the opportunity to collaborate with scientists shows students what it is like to be part of the scientific community. They are able to see what a scientist does in a particular field. It could be a field that they don't know much about so they don't even consider it for a career option. By students being introduced to these new fields a new passion can be created. Siegel, Mlynarczyk-Evans, Brenner and Nielson (2008) insist that working with a scientist helps students consider their careers. The students are able to see what the profession of a scientist entails. They have the opportunity to observe what scientists do in their labs and how they are trained. The scientists guide the students through this whole process. However in a study done by Burgin, Sadler and Koroly (2012) their results showed that some students had no changes in their future plans. Getting students into STEM careers is the ultimate goal of student-partnerships but not every student can be reached. Another possibility of getting students more interested in a STEM career is to eliminate any negative stereotypes that they have about scientists and the scientific community.

2.1.4 CHANGE STEREOTYPES OF SCIENTIFIC COMMUNITY

To get a better perception of what students think a scientist looks like teachers have their students draw a scientist. This has become a popular tool because of the simplicity of it and it gives teachers a look into a student's mind. Ozgelen (2012) discusses having students draw scientists and what results came of this study. Some stereotypes that were prevalent were that scientists were Caucasian, they wore glasses, had some type of facial hair and were a man. Not all students had this same image but this was the majority image from the drawings. Schibeci (2006) also confirms this image as the majority

image from the students. Looking at these drawings can give researchers a reason why students have positive or negative perceptions of scientists. Yontar (2013) also has similar results from the students who participated in the study. The stereotypical image that was portrayed the most was a bald male with glasses and facial hair who works indoors.

Students have different perceptions about scientists and how the scientific community works. These perceptions come from school, internet, social media and television. Normally these perceptions are inaccurate and extremely far-fetched. Having students work with scientists and be a part of the scientific community can change these perceptions. The stereotypical student view of a scientist is a frail elderly male (Seraphin, 2012). Clearly this view is very narrow because scientists can be young or older and can be male or female. When students work with a variety scientists they can see these differences. There are many stereotypes/perceptions that can be broken down when students work with scientists (Marx et al., 2006). Stereotypes like what scientists do in a lab, what college is like, what graduate school is like and what it takes to become a scientist/engineer. These students have not been exposed to the scientific community, so their perceptions are most likely incorrect.

Abraham (2012) has shown that a student's perception of a scientist can change after working alongside them. Students commented on how scientists looked and that the scientists can enjoy literature and culture. Before their experience, it showed that the students expected the scientists to look a certain way and that the scientists only enjoyed science. The students were able to see that the scientists were "real people." "In other words, the opportunity to work alongside active researchers helped to humanize science for many high school students" (Abraham, 2012, p.231). When students see that scientists are normal people then they can believe that they can go into a science career. Often students have a perception that scientists are isolated and the students do not want that for themselves. Going through this experience can show the students that it is quite the opposite. There is more to a scientist than the perceptions that these students have.

2.1.5 INCREASE UNDERSTANDING OF NATURE OF SCIENCE (NOS)

After being able to partner up with scientists, students can gain more knowledge of the nature of science (Abraham, 2012). During the internship, the students were able to gain an in-depth understanding of the nature of science. An example of how this took place was by the extreme weather, unexpected delays and flawed data sets. Students do not consider these kinds of setbacks and so they are able to see firsthand what could happen out in the field. The author explains that the nature of science is more than just scientific content and facts. The nature of science is a description of what science is, how science works and how scientists work as a social group. The students were able to experience that an answer does not always come at the end and that they needed to be flexible when doing an experiment.

Barab and Hay (2001) show results of student gaining knowledge of the nature of science through a partnership. These students had to give presentations to their peers and it illustrated that they had a better understanding of the nature of science. The students showed that they understood the scientific process going on in the lab. When engaging with the nature of science students have to deal with outliers and they quickly realize that science is a complex subject (Barab & Hay, 2001). When students in the classroom make a mistake they look at what was implemented. The students do not see that they can learn from unexpected results. This can be a confusing concept since students are trained to only get the right answer (Barab & Hay, 2001). By doing authentic science they can observe that it is not about finding the correct answer in one day. There could be unexpected obstacles that lead the students onto a different path. Science is very complex and there is no simple format to follow.

Burgin et al. (2012) also point out that having students be a part of a partnership can help them understand more the nature of science. The students see themselves and scientists as part of a larger community in which they can collaborate together. Another aspect that the students see is that in science you do not always need to have a step-wise procedure such as the scientific method. Sometimes scientists work backwards and find their hypothesis at the end of the research. There is no concrete way

in order for scientists to conduct research. Students also are able to gain more findings that challenge their hypothesis. These findings could include unexpected results that the student did not think of beforehand. They could have missed a variable and ended up with negative results. The students are able to learn many new features that they have never thought of through the understanding of the nature of science.

However, in some cases students are still not able to fully understand the nature of science after an internship. One student showed that she thought scientists only prove what has already been established as true (Burgin et al., 2012). This particular student believed that science is a step-by-step procedure and the scientific process is several repetitive tasks. The nature of science is a key factor in doing partnerships but sometimes the results are not what researchers expect.

2.2 From a Scientist point of view

Kaser, Dougherty and Bourexis (2013) discuss what geneticists discovered during the process of a partnership. The geneticists were able to see their own gaps in how they thought students learned. They had multiple opportunities to correct this view and learn to adapt to the students' needs. These scientists were also able to see that in high school the lesson plans are more student-centered. This is different from lectures utilized by the science faculty. Seeing how lesson plans are done in high school made an impact in how the scientists lectured their own courses. The scientists also acknowledge that now they are able to identify misconceptions and know how to address them. Oliver, Rybak, Gruber, Nicholls, Roberts, Mengler and Oliver (2011) show the positive experience that the scientists had working with high school students. One scientist expresses that he/she was able to share their passion of science with the students and it was a fun experience for them. Another scientist articulates that he/she was able to put himself/herself in the position of the students in order to explain things to them. Also, that this partnership gave the students a good insight into science research. The scientists had an overall

rewarding time working with high school students and recommend other students to be involved in a partnership.

It has been shown that scientists enjoy showing students their research and creating an interest in science for them (Weaver & Mueller, 2009). Scientists are also able to develop their communication skills and show students how science is relevant to their lives. It can be a challenge working with students because they do not know the necessary scientific language that scientists use. During the experience of a partnership the scientists learn how to communicate to the students so that they understand the terminology and information. Weaver and Mueller (2009) make it clear that the students and scientists learn from each other. Scientists learn how the students learn new material and the students gained knowledge on scientific topics.

The role of the scientist is a vital part in stimulating young minds. Many positive outcomes have come from having students work with scientists. These outcomes that have been described in research seem to be repeating the same results. The results that are repeating have been already been discussed in the previous paragraphs. This is why it is important to research the perception of student-scientist partnership. Looking at the perception of student-scientist partnership is not a common aspect that is being observed in education research. There has been little done to show this different outlook. The next section describes the methods of conducting this research.

2.3 Draw a Scientist

To get a better perception of what students think a scientist looks like teachers have their students draw a scientist. This has become a popular tool because of the simplicity of it and it gives teachers a look into a student's mind. Ozgelen (2012) discusses having students draw scientists and what results came of this study. Some stereotypes that were prevalent were that scientists were Caucasian, they wore glasses, had some type of facial hair and were a man. Not all students had this same image but this was the majority image from the drawings. Abraham (2012) has shown that a student's perception

of a scientist can change after working alongside them. Students commented on how scientists looked and that the scientists can enjoy literature and culture. Before their experience, it showed that the students expected the scientists to look a certain way and that the scientists only enjoyed science. The students were able to see that the scientists were “real people.” Fung (2002) showed that there was a difference of gender in the drawing of a scientist. The students were able to draw two scientists and male students only draw male scientists. Female students draw a male scientist and a female scientist. Nicholson, Warren, Oppenheimer, Goodman, Codling, Robinson and JeeYoung (2013) claim that college students showed that they thought women in STEM fields are less attractive than in Non-STEM fields. This stereotype could possibly mislead women from not going into a STEM career because they don’t want to be labeled as unattractive. Ozel (2012) states that scientists are often portrayed as a middle aged man who wears glasses and works indoors in a lab. Song and Kim (1999) show that the students see themselves different from a scientist. The students say they have qualities such as caring and humane but the scientists do not. The students considered a scientist as a “bad guy”. A current component used to help with these misguided perceptions is having students work with scientists. All of the studies done on students working with scientists look at solely the individual student and not a partnership. Looking at the perceptions of high school students and science professionals focuses on a partnership and it can add another outlook to analyze.

3. Methods

3.1 Participants

The research was conducted in a mid-sized city in the southwest. This thesis was done by using secondary data from the NSF project, Transforming Students' Partnership with Scientists through Cogenerative Dialogues. For this project a T-STEM high school in this southwest city was chosen to be studied. The high school students are predominately Hispanic and are considered economically disadvantaged. These high school students are self-select participants for this NSF project. The participants include 46 students from the high school and nine science professionals. The first step was to interview four scientists and five science research assistants associated with the project. The scientists interviewed were from the fields of engineering, chemistry, geological sciences and biochemistry. The science research assistants that were interviewed consisted of two PhD students and three undergraduate students. All of the interviews were conducted in a research office in the education building at UTEP. After this 46 11th grade students were interviewed individually. These interviews took place at the high school and were conducted for two straight weeks all day.

3.2 Data Sources and Collection

This study looked at the perception of student-scientist partnership of high school students, science research assistants and scientists. To investigate, six questions were generated to see different angles of how high school students and scientist professionals perceive each other in a partnership setting. Each participant was interviewed individually. The following questions were used in this thesis:

- 1) What does a scientist mean to you? (without map)
 - a) When you hear the word scientist what keywords come to your mind? (with map)
- 2) What are some benefits you think high school students will have by working with scientists?
- 3) What are some obstacles you think high school students will have by working with scientists?

- a) What difficulties could they face?
- 4) What are some benefits you think scientists will have by working with high school students?
- 5) What are some obstacles you think scientists will have by working with high school students?
 - a) What difficulties could they face?
- 6) What would be the best relationship between high school students and scientists? Could you give a metaphor for this relationship?

To help high school students with the first question I used a mapping strategy. Hsu and Roth (2009) had used this method for their research. The authors explain that this strategy allows the students time for reflection and provide a visual resource for the interviewer and interviewee. For the first question the high school students were asked to list five characteristics of a scientist. Then they were asked to explain each characteristic and why they chose them. Next I had them order the five characteristics from most important to least important. I then asked them to give an explanation as to why they chose that certain order.

