A DESCRIPTIVE STUDY OF THE PARTNERSHIP BETWEEN HIGH SCHOOL STUDENTS AND SCIENTISTS

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST Of FIGURES

ABSTRACT

This Action Research study investigated the impacts on high school students from participating in a field experience working alongside scientists in a hospital or lab setting. Students applied to participate in either a three-day experience with the pathology department, one-day experience in a frog embryo lab, or a one-day tour of the pathology labs. Primary sources of data were pre and post surveys and interviews that looked at any impacts the experiences may have had. Questions focused on prior lab experiences, motivation for participating, perceived value of lab work, and content understanding. Results showed the overall impacts of the experiences varied based on the design of the experience. Students who participated in the more extensive, three-day partnership were much more positive in their feedback and had a better understanding of the content than the other two experiences. Students primarily applied for the experiences to assist them in finding a career path or because they had an interest in the specific topic. Though feedback varied from student to student, all students responded that they valued the experience and would like to continue participating in authentic field experiences with scientists.

INTRODUCTION AND BACKGROUND

During the summers of 2015 thru 2017 I had the opportunity to take science field courses through Montana State University's Master of Science in Science Education program. I have felt extremely privileged to work with such knowledgeable and dedicated professors who have inspired me to continue my growth as a scientist and a science educator. When it came time to develop an action research plan I knew I wanted to provide my students with similar experiences that I have had over the last four years. To do this, I provided three opportunities for them to work alongside experts and participate in authentic science work. My Action Research focused on assessing the impacts that working alongside science experts in their labs had on my student's interest in science.

My motivation for choosing this action research comes not from a true problem that I see in my classroom, but out of a desire to better engage my students and demonstrate the meaning and value of what I am teaching them. I find that so often students are simply motivated by grades and, consequently, do the minimum work required to earn an A. Rarely do I teach students that show a deeper interest in the curriculum. I wanted to investigate what would happen if I provided experiences for students that will spark an interest, expose them to a variety of science professions, and demonstrate that the work we do in class provides the foundational knowledge of many careers. Harnik and Ross (2003) noted "This educational shift towards more active engagement in scientific process is essential in order to adequately train future scientists and, more importantly, foster a general public able to make informed decisions from

scientific information" (p. 5). In developing these partnerships my goal was to facilitate students on their path to discovery of personal interests or potential career choice.

Another influence for my topic choice was legislation that was passed by Virginia's governor a few years ago. Starting with next year's 2018 incoming freshmen class, graduation requirements will significantly change to provide less focus on standardized tests. Instead, there will be a much stronger focus on providing students with: (1) opportunities to develop workplace skills, and (2) meaningful experience that will better prepare them for college or the workplace. My action research examined this change by studying the impact of partnering high school biology students with local scientists to participate in an authentic lab experiences.

I focused on two supporting questions to break down what impacts these experiences had on my students.

Sub-question 1: In what ways does working with science professionals broaden students' understanding of what scientists do and what background knowledge is necessary to do it?

Sub-question 2: Does an authentic lab-based experience improve a students' mastery of biology concepts?

Throughout this AR process I received help from several people with varying professional backgrounds. Their expertise has been helpful in the design of an achievable study and the preparation of an action research based, professional paper. Dr. Walt Woolbaugh has been my tireless advisor through every step of this process. I chose Dr. Dave Wiley to be my science reader. I have had the privilege of taking two of Dave's

courses through the Masters of Science Education program and these courses are one of the main motivational factors for my research. I also enlisted the help of my father, Darrell Schwalm. Darrell is a master of many trades having worked in the science field for over 30 years and then completing a master of education program during his retirement. His previous experiences both in life and thorough nature have played a large role in both the designing as well as reporting aspects of the capstone.

CONCEPTUAL FRAMEWORK

The push for meaningful educational experiences is higher than ever with states passing legislation to better prepare students for the ever-changing workplace. A quick Internet search on 'changing high school graduation requirements' will yield articles from states such as Washington, Michigan, Illinois, and South Carolina on the adoption of new standards for high school curriculums and graduation requirements. In April of 2016, Virginia Governor Terry McAuliffe passed two bills that directed the Virginia Board of Education to develop a Profile of a Virginia Graduate (Virginia Dept. of Education, 2016). The aim for changing the graduation requirements is to better prepare Virginia graduates for success after high school. This new focus followed an executive order (McDonnell, 2010) that was signed in 2010 by Governor Robert McDonnell that called for an increase of 100,000 additional associated and bachelor's degrees earned by Virginia high school graduates. The 2010 order created the Virginia College and Career Readiness (CCR) Initiative that was designed to "Ensure that college and career-ready learning standards in reading, writing and mathematics are taught in every Virginia high school classroom. Strengthen students' preparation for college and the work force before

leaving high school" (Virginia Dept. of Education, 2010, p. 1). These initiatives have resulted in school systems implementing new strategies that attempt to effectively meet the current needs of student at the same time preparing them to be successful in a rapidly changing world once they leave high school. One of these strategies, to provide students with community-based learning experiences, is a pillar of Albemarle County Public Schools High School 2022 plan (High School 2022, n.d.). These experiences include internships, job shadowing, mentorships that aim to give students an insight into possible careers, and the skills needed for these careers.

