

ONLINE & VIRTUAL EDUCATION:  
IT'S EFFECTIVENESS & IMPACT ON HIGH SCHOOL MATHEMATICS AND  
SCIENCE STUDENTS

by

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## ABSTRACT

This descriptive research paper discusses the effects of online instruction on high school mathematics students. The project was designed to determine if students enrolled in online mathematics and science courses can or will receive a level of instruction comparable to students who take their high school mathematics courses in a traditional classroom. It is desired that students in online courses make progress during the semester or year equal to or within a range of those students in traditional courses.

Online education has the potential to bring quality education to those students who may not be able to find it in a traditional classroom. By helping these students to receive their education despite varying circumstances, we will be helping to reduce the dropout rate as well as encouraging students to complete their education, and perhaps go to college. Students with differing circumstances were enrolled in online courses at Rawlins High School in Rawlins, Wyoming. These students were monitored during the course of the 2010 – 2011 school year, and their progress was measured and compared to progress made in traditional courses. The teacher completing this research chose to examine the progress of all students who successfully completed one or more online mathematics and science courses. Their data was then compared with the data from the students enrolled in the teacher's traditional mathematics courses. At the conclusion of the 2010 – 2011 school year, it was determined that students enrolled in online mathematics and science courses made sufficient progress. However, student comments and data suggested that a hybrid-type online course may be more effective and better accomplish the desired goals for students with exceptional circumstances.

## INTRODUCTION AND BACKGROUND

There are students in our school district, Carbon County School District 1 (CCSD1), who participate in online education courses on a daily basis. Local community colleges, such as Western Wyoming Community College, and other universities, like Utah State University, have administered these courses, and the students involved receive college credit as well as high school credit. Some students take these online courses for credit recovery purposes in order to get caught up with their education after falling behind for one or more reasons. Other students take online courses in order to get ahead in their education and to take advanced courses. Our school district offers the standard core courses to help each student meet their general education requirements. It may not help very much to offer students who get through these classes and want to begin furthering their knowledge in a field of study that will better prepare them for college or a chosen vocation.

My school district was offering students the ability to further their education and to recover lost credits before I arrived in the district three years ago. Students were allowed to enroll in classes at our local Carbon County Higher Education Center (CCHEC) which were taught and administered through Western Wyoming Community College (WWCC). Students would take these courses during their school day in lieu of other elective courses, and were given high school credit as well as college credit for successful completion of the courses. The only limits to the courses available were imposed by WWCC, based on the availability of professors and instructors who were capable and willing to teach these distance-education courses. Enrollment in these

courses differed each semester, but generally included between ten to fifteen students at any one time.

These distance learning courses were only offered during the normal school day and students were expected to attend these courses, bussed from the high school to CCHEC each day, as part of their credit. Also, the majority of students who were willing to attend these courses were not part of the at-risk student population, and focused mainly on students who were seeking to get ahead in their studies and to graduate from high school with some college credits already “under their belts,” so to speak. It was determined that a more flexible approach was necessary in order to offer educational opportunities to a larger student population that might include at-risk students.

Therefore, in order to maintain student population, to discourage drop-outs, and to offer positive learning opportunities to students with exceptional circumstances, the school district has adopted an online learning program in order to offer another educational opportunity to those students who may not find success in the traditional face-to-face classroom. If online and virtual education is equally effective as education received in traditional classrooms, then these opportunities can be extended to those students. The demographics at Rawlins High School include students who travel to school from rural areas surrounding the main community, online education could benefit the distant student population. The school district also struggles with how to best serve students who fall behind on credits due to poor performance in classes taken in their first few years of high school. Online and virtual education could be extended to our struggling credit recovery students, our advanced students, as well as those who have challenges learning in traditional classrooms. There are also students who have



circumstances that require them to be away from the traditional classroom for extended periods of time. These circumstances may include but are not limited to teen pregnancy, disciplinary suspensions or expulsions, or to students who need to enter the work force to help sustain or support their families. Online and virtual education can be offered to these students as an alternative to dropping out of school. Thus, it allows them to continue to earn their high school diploma while progressing through the courses at their own pace and on their own time.

Our district is making plans to offer its own set of online courses that meet the needs of these nontraditional students. In time, we hope to offer a customized curriculum designed by our own teachers and instructors that is aligned with national, state, and district standards and goals. These courses can be offered to our students and administered by our faculty.

Until the school district develops its own software, establishes the curriculum, and has the ability to offer and administer its own online courses, it purchased a license to use an online software program called *Apex Learning* for our virtual environment. Students may enroll in the courses offered by Apex Learning, and district faculty facilitates and monitors students in these online courses. The faculty also adjusts the curriculum to meet the needs of our local students. The online software program allows district staff and faculty to make specific adjustments to the content of the courses that are offered, thus customizing the curriculum to fit the content taught in the traditional classrooms.

The general purpose of this study is to determine if mathematics and science students at the high school level (grades 9 through 12) can benefit equally from receiving their education via an online or virtual source as they currently do from face-to-face

traditional classrooms. I performed a descriptive study, analyzed the academic progress of students that I monitor in the virtual courses, and compared their progress to students in traditional courses I also teach.

Many of our students enrolled in the online mathematics courses are also enrolled in traditional courses, thus completing a hybrid schedule of both online and on-campus. We have a handful of other students who are only taking online courses, and I have limited contact with these students. Since this study only analyzes the progress made in mathematics and science courses, data was gathered from both online mathematics and science students and from different students in my traditional on-campus courses. The data was used to compare progress made by students in online mathematics or science courses to the progress made by the students I see every day in my on-campus courses. I will also describe the online program and the traditional programs then make comparisons between the programs rather than individual students themselves.

### Research Questions

In order to more fully understand the impacts and the effects of online virtual education, I developed the following research questions. My main research question is: What is the impact of online education on student achievement at the high school level? Additionally, I focused my research by developing the following four sub-questions in order to help in the analysis of the data and the formation of my conclusion. What are the benefits of online education for high school students? How do student grades in online classes compare to those in traditional classrooms? What are student attitudes and concerns toward online education? What are the impacts of online education on

teachers? The questions above are used to create the conceptual framework that will form the body of the research. The conceptual framework thus follows below.