Research has shown that using interviews is a good strategy to collect data. Doody and Noonan (2013) discuss the advantages of using interviews. The two main advantages that I feel are important are about two types of clarification. If a student does not understand the question, follow up questions can be asked to help clarify. If a student answers a question that is not understood then questions for clarification can be asked. If I would use only surveys we wouldn't have this advantage. Students could be confused by the statements they read and answer the question differently than if they were clear about what was being said. Some other advantages to using interviews are having the student tell their own story, the researcher can build a rapport and it helps the student to give detailed responses (Doody & Noonan, 2013). Also being able to do a face-to-face interview the researcher can observe and listen to the students. The researcher can see their body language and facial expressions to get a sense of how the student is feeling. These advantages make interviews a great tool in qualitative research.

In contrast with a focus group interview, individual interviews have many advantages. The structure of a focus group interview is a group session, with a group leader, held in an informal setting and used to get information on a topic (McLafferty, 2004). Focus group interviews are considered an excellent tool for reflecting the realities of a cultural group. The whole purpose of a focus group interview is to get participants to speak to each other in order to generate data. Focus group interviews can provide great insight into attitudes, opinions and beliefs. Since there is a group of people involved, there could be a rich conversation or debate that could happen. A rich conversation can generate new ideas or opinions. However there could be many flaws that go into the process. One major disadvantage is it can silence voices. Some people are more outspoken than other people and they can dominate the conversation. Individual responses are what are being looked for. When people dominate the conversation the other participants tend to agree with what they say. So what we get is a consensus, not their personal opinions. Having a homogenous or heterogeneous group is a concern in using focus group interviews (McLafferty, 2004). A homogenous group would include people who have the same age, status, class and occupation. A heterogeneous group does not include these aspects. The decision for what kind of group is needed can directly influence the interaction in the group. Another factor that would need to be looked at is how many people in each group. Having too few people might not create a strong enough conversation while having too many people can overwhelm the process. By using individual interviews these different variables will not have to be dealt with.

3.3 Data Analysis

The interviews were analyzed using Braun and Clarke's (2006) model for Thematic Analysis. In this article the authors explain the model in six phases. The six phases are familiarizing yourself with your data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. Themes will be identified from the pre-interviews. After this is done I

will be able to compare the themes from each question and see the differences and similarities among the questions.

Thematic analysis is considered a flexible and useful tool for qualitative research which can potentially lead to detailed and rich findings (Braun & Clarke, 2006). As a research tool it identifies, analyzes and reports themes within data. Thematic Analysis involves the search for common threads throughout interviews or set of interviews. Thematic analysis can be used as a realist method which reports meanings, experiences and the reality of a participant or it can use a constructionist method which examines the effects of meanings, events and experiences on a society (Braun & Clarke, 2006). Both of these approaches have been largely based on the “factist” perceptive. This perceptive means that the researcher wants find out about the actual attitudes, behaviors and real motives of the people being studied or detect what has happened (Vaismordai, Turunen & Bondas, 2013).

In order to use thematic analysis the researcher must first transcribe any data and reread it many times. By doing this the researcher familiarizes with the data and can write down any initial ideas. Secondly the researcher creates codes of interesting features of the data and collates any relevant data to the different codes. Next the researcher will collate the codes into potential themes. After that the researcher will check if the themes work in terms of the data and create a thematic map. Next the themes are still being analyzed and eventually clear definition of the themes will be created. The final part is producing a report of your analysis.

Thematic analysis is very similar to other methods such as constant comparative analysis. The key difference between these methods is one generates categories and one generates themes. Categories can be described as a descriptive level of content while a theme is the expression of the content (Vaismordai et al., 2013). A category can turn into a theme. An example of what thematic analysis results look like is in a study by Falloon (2013). Some themes that were generated were “Institutes consider engagement with schools to be important, but not crucial to their core business,” “Institutes

view improving the knowledge of teachers as the best way they can support school science” and “Institutes view technology as a means of cost-effectively sustaining interactions”. A study by Putten and Nolen (2010) shows results from a constant comparative analysis. Their resultant of categories includes education experiences, class background, mutual support, values and spousal occupation. By looking at both studies by Putten and Nolen (2010) and Fallon (2013) a researcher can see the difference between a category and a theme. A category can be a couple words while a theme is usually a sentence. Themes give more detail and try to capture what the interviewee is trying to say. In thematic analysis the importance of the theme is not based on a number but rather if it captures something important that relates to the overall research question (Braun & Clarke, 2006). In order to get a grasp of the high school students’ and scientists’ perception of a student-scientist partnership the analysis needs to look beyond repeated patterns and words. There needs to be a deeper look into what the students and scientists are really trying to express. Thematic analysis allows researchers to capture this and come to a rich conclusion.

3.4 Inter-rater reliability

Reliability is used in data collection to assure the overall confidence of a research study accuracy (McHugh, 2012). In this study another researcher coded all 46 high school student and 9 scientist interviews. This coding will be done using the software Nvivo. The first coder will coded every interview and then the second coder will coded the same interviews. Through the software of Nvivo, the inter-rater reliability will be calculated. Cohen’s kappa values were used to interpret the inter-rater reliability between the coders. Cohen’s kappa values are as follows: ≤ 0 is indicating no agreement and 0.01-0.20 as none to slight, 0.21-0.40 as fair, 0.41-0.60 as moderate, 0.61-0.80 as substantial and 0.81-1.00 as almost perfect agreement (McHugh, 2012). The goal for this study were values of 0.81 to 1.00 agreement to validate accuracy.

4. Findings

This study analyzed interviews from high school students and scientists. In this chapter each question was analyzed thoroughly. Through the qualitative approach of thematic analysis certain themes were found from each question that were asked during the interviews. These themes will be displayed for each question along with examples of student responses and frequency. Each question will have a comparison between the high school students' and scientists' themes and responses.

4.1 Question 1 “What does a scientist mean to you?”

The data analysis suggests that the responses for question one “What does a scientist mean to you?” can be categorized into three themes, “scientist practice” (inter-rater reliability: 99.52), “attire” (inter-rater reliability: 98.19), and “required knowledge and skill” (inter-rater reliability: 99.72). In this first question high school students were asked, “When you hear the word scientist what keywords come to mind?” They were able to write down five words on strips of papers. Next, the researcher asked the student to explain why they chose each word. After this the student was asked to order these words from most important to least important. During this process high school students were given plenty of time to organize their thoughts and were able to express themselves. Table 2 displays the response frequencies of different themes between high school students and scientists and examples of responses.

4.1.1 MEANING OF THEMES

The data analysis suggests the high school students' and scientists' can be categorized as follows. The first theme is “attire.” The theme “attire” is describing what a scientist looks like or wears. The second theme is “scientist practice.” “Scientist practice” signifies what a scientist does in their job.

The last theme is “required knowledge and skill.” “Required knowledge and skill” indicates intelligence and characteristics/skills needed to be a scientist.

4.1.2 KEYWORDS IN STUDENT AND SCIENTIST RESPONSES

Keywords and expressions were found that correlated with each theme. Words such as “glasses,” “lab coat,” and “beard” were evidence of “attire.” “Scientist practice” keywords included “research,” “investigate,” and “experiments.” Keywords such as “smart,” “genius,” “determined,” and “hard working” describe “required knowledge and skill.”

Table 2: Responses for Question 1: What does a scientist mean to you?

Table 2 Responses for Question 1: What does a scientist mean to you?

Theme	Student Examples	Scientist Examples
Attire	<p>1L3LG: “I: And lab coats?” S: “They wear them”</p> <p>1L2AM: I: Glasses? S: Just the way they look. Like the pictures scientists have glasses and white coat.”</p> <p>1CEA: I: Okay so you have goggles, why did you choose this word? S: Because they use goggles during the experiments</p>	
Scientist Practice	<p>L4BQ: “I: So, you wrote here research, so why did you write that? S: Well what I... Because usually scientist do</p>	<p>L1LJ: “Ah, it means that you know we are going to have a lot of unknowns and then we have</p>

	<p>research and stuff well the way I think of it, I'm going to be a Marine biologist so I'll have to do research all that stuff."</p> <p>1L2MR: I: You chose experiments, why did you choose experiments? S: To prove their facts, like the subject on what they're doing.</p> <p>1CMB: "And they investigate nature you can say, they are usually, like they look like for bugs and things that are outside like to take a look at them."</p>	<p>hypothesis and that there will be some ways of testing those hypothesis".</p> <p>L3AL: "I think a scientist is someone who make like gain information in like research in order to make like better things".</p> <p>L2MA: "Ummm... Someone who's fond of exploring new idea. Exploring new things... uh someone who wants to do research".</p>
Required Knowledge and Skill	<p>L4CF: "I: Ok. So you have knowledge, why knowledge? S: Because they should have a lot of knowledge on everything generally."</p> <p>1L2MR: "I: Ok. Determined? S: To never quit on certain lab that they're doing to prove to anybody else."</p> <p>1L2LV: I: Ok, I see you have genius. Why did you write genius? S: Because they know some of the stuff they teach to the students.</p>	

4.1.3 COMPARISON BETWEEN STUDENTS' AND SCIENTISTS' RESPONSES

This section shows a breakdown of high school students and scientists responses that aligned with the three themes. There are a total of 46 high school students and nine scientist responses used in this study. For the first theme attire, there is a total of 5 high school students and zero scientist responses that align. The theme of scientist practice has a total of 31 high school students and eight scientists' responses aligning. The last theme of required knowledge and skill has a total of 18 high school students and zero scientist responses. The frequencies for each theme are provided in Table 3.

Table 3. Frequencies for Question 1: What does a scientist mean to you?

Frequency (Percentage)		
Theme	Students	Scientists
Attire	5/46 (10.8%)	
Scientist Practice	31/46 (67.4%)	8/9 (88.8%)
Required Knowledge and Skill	18/46 (39.1%)	
Total participants	46 (100%)	9 (100%)

When observing Figure 1, it is evident that the high school students had multiple ideas about what a scientist means to them. In the first theme “attire”, only the high school students had responses that aligned. The second theme of “scientist practice” was the highest frequency for both parties. The last theme of “required knowledge and skill” only had high school students that aligned. For the high school students the highest frequency is “scientist practice.” The highest frequency for the scientists is also “scientist practice.”