The push for partnering expert scientists with classroom teachers is nothing new. Starting in 1999 the National Science Foundation began the Graduate Science, Technology, Engineering and Mathematics Fellows (GK-12) program. One of the goals is to enrich the learning of K-12 students and foster stronger partnerships between institutions of higher education and local school divisions (Gamse et al., 2010). It was found in a review of the effectiveness of the program that students' learning of science is enriched and their exposure to role models and science careers is enhanced (Gamse et al., 2010). The partnerships between graduate students and teachers were also viewed very positively in the eyes of teachers, both in their experience and the perceived impact on students. The review found that the GK-12 had a perceived major positive impact of students' knowledge of science 52% of the time (N=367) and knowledge of and interest in careers related to science increased 43% (N=306). Of the 740 teachers in the program 94% of them stated that the program had a positive impact on the interest and excitement about learning science in school on their students. These partnerships expanded students'

curriculum understanding by introducing different interpretations and explanations or invoking new ideas (Peker & Dolan, 2012).

The GK-12 program also had a positive impact on the participating teachers. Gamse et al (2010) stated, "Overall, nearly three-quarters of teachers (73%) reported that participation in the GK-12 program had increased their content knowledge about topics they teach to some or a great degree" (p. 94). Siegel, Mlynarczyk-Evans, Brenner, and Nielsen (2005) also viewed partnership programs beneficial to all parties involved stating that, "Teachers gain content knowledge and understanding of the nature of science, curricular resources, and increased professional development opportunities" (p. 42). These partnerships were valuable tools in the development of lab activities and adding an authenticity to classroom activities.

Student-scientist partnerships (SSP) or student-teacher-scientist partnerships (STSP) can take on a variety of forms. Each of these partnerships comes with their own unique challenges and benefits but all have the same goals of improving science education and getting more youth interested in science. These partnerships facilitate current science reform efforts to better engage K-12 students through science-based inquiry practices (Houseal, Abd-El-Khalick, & Destefano, 2014). One form of a unique STSP is Expedition: Yellowstone!, This four or five day STSP takes place inside of Yellowstone National Park and focuses on geology, ecology, and human history. In this STSP the activities were designed to help students better engage in the authentic science experience rather than just collecting data for the scientists' research. Students were able to explore their own interests, collect data, and were expected to communicate their

results to individuals outside of their classroom. In analyzing their results, they found that "students showed significant content knowledge gains and increased positive attitudes regarding their perceptions of scientists" (Houseal, Abd-El-Khalick, & Destefano, 2014, p. 84).

A different version of an SSP that was studied is a mentorship program started in Washington State that culminated with the first Student Biotechnology Expo in 2001. One hundred and ninety-two students from the greater Seattle-area were partnered with a science mentor that supported them through their science fair project (Chowning, 2002). These mentors provided students with guidance, support, feedback and resources they would otherwise not have access to. From the post-experience survey Chowning (2002) found that "95% (of the students) felt that the Expo increased their understanding of biotechnology and 88% indicated that the Expo had increased their interest in biotechnology" (p. 338).

In a similar action research study to mine, Metzger (2012) developed partnerships between his students and college students to implement project based learning. His students participated in various field experiences such as electrofishing, to get a better understanding of what would be expected of them in college and to interest more students into studying science. Metzger found that all of the experiences had a positive impact on students, but it was difficult to truly value the experience without following these students throughout their lives to see if they do pursue a science career. In his research he surveyed the students' parents to see what they perceived the impact of the experiences was. Metzger (2012) found that "60% of respondents stated their

involvement had a positive influence on the perceptions of science, while 40% stated it had affected their post-secondary choices" (p. 30).

SSP and STSP's are not solely created to better teach content information to students. These partnerships have been shown to have positive impacts on all parties involved. Houseal, Abd-El-Khalick, and Destefano (2014) found that the "Expedition: Yellowstone!" program had "significant positive shifts in teachers' attitudes regarding science and scientists, and shifted their pedagogical choices" (p. 84). Tanner (2000) noted that scientists that participated in the scientist-teacher partnership reported that following the partnership they "interact with colleagues in new ways, develop skills that are useful in their profession and reflect on their understanding of or enthusiasm for science" (p. 3). Seraphin (2010) partnered 229 students with marine biologists to study the role that sharks play in an ecosystem. Seraphin (2010) stated that, "the establishment of short-term partnerships between science researchers and the K-12 students and teachers appears to a viable mechanism for influencing student attitudes" (p. 211). Students came into the experience with certain feelings towards sharks and science, but showed some positive shifting in attitudes following their experience. She attributed some of the positive shift in attitude towards sharks and scientists to an increase in exposure and the "glamorization of scientists in television shows such as 'CSI'" (p. 215). Her study also alluded to the partial misconceptions that students have about what are scientists, for example, most student descriptions of a scientist focused on white lab coats, chemicals, exotic lab equipment and other stereotypes.

METHODOLOGY

Treatment

The treatment aspect of my research involved partnering my students with scientists in the community to expose them to the work that the scientist do. I arranged that students could apply for one of three different experiences. Students were given a brief overview of what each experience would entail and then were encouraged to apply to be part of the experience. The applications (Appendix A) were offered to one or two of my honors biology classes for each experience, with no class being offered to participate in more than one experience. Each experience was capped at eight students due to the limited space in the lab. As it turned out, all students who applied to be part of these experiences were accepted.

The first lab experience entailed spending one day with University of Virginia (U.V.A.) senior scientist, Bette Dzamba. Ms. Dzamba is currently working with frog embryos to see how cells communicate with one another. Students were able to work alongside scientists in the lab extracting and fertilizing eggs, removing tissue from the zygotes, and tracking the movement of cells. For our second experience, a group of students joined Dr. Hunt MacMillan and the Pathology Department at Martha Jefferson Hospital for a three-day period to learn about the process involved with diagnosing cancer and other diseases. During this experience, students took part in the entire process from the initial gross examination of tissue, to preparing and analyzing slides, and then working alongside the pathologist to diagnose and develop a treatment plan. The third experience was a daylong-guided tour of the Pathology Department at U.V.A hospital.