## CONCEPTUAL FRAMEWORK

In order to better serve my students and refine my research questions, I studied a number of articles and case studies that dealt with the topic of online and virtual education as it related to students and the future of education. Seeing virtual classrooms as a more popular choice in coming years, I felt it important to gather current opinions on the subject. Since my research was to focus on the effectiveness of virtual education on mathematics and science students, I felt it might be helpful to include in this section some broader topics currently affecting online and virtual learning. Other questions that are discussed here include (1) How does online education in mathematics differ from online education in other subjects, (2) How popular is online education, (3) How does the public view online education, (4) What is online education currently being used for, and (5) What are some of the issues facing online education and it's students?

I attended the Virtual School Symposium of 2010 in Phoenix, Arizona with some colleagues. The Symposium offered several workshops. Each workshop was very informative, focusing on the growing popularity of online and virtual learning. Opportunities for online professional development for teachers were also popular, along with free online resources that teachers can use in the classroom or online in order to emphasize or reinforce topics discussed in class.

One workshop I attended included a presentation by Kevin Oliver of North Carolina State University where he presented data he and his colleagues gathered on high

school students enrolled in online courses in the North Carolina Virtual Public School (NCVPS). The purpose of his research was to “help the school improve its student services, technology systems, course designs, and teacher preparation” and to “seek any significant differences in how courses were perceived” (Oliver, 2009, p. 1). The research does not determine how much student progress was made in the field of mathematics (which is the purpose of my descriptive study), but rather to discover differences in how students felt they were successful in a variety of classes and compare the student responses. In the study, Oliver (2009) discovered that students in mathematics courses were less impressed with their experiences and the curriculum than in other courses such as language arts or social studies, and that the positive responses differed by about 20%. He then prepared a follow-up survey to gather student information about why students may not be learning as much in math courses compared to others as well as to find out why not as many students were recommending online math courses compared to other courses. This study was particularly important to me because I felt initially that this was exactly what I was doing and that someone else had already done it! However, Oliver’s initial research did not focus on the amount of progress made in mathematics courses only, but rather the opinions and perceptions of the students who took online courses in a variety of subjects. The students examined in Oliver’s research could have had a lot of success in the course, but felt it was more challenging than in traditional face-to-face classes, and his research did not look at the gains in student knowledge. I use my own personal research, contained herein, as well as Oliver’s research as a stepping stone to doing further research in my district to try and improve the overall quality and experience of the online courses for mathematics students. In Oliver’s follow-up survey, he states,

“that math as a subject area was fundamentally challenging” and that those challenges only “exacerbated the difficulty of the subject, particularly due to the inability to get teacher explanations” (Oliver, 2009, p. 12).

I also wanted to find general articles or journals that supported online education. I did not necessarily want to find articles dealing with mathematics or science, but I wanted to help the reader recognize some of the benefits of virtual schooling. There were several reasons why students in my school district chose to take online courses and leave the traditional classroom. Those reasons are analyzed in the Data and Analysis section of this paper. The following articles were gathered from the educational journal titled *Edutopia*, some of which can be found online at their website. One such online article references an online poll to examine reader opinions on whether online education can be just as effective as classroom learning (Bernard, 2007). The results of the poll suggest the majority of readers, approximately 53%, agree that online learning can be just as effective as classroom learning, with another 27% stating that online courses should be offered to students for educational opportunities but should not be mandatory (Bernard, 2007). Only 18% disagreed. Their target audience, being an online educational journal probably mainly included educators, and since it was an online poll, most likely included those educators who were already familiar with and comfortable using the internet and related technologies.

Another online *Edutopia* article from April 2005 offers a study similar to that which I am hoping to accomplish with my Action Research project. The article cites several studies that show how much success high school students can achieve by attending classes online, at least part time if not full time. The article discusses the

relevance to students who wish to move ahead in their normal high school curriculum or have the option to take courses that their high school does not normally offer. There seems to be an increasing number of students involved in such programs across the country. The article also supports the use of online education for students who are “in a rural or poorly funded school” in order to gain access to curriculum they would not normally have access to (Wood, 2005).

The same article discusses the importance of virtual or online learning for students who are looking for more “flexibility” in their courses. Many students who are self-motivated and want to be able to participate in extra-curricular activities may decide to turn to online education to fill holes in their normal education, yet still have the time to participate in other activities outside of school. “In Hudson, Massachusetts, junior Zoe McNealy is a full-time honor student at Hudson High School and a competitive ice skater, thanks to the flexibility of online courses” (Wood, 2005, para. 9). The article goes on to describe some of the issues that come with virtual learning, such as an increased workload for teachers, and addressing the lack of face-to-face contact between students, their instructors, and other peers. The future of virtual learning is also the topic of a section of the article as it is compared to the increase in online education in post-secondary education.

As my school district is increasing its options for students by offering online courses in a virtual school, it was important for me to be familiar with the challenges and issues that arise in virtual education. I expected to see some similarities between the data I gathered and the studies that are presented in these paragraphs.

One of the articles I chose to read and review here discusses the growth and spread of the internet as a whole. There have been several additions to the internet which make it more of a “user’s world” rather than one solely for the “providers.” As stated in the article,

It's amazing in many ways that in just a few short years, we have gone from a Web that was primarily "read only" to one where creating content is almost as easy as consuming it. One where writing and publishing in the forms of blogs and wikis and podcasts and many other such tools is available to everyone (Richardson, 2006, para. 3).

I also mentioned in a thread post in one of my Master of Science in Science Education (MSSE) courses, EDCI 505, the world wide web is becoming a place where everyone can be a provider of knowledge, not only a seeker of it. Blogs, wikis, Facebook, MySpace, and Twitter have all given the average person a place to share what they know and what they experience. Such online journals, so to speak, give people an avenue through which they can share just about anything. The challenge now would be teaching students how to be responsible with the use of the technology, and become lifelong learners, in essence to “become a nomadic learner; [and to] graze on knowledge” (Richardson, 2006, para. 8). One topic of this article I found most valuable discussed the ways in which students can “turn in” their work or demonstrate their proficiency in a subject. It mentions offering blogs, web pages, YouTube videos, and others as ways to submit their work. Similar to the MSSE online courses many courses, including those in the Apex software that my school district uses as a platform for our virtual school, use several types of online communication including forums and email. My students, however, do not ask many

questions on the forums, the answers to which would benefit all students. Students also send me questions via email when they are too timid to ask questions on the public forum. Still other students communicate with me via texts and cell phone conversations when they need more immediate attention to their concerns.