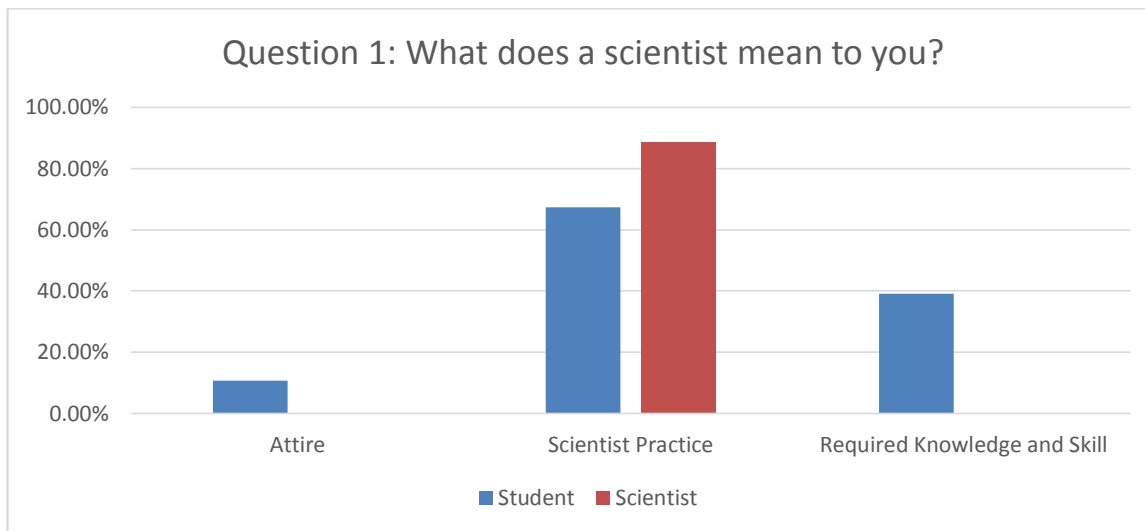


Figure 1: Comparison between student and scientist responses for question 1.

4.1.4 SUMMARY OF RESULTS FOR QUESTION ONE

Looking at Table 3 there are some differences in the student and scientist responses. First, high school students are more likely to have different ways to describe a scientist. The high school students' responses aligned with three different themes. Second, the responses from the scientists are more likely to align with the theme of scientist practice. Looking at the perceptions of a scientist from the high school students is an important component in this study.

4.2 Question 2 “What are some benefits you think high school students will have by working with scientists?”

The data analysis suggests the responses for question two, “What are some benefits you think high school students have by working with scientists?” can be categorized into four themes “future benefits” (inter-rater reliability: 99.21), “gain knowledge” (inter-rater reliability: 99.19), “gain experience” (inter-rater reliability: 99.65) and “changed perception” (inter-rater reliability: 99.33). Table 4 shows the response frequencies of different themes between high school students and scientists and examples of responses.

4.2.1 MEANING OF THEMES

The data analysis suggests the responses of high school students and scientists are categorized into the following. The first theme is “future benefits.” This theme is about how students will benefit in the future by being involved in the internship. The second theme is “gain knowledge.” “Gain knowledge” is about the students expanding their knowledge during the internship. The next theme is “gain experience.” This theme is about the student gaining real world experience as a scientist. The last theme is “changed perception.” This theme refers to the students having a changed perception of scientists and the science world.

4.2.2 KEYWORDS IN STUDENT AND SCIENTIST RESPONSES

Keywords and phrases were found that aligned with the four themes. Words such as “college”, “career” and “college applications” indicated “future benefits.” For the second theme of “gain knowledge,” words such as “learn” and “knowledge” aligned. Words such as “experience” and “real world experience” signified “gaining experience.” In the responses words such as “perception” and “right idea” indicated a “changed perception.”

Table 4. Responses for Question 2: What are some benefits you think high school students will have by working with scientists?

Theme	Student Examples	Scientist Examples
Future Benefits	L2AG: “I think it would make them understand more of what they're doing and it can help them in the long run in the future.”	L2CX: “I hope this program can attract more high school kids more willing to be a scientist or engineer”. L2MA: “Maybe in terms of research they can see what real research is like

	<p>1L2SG: “That they... they’ll see if they have an interest in becoming a scientist in their future.”</p> <p>1CAR: “They’ll see what it’s like in college.”</p>	<p>and maybe this is something they would want to do”.</p>
Gain Knowledge	<p>1L1EM: “Benefits ...Probably more knowledge I guess because you actually get to work with the professionals.”</p> <p>1L3LI: “Gain some experience by working with scientists and learn more than the actual science teacher”</p> <p>1L3LG: “Well, like expanding their knowledge, you know it's not gonna be limited to textbooks but you'll get perspective of other people that understand”</p>	<p>L1AO: “So I think, from working with an actual scientist, it would span their horizons as to what an actual scientist does and they’ll see that they can do it too”.</p> <p>L3AL: “I think they will. This will help a lot since, well when I started I didn't really know that much about research but now I, it's been like...in a couple of years I learned it It is really really important”.</p> <p>L1LJ: “Um, so you know, um the students may see exactly how science is done. You know in real life”.</p>
Gain Experience	<p>1L1OG: “Well one is like if they’re interested in that field they’ll get hands-on experience before the actually enter college”.</p>	

1L3AA: “Well... if you do want to
further your education on science
then... to start off early um, you get
more experience about it”.

1L2AM: You can get like hands on
college experience or environment
and then good teaching possibility I
feel like we are learning something,
getting something out of it”

Changed

Perception

L3WL: “That's one, and two is I think
the most beneficial thing is for them to
have right, um, idea”

L2CX: “I think they, for example, a
student who likes science is presented
like a nerd, presented like a weird
person. That need to be changed, I
feel”.

4.2.3 COMPARISON BETWEEN STUDENTS’ AND SCIENTISTS’ RESPONSES

This section displays a breakdown of the responses into the four themes. In some responses there are multiple themes that align. For the first theme of “future benefits” there was a total of 13 high school students’ and two scientists’ responses that aligned. In the next theme of “gain knowledge” there was a total of 20 high school students’ and six scientists’ responses aligning. The theme of “gain experience”

there was a total of seven high school students' and zero scientists' responses. The last theme of "changed perception" there was a total of zero high school students' and two scientists' responses that aligned. The frequencies for each theme are provided in the Table 5.

Table 5. Frequencies for Question 2: What are some benefits you think high school students will have by working with scientists?

Theme	Frequency (Percentage)	
	Students	Scientists
Future Benefits	13/46 (28.3%)	2/9 (22.2%)
Gain Knowledge	20/46 (43.4%)	6/9 (66.6%)
Gain Experience	7/46 (15.2%)	
Changed Perception		2/9 (22.2%)
Total participants	46 (100%)	9 (100%)

Looking at Figure 2 the high school students aligned with three themes and the scientists also aligned with three themes. The themes of "future benefits" and "gain knowledge" had both high school students and scientists align. For the theme of "gain experience" only high school students had responses that aligned. For the last theme of "changed perception" only scientists had responses that aligned.

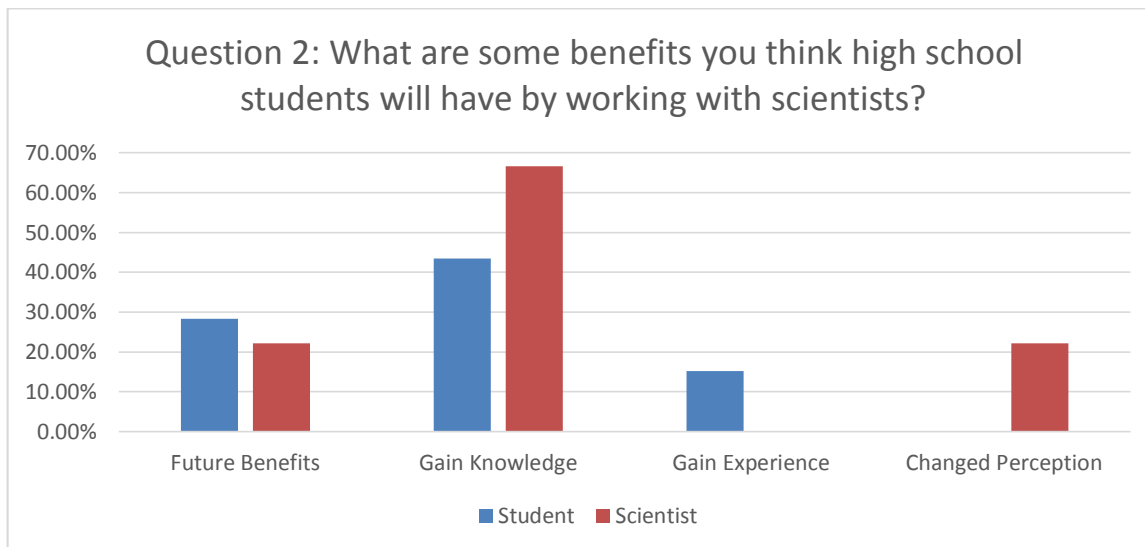


Figure 2. Comparison between student and scientist responses for question 2.

4.2.4 SUMMARY OF RESULTS FOR QUESTION TWO

While observing the results of question two, some similarities arise. Both high school students and scientists are more likely to align in the themes of “gain knowledge” and “future benefits”. The high school students and scientists had responses that aligned with both themes as shown in Table 5. Looking at the highest frequencies, it is evident that the theme of “gain knowledge” is the highest for both high school students and scientists. It can be said that both high school students and scientists are more likely to be in agreement with “gain knowledge” as an important benefit. When studying the benefits that were discussed from high school students and scientists it is clear that these benefits are attainable. Since these benefits are attainable, a student-scientist partnership can possibly be successful.

4.3 Question 3 “What are some obstacles you think high school students will have by working with scientists?”

The data analysis suggests the responses for question three, “What are some obstacles you think high school students will have by working scientists?” can be categorized into three themes, “knowledge gap” (inter-rater reliability: 98.05), “time conflict” (inter-rater reliability: 99.8) and “workload” (inter-

rater reliability: 99.77). Table 6 displays the response frequencies of different themes between high school students and scientists.