This was less of a hands-on experience and more of a tour to help students understand the numerous labs involved with diagnosing diseases and the various job opportunities within the field of pathology.

Methods

I developed several assessment instruments to provide me with a better insight into the benefits these experiences may have had on the students' views. These instruments focused on classroom lab experiences, working with experts, science careers and the role that labs played in their understanding of science content. Students that wished to be part of the experience completed the Field Trip Application (Appendix A). This form gave me insight into their motivation for being part of the experience as well as some of their thoughts regarding the role of classroom labs.

The research took place with students who attended Albemarle High School in Charlottesville, Virginia. Albemarle High School (AHS) is the largest school in central Virginia with a 2017-18 enrollment of 1,992 students (Fact Sheet – Albemarle High School, 2017). AHS is a fairly diverse school with minorities making up 41% of the population and students at AHS speak more than 30 different first languages. Students who receive free and reduced price meals under the federal program account for 28% of the population. There were 20 students that participated in the three experiences; 15 females and five males. These students were enrolled in my honors biology class and planned on continuing their education at a four-year university or college following high school. Five of the students were freshmen and 15 of them were sophomores. Of the 20 students, 14 received an A for the first semester, four received a B, one received a C, and

one received a D. The vast majority of the students who participated in these experiences were hardworking and motivated individuals. Responses from their applications indicated that most of them applied because they had an interest in the science topic and wanted to be part of an authentic lab-based experience. The honors level biology course is the highest of three levels of introductory biology that are offered at AHS. The standards of learning are established by the Virginia Department of Education. These standards are used as a minimum framework for the work done at the honors level. Students in these classes can handle a faster paced, heavier workload and therefore are able to learn more in-depth about the different concepts. Lab work is a vital part of the curriculum, and I strive to spend around 40% of the class time on lab related work.

Students completed the Pre-Experience Survey (Appendix B) and were interviewed (Appendix C) prior to participating in the trip. The survey was conducted through Google forms and gave me a baseline regarding such things as their interest in pursuing a science career, comfort level performing classroom labs, experience working with science experts, and value of labs in learning content. The Pre-Experience Interviews were conducted in groups of two due to both time constraints and to hopefully alleviate any nervousness students may have by being interviewed. In developing the interview questions I modeled them from a study done by Tanner (2000), who interviewed the participating scientists in a research paper on the benefits of partnering students with scientists for a research paper. The interviews focused on the same themes as the surveys but provided me with more in-depth responses, and a better understanding of the mindset of the participating students. My focus was to look at the role that science

labs played in their understanding, their views of science, and how working with a science expert may influence these views. By modeling my survey and interview questions off of Tanners (2000) work, my aim was to increase the validity and reliability of the instruments. The interview and survey questions were also vetted by my readers with the goal of phrasing questions in a clear and concise manner that provided students with the opportunities to express their honest opinions.

Following the experiences, I administered the Post-Experience Survey (Appendix D) and conducted follow-up interviews (Appendix E). The surveys were administered through Google forms and were similar to the Pre-Experience Survey questions but written to explicitly reflect responses. I wanted to conduct the follow-up interviews in a one-on-one setting to remove any influences due to having a peer in the room. I was able to accomplish this for the first experience but not for the second or third. This was due to class period time constraints and the lower number of students I had participating in the first experience.

I was able to administer another instrument for pre and post content assessments (Appendix F) for the second experience. I had previously taken a non-study group of students to work with Dr. MacMillan, so I had a much better idea of the specific content they were going to discuss as opposed to the first and third experiences with Bette Dzamba and the UVA Pathology Department. The pre and post assessments were administered through Google forms and focused on biology-based information that was presented to the students during the experiences.

Table 1 shows a breakdown of the instruments used for the field experiences and what specific research questions they targeted.

Table 1
Data Collection Methods

	Data Collection Methodologies				
Research Questions	Application	Pre and Post	Pre and post Interviews	Informal Observatio	Formative Assessment
Main Question: What are the benefits of partnering high school students with science experts to participate in authentic lab experiences?	✔	✔	✔	✔	✔
Sub Question #1 In what ways does working with science professionals broaden students' understanding of what scientists do and the background knowledge necessary to do it?	✔	✔	✔	✔	
Sub Question #2 Does an authentic lab-based experiences improve a students' mastery of biology concepts?	✔	✔	✔	✔	✔

The research methodology for this project was granted an exemption of review from the Montana State University Institutional Review Board (Appendix G).

DATA AND ANALYSIS

Introduction

The analysis I conducted examined the overall impact of the experiences with specific regard to the two sub-questions; students' understanding of what scientists do and the value of these experiences in their understanding of science content. Pre and post

interviews gave me an understanding of students' prior lab experiences, what they hoped to gain and some insight on what they gained.

I first tried to understand the student's motivation for participating to gauge the possible benefits of partnering my students with expert scientists. The experiences, interviews and surveys were analyzed to look for common trends that highlighted the overall reasons. This analysis indicated that students applied to be part of these experiences for a variety of reasons. They wanted to explore future jobs, understand more on the topic, or simply wanting something that would look good on their college application. The following are examples of student statements regarding their reason for participating:

> Student 8
> I've always been very interested in working in a position in the medical field. Biology fascinated me and I love doing labs. Working in a lab seems to become more and more ideal for me. I never get bored with it and studying cells, especially with intentions of making medicine, is something I can see myself doing [every day] of my life. Finally, cancer runs in my family and I have lost loved ones to cancer. Being able to experience firsthand what a real job in pathology is would be a huge component in my life decisions.