In another article titled “Learning with Laptops” (Muir, 2005), the article has little relevance to online learning, but shares some good insights on what can be accomplished with the use of technology in general. For example, a section titled *Project-based learning* discusses the educator’s ability to use technology to target multiple intelligences and differentiated learning styles. There is also mention of “students using multimedia to create presentations, Web pages, and movies to illustrate their knowledge” (Muir, 2005, p. 4). Another section in the same article titled *Online Research* targets the internet as more than just a large answer key, but a place to search for answers to problems and a place to find out ways to apply the knowledge they gain through research. Most students these days, and ours are no different, are so familiar with technology that many of them rely on technology on a daily basis. Regardless of the demographics or social standing, many students in my school district carry internet-ready cell phones and other electronic devices. In my classroom, I have encouraged these students to use their phones and devices to seek information and to use it in a responsible way. I also encourage my virtual school students to use their technologies wisely and responsibly, seeking knowledge rather than answers. Many students in my school district have sent me friend requests on Facebook, and have used it as a way to communicate with me about their progress or questions they have on their assignments. The comfort that students feel with these technologies translates over to their online courses. To my students, learning online



is no different than learning in the classroom because of the amount and type of interactions they have with me and with other students who are also in the virtual school or who are on campus at the high school.

I have also done research into the works of John Dewey, whose educational research and philosophies dealt with the social aspects of school, where school is a place where students not only gain knowledge but also gain experiences and learn important life-lessons. Dewey argues two different points that I will use here. The first is that school should be a place where social interactions can teach and train young minds to become responsible citizens. He states, "School is primarily a social institution. Education being a social process" (Dewey, 1897, Article Two, para. 1). This seems to support a place where students interact socially and face-to-face with each other and their instructors on a daily basis, thus learning their "manners" so to speak and how to interact socially. The second point I would like to bring up is that Dewey supports an educational environment where the teacher is merely a facilitator and is not the center of the classroom. The student should be the one who is directing the educating and is doing research for his or her self. Dewey states, "Far too much of the stimulus and control proceeds from the teacher" (Dewey, 1897, Article Two, para. 13).

As a response to a sub-question, I thought it important to examine an article that would possibly give me insight into a potential downfall of online or virtual learning. This dealt with the disconnect between a learner and the instructor or the learner and his or her peers. These relationships are fostered in a traditional classroom, but would definitely be affected if a student chose to strictly attend online courses from home without attending any traditional classrooms.

One such article I came across purports that technology has disconnected us from the realities of where we are (Edwards, 2009). One passage gives examples of people who go on trips and could see many great and wonderful things, but pay more attention to the screens on their digital devices than on the actual wonders they are proving that they've visited or seen (Edwards, 2009). To quote one relevant line, students who lost interaction with real friends while studying via online education or virtual learning might find themselves in a situation where "sitting alone in a room with a gaggle of digital friends replaces hanging out with actual companions" (Edwards, 2009, para. 9). The lack of interaction with students is an important aspect to study or consider. As for the importance of the traditional classroom, the article states "schools are learning environments, but they are also microcosms of the larger world" (Edwards, 2009, para. 18). This statement emphasizes one of the more important aspects of the traditional classroom that students learn important points about social interactions within the traditional classrooms that they miss out on while in a virtual classroom. Thus, students may have more opportunities opened up to them through online or virtual learning, but at the same time, they may be missing out on other opportunities to learn valuable information about social skills. Something else I'll need to consider is the on line experience of the learner. When students take their first online course, it can be a challenge. By the third class, they are really up and running (personal communication, Woolbaugh, 2010). So data collected from a first time online student would be very different than a third time online student. For instance, it may be beneficial to first examine my data as a whole and then examine the data segregated by students who have and who have not taken online courses in the past. There may be a greater increase in

student progress from the beginning to the end of the school year for students who are more familiar with online education than for those who are having their first experiences with online education.

This is reiterated in an article titled *The Good, the Bad, and the URL* (Eisenstock, 2009). It discusses the immaturity of many online users. The article discusses the dangers of internet use by those who cannot tell the difference between a friend and a predator. Internet and technology safety need to be taught in order to make students more responsible with their internet use. A major danger to youth in the virtual world is described as “sexting.” Such behaviors are dangerous and very irresponsible, not to mention illegal. All these things aside, however, the article states, “the majority of kids’ digital media and online connections mirror their offline friendships” (Eisenstock, 2009, p. 7). The students use technology, such as texting, cell phones, Facebook, and Twitter, which are virtual communities, to arrange and order their relationships with their real life friends and colleagues. “They are the say-anything, post-everything generation who have yet to understand there are no take-backs in the virtual world” (Eisenstock, 2009, pg. 6). This last quote sums up the article for me, and emphasizes the point made in the previous paragraph. Several students may be technologically savvy and comfortable using technology. However, the question still remains unanswered, are the students mature enough to use the technology responsibly? Will they be able to focus their use of technology to be motivated enough to complete an online course?

Through this research and literary review, I was able to read about many of the positive benefits of online and virtual learning and education. The opportunity to give students more options in classes and to open the world wide web of information to them

and those who are self-motivated learners is a spectacular prospect. Also, this online education can be taken advantage of by those who might miss out on a high school diploma due to a lack of credits for math, science, or social studies.

I have encountered some information on what to consider as the possible downfalls of running an online learning program, which will allow me, the administration, and the other faculty members I will be working with the opportunity to develop ways to circumvent these issues. All of this has been valuable information.

In closing, I've discovered that there has been a great deal of research done in online and virtual learning. There are several concerns about the social aspect of school that students may not be able to receive when studying in an online virtual learning environment. These concerns may be addressed with social networking tools as well as Web 2.0 tools. At the same time, virtual learning may offer opportunities for students to gain experiences and knowledge they would not otherwise gain. Students in the coming generations may find it more important to be able to find and utilize information found with "mobile learning devices" than to actually sit in a classroom and experience rote memorization. There are a lot of things that I will still need to learn about and study in order to validate my research in this area.