4.3.1 MEANING OF THEMES

The data analysis suggests the responses of high school students and scientists can be categorized as follows. The first theme is “knowledge gap.” “Knowledge gap” refers to the scientist and high school student not being able to communicate efficiently because of the scientists’ further knowledge. The second theme is “time conflict.” “Time conflict” is about the students having extra activities outside the internship that could interfere with the students’ progress. The last theme “workload” describes students’ fear of how much work they will need to do in the internship.

4.3.2 KEYWORDS IN STUDENTS AND SCIENTIST RESPONSES

Keywords and phrases were found that aligned into the two themes. Words such as “keeping up,” “understanding,” and “communicating” signaled “knowledge gap”. In the second theme of “time conflict,” words such as “personal life,” “sports,” “job,” and “extracurricular activities” aligned. Words such as “work,” “amount,” and “hard” demonstrate “workload”.

Table 6. Responses for Question 3: What are some obstacles you think high school students will have by working with scientists?

Theme	Student Examples	Scientist Examples
Knowledge Gap	1L3LG: “S: Probably keeping up with scientists. I: Can you elaborate? S: Well, scientists know a lot of science, but then high school students don’t generally know that much about science.”	L1LJ: “Um, so the students might ah, have some difficulty ah working in the lab because I don't think they have a lot of experience working in a lab”.

	<p>1L4BQ: “Obstacles... Maybe understanding, understanding because to me I feel like it is going to be higher um... Higher education so it’s going to be much more difficult so”.</p> <p>1L2SG: That scientists sometimes use to... um to big of words. Big words that probably high school students are not going to understand or the instrument that the scientist used”.</p>	<p>L4AA“Communication gap I believe. Like, let’s say so a system design, and then I expect someone to know what a system design is.”</p> <p>L2CX: “Another thing is math. I think that in the United States mathematics training is very weak. Even at the college level I see that students even don't know a lot so that's uh, may be a concern”.</p>
Time Conflict	<p>1L4MC: “I believe they would gather of some obstacles like students personal life”</p> <p>1L3CC: ...especially if they’re in sports; they will sometimes have games on Saturdays while there’s going to be school, so that can be one problem..”</p> <p>1L2AG: “Oh, um by like just the timing and how they have other curricular activities but, that's just it, just the timing”.</p>	<p>L3WL: “So, if you think about their lives, they have school, they will have any, uh, some, uh extra-curricular activities. I know some play sports”.</p>

Workload	<p>1L2AM: “Lot of the work. I hear there can be a lot of work and lot of people are lazy and aren’t willing to do it”.</p> <p>1L4EA: “All the work, they’re not use to working”.</p> <p>1CJM: “Umm maybe the amount of work they might need to do, how hard the curriculum might actually be”.</p>
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4.3.3 COMPARISON BETWEEN STUDENTS’ AND SCIENTISTS’ RESPONSES

In this section the responses are broken down into each theme. In some responses there are multiple themes that align. For the first theme of “gain knowledge,” there is a total of 25 high school students’ and five scientists’ responses that align. In the theme of “time conflict,” there is a total of five high school students’ and one scientist’s responses that correlate. In the last theme five high school students and zero scientists’ responses align. The frequencies for each theme are provided in Table 7.

Table 7. Frequencies for Question 3: What are some obstacles you think high school students will have by working with scientists?

Theme	Frequency (Percentage)	
	Students	Scientists
Knowledge Gap	25/46 (54.3%)	5/9 (55.5%)
Time Conflict	5/46 (10.9%)	1/9 (11.1%)
Workload	5/46 (10.9%)	
Total participants	46 (100%)	9 (100%)

Looking at Figure 3 below it is apparent that the high school students and scientists were in agreement with the first theme of “knowledge gap”. In the second theme of “time conflict” both parties are also in agreement with this obstacle. The last theme “workload,” had only high school students responses align. For the high school students, the highest frequency is “knowledge gap”. The highest frequency for the scientists is also “knowledge gap”.

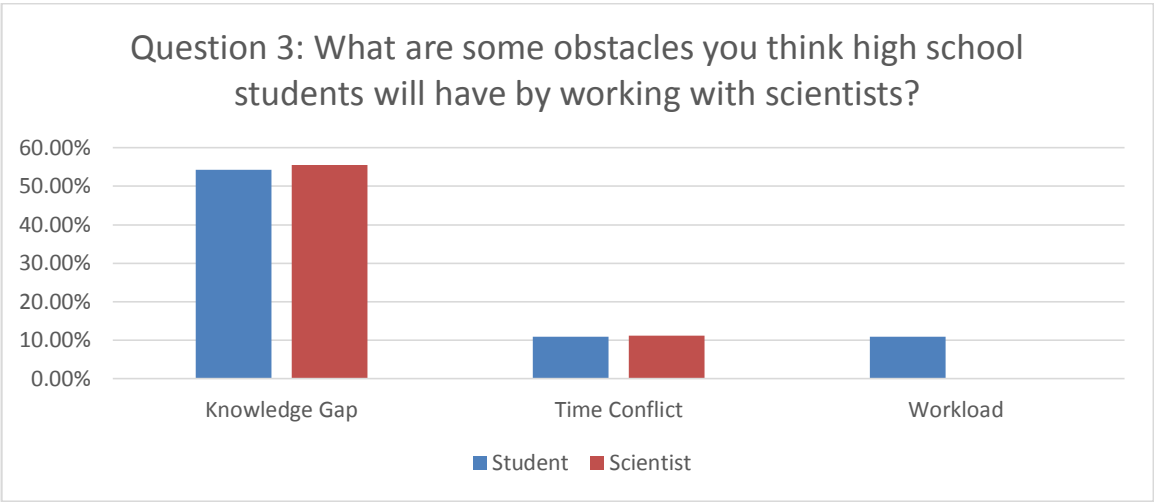


Figure 3. Comparison between student and scientist responses for question 3.

4.3.4 SUMMARY OF RESULTS FOR QUESTION THREE

Looking at the responses for question three, some similarities occur. First, high school students and scientists are more likely to align with the themes of “knowledge gap” and “time conflict”. The highest frequencies for both high school students and scientists align with the theme of knowledge gap as shown in Table 8. Allen, Howell and Radford (2013) discuss what some factors that make a partnership successful are. One of the factors that they found is communication. Another factor that can create a successful partnership is having flexibility with the students schedule (Allen & Howell & Radford, 2011). Both obstacles that were discussed by high school students and scientist can be solved in order for a partnership to be successful.

4.4 Question 4 “What are some benefits you think scientists will have by working with high school students?”

The data analysis suggests the responses for question four, “what are some benefits you think scientists will have by working with high school students?” can be categorized into four themes of “understanding students’ backgrounds” (inter-rater reliability: 99.45), rewarding experience (inter-rater reliability: 99.58), “pedagogical skills” (inter-rater reliability: 99.18) and “inspire students” (inter-rater reliability: 99.67). Table 8 will show the response frequencies of different themes between high school students and scientists.

4.4.1 MEANING OF THEMES

The data analysis suggests the responses can be categorized into the following themes. The first theme is “understanding students’ backgrounds.” “Understanding students’ backgrounds” refers to the scientists learning about how high school students think and learn. The second theme is “rewarding experience.” “Rewarding experience” is about how the scientist will feel about helping high school students. The third theme is “pedagogical skills.” “Pedagogical skills” is about the scientists gaining more efficient teaching skills by being challenged to teach high school students. The last theme is “inspire students.” “Inspire students” is the scientists hoping that the students will want to become scientists in the future.

4.4.2 KEYWORDS IN STUDENT AND SCIENTIST RESPONSES

Keywords and expressions were found that aligned with each theme. Words such as “learn,” “knowledge,” and “high school student” point out “understanding students’ backgrounds”. Words such as “help,” “teach,” and “feel good” demonstrate “rewarding experience”. For the third theme of “pedagogical skills” words such as “learn”, “better,” and “teach” aligned. For the last theme of “inspire students” words like “future,” “inspire,” and “teach” aligned.

Table 8. Responses for Question 4: What are some benefits scientists will have by working with high school students?

Theme	Student Examples	Scientist Examples
Understanding Students' Backgrounds	<p>1L3ZC: "I think they, I think they would figure out how like the young mind learns, so like they". Can like teach it better and be like able to teach them more.</p> <p>1CAA: "They probably get to know, like, our knowledge, and how we work and they might learn new stuff that they didn't know".</p> <p>1CYF: "They get to see how we learn and how we how we umm how we learn and and how we get the material and what we like and we don't like and how we learn better when one things and another thing".</p>	<p>L3WL: "We'll get to know our student source of better because many of our student are coming from local high schools".</p> <p>L4AA: Maybe we will have fun.</p> <p>Maybe you get a new perspective on how students think".</p>
Rewarding Experience	<p>1L2MR: "They'll have, they will feel good about themselves by teaching newer kids that actually want to learn and do something with their lives to get them up there to that certain level that they want to be".</p>	

1L1JG: “umm..... It would give
them a chance to teach so and give
them more knowledge the
knowledge they don’t know. I think
it would help them to feel good
about themselves”.

1CMB: “They are going to, well
they’re going to feel good by
helping other people so they could
probably want to work with them.”

Pedagogical
Skills

L2CX: “So maybe this will also give
me a sense how to, teach ...how to,
especially high school.”

L1LJ: “Um, and you know just
working with high school students
they give me ideas, you know. How
to, you know I teach class, I teach soil
classes. I teach environmental classes.
So you know, um, working with high
school students helped me with work
with my college students you know”.

L3WL: “So now uh, in a different
audience we have to talk to them in
different language. Sort of right? So

	<p>it's sort of training our brain how to</p> <p>explain science from a different</p> <p>perspective right?"</p>
Inspire Students	<p>L1LJ: "So I hope you know, um, they can see what exactly Geology is, you know. They have this experience and hopefully you know they will become Geologists in the future".</p> <p>L2MC: "Well for me I'll be able to teach them and hopefully inspire them to become scientist themselves because I went through that".</p>

4.4.3 COMPARISON BETWEEN STUDENTS' AND SCIENTISTS' RESPONSES

In this section each response is divided into each theme. In some responses there are multiple themes that align. For the first theme of "understanding students' backgrounds," there is a total of 23 high school students' and two scientists' response that lines up. The second theme of "rewarding experience" has a total of six high school students' and zero scientists' responses that align. The third theme of "pedagogical skills" has a total of zero high school students' and three scientists' responses that are aligning. The last theme of inspire students had zero high school students and two scientists' responses aligned. The frequencies for each theme are provided in Table 9.