> Student 9
> Something new and beneficial always grabs my attention, especially when it can better my understanding of Biology. Working in a lab is more my style, it's cliché but hands on activities really help my learning. I also love the pinnacle moment when you find what you're looking for, or find something totally amazing.

> Student 4
> I'm interested in animals and learning about their behaviors and the traits that they have that allow them to live in the environments that they live in.

> Student 10
> I have a scary lack of (pause), I have no idea what I want to do when I grow up so I thought I would try new things to see what interests me.

There seemed to be three different cohorts of students that chose to apply. Seven of the students (37%) were primarily interested in the specific content being addressed and wanted to learn more about it. Another seven of the students (37%) were interested in the medical field as a potential career and five students (26%) were just interested in participating in a unique experience.

Working with Scientists

Sub-question one addressed students' understandings of what jobs different science professionals have and the skills needed to do them. I was first interested to know if the students could identify various jobs that a biology degree would help somebody obtain. When asked to list different jobs only one of the 20 students could identify more than three biology related professions. Most of the responses focused on either a medical or educational profession. A second variable that I was curious about was the prior experiences that students had working in classroom labs and working with science experts. The interviews and surveys indicated that prior lab experiences greatly varied with factors such as previous schools attended and prior teachers having a huge impact on them. Almost half of the students, 45% (N=5), stated that they had worked with expert scientists before. These students all went to the same middle school and attended a watershed program that is offered to students in Virginia. The students were all excited to have the opportunity to work with science experts. When asked about the difference in working with a science expert over their science teacher, all of the students said that the scientist would have a much deeper understanding or more expertise than the

science teacher. Students generally felt as if teachers had a broader range of knowledge whereas the experts are going to know a lot about their specific field.

Two of the students seemed a little intimidated by the thought of working alongside experts.

> Student 3
> It's going to be cool knowing you are working with an expert, have to make sure you don't say something stupid. You know, in school you say something, you can learn about it, but there it's just like…they're experts, that stuff comes easily to them.

Two students expressed concerns over being able to effectively communicate with the experts stating that the vocabulary might be difficult and the scientists do not know what background knowledge the students have.

In the post-experience interviews my first question asked them to reflect on how the overall experience compared to what they expected. Results were consistent for the first two experiences but drastically varied for the third (Table 2).

Table 2
Experience Reflection

	How did the experience compare to what you were expecting?		
	Different than expected (Negatively)	Much better than expected	Similar to what was expected
Experience 1 Frog Embryo Lab (*N*=4)	0%	75%	25%
Experience 2 3-day Pathology (*N*=8)	0%	75%	25%
Experience 3 Pathology Tour (*N*=8)	62%	13%	25%

Students from the first two experiences were a little shocked at what they were able to do on the trip, while most participants from the third experience were left wanting to do more.

> Student 1 (Frog Embryo Lab)
> I liked that a lot (working with an expert), especially since it was one-on-one. I like being able to ask my own questions and not have someone beat me to the question. I tend to be very quiet and don't get to ask my questions. I liked being one-on-one with someone who really knew what they were doing.

> Student 10 (3-day Pathology)
> Definitely different, I thought it was going to be a lot more just watching them do stuff and watching Dr. McMillan did. I didn't realize we were going to do what Phon (Pathologist's assistant) did and actually cut up human body parts.

> Student 18 (Pathology tour)
> I thought it would be more 'hands-on' and that we would be able to see more of what the scientists were doing. We did see a lot of different rooms with a quick explanation of what the experts were doing in them but we didn't get to sit down with them and learn how they were doing it, if that makes any sense.

When I probed students to get a sense of what they may have gained from the experience students expressed a strong sense of better understanding the content with 54% (*N*=13) of the responses, 13% (*N*=3) stated it helped them develop certain skills, and 33% (*N*=8) said that the experience helped them narrow down a career field. Some student responses were also tied to future career choices. Student 8 immediately responded to being asked if they gained anything from the experience with, "Oh definitely, I want that job" *(*Pathology Assistant). Students 4 and 10 remarked that working in that type of environment was not for them and questioned why people would choose to work in a confined lab space like that (large basement lab facility).

In preparing the students for these experiences I stressed the importance of professionalism and the understanding that we are going into a working environment. One thing that set the tone for the experience was that students were given Health Insurance Portability and Accountability Act training before heading into the lab. Going through this training I could sense a change in the students and an understanding that what they were doing was authentic. The students sat up a little straighter, the gazes around the room stopped and everyone focused in on what the pathologist was talking about. This change in demeanor carried through to the labs as well. Students were eager to get suited up in lab coats and mask, whereas in class they always dread putting the goggles on. Walking through the halls and visiting the different labs I noticed a sense of pride in the students, they remarked how cool it was to be able to be behind the scene.

In one instance during the three-day pathology experience a sample was rushed down to the pathologist assistant to be quickly analyzed. The assistant explained to the students that an individual was currently in surgery to remove a mass from her breast and they were checking the primary lymph node to see if the cancer had spread. Prior to this sample being rushed down students were eager to touch and examine the different samples and there was a relax feel among them. I think it was very eye opening to the students to learn that a patient was currently in surgery and the surgeons were waiting on the diagnosis of tissue that they were currently looking at. I am not sure if they even realized they did it but slowly they all backed up from the station a little bit as if their presence was hampering the pathologist's assistant's work. Once the pathologist

determined that the cancer had not spread the students let out a big cheer and sigh of relief.