## METHODOLOGY

The opportunity was made available to me to study the effectiveness of online learning or virtual education when my current school district adopted a virtual classroom setting to offer to students with certain circumstances. Our school district then opened a position to hire a Coordinator to handle the administration of the online classes. This freed up teachers who were already involved in online learning during the previous summer school term to be facilitators of the different content areas, such as math, science, social studies, and language arts. I was given the privilege to be the facilitator for mathematics classes and the students enrolled in them. This meant that I was available during certain hours each day to offer tutoring to students enrolled in these online courses. I would also offer my time to grade the Teacher Scored Tests (TSTs), those tests in the online environment that the students would print, complete, and submit via mail, drop off at the school, or deliver to me during my visits.

I did not have access to students who were enrolled in the various science courses offered online, as there was another science content teacher contracted to facilitate these science courses. However, for the sake of this study and to increase the sample population, I am also including data from students enrolled in our virtual science courses. Their data will be presented in this paper in order to help substantiate the data gathered more readily in the mathematics courses. Information on the two science students is provided here for the reader. One student, a male, had taken a Physical Science course for credit recovery. The other student, a female, had taken her Biology course online along with all her other courses due to health issues, but she also cited bullying as another motivating factor for her attendance in the virtual school.

The selection of students I considered for my research population initially included all those who participated in mathematics and science online courses during the 2010-2011 school year at Rawlins High School, in Rawlins, Wyoming. The total number of students, including all students enrolled, not just those in mathematics or science courses, fluctuated during the year. There were 9 initial enrollees in our virtual school, and as many as 64 students at one time during the school year (see Figure 7). Data from the online students was gathered at intervals during the school year. The data from my traditional classrooms was gathered during the course of the 2010-2011 school year and was used only for comparison purposes. These are different students than the online students whose courses I facilitate. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained.

Students enrolled in online courses at Rawlins High School for a variety of reasons. Some took online courses for credit recovery and were also on campus taking traditional courses. Still others were given opportunities to continue their education despite being home-bound. Regardless of the reason, these students were monitored during the course of the 2010 – 2011 school year and their progress was measured and compared to progress made by a separate group of students in my traditional courses. I attempted to examine the progress of all students who successfully completed one or more online mathematics and science courses and compare the data to the students enrolled in traditional mathematics or science courses. However, most students proved more difficult to contact than anticipated, so the number of students used for the data collection methods had to be reduced.

The Data Collection Matrix below includes my main focus question for my action research project along with the five sub questions that I narrowed down and focused on. The matrix also includes the six methods of data collection that I used. These collection methods were chosen in order to best triangulate and validate the data and to support the conclusions.

Table 1  
*Data Collection Matrix*

	<b>Data Collection Methods:</b>					
<b>Research Questions:</b>	1. Student Exit Survey (Hybrid).	2. Student Post-Survey Interview.	3. NWEA MAP Test RIT Scores.	4. Virtual/Traditional End-Of-Term Student Grades.	5. Teacher/Facilitator Interviews.	6. Online Enrollment Information.
What is the impact of online education on student achievement at the high school level?	✓	✓	✓	✓	✓	✓
1. What are the potential benefits/detriments of online education for high school math and science students?	✓	✓				✓
2. How does student success in online math and science classes compare to that in traditional classrooms?	✓		✓	✓		
3. What are student attitudes and concerns toward online education?	✓					✓
4. What are the impacts of online education on the teachers?	✓				✓	

Following the Data Collection Matrix, I will give brief explanations of each one of the data collection methods. I will include details about the data collected thus far, the progress attained, and the goal for each one of the methods. Information on where the data was collected, how it was collected, and the timeframe for the data collection will also be included in each description. In order to best study the effectiveness of the online education and to compare said learning to the traditional learning that I was already offering in my traditional classroom.

#### Data Collection Method 1: Student Exit Survey

In order to take a quantitative as well as a qualitative snapshot of what the students involved in our online program think or thought of their virtual courses and how they feel about their experiences, I chose to create a hybrid survey. This survey borrows points from the Likert Scale as well as components from a standard structured survey, or questionnaire. There are also a few open-ended questions asking for feedback and opinions from the students.

With the survey came the necessity to create a permission slip that would be signed by the parents or guardians of the students, or the students themselves if they were already over age 18 and could legally sign for themselves. The survey covered information such as why the student took the online course, how they felt about it, their own struggles, what the course lacked, what it's strengths were, and their overall opinion of the online learning environment (see a copy of the survey in Appendix A).

The idea was to administer this survey to each student as they exited a mathematics or science course, regardless of whether they finished the course or not.



Parental consent forms (Appendix A) were sent home with each student for parents to review the purpose of the survey, and as each student completed an online course, the surveys were given out and collected. However, because none of the students enrolled in the selected online courses were returning the required parental acknowledgement and consent forms, it became tedious to attempt to track down each student and make the number of required phone calls.

In order to shorten the list of parent contacts I had to make, I limited myself to a list of 15 to 20 students who had taken an online mathematics or science course and had been marked as “Completed” by the district’s Virtual School Coordinator. A student was marked as completed if they had successfully completed the course and had been given a letter grade, they had been dropped from the course for not having met the required deadline, or the student had requested to be removed from the course for personal reasons.

Since the students had returned none of the parental acknowledgements, an addendum was added to it and approved by the school’s administration (see paragraph 4 of the Methodology section, and Appendix B). This addendum allowed me to contact the parents via telephone or personal email in order to get permission to administer the survey.

The addendum contained a preformatted template I would use to describe the survey, its intentions, and its anonymity. It also included a check box with a line reading, “Parent/Guardian was contacted by phone, and permission to administer the survey to the student was granted.” The preformatted conversation is included below, which is an abridged version of the information provided on the permission slip (see Appendix B):

Hello, my name is Christian Mills. I am a mathematics teacher at Rawlins High School. I am also the facilitator for the online learning virtual school your son/daughter is/has been participating in. I am gathering data to find out the effectiveness of the curriculum and instruction your son/daughter received in their online class. The survey will ask 20 questions about their experience with the course, what they liked, and what they wish had been different. The survey will be anonymous, so your student's name will not appear on the survey at all, and their identity will not be connected to the study. May I have your permission to administer this short survey to [Student Name]?