Table 9. Frequencies for Question 4: What are some benefits scientists will have by working with high school students?

Theme	Frequency (Percentage)	
	Students	Scientists
Understanding Students' Backgrounds	23/46 (50%)	2/9 (11.1%)
Rewarding Experience	6/46 (13%)	
Pedagogical Skills		3/9 (55.5%)
Inspire Students		2/9 (22.2%)
Total participants	46 (100%)	9 (100%)

While examining question 4, “what are some benefits you think scientists will have by working with high school students?” the high school students and scientists did not have similar responses. The high school students aligned with the themes of “understanding students’ backgrounds” and “rewarding experience.” The scientists aligned with the themes of “understanding students’ backgrounds,” “pedagogical skills,” and “inspire students.” For the high school students, the highest frequency is “understanding students’ backgrounds.” The highest frequency for the scientists is “pedagogical skills.” All of this can be seen in Figure 4.

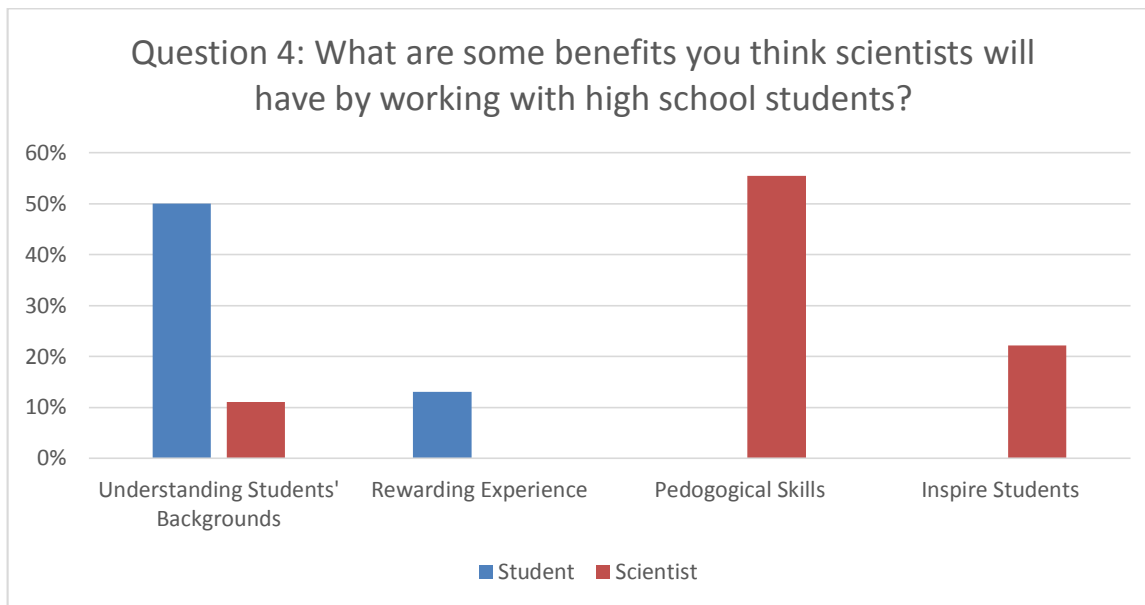


Figure 4. Comparison between student and scientist responses for question 4.

4.4.4 SUMMARY OF RESULTS FOR QUESTION FOUR

In question four, there are differences in the responses for the high school students and scientists. First, the high school students are more likely to align with the theme of understanding students backgrounds. Second, scientists are more likely to align with the theme of pedagogical skills. The highest frequency for the high school students is “understanding students’ backgrounds”. The highest frequency for scientists is “pedagogical skills.” By looking at Figure 4 the researcher can see that the high school students and scientists are in disagreement on the benefits for scientists. When studying the benefits that were discussed from high school students and scientists it is clear that these benefits are attainable. Since these benefits are attainable, a student-scientist partnership can possibly be successful.

4.5 Question 5 “What are some obstacles you think scientists will have by working with high school students?”

The data analysis suggests the responses for question five, “What are some obstacles you think scientists have by working with scientists?” can be categorized into three themes “student behavior”

(inter-rater reliability: 99.32), “knowledge gap” (inter-rater reliability: 98.05) and “time conflict” (inter-rater reliability: 99.8). Table 10 will show the response frequencies of different themes between high school students and scientists.

4.5.1 MEANING OF THEMES

The data analysis suggests the responses can be categorized into three different themes. The first theme is “student behavior.” “Student behavior” refers to how the students’ actions can be an obstacle for scientists. The second theme is “knowledge gap.” “Knowledge gap” describe scientists having a hard time teaching high school students because they don’t have the knowledge. The last theme is “time conflict.” “Time conflict” insinuates that students and scientists might have extra activities to attend to.

4.5.2 KEYWORDS IN STUDENT AND SCIENTIST RESPONSES

Keywords and phrases were found that aligned with each theme. For the first theme of “student behavior,” words such as “immature” and “lazy” imply “student behavior”. Words such as “impatient” and “frustration” denote “knowledge gap.” Words such as “activities” and “job” align with “time conflict.”

Table 10. Responses for Question 5: What are some obstacles scientists will have by working with high school students?

Theme	Student Examples	Scientist Examples
Students Behavior	1L4CF: “S: Immaturity. I:	L4BT:” Teenagers the in terms of
	Immaturity? Can you elaborate that?	behavior is not that mature”.
	S: May be like messing around. Not being on time”.	L3AL: “I think the main obstacle would be that sometimes they can be kind of lazy, but if they like it they will like help.”

	<p>1CEV: “They might not follow directions and they might do something wrong”.</p> <p>1L2CE: “Students, high school students are very... Sometimes they get distracted very easy or its we’re procrastinators and usually put things off”.</p>	<p>L1AO: “Oh, well most of the time, because they are younger, and a little more immature, so it’s a definite obstacle.”</p>
Knowledge Gap	<p>1L1CZ: “Like getting frustrated Like we are not as smart as them or we are not as their level they'll have to break it down or try to repeat themselves to help us out to learn more”.</p> <p>1L2LV: “Oh. By understanding what the scientist is talking about because they use bigger words that they need to teach the students”.</p> <p>1CLM: “I guess the same , they will have to explain some things that we might not be able to like to like well for them like it’s not hard but for the students maybe it is”.</p>	<p>L3WL: “Even though it's by default they may not know that, but w-, we're not used to this level at all, right?”</p> <p>L1LJ: “Um, um, you know maybe there's you know there's gap between me thinking about things and how they do things, you know? Like I can plan things in my way, but they might be learning it different way.”</p> <p>L2MA: “Mmm maybe it will either a... uh maybe the knowledge gap in between high school and college, so I think that will be an issue.”</p>

Time Conflict	<p>L3WL: “So, if you think about their lives, they have school ...uh extra-curricular activities.”</p> <p>L2CX: “Maybe time. So, because we to do research. We do the service. We have a lot of other obligations we need to fulfill. So, I don't know how much time we can really spend on those high school kids”.</p>
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4.5.3 COMPARISON BETWEEN STUDENTS’ AND SCIENTISTS’ RESPONSES

In this section the responses were broken down into each theme. In some responses there are multiple themes that align. In the first theme of “student behavior” had a total of 15 high school students’ and three scientist responses that correlated. The next theme of “knowledge gap” had a total of 19 high school students’ and four scientist responses. The last theme of “time conflict” had zero high school students and two scientists who aligned. The frequencies for each theme are provided in Table 11.

Table 11. Frequencies for Question 5: What are some obstacles scientists will have by working with high school students?

Theme	Frequency (Percentage)	
	Students	Scientists
Students Behavior	15/46 (32.6%)	3/9 (33.3%)
Knowledge Gap	19/46 (41.3%)	4/9 (44.4%)
Time Conflict		2/9 (22.2%)

Total participants	46 (100%)	9 (100%)
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While observing the figure below high school students and scientists only agree with the first theme of student behavior. For the second theme of knowledge gap both parties had the highest frequencies. In the third theme of time conflict only scientists had responses that aligned. All of this can be seen in Figure 5.

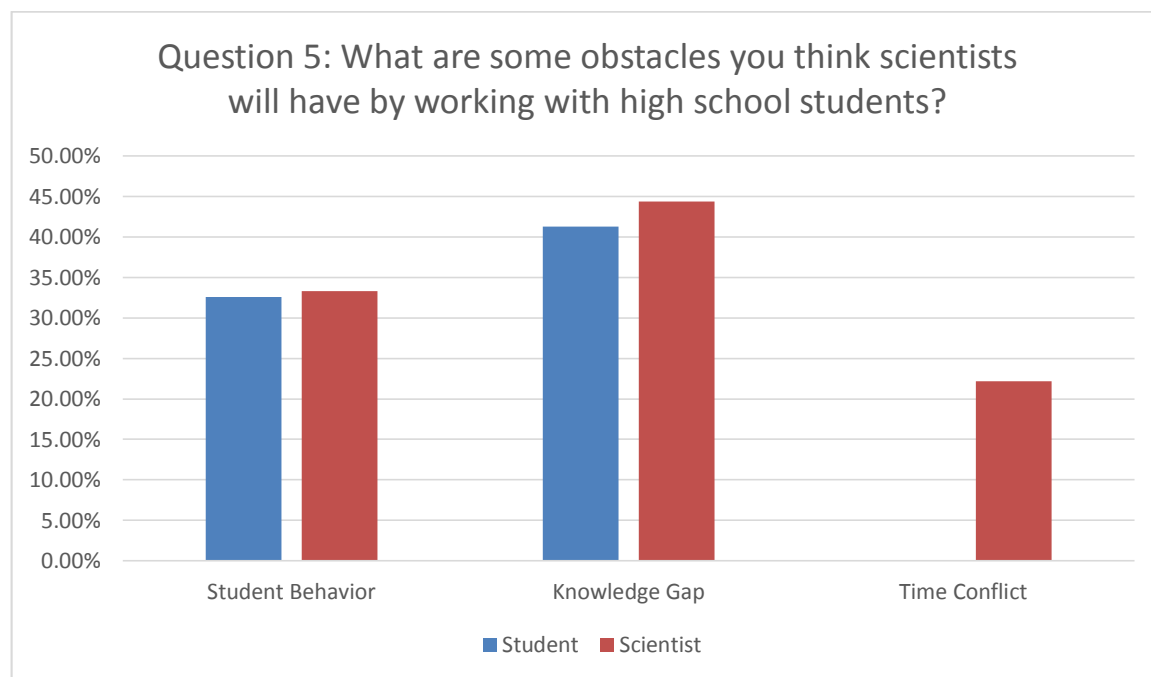


Figure 5. Comparison between student and scientist responses for question 5.