My observations showed me that students did value the experiences they were having. Throughout all three experiences students were completely engaged, asking questions, volunteering, and carried themselves as professionals would. The frog embryo experience allowed two students that are normally quiet and shy in class the opportunity to work one on one with the scientist using modern equipment. Both of these students reflected fondly of this opportunity.

Curriculum Content

One of the main objectives in doing classroom labs or providing opportunities for students to work alongside science experts is to deepen their understanding of the science content. During the pre-experience interview I asked students content questions relating to the lab we worked on two-days prior. For the post-experience interview I asked them to summarize the content from the field lab experience. I organized their responses into three Bloom's categories; remember, understand, and apply. I then evaluated the responses based on their level of achievement (Figure 1).

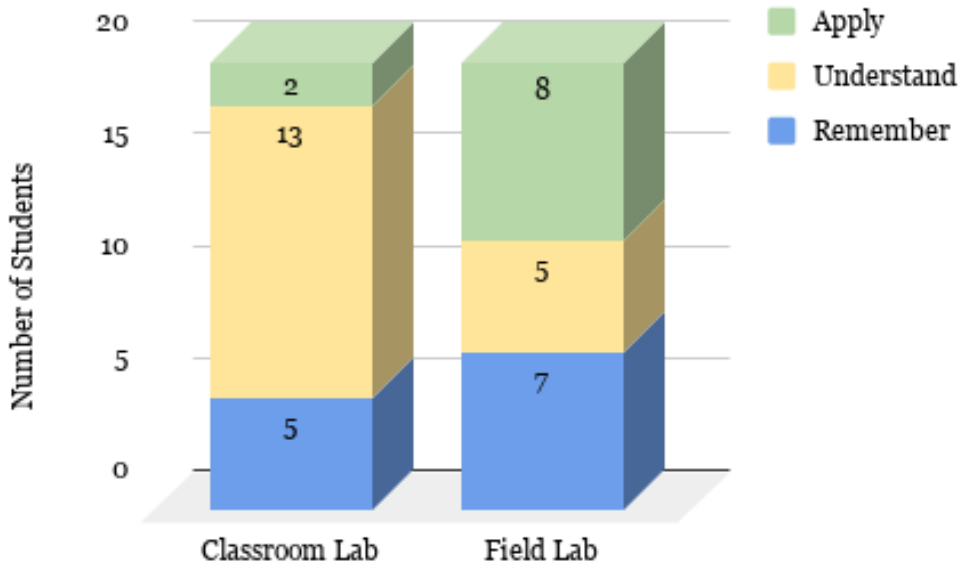

Figure 1. Categorized responses of lab content understanding, (*N*=20).

One interesting factor to note regarding the chart is that for the Field Lab data, none of the students who participated in the three-day pathology experience were at the remember level. These students were much more articulate in their description of the science content and were able to make better connections in their descriptions of what was done during the experience. Participants in this experience had more time to ask questions, re-visit stations, and the material was presented at their level. All four students that participated in the frog embryo experience responded at a remember level. This experience was the most lab technical of all three experiences, though students were very engaged they seemed to also be overwhelmed by the depth of information presented. The results from the pathology tour group were mixed, three students were at the remember and understand levels and two students were at the apply level. Both students who were able to give a response at the apply level discussed the chromosome karyotyping lab station that we visited. Karyotyping is an activity that we had worked on in class a few

weeks prior and the students were able to use their background understanding to translate what the scientists were doing.

Having participated in the three-day pathology experience before I had a much better idea of what the students would be learning from the experience. I developed and administered a pre and post-assessment containing specific cancer related questions (Appendix F). Due to absences, only six of the eight students took the assessments. The mean score for the pre-assessment was 37.5% (N=6) and the mean score for the post-assessment was 81% (N=6). With so few students taking the assessments it is difficult to say how valid the scores are but these limited findings do show a strong increase in understanding of cancer related questions.

The pre and post surveys also asked students how well the classroom labs and field experiences helped them understand the content. Table 3 highlights the survey responses and coordinating interview responses regarding the value of labs in teaching content.

Table 3
Content Through Labs Responses

Pre Survey Question: Lab experiences help me understand the content being taught.

Post Survey Question: I can explain the content studied during the field experience.

Likert Scale	Pre	Post	Student Interview Responses
Strongly Agree	37%	20%	"Going into high school sciences I felt prepared from Mrs. L (middle school science teacher)" "I loved being able to see classroom concepts translated into the real world, like with the karyotype analysis."
Agree	52%	65%	"It definitely helped with cancer and understanding cancer. You always hear the word thrown around but I never knew it was so complex and could be anywhere from the brain to the uterus." "Learning about the lymphs was pretty cool, I didn't even know we had such a big system. I always assumed it was just like four. Cancer goes up to the first lymph node in the armpit and if it gets past that it gets into all the lymph nodes and spreads throughout the body. When he said that I was like yo, cancer can spread so fast if it gets there, I didn't realize cancer can spread so rapidly."
Neutral	11%	15%	"We did labs here and there, it (previous school) wasn't well funded so that was hard. The Earth science labs (last year) are not very sciency (sic)."

Note. (N=20).