After the surveys were collected from the students, I began to examine the results using the form Survey Results Record Sheet (Appendix C). I went through each survey and used tally marks on my Record Sheet to keep track of how many responses there were to the standard-type questions found in Sections I and II of the survey. This data would be used to paint a picture of the type and background of the students who participated in the online and virtual classrooms. A graph was then created using Microsoft Excel to visually represent the data as bar graphs. For Section III of the survey, a similar method was used for the responses to the Likert-style questions. Tally marks were made on the record sheet to keep track of the student's responses, then graphs were made to represent the data. For Section IV of the survey, the open-ended questions, student responses were typed word for word (except for correction for spelling) into the record sheet for analysis at a later date.

To provide the reader with an idea of the demographics of this particular sample of students, the survey asked for the students to provide answers to questions about themselves. The first questions in Section I of the survey asked the students to provide basic demographical information, including gender, primary language, and grade level. Based on the surveys submitted, there were nine females and eight males, leaning slightly toward the females who were enrolled in the online mathematics or science courses. I noted that there was somewhat of a correlation between the gender and the reasons why a student was taking the online course. A majority of the males who were taking these online courses were taking the course to get ahead and take college classes their senior year or were taking the classes for credit recovery. There were two male students who were surveyed who were taking the online courses because they had been expelled from school for one reason or another. Of the females who completed the survey, most were taking the online courses for credit recovery. There were two females who had taken the online courses due to unplanned pregnancies, one who was unable to attend campus courses because of health issues, and one who opted for the online courses because of bullying that she had experienced while attending traditional classes.

#### Data Collection Method II: Student Post-Survey Interviews

In order to clarify some of the responses given by students in the survey and to probe deeper into the meaning of how the students had responded a post-survey interview was conducted with certain students. The survey consisted of questions based on student responses in their surveys and was not consistent from student to student. The responses

from students to the interview questions were dictated by hand and collected for use in the Data and Analysis section of this paper.

The data from these interviews was used to supplement the data gathered from the initial Student Exit Survey as well as to add depth to the responses already given in the Open-Ended section of the survey. Responses to this interview give a qualitative perspective to the quantitative data from the survey. This interview also helps to add validity to the data by offering this alternative perspective.

### Data Collection Method III: NWEA MAP Test RIT Scores

Besides the survey, I also looked for assessment-based ways to look at and measure student progress in both the traditional and the virtual classrooms. This way I could use quantitative data to measure student progress and to compare progress made by students in the virtual classroom and compare this to the progress made by similar students in the traditional classroom.

The Measures of Academic Progress (MAP) Test is a test that measures the RIT, or Rasch Unit, of each student who takes the test. The RIT score is one method CCSD1 uses to determine the educational level, or grade level, for each student. The district administers the MAP test three times during the school year. The first testing of the year, typically in September, is given to determine the correct course placement for each student, and is later used to determine individual student progress. This test includes 52 questions and is one of the more accurate ways to measure student progress. The second time the students take the test, typically in December, is a shorter version of the test. This test only includes 26 questions, and is not considered as accurate as the fall or spring

MAP Tests. The third testing is given in the spring, this year in early May, and is the same length as the first test.

The MAP Test gives each student a set of questions with a grade level and difficulty attached to each. The student answers each question starting out with a basic level question, and moving up in grade level and difficulty based on the answers to their previous questions. Once a student begins answering questions wrong, the test is designed to decrease the level of difficulty until the student begins answering them correctly again, then moving back up in difficulty, so on and so forth. In this way the test hopes to find an accurate grade level equivalency measurement.

It is possible, and even likely, that the RIT levels for the traditional students may be higher than the RIT levels of the virtual learning students. Several of the students are in the online program because they were not finding success in the traditional classroom. Their learning levels may be well below those of traditional students because of time spent out of school for health, personal, or employment reasons. It may also be true that there will be higher RIT scores from some of the virtual learners if they are taking the online courses in order to get ahead in their education.

The MAP test scores from students in the online virtual school who took both the first and third MAP tests is used to determine the amount of progress made by these students. There are several students who may have taken the first MAP test but not the third, or vice versa, or who may have started out the school year in a traditional classroom and were moved to the virtual during the school year, or vice versa. In either case, their scores may be used, but their data was identified and kept separate.

Since our district administers the MAP test three times during the school year, I am including a data chart for the first round of MAP tests done in September. I collected the RIT scores from the participants of the virtual school and looked for signs of improvement between their September scores, their December scores, followed by their May MAP RIT scores. I have also collected the RIT scores from the traditional students to look for the same signs of improvement.

After the data was collected from the third test, which was administered during the first and second weeks of May, 2011, the scores were used to identify student progress. The scores were used jointly to find an average for the scores of online students and of traditional classroom students to see if these groups have made a comparable amount of progress from the beginning to the end of the school year. I have also separated the data by class or course, comparing progress made by students who took courses traditionally to those who took the same or similar courses online. For instance, I compared progress made by students in my traditional Algebra I course to students who took an Introductory Algebra or Algebra I course online. Lastly, I compared scores for students individually to see if the students were able to progress, how many were, how many may not have, and by how much. An average may tell a lot about a population, but may not show that there were a few students who did not make any progress or one student who actually regressed in his knowledge because of a bad experience with either a traditional or online class.

I made the decision to use the same sample of students for the MAP Test results as had submitted the survey. This decision was made in order to maintain consistency in the data by using the same sample size and to make the data more valid by using the same

students instead of a separate group. In order to inform the reader and give some sense of the size of the community and student body, Rawlins High School began the 2010-2011 school year with an approximate student population of 470 students. At the time this was written, there were 437 students enrolled at the high school. By choosing this sample of 15 students, I am examining roughly three to four percent of the overall student population. However, of those students enrolled in online mathematics or science courses by the end of the school year, currently there are 54 students, I am looking at a population of about twenty-eight percent. There has been up to 116 students enrolled in virtual school courses at one time during the year.

By the end of the school year, my Algebra I class contained 14 students, Geometry had 21 students, and my Algebra II class maintained 22 students. My physics class contained 19 students consistently throughout the school year. In order to make comparisons in student progress I looked for a RIT score improvement of approximately 4 points for students enrolled in online courses of Algebra I or under, a RIT improvement of about 3 points for students in Geometry courses, and a RIT improvement of about 2 points for students enrolled in online courses Algebra II or higher. These cut-off scores were used based on the data collected from the traditional classrooms and the progress they made during the course of the school year (see Data and Analysis, Table 2).