4.5.4 SUMMARY OF RESULTS FOR QUESTION FIVE

For question five there are some similarities in the responses between the high school students and scientists. First, the scientists are more likely to align with the theme of knowledge gap. The theme of knowledge gap was the highest frequency for the scientists when compared to the other themes. The high school students are more likely to align with the theme of knowledge gap. This theme of knowledge gap has the highest frequency for the high school students in comparison to the other themes. After looking at the similarities it is evident that both high school students and scientists agree with the

theme of knowledge gap with being an important obstacle for the scientist. Allen, Howell and Radford (2011) discuss communication as being an important component in a successful partnership. Both themes of “knowledge gap” and “student behavior” require excellent communication. Both obstacles can be solved to make a partnership successful.

4.6 Question 6 “What would be the best relationship between high school students and scientists?”

The data analysis suggests the responses for question six, “What would be the best relationship between high school students and scientists?” can be categorized into three different themes “personal relationship” (inter-rater reliability: 99.74), “mentor relationship” (inter-rater reliability: 99.49) and “collaboration” (inter-rater reliability: 99.7). Table 12 will show the response frequencies of different themes between high school students and scientists.

4.6.1 MEANING OF THEMES

The data analysis suggests the responses can be categorized into two themes. The first theme is “personal relationship.” A “personal relationship” is about building a personal relationship during the internship. The second theme is “mentor relationship.” “Mentor relationship” is strictly the scientist being a mentor to the high school student. The last theme is “collaboration.” “Collaboration” describes a relationship where the high school students and scientists can work and learn efficiently together.

4.6.2 KEYWORDS IN STUDENT AND SCIENTIST RESPONSES

Keywords and expressions were found that aligned with each theme. For the first theme of personal relationship, words such as “friend,” “comfortable,” and “get along” show interpersonal

relationship building. Words such as “mentor” and “guide” describe a mentor relationship. Words such as “together,” “both,” and “learn” infer a collaboration.

Table 12. Responses to Question 6: What would be the best relationship between high school students and scientists?

Theme	Student Examples	Scientist Examples
Personal Relationship	<p>1L2CE: “Um.... It would be like a teacher that’s a friend as well can learn but also have a good relationship with them”.</p> <p>1L2IR: “Like that communication. Maybe friendship where like, like have, have a, like a... Like get to know them I guess”.</p> <p>1L2AM: Friendly relationship. They can get along, to be like, be on the same page all the time</p>	<p>L3AL: “I think, well, respect first of all, on both sides, since, I mean teenagers they just want to be like treated as adults, which they are not, but yeah if you just, you have to be like make them trust you, like, so they can feel, or they can tell you anything.”</p>
Mentor Relationship	<p>1L1MA: “I think like a mentor, someone that can teach me more and help me um understand what science really is and um like inspire me to get into science and stuff”.</p>	<p>L2CX: “I hope I can be a long term mentor, to guide them to a same field.”</p> <p>L4BT: “Umm.... I think the uh, you know, you could be like uh mentor and disciple that kind of uh relationship.”</p> <p>L3WL: “I don't, I don't, um, I don't plan to become their, their</p>

	friend. No. That's not my goal. I do, however, want to become their mentor”.
Collaboration	<p>1L2DB: “The projects that they make because both of them are gonna learn, as a scientist gonna learn by knowing how to treat a high school student, as a high school student is gonna learn new stuff”.</p> <p>1L3ZC: “I I I mean like, I think like it would be like doing experiments together, learning together and talking and something like that.”</p> <p>1L2LV: “One where they talk with each other to see how much we know and then how much scientist knows by teaching each other”.</p>

4.6.3 COMPARISON BETWEEN STUDENTS’ AND SCIENTISTS’ RESPONSES

In this section all the responses were broken down into each theme. In some responses there are multiple themes that align. The first theme “personal relationship” has a total of 19 high school students’ and two scientists’ responses. The second theme “mentor relationship” has a total of seven high school students and six scientists’ responses. The third theme of “collaboration” has eight high school students and zero scientists’ responses. The frequencies for each theme are provided in Table 13.

Table 13. Frequencies for Question 6: What would be the best relationship between high school students and scientists?

Theme	Frequency (Percentage)	
	Students	Scientists
Personal Relationship	19/46 (41.3%)	2 (22.2%)
Mentor Relationship	7/46 (15.2%)	6 (66.6%)
Collaboration	8/46 (17.4%)	
Total participants	46 (100%)	9 (100%)

While studying Figure 6, it is clear that the responses of high school students are mixed. In the first theme of “personal relationship” the high school students had more responses for this relationship than the scientists. The highest frequency for the scientists is a “mentor relationship.” For the high school students, the highest frequency is “personal relationship.”

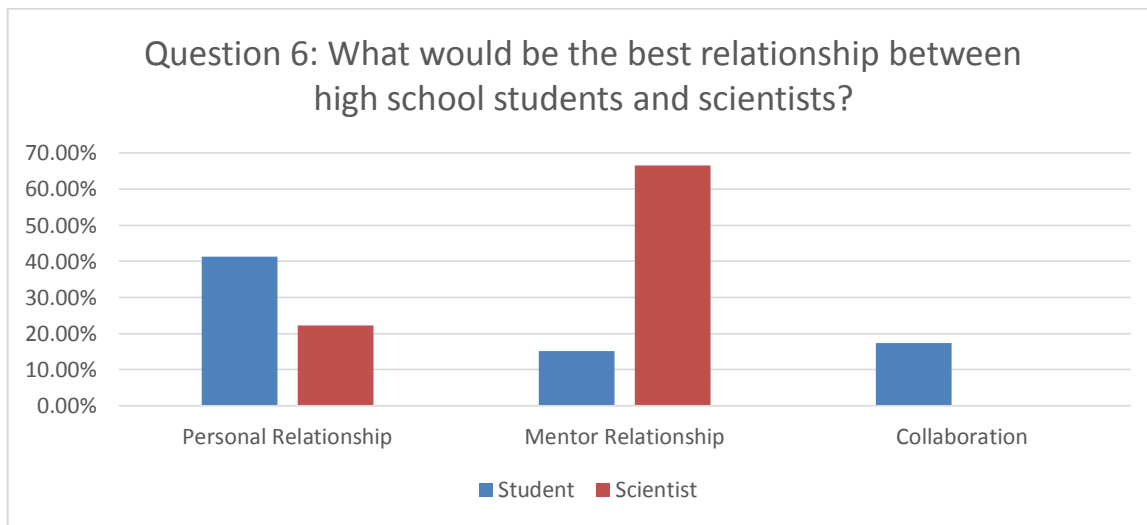


Figure 6. Comparison between student and scientist responses for question 6.

4.6.4 SUMMARY OF RESULTS FOR QUESTION SIX

When looking at question six, it is evident that are differences in the responses between high school students and scientists. First, the high school students are more likely to align with the theme of

“personal relationship.” The theme of “personal relationship” had the highest frequency for the high school students in comparison to the other themes. Second, the scientists are more likely to align with the theme of “mentor relationship.” The theme of “mentor relationship” is the highest frequency for the scientists when compared with the other themes. After looking at these differences it is evident that the high school students and scientists disagree about what type of relationship that they want. Radermacher (2011) discusses what it takes to make a health partnership successful. The success of a partnership can depend on the relationship between the individuals involved. Since the high school students and scientists have different opinions on what type of relationship they want, this can cause an unsuccessful partnership. This can be addressed when creating a student-scientist partnership in the future.

4.7 Question 7 “Could you give me a metaphor for this relationship?”

The data analysis suggests the responses for question seven, “Could you give me a metaphor for this relationship?” can be categorized nine different themes “student-teacher based” (inter-rater reliability: 99.81), “parent-child based” (inter-rater reliability: 99.91), “sibling based” (inter-rater reliability: 99.99), “hero based” (inter-rater reliability: 100), “coach-player based” (inter-rater reliability: 99.78), “friendship based” (inter-rater reliability: 99.73), “garden based” (inter-rater reliability: 99.96), “couple based” (inter-rater reliability: 99.99) and “collaboration based” (inter-rater reliability: 99.8). Table 14 will show the response frequencies of different themes between high school students and scientists.

4.7.1 MEANING OF THEMES

The data analysis suggests the responses can be categorized into the following themes. The first theme is “student-teacher based”. A “student-teacher based” metaphor describes the scientist being a teacher and the high school students being the student. A “parent-child based” metaphor describes the

teacher being the parent and the student being the child. A “sibling based” metaphor describes the scientist and high school students being brother and sister. A “couple based” metaphor describes a relationship between husband and wife or girlfriend and boyfriend. A “collaboration based” metaphor describes the scientists and high school students working together. A “friendship based” metaphor describes the scientist and students being comfortable with each other and having a friendship. A “garden based” metaphor refers to comparing a relationship with a scientist and student to garden being nurtured. A “coach-player based” metaphor refers the scientist to being a coach and the student being a player. A “hero based” metaphor refers to the scientist being a hero.

4.7.2 KEYWORDS IN STUDENT AND SCIENTIST RESPONSES

In this particular question, keywords were not looked at to align with a theme. The explanation of each metaphor is what was examined to determine which theme aligned with it. Examples of a student-teacher based metaphor are “mentor” and “student and teacher”. Examples of a parent-child metaphor are “parent and son” and “kangaroo with its baby”. Examples of a sibling based metaphor is “brother and sister”. Examples of a couple based metaphor is “husband and wife” and “boyfriend and girlfriend.” Examples of a collaboration based metaphor are “partnership” and “working united”. Examples of a coach-player metaphor is “football team” and “coach and player”. Examples of a garden based metaphor is “you spread a lot of seeds and add water”. A hero based example is “superman and janitor”. A friendship example is “peanut butter and jelly”.

Table 14. Responses for Question 7: Could you give me a metaphor for this relationship?