One of Albert Einstein's famous quotes comes to mind in reviewing the post survey responses when compared to the pre survey responses -- "The more I learn, the more I realize how much I don't know." The students' explanations of the field labs, especially regarding the topic of cancer, were much more in-depth and showed an ability to connect multiple concepts than those from the pre-experience interviews. Curiously, in the post-experience surveys students scored their understanding lower when compared

to the last classroom lab. The wealth of information introduced to the students during the field experiences was much greater than that typically presented to them during a typical classroom lab. I believe students were much more aware about how little of the topic they actually understood when presented with the entire picture as opposed to just a snap-shot that is typically presented in a class lab. When asked if they felt confident leading a similar lab in the class for their peers 37% (*N*=7) of the students responded they would be confident, 37% (*N*=7) said they would be very confident, and 32% (*N*=6) said they were neutral. Student 8 enthusiastically proclaimed "So confident, that would be so much fun!" The distribution of the responses once again varied greatly depending on the experience. All of the students who participated in the three-day pathology experience responded either very confident (*N*=5) or confident (*N*=3). Whereas, five students from the pathology tour experience responded neutral, one responded confident and two responded very confident.

INTERPRETATION AND CONCLUSION

As a teacher I am constantly reflecting on the effectiveness of my teaching. Whether I am testing out a new lab, or project, or want to see if students were able to grasp concepts from a lecture. In reflecting on the overall value of these experiences the last question of my post-experience interview really stands out to me. The last question I asked was if I offered another opportunity to work with experts in the field would they participate. Every single student unhesitantly said "yes," with five of them being notably enthusiastic in their response. Even the students that participated in the tour responded that they would go on another field trip because of their desire to experience different

things and aid in their path of discovery. This suggests that anytime you can get students excited to participate in educational experiences you have accomplished something regardless of whether the students were able to better understand the biology content or not. Each experience may have had varying levels of value, but I can confidently say that all of the students benefited in one way or another from these experiences.

While working with the scientists to develop these experiences I was unsure how motivated students would be to sign up for them. My students are typically very busy and stressed out with keeping up with their schoolwork. For some of them missing a day, or even three days of school to attend an optional field trip is a big deal. I was very shocked when student 10 told me that he was scared because he did not know what he wants to do when he grows up, this is coming from a 15-year-old.

When students think about possible careers in the medical field everyone says they want to be a doctor or a nurse, no one ever says they want to be a cytologist or a histologist. One thing I was trying to do by providing these experiences was to expose students to different professions they could pursue with a science degree. Sub-question one looked at the different jobs that scientists have and the skills needed to do them. In my initial probing of how many biology related jobs students could name, only one student could identify more than three. Following the experience, 14 students were able to identify more than three biology professions, many able to go beyond three. Responses were also more specific, instead of doctor; students would say pathologist or oncologist and so forth. I believe these experiences gave the students much better insight to potential careers available. In the follow-up interview Student 1, who participated in

the frog embryo lab, mentioned that she was really intrigued by the lab manager's position that was responsible for overseeing the health of the frogs. She mentioned that she really enjoyed working with animals, but did not want to be a veterinarian and that this is a job she could see herself doing.

As an educator my primary job is to teach students biology content and sub-question two looked at the value of these experiences on students' understanding of biology content. Part of my pre and post questioning focused on their perceived value of the classroom labs that we do in comparison to the field experience. Figure 1 shows a comparison between their levels of understanding of a classroom lab compared with the content from the field experience. These results showed that just because students participated in a field experience does not automatically equate to a better understanding of the material. The design and execution of the experience plays a major role in student understanding. Experience one, the frog embryo lab was very hands-on but students had a difficult time grasping the content as it was presented. When asked to explain content from the lab, every student was at the remember level. Experience two, the three-day pathology visit yielded much higher levels of understanding, where 75% (N=6) responded at the apply level. This experience was well designed, with instructional time and lab time, similar to what you would experience in a typical science classroom. Experience three results varied greatly. Some students were able to connect to a station or two that we went to, particularly the karyotyping, but for the most part students were not able to articulate how pathology works. During this experience, students were never

formally presented information, they were guided from one lab to another where the lab tech would describe what they do.

My research goal was to look at the impacts of partnering my students with expert scientists. One of the main things I was trying to do was to light a spark. Sometimes these sparks get lit very quickly, other times they smolder for a while and then ignite. It will be interesting to see what happens to the sparks that were created during these experiences. The two main focuses of the research were to look at the impact these experiences had on students' understanding of science professions and improvement of their content understanding. After participating in the experience half of the students (*N*=10) were able to identify more than five biology related careers. Thirty-three percent of (*N*=8) students reflected that the experiences helped them narrow down a future career choice. Through observations I really got a sense that students developed an understanding of different work environments and both the hard and soft skills necessary to do them. Measuring content understanding was difficult due to the various circumstances but students in the first two experiences showed a much deeper understanding of the material explained in the field lab versus the previous classroom lab (see Figure 1). Both of these groups showed an increase in lab confidence as well as an increase in understanding of cancer related content for the three-day pathology group.

VALUE

These experiences have shed light and been a positive reminder to me of how students at this age crave new experiences and want to be grown up. At every chance the students were asking to use the equipment or had clarifying questions to better understand the diagnosis. Throughout the time I constantly overheard conversations in which the students were putting themselves in the place of the scientists. In some instances, students remarked that they could not imagine working in that type of environment. Even though it may have just been talk or curiosity, I think there is something powerful about them visualizing a successful future for themselves. For me personally, it was very gratifying to see a group of my students in lab coats and masks dissecting a colon that was taken out of an individual just an hour ago.