#### Data Collection method IV: End-Of-Term Student Grades

Along with the MAP Test scores that were gathered to help determine student progress from beginning to ending of the school year, it was determined that another source of data might be helpful in supporting and triangulating the data. Another way of

comparing the online courses to the traditional courses is to compare the grades earned by students in the traditional classrooms to the grades earned by students in the virtual classes.

The data for the traditional mathematics courses was gathered from my own traditional courses. I taught one of each Algebra I, Geometry, and Algebra II course, along with one supplemental Algebra I course, titled Algebra IB. These courses were taught year-long, broken into two semesters. The Algebra I and IB course each contained 18 students, while the Geometry and Algebra II classrooms each had 26 enrolled students. Grade levels varied in each class, from ninth and tenth grade students prominently in my Algebra I and IB courses and a mixture of tenth, eleventh, and twelfth grade students in each of my Geometry and Algebra II courses.

I taught one science course during the 2010-2011 school year. This Physics course was taught to twenty eleventh and twelfth grade college bound students, and none of our virtual students enrolled in an online physics course. Therefore, data for the science courses had to be gathered from other teachers.

From each of the classes taught traditionally, information was gathered in order to compare these traditional students to those who were taking similar or equal courses online. This information included highest and lowest grades, average classroom grade, and number of each letter grade. The overall issue with gathering this data was that it wasn't available for data collection until the 6<sup>th</sup> of June, 2011. This data was gathered quickly and placed into a spreadsheet for easy viewing as well as for graphing to be presented in this paper.



### Data Collection Method V: Teacher/Facilitator Interviews

In order to add validity to the data gathered from the Student Exit Survey, a teacher/facilitator interview was conducted with each of the teachers involved in facilitating their content area in the virtual school. I approached each of the teachers who had been facilitating their subjects for the virtual school and asked them these questions in May of the school year. However, only three of the teachers offered comments. Their responses were recorded on paper, annotated by myself. The purpose of the facilitator interviews was to see if there would be any correlation between student responses in their exit survey (Appendix A) and the responses gathered from the teacher facilitators. The questions used for this interview can be found in Appendix D. As a facilitator for the mathematics courses, I also wrote down the responses that I would give, and included them in the data.

### Data Collection Method VI: Online Enrollment

Another way I thought might be worth sharing in order to triangulate my data is to show the enrollment numbers for the virtual school. As students hear about the option to take virtual online courses, and as they hear about them from friends and school faculty, the popularity increases. It may be of interest to see the online enrollment data as a way of seeing the number of students each month that were taking online courses.

Along with the enrollment numbers will be the number of students who have successfully completed one online course. This data includes not only those students

enrolled in mathematics and science courses, but those enrolled in *any* virtual course, as the data that was presented to me was not segregated by core subject.

### Summary

I supported the validity of my research by analyzing the quantitative data gathered from the surveys, academic progress exams, enrollment numbers, and student end-of-term grades. I combined this quantitative data with qualitative data by examining the responses students gave in the open-ended section of the survey as well as the Post-Survey interview responses and the Teacher/Facilitator interview responses. It is my hope that the research and the data discussed herein will be sufficient to draw conclusions to the research questions asked in the Introduction of this paper as well as to inform myself, my school district, and my readers as to the directions we should be heading in the future with respect to online education in mathematics courses.

## DATA AND ANALYSIS

The nature of a descriptive study is to summarize the data that is gathered and to make inferences based on that data. I will be making some comparisons based on the data, but the main goal of the data collection and analysis will be to gain a basis or foundation for further research on the students in my school district. As stated above in the Introduction and the Methodology, it is the ultimate goal of this research to determine if students enrolled in online mathematics and science courses can or will receive a level of instruction comparable to students who take their high school mathematics and science

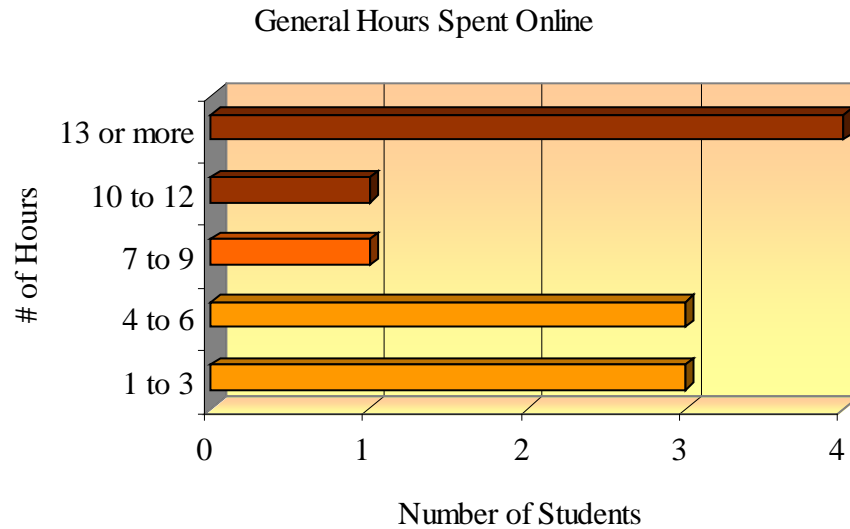
courses in traditional classrooms. It is desired that students in online courses make progress during the semester or year equal to or within a range of those students in traditional courses. The data collected will be used to determine if sufficient or comparable progress was made, keeping in mind that further research will need to be done in order to describe the level and amount of progress made by student sample sets.

In the following Data and Analysis section, I plan to cover a few important topics. The first will be whether or not students are comfortable working with technology and are familiar with use of the internet. The second topic that will be discussed deals with student attitudes and concerns about learning online. Thirdly, and most importantly, I will be showing the data gathered from the various quantitative sources to discover if students make a comparable amount of progress in their virtual courses as compared to students in traditional courses. Following this will be a report on what students and teachers are missing from the virtual courses, and what can be done to improve the courses. Lastly, I will give a brief description on the effects of virtual learning on the teachers and facilitators.

The first concern I'd like to share data for is whether or not students are comfortable learning online. Students are using technology more and more, as seen in the Conceptual Framework. I wanted to know if my sample of students felt the same. The figure below shows data gathered from the sample of virtual students in the mathematics and science courses in response to a question from the Student Exit Survey.