Theme	Student Examples	Scientist Examples
Student-Teacher Based	1L1JG: “Like a mentor.”	L2CX: “Very hard. (laughs) I
	1CEV: “A scientist teaching a student.”	think it's a mentor, mentee relationship, right? So, I don't

	<p>1L3LI: “So you say scientists are teachers are a guide.”</p> <p>1L3LG: “Just like teacher and student.”</p> <p>1L3LP: “Probably a professional relationship because they had to teach you something and you should respect.”</p> <p>1CCR: “Those two or more currents in the ocean. Well I mean actually the scientist teach students and the students understand exactly what they say, they’ll understand each other perfectly.”</p>	<p>know what other thing I can metaphor, said a metaphor that.</p> <p>I'm not terribly [inaudible 00:11:55] so I'm not good at that.”</p>
Parent-Child Based	<p>1L2LV: “So the high school students are like kittens and the scientist is like the mom.”</p> <p>1L4JJC: “I guess It could be like as a father and a son.”</p> <p>1CLM: “Probably like a parent with the with the child,</p>	<p>L1AO: “A kangaroo with her baby.”</p> <p>L3WL: “Um, let me see. Um, it's more like ... How should I say? (Clicks tongue) Uh, what first come into my mind is this. I remember one time I was watching discovery channel,</p>

teaching them stuff for the
future.”

okay, and this is a, a clip where,
um, they film, um, what's it
called? Um, is it condor? Bird, a
big bird. Okay. It's teaching how
to help the little bird to fly.
Okay. So, so, what I remember
was that when the mother bird
sort of realized the little bird is
ready, she just grabbed the little
bird, okay, and then fly out, and
then dropped the baby bird. And
the baby bird will have to fly,
you know. But the mother is
[00:32:00] like right there. So in
other words, if the big bird
wouldn't fly, the mother bird
will go in and grab it. Grab it
out.”

Sibling Based

1CJR: “OK, umm mm they
can grow to know each other
like brother and sister.”

1CYF: “That the student and
scientists act like brother and
sister.”

Couple Based	<p>1L3LA: “Like boyfriend and girlfriend, you guys love each other.”</p> <p>1CEA: “Get along like husband and wife.”</p>	
Garden Based	<p>1L2DB: “That high school students are like a plant that you need to nurture with all the knowledge of science.”</p>	<p>L4BT: “So you spread a lot of seed, you add waters, you uh take care of those the seeds and, you know, um you take care of them every single day.”</p>
Hero Based	<p>1L3DG: “Okay, I think our relationship is going to be like Superman and a janitor.”</p>	
Friendship Based	<p>1L3JS: “Cause friends stay... they’re always together they always talk to each other.”</p> <p>1L3AA: “Peanut butter and jelly. Why peanut butter and jelly? Because they stick together.”</p> <p>1CAH: “Like peanut butter and jelly. Peanut and butter why is that? Because they stick together.”</p>	<p>L4AA: “Like, uh... I would say like a relationship between friends.”</p> <p>L2MC: “Umm well the best thing is like me and my mentor like just like kind of a friendship, but not too close, just like... like I said like they could see me for how like kind of not panic, but like you know ummm... comfortable like I</p>

	1L2NDLS: “Well ok a scientist and the student work together like, like two playful kittens; curious.”	don’t know how to answer that. Ummm... I guess... I don’t know like your favorite teacher (jokes and laughs), that’s the only thing I can think of.”
	1L4MC: “Children are having... Children are playing... The children are sharing their toys they can have more fun.”	

Coach-Player Based

1L4CF: “I guess kind of like karate kid, student master, like Mr. Miyagi.”

1L2MR: “Football team; Because in a football team they usually, on an offence they try to communicate with each other to get with the coach. Like the coach wants to know about the star player or teach the star player or teach everybody else what they want to, in other words. To come together and be a championship team.”

1L1EM: “Probably like a
coach and his player.”

1L1OG: “It would be like a
master to his apprentice.”

Collaboration Based

1L4BQ: “Maybe walking
together because I mean that
trying to teach each other and
we’re trying to learn so it is
going to be combined so.”
1L3CC: “Um... I guess, would
be partner...I think partnership
though.”

1L2IR: “Work United.”

1CJM: “Probably... (Pause)
two minds being linked
together in learning could be
as effective as any kind of
experiment.”

1CAA: “Scientists and umm I
don’t know um scientist and
the student communicate like
when in a concert.”

L2MA: “The students and
professor are.”

4.7.3 COMPARISON BETWEEN STUDENTS' AND SCIENTISTS' RESPONSES

In this section all of the responses were broken down into each theme. In some responses there are multiple themes that align. For this specific question only 36 high school students had a response. After follow up questions and examples some students were not able to come with a metaphor. All 9 scientists had a response to this question. For the first theme of “student-teacher based” there is a total of six high school students’ and one scientist responses aligned. The second theme of “parent-child based” has a total three high school students’ and two scientists’ responses. The third theme of “sibling based” has a total of two high school students’ and zero scientists’ responses. The fourth theme of “couple based” has a total of two high school students’ and zero scientists’ responses. The fifth theme of “collaboration based” has a total of five high school students’ and one scientists’ responses. The six theme of “garden based” has a total of one high school student and one scientist responses. The seventh theme of “hero based” has a total of one high school student and zero scientists’ responses. The eighth theme of “friendship based” has a total of five high school students’ and two scientists’ responses. The ninth theme of “coach-player based” has a total of four high school students’ and zero scientists’ responses. The frequencies for each theme are provided in Table 15.

Table 15. Frequencies for Question 7: Could you give me a metaphor for this relationship?

Frequency (Percentage)		
Theme	Students	Scientists
Student-Teacher Based	6 (16.7%)	1 (11.1%)
Parent-Child Based	3 (8%)	2 (22.2%)
Sibling Based	2 (5.6%)	
Couple Based	2 (5.6%)	
Garden Based	1 (2.8%)	1 (11.1%)

Hero Based	1 (2.8%)	
Friendship Based	5 (13.9%)	2 (22.2%)
Coach-Player Based	4 (11.1%)	
Collaboration Based	5 (13.9%)	1 (11.1%)
Total participants	36 (100%)	9 (100%)

While looking at the figure below we can see that both high school students and scientists are not in agreement. The highest frequency for the high school students is the theme of student-teacher based. For the scientists, the highest frequency is parent-child based and friendship based. All of this can be seen in figure 7.

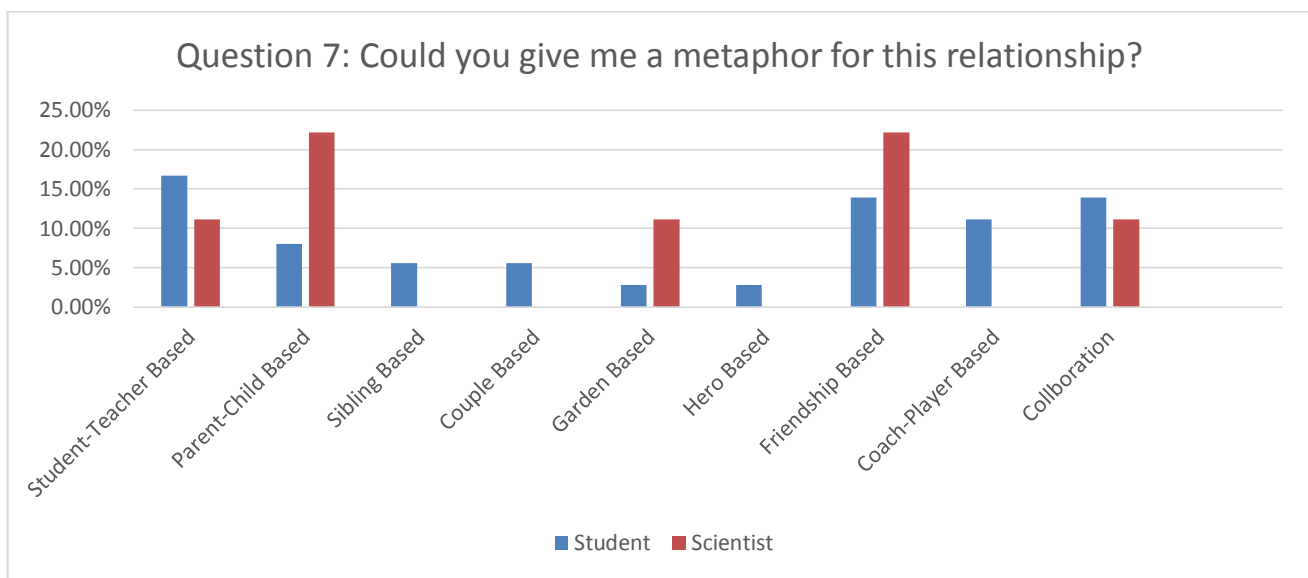


Figure 7. Comparison between student and scientist responses for question 7.

4.7.4 SUMMARY OF RESULTS FOR QUESTION SEVEN

For question seven there are differences in the responses for the high school students and scientists. First, the high school students are more likely to align with the theme of student-teacher based. For the scientists, the highest frequency is parent-child based and friendship based. Allen, Howell

and Radford (2011) discuss communication as being an important component in a successful partnership. If high school students see themselves as not equal to the scientists then this can make them feel inferior. This could possibly hinder the high school students from asking questions and sharing ideas. The results from this question can give an insight into what high school students and scientists are thinking and make improvement for student-scientist partnerships.

5. Discussion

The purpose of this study is to understand high school students and scientist perceptions of a student-scientist partnership. The high school students and scientists were interviewed individually. During the interviews, follow up questions were asked to enhance their responses. Each question and response were analyzed using thematic analysis. Every question had themes that were formed from the responses.

When examining question one, “What does a scientist mean to you?” it is evident that there is a distinct difference between scientists and high school students’ responses. The high school students have different ways to express what a scientist means to them. The themes that aligned with the high school students responses are “attire,” “required knowledge and skill,” and “scientist practice.” High school students have only been exposed to a classroom setting and this could possibly explain their different ways of describing a scientist. Moscovici (1984a) discuss that our perceptions are influenced by the stimuli in our environment. The media portrays scientists as very intelligent and always wearing a lab coat. Since the high school students have been exposed to this image of a scientist, this is what comes to mind when they describe a scientist. During a student-scientist partnership the high school students’ ideas might change and could inspire students to go into the science field. Many articles suggest that having high school students work with scientists can promote science knowledge and careers in science (Abraham, 2012; Clendening, 2004; Pegg, Schmook & Gummer, 2010).