An unexpected feedback I received came from one of the students' mother the day following our first day working with the pathology lab. She said that her child talked non-stop at the dinner table about the experience and how cool it was to 'actually touch cancer.' Her child was very excited to be able to go back the next day and learn more. These types of feedback regarding how engaged and excited the students were during these experiences has motivated me to continue establishing connections to provide more opportunities for my students. Through these experiences some students found out that a career in laboratory science is not for them, others were very intrigued with the thought of working in the medical field but not having to be a doctor to do it. I truly believe that through this experience, Student 8 has found a career path that they are motivated to follow. Their excitement and interest throughout this process was unlike anything I have

seen from them the entire year. At the end of the year I followed up with Student 8, they told me they signed up to take Anatomy and Physiology next year because of the experience they had in my class. This elective will help them continue down this path they discovered through our experience.

Since this is a descriptive study, I think that my personal views and opinions can certainly influence the way that I interpret the data and perceive the conversations with my students. Developing a coding system for the interviews was one way to minimize this bias, but even categorizing their responses can be difficult. Throughout the process I encouraged students to be as brutally honest with their feedback, and I believe they were, especially with the free response survey questions.

Moving forward there were a couple of aspects of these experiences that really stood out to me. I was amazed at the support I received from both my school as well as the community scientists that I reached out to in attempts to establish a field experience. The local community is eager to work with our students in experiences like these and I plan on continuing these opportunities as well as developing many more. Though I did not get as many applications for each trip as I was hoping, the students that did participate found the experiences very rewarding. I think that once these types of trips are established as a norm in my classroom, students will be more eager or comfortable applying to them. To continue looking at the impacts that field experiences have on students I think you could extend the research time to see what courses they enroll in during high school and even onto college. These feedback loops are difficult and it is not always one experience or one teacher that pushes a student down a certain path. One

aspect of the changing high school model is the greater emphasis on internships for seniors. These internship selections would be another way to value the impact that prior field experiences may have had on the students.

In most of the literature that I read there always seemed to be a section that described the challenges that teachers face in developing these types of SSP or STSP's. These challenges included finding willing scientists and students, time during the year, financing, transportation, meaningful experiences, etc. I was aware of these challenges and was able to plan accordingly, even going as far as obtaining my commercial driver's license to alleviate the transportation problem. In continuing to develop these partnerships I see one major challenge, which I have shown can drastically impact the value of the experience, the overall design or structure of the experience. By far the most valuable experience was the three-day pathology visit. Students were pretty shy and did not know what to expect the first day, but by the second and into the third day they were much more comfortable in all aspects. The number of questions increased, students were all eager to volunteer for various tasks, they would ask for something to be shown again or rephrased. There was a sense of ease and confidence that was not present the first day. I tried, to no avail, to convey the positives of this experience to the U.V.A hospital education outreach individual that I worked on designing the third experience. There is a fine balance that I found that needs to be played when working with the volunteers in developing these experiences. The scientists are experts in their field and have so much information they want to share with the students, but do not necessarily have the experience in sharing their knowledge with teenagers. I was very grateful of them

volunteering their time to work with my students but I was not as assertive as I should have been on what design would best benefit the students. The focus really needs to be as much about how exactly we are transferring that knowledge from the experts to the students, as it is on what knowledge we are sharing.

As previously mentioned, in our school district there is a stronger emphasis on providing students with authentic experiences and internships to help them find their path. This is a change that has found rare unanimous support from all stakeholders. Students today constantly want to know why they are doing or learning something. By providing them with experiences that make the connection between what is being taught in class and what knowledge professionals are using we are creating a more engaging and authentic educational experience. Following these experiences, I have already planned another field experience for this group of students. Using personal and student feedback I have designed an experience that will hopefully exceed the expectations of students while transferring knowledge from the scientists to the students.

My goal in future years is to provide enough different experiences so that all of my students can choose to participate in one. As the data shows, students are already thinking about their future and desire to experience things in life to help them figure out which path they want to take. Most students who participated in one of the three experiences this year have shown to better understand the science content and what different science professions are.

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APPENDICES

APPENDIX A

FIELD EXPERIENCE APPLICATION

We have a unique opportunity to visit the Anatomic Lab at Martha Jefferson Hospital to get a behind the scene view of how doctors diagnose patients with cancer and other diseases. Under the supervision of Dr. Hunt McMillan, the laboratory medical director, and the technicians present, students will undergo HIPAA orientation and participate in the actual work of preparing a tissue specimen for diagnosis of potential cancerous cell growth. Students will move through various stations in said preparation including the removal of water and injection of formalin via osmosis, the encasing of the sample in paraffin, the slicing of the sample in slide preparation and finally slide staining.

Because of the sensitive nature of the medical work, HIPAA guidelines and protocols will be a part of the trip. Also, students will be working in the laboratory itself; as such, behavior must be impeccable.

The trip involves three, three-hour sessions on Nov. 14, 15, and 16th from 9:00 - 12:30. Due to lack of space in the lab we are only able to send 8 students to the lab.

1. Name (last, first)

2. Why are you applying for this field trip? What about working in a lab interests you?

3. Do you have any experience working in a lab outside of school? If so, describe what you did.

4. Do you plan on taking any biology-based electives in high school?

5. What skills or knowledge would you bring to a lab experience like this?

6. What do you hope to gain from this experience?

APPENDIX B

PRE-EXPERIENCE SURVEY

1. I am confident in my ability to correctly use the classroom lab equipment, such as a microscope.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

2. Previous lab experiences help me to understand the content that was being taught.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

3. I am engaged during labs.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

4. I typically enjoy the labs I do in science class.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

5. Following a lab, I could re-teach that lab to a different group of students.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

6. I find value in working with my lab partners.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

7. I can identify a variety of career paths of biologists.

a. Strongly disagree
b. Disagree
c. Neither agree nor disagree
d. Agree
e. Strongly agree

8. I am interested in continuing to study biology.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

9. I plan on taking a biology science elective such as AP Biology, Anatomy and Physiology, AP Environmental Science or Ecology at some point during high school.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

10. I think it is important to be taught by someone who is an expert in his or her subject.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

APPENDIX C

PRE-EXPERIENCE INTERVIEW QUESTIONS

Italicized font represents possible probing questions.