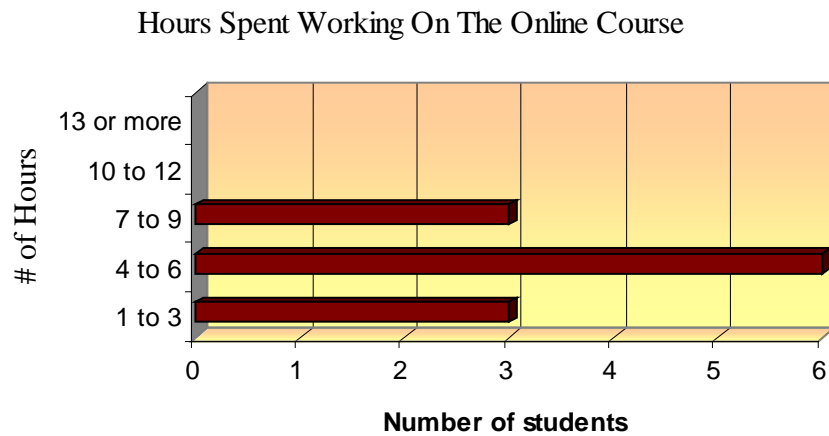
Figure 1, below, shows the number of students who spent a specific number of hours online during an average week. These would be the number of hours the students spent recreationally online or completing tasks unrelated to their online courses. This

data shows that half of the students who took the survey, six out of twelve or 50%, spend at least seven to nine hours each week recreationally online. This is equivalent to one hour or more online each day recreationally.



*Figure 1.* How many hours did you spend online generally during the week? The number of student responses for each of the options is shown ( $N=12$ ). From the Student Exit Survey, Appendix A.

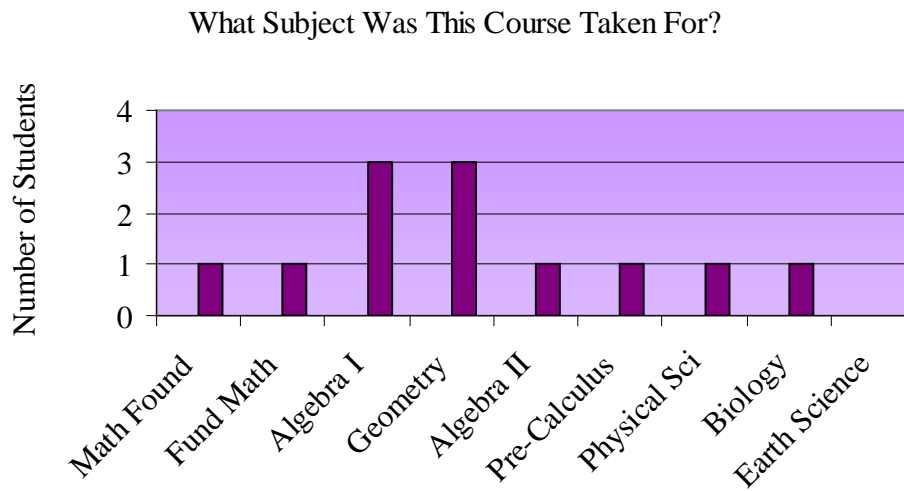
In comparison to the online students and more out of curiosity, I asked a few of the questions from the virtual Student Exit Survey to my traditional students to find out how many hours each week my students spend online in non-educational pursuits. Of the 76 students in my traditional classrooms, 60 students, or about 79% of them, spend at least an hour or more online each day, and 60% of the students spend ten or more hours each week. An equal number of students indicated that they accessed the internet via a mobile device at least once each day. This shows that students in general, not just those in online courses, are comfortable using the internet and the electronic devices at their disposal.



*Figure 2.* How many hours did you spend online working on your online class? The number of students who answered, and how many hours they indicated are shown ( $N=12$ ). From the Student Exit Survey, Appendix A.

For discussion, it might be of interest to ask why my traditional students spend more time using the internet for non-educational pursuits than do the virtual students. While I do not know the entire answer to this question, one piece of data I have suggests that at least part of the time that our virtual students spend online is actually working on their virtual courses. Figure 2 above shows the distribution of student responses for hours spent online working on their virtual course.

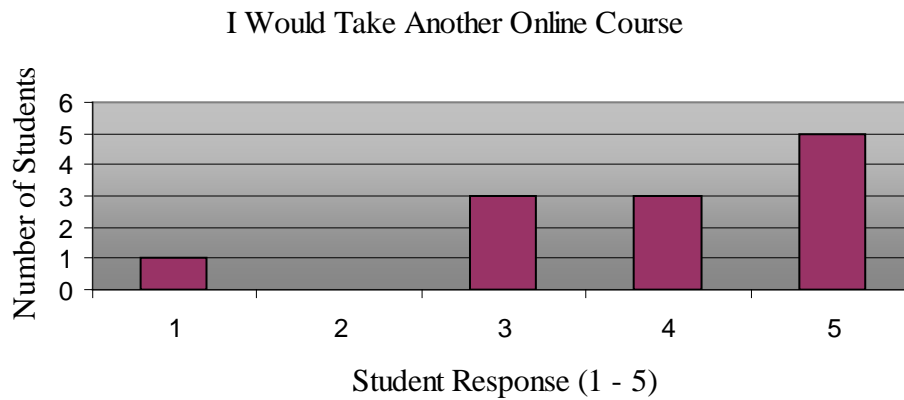
For the next topic, I'd like to discuss the student's attitudes and concerns about learning online. To begin with, I'd like to share some data about the courses that were taken online. Recall from the Conceptual Framework that math was considered generally to be a difficult and complex topic. Figure 3 below shows the distribution of courses taken by students who took the hybrid survey.



*Figure 3.* What Online Course Was Taken? The graph shows the courses that were taken by students in online courses, and how many had taken each ( $N = 12$ ). From the Student Exit Survey, Appendix A.

From the figure above, we can see that of the twelve students who were surveyed, ten of them were taking or had taken a mathematics course. This data was shared because, as challenging as mathematics is as a subject, the students appeared generally positive about their experiences with their online courses.

The hybrid survey that I prepared for the students had a section of sixteen Likert-style statements that the students were asked to rank from one to five, with one being that they strongly disagree and five that they strongly agree. The figure below shows that a majority of students enjoyed their online course, to the point even that they would take another online course.