When exploring question two, “What are some benefits high school students can have by working with scientists?” it is clear that the high school students and scientists have agreeing responses. By asking this question the researcher is wondering what the high school students are wanting gain by being in a partnership with a scientist. If the benefits are attainable, then there is a possibility for a successful partnership. The high school students responses were categorized into three themes: “future benefits,” “gain knowledge,” and “gain experience.” The scientists’ responses were categorized into three themes: “future benefits,” “changed perception” and “gain knowledge”. Since these high school students are in their junior year, they are constantly thinking about their future since they are graduating soon. On the other hand scientists seem to be really invested in the future of these students to help and guide them along the way. Both participants also used gain knowledge in their responses. It is clear that the students were hoping to gain more knowledge about science and what a scientist does for a career. The scientists also showed that they want the students to gain knowledge of science and have an accurate perception of a scientist. When students were talking about gaining knowledge, they would mention how it would help get them into a college that they wanted. They also showed that they were excited to gain this type of experience and of them being considered a scientist. Research has shown that these benefits have been attained through a student-scientist partnership (Abraham, 2012). If the high school students are able to attain these benefits then it is likely for them to have a positive experience. In turn, they will tell other students about their positive experience and hopefully recruit more students to join in a student-scientist partnership. Therefore having more high school students being exposed to authentic science.

When analyzing question three, “What are some obstacles high school students will have by working with scientists?” it is clear that the high school students and scientists have similar responses. By asking this question the researcher is wondering what type of obstacles the high school students can come across during a partnership. If the obstacles can be solved then a partnership can possibly be

successful. For high school students and scientists, their responses were categorized into three themes: “knowledge gap,” “workload,” and “time conflict”. High school students showed a concern about the amount of work they would be doing and if they could handle the workload. High schools students also explained that since they are only juniors in high school they would have a hard time understanding the scientists. There is a possibility that the high school students wouldn’t feel confident asking the scientists for help. The scientists communicated that they are used to working with graduate students and that it would be difficult to work with high school students because of their lack of knowledge. One component that makes a partnership successful is communication (Allen, Howell & Radford 2011). Both high school students and scientists explained that communication would be an issue. This issue can be addressed by having the scientist gain trust with the students and show that they care about their progress. Analyzing the second theme, high school students mentioned that a lot of them had jobs or were in extra-curricular activities. The scientists also suggested that the students could have other obligations that could get in the way of the internship. The scientists really wanted the students to be fully engaged in the internship. Another element in a successful partnership is having a flexible schedule (Allen, Howell & Radford 2011). This issue can be resolved by having a schedule that works well for the high school students. The schedule should take into account students jobs and extra-curricular activities. When designing a student-scientist partnership these obstacles can be taken into account to make sure the internship is a success.

After evaluating question four, “What are some benefits scientists will have by working with high school students?” it is noticeable that high school students and scientists had different ideas about this question. By asking this question the researcher is wondering what the scientists want to gain from type of partnership. If the benefits are attainable then there is a possibility for a successful partnership. For high school students they talked about the scientists learning more about high school students and how they learn. Also some students explained that scientists would feel good about themselves for

sharing their knowledge and helping students learn science. The scientists focused more on the improvement of their pedagogical skills. Since the majority of the scientists have not worked with high school students they are hoping to improve their teaching since this would be a new experience for them. For the scientists, they are constantly trying to progress their teaching skills at the college level and by going through this internship they feel they will learn tremendously. They also want to be able to inspire students to become a future scientist. Research about student-scientist partnerships has discussed these same benefits (Oliver, Rybak, Gruber, Nicholls, Roberts, Mengler & Oliver, 2011; Weaver & Mueller, 2009). Since these benefits are attainable the scientists should have a positive experience. If they have a positive experience they can promote to other scientists that they should join in and be involved with high school students.

When looking at question five, “What are some obstacles scientists will have by working with high school students?” it is observable that once again both participants have different opinions on this question. By asking this question the researcher is wondering what obstacles the scientists can face during a partnership. If the obstacles can be resolved then a partnership can be successful. The high school students focused more on “student behavior” and “knowledge gap.” They expressed that the scientists will have a frustrating time explaining concepts to the students. The scientists agreed with the “knowledge gap” being a potential obstacle. This issue can be solved by having an open communication between the high school students and scientists. Communication is a major element that can make a partnership successful (Allen, Howell & Radford 2011). The scientists can express to the high school students that they want the students to succeed and excel in this partnership. When the students were talking about students’ behavior they articulate that they can be lazy and tend to not listen. The scientists expressed that the high school students tend to be immature and this can be an obstacle. This issue can be resolved if the scientists make it clear what their expectations are of the high school students. Another obstacle that the scientists considered, was that the students would have other extra-curricular activities

that could interfere with the internship. They wanted the students to be present at all of the internship dates so they could get the most out of it. This obstacle can be resolved by having a flexible schedule with the high school students. Since “knowledge gap” and “time conflict” appear in question three and question five, these obstacles need to be considered when creating partnership. Every obstacle that was expressed from both scientists and high school students can be resolved in order for a successful partnership.

While reviewing part one of question six, “What would be the best relationship between high school students and scientists?” it is certain that the scientists and high school students have different perceptions about this question. The majority of the scientists talk about being a mentor to the students. They want to be able to guide the students and to have a long lasting mentor relationship. The high school students emphasize on building an personal relationship with the scientists. Moscovici (1984a) articulates that our perceptions are influenced by our environment. High school students have only been subjected to a classroom setting. In high school the classes are small and the students can possibly develop a personal relationship with their teachers. A college setting is very different from a classroom setting. In college the classes are much bigger and it is harder to develop a personal relationship with your professor. This can possibly explain why high school students expect a personal relationship and the scientists expect a mentor relationship. A major component for a partnership to work is the relationship between the individuals involved (Radermacher, Karunarathna, Grace, & Feldman, 2011). Looking at both the high school students and scientists responses it is evident that they are not in agreement with which type of relationship they are expecting. In turn this could create an obstacle and cause the partnership to not become successful. An intervention can be implemented in the process of creating a student-scientist partnership. The scientists should be chosen based upon what type of relationships the researcher wants to transpire.

When observing question seven, “Could you give me a metaphor for this relationship?” it is clear that the scientists and high school students have different views. For high school students the highest frequency is “student-teacher based”. The scientists’ highest frequency is for “parent-child based” and “friendship based.” The high school students had several different metaphors. Some of the metaphors demonstrated the high school students and scientists not being equal. Such as “student-teacher based,” “parent-child based,” “coach-player based” and “hero based.” In a student-scientist partnership, educators want high school students and scientists to be able to communicate and share ideas. Based upon their responses, high school students may have trouble communicating their ideas out of fear of being inadequate next to the scientists. An intervention can be used so that communication will not be a problem. Educators want high school students to be comfortable in a student-scientist partnership. If the high school students are comfortable then they should have a positive experience.

Before these interviews I expected for the high school students and scientists to have very different answers to each question. Since these high school students are considered economically disadvantaged, I assumed they wouldn’t have similar responses. After the interviews I noticed that the high school students and scientists actually had similar responses. This might be the case because these high school students are self-selected to the program. They have been exposed to what the program has to offer before they applied. If this questions had been asked to economically advantaged high school students, I assume that their answers would also be similar to the scientists’ responses.

I noticed that the high school students portrayed that they were intimidated by the scientists and that they would be a burden. Due to this some high school students will not feel comfortable expressed their ideas or asking the scientists questions. I would suggest to future directors of student-scientist partnerships to express to the scientists that they should make the high school students feel like they are valuable to the partnership. The high school students should be encouraged to express their ideas and

opinions without feeling intimidated by the scientists. If the high school students feel comfortable in the partnership then they will most likely have a positive experience.

Each question was designed to be able to give researchers an insight into what type of partnership high school students and scientists are expecting in a student-scientist partnership. The findings from each question can provide researchers important components to consider when designing a student-scientist partnership. A major goal in science education is to have students exposed to authentic science in order to promote a realistic view of science. With the findings in this study, student-scientist partnerships can be improved upon. Both high school students and scientists need to be given a voice into what they expect out of a partnership. If both parties are happy in a partnership then this type of partnership can continue to be implemented. Frequent improvements of student-scientist partnerships can only promote authentic science and hopefully inspire high school students to become future scientists and engineers.

5.1 Future Research

Based upon this study, further research can be conducted. Workshops can be used to share benefits of a student-scientist partnership with high school students and scientists. This can be a good recruiting strategy for future student-scientist partnerships. In these workshops, the obstacles can be discussed and addressed about student-scientist partnerships. Input from high school students and scientists can help improve student-scientist partnerships. Additional questions can also be asked in interviews so the researcher can have richer responses. Richer responses can give the researcher more insight into the perceptions of a student-scientist partnership. The main goal is to get more high school students excited about science and engineering. By creating successful student-scientist partnerships, this goal is a possibility.

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Appendix

Prompt Questions on “Perception of Students Scientist Partnership”

1. What does a scientist mean to you? (without map)
 - a. When you think of a scientist, what keywords come into your mind? (with map)
2. What are some of the benefits you think high school students will have by working with scientists?
 - a. What will the student get from the experience?
3. What are some obstacles you think high school students will have by working with scientists?
 - a. What difficulties could they face?
4. What are some benefits you think scientists will have by working with high school students?
5. What are some of the obstacles you think scientists will have by working with high school students?
 - a. What difficulties could they face?
6. What would be the best relationship between high school students and scientists? Could you give a metaphor for this relationship? [At least a 15 second pause for this question]

[What do you mean? Would you give me an example? Would you tell me more about that?]

Vita

I was born in Richardson, Texas and shortly moved to El Paso, Texas to be around family. I graduated from Franklin high school in 2007. I then went to college for a year at Sam Houston State University to study forensic chemistry. I did not enjoy my time there so I decided to move back home and go to the University of Texas at El Paso. I was on track to study accounting when I first started. I finally decided that I should go into teaching at the high school level. I had always had teaching in the back of my mind but I wasn't quite sure if I should pursue it. My favorite subject was mathematics and I enjoyed tutoring my friends so I thought I would give it a shot. I became an orientation leader and a peer leader shortly after and this confirmed that I wanted to be working with students. I graduated in May 2012 with a Bachelor's of Science in mathematics and a secondary education minor. In August 2012 I started graduate school following the M.Ed in mathematics education route. In January 2013 I became certified to teach 8-12 mathematics. It wasn't until I meet Dr. Pei-Ling Hsu for a job interview that I decided to go through the M.A route and do a thesis through her project. I began teaching high school math in August of 2014. I hope to pursue a PhD later on and do educational research.

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