1. Why were you interested in participating in the fieldwork experience?

2. What were you hoping to gain from the experience?
    a. *Personal gains, content understanding, exposure to different fields?*

3. Have you worked with professional scientists before?
    a. *If yes, please explain.*
    b. *Why might that experience be helpful to you?*

4. How do you imagine it will be different working with an expert rather than your science teacher?
    a. *Have you worked with experts in previous classes?*
    b. *What do you think some advantages might be? What about any disadvantages?*

5. What has been your experience working in science labs to this point of your life?
    a. *Probe for specifics about previous years science classes.*

6. How have previous labs helped in your understanding of the content?
    a. *Can you give me an example?*
    b. *Why do you think they haven't?*

7. Can you explain the content related to the last lab.

8. What value do you see in working in lab groups?
    a. *What are some of your experiences regarding lab group work?*
    b. *What might be some disadvantages?*
    c. *Positive or negative lab experience you've had?*

9. What are some skills that help make working as a group successful?
    a. *What are some disadvantages of lab group work?*

10. Can you give me examples of jobs that biologists have?

11. Can you explain the content of the last classroom lab?

12. What is your favorite thing about doing classroom labs?

13. Do you think we should do more or less labs in class?

    a. *Why or why not?*

14. Rate your interest level in pursuing a career that involves some type of science:
    a. Not interested at all
    b. Very little
    c. Neutral
    d. Somewhat interested
    e. Very interested
    *** Why did you answer the way you did in the above?*

15. Rate your confidence level in performing classroom labs:
    a. Very confident
    b. Confident
    c. Neutral
    d. Very little
    e. Not confident

*** Why did you answer the way you did in the above?*

APPENDIX D

POST-EXPERIENCE SURVEY

1. Following the lab experience I am more confident in using lab equipment.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

2. I can explain the content studied during the field experience.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

3. I was more engaged in the Pathology/Embryology lab than I normally are in classroom labs.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

4. If I had the choice I would like to conduct my labs in an off-site location working alongside of experts rather than in the classroom.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

5. If Mr. Schwalm brought in a sample from the field experience I could help lead a lab on it to my peers.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

6. I found value in working with the other students during the lab experience.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

7. I can identify more career paths of biologists following this lab experience.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

8. This experience furthered my interest in continuing to study biology.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

9. I plan on taking a biology science elective such as AP Biology, Anatomy and Physiology, AP Environmental Science or Ecology at some point during high school.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

10. I think it is important to be taught by someone who is an expert in his or her subject.
    a. Strongly disagree
    b. Disagree
    c. Neither agree nor disagree
    d. Agree
    e. Strongly agree

APPENDIX E

POST-EXPERIENCE INTERVIEW QUESTIONS

Italicized font represents possible probing questions.

1. How was the experience similar or different from your initial expectations?

2. What do you think you gained from the experience?

3. How was it similar and different working with experts in the lab compared to working with your science teachers?

4. How did the experience help in your understanding of the content?

5. Can you explain the content?

6. Describe how your grouped functioned throughout the experience?
    a. *What were some advantages? What were some disadvantages?*

7. What are some skills that helped make your group successful?

8. Can you give me examples of jobs that biologists have?

9. What was your favorite thing about working with the experts?
    a. *In your viewpoint, what were some disadvantages?*

10. Would you choose to participate in one of these experiences again?
    a. *What suggestions would you make to me as the teacher, if I were to do this again?*
    b. *What were some advantages to working with experts? Disadvantages?*

11. Rate your interest level in pursuing a career that involves some type of science:
    a. Not interested at all
    b. Very little
    c. Neutral
    d. Somewhat interested
    e. Very interested

12. How comfortable would you be in leading this lab for a different group of students?
    a. Very confident
    b. Confident
    c. Neutral
    d. Very little
    e. Not confident

APPENDIX F

PRE AND POST ASSESSMENT QUESTIONS

1. Name (First, Last)

2. These types of tumors grow in one place and don't tend to spread to other parts of the body?

3. These tumors tend to spread to neighboring tissues via the blood or lymph system.

4. Genes called _____-_____ stop a cell from dividing too often.

5. When a change occurs in DNA, we call it a _____. This can lead to uncontrolled cell _____.

6. The division of somatic cells is called?

7. The uncontrolled division of cells is called?

8. About 50% of all human cancers may involve an abnormal or missing:

    a. Oncogene
    b. P53 gene
    c. proto-onco gene
    d. BRCA-1 gene

9. What is one way to identify cancerous cells?

10. What is a 'polyp'?

11. Define 'carcinogen'. List three examples.

12. Define 'metastasis'.

13. Identify various ways to treat cancer cells.

APPENDIX G

INSTITUTIONAL REVIEW BOARD EXEMPTION

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
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MEMORANDUM

TO: Jeffrey Schwalm and Walter Woolbaugh

FROM: Mark Quinn Mark Quinn cmj
Chair, Institutional Review Board for the Protection of Human Subjects

DATE: October 25, 2017

RE: *"A Descriptive Study of the Partnership between High School Students and Expert Scientists"* [JS102517-EX]

The above research, described in your submission of October 25, 2017, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

X (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

X (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

___ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

_____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.