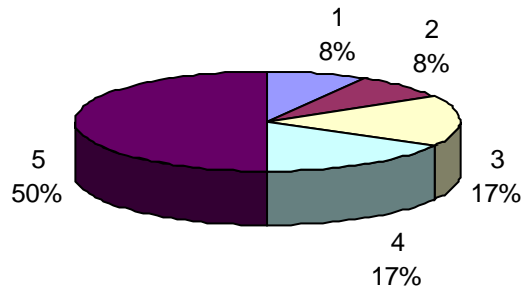


*Figure 4.* I would take another online course ( $N=12$ ). From the Student Exit Survey, Appendix A. Student responses are from the Likert-scale, with 5 being Strongly Agree.

With the exception of one student who may have had a bad experience in their course, the rest of the students agreed or strongly agreed that they would take another online course in the future. Recall that one of the focus questions I am asking in this research is, “What are student attitudes and concerns toward online education?” This data suggests that student attitudes about their online educational experiences have been generally positive, and that these students will be likely to choose another online course later on in their education. The more positive their experiences are now, the more likely they will be to take advantage of virtual and online educational opportunities in the future.

To add to this, not only did students respond that they would be willing to take other online courses in the future, but that they would also recommend online courses to their friends.

## I Would Recommend Online Courses to a Friend



*Figure 5.* Would you recommend online courses to your friends ( $N=12$ )? Numbers are Likert Responses with a 1 meaning Strongly Disagree and a 5 meaning Strongly Agree. From the Student Exit Survey, Appendix A.

The pie chart above is also taken from data collected from one of the Likert questions. Students ranked whether or not they would recommend online courses to their friends, with 5 being that they strongly agree. Ten of the twelve students responded in the affirmative.

In order to get an idea of why the students had such a positive experience in their online course, we can look at some of the student responses from the Open-Ended questions at the end of the survey, as well as some of the comments left in the Post-Survey Interview. Students left the following remarks about their reasons for having positive experiences in their online course:

“It allowed me to work at my own pace and achieve a high standard of work.”

“Because I can take my time and I can study more. I seem to have better grades and better grades on quizzes and tests.”

These comments left by students suggest that time is a big factor for them enjoying their online courses. Students are allowed to work at their own pace through the curriculum,



with the only exception being if they want the credit for the course to appear on a particular report card. Otherwise, student deadlines for completion are discussed between the student, their parents, school administration, and the facilitating faculty.

Still other students left shorter but similar comments, suggesting as well that the overwhelming strength of the online courses that we offered gave students the opportunity to work at their own pace. One comment that was unique for this question suggested that students found the online courses simpler than the traditional because of the specific work load. “It was mostly easy to figure out so it wouldn't take forever to get the assignments done,” commented one student.

More relevant and important than whether or not students enjoyed their online courses is whether the quality of education that students receive is comparable to what they would experience in a traditional classroom. To begin, I would like to bring some attention to the MAP Test scores for both my traditional classes and for the students enrolled in our virtual school mathematics and science courses. The data table shown below, Table 2, includes the data collected over the year from my traditional courses, the three mathematics, and the one physics class I taught. Included in the table is the student population for each class, the RIT scores for each of the three administrations, as well as the RIT point growth and the percentage of increase or decrease.



is the jump in RIT score from the end of Algebra I to Geometry. The school district teaches the courses in the order shown in the table, and student scores at the end of their Algebra I course are 9.2 RIT points lower than they are at the start of the Geometry course. These are different students in different courses being taken at the same time, so more research will have to be done to determine if the same will occur next school year.

In comparison to the data above, the Northwest Evaluation Association (NWEA) website (<http://www.nwea.org/support/article/980/normative-data-2008>) has normative data from their 2008 study. I am including the data below for reference.

2008 MATHEMATICS STATUS NORMS (RIT VALUES)						
Grade	Beginning-of-Year		Middle-of-Year		End-of-Year	
	Median	Mean	Median	Mean	Median	Mean
K	148	149.5	152	153.1	158	158.1
1	164	163.4	171	169.9	178	176.7
2	179	179.5	186	186.5	191	190.8
3	192	192.1	199	198.0	203	202.4
4	203	203.0	208	207.6	211	211.4
5	212	211.7	216	216.0	220	219.2
6	219	218.3	222	221.4	225	223.8
7	225	224.1	228	226.4	230	228.3
8	230	229.3	232	230.9	234	232.7
9	233	231.6	234	232.5	236	234.0
10	237	235.2	238	235.9	239	237.1
11	239	237.1	240	238.5	241	239.8

*Figure 6.* NWEA MAP Test 2008 RIT Norms for grades K – 11. Data is found online at [www.nwea.org/sites/www.nwea.org/files/resources/2008\\_Normative\\_Data.pdf](http://www.nwea.org/sites/www.nwea.org/files/resources/2008_Normative_Data.pdf)

If we examine the mean values in Figure 6 above, we can see that national gains from beginning of the year to end for grade 9 are from 231.6 to 234.0, or a RIT point gain of 2.4 or about 1%. The gains for grade 10 are less, a RIT gain of 1.9 or about 0.8%. The gains for grade 11 increase slightly, with a RIT gain of 2.7 or 1.1%. Concluding from

this normative data from 2008, we could almost consider that a gain of about 1% from the beginning of the year to the end could be expected. My traditional students, considering all classes combined, averaged about 1.5% increase overall.

Students in my Physics course took the science MAP Test, which is broken into two sections of 32 questions each. Section 1 is titled “Concepts & Processes” and Section 2 is titled “General Science.” The scores presented in Table 2 are an average or overall RIT score for their test, and are not divided into the two categories being tested. The test focuses mostly on the student’s ability to reason and identify the steps of the scientific method, and less on subject specific knowledge, however most of the questions asked in the MAP Science Test focus on Biology and Earth Science processes than on Physics and Chemistry. It is important to note that the grade-level equivalency for the science MAP Test is significantly less than that of the MAP test, due to the nature of these subject-specific questions. The students in my Physics course made a RIT increase of less than one RIT point, showing basically no improvement during the course of the year.

The values presented above are used only to make comparisons in the annual progress made during the 2010-2011 school year between my students in the traditional face-to-face classrooms and the students who were enrolled in the mathematics and science courses as online students that I facilitated. To reiterate, I only gathered data for the students who had completed a survey for me in order to maintain consistency across the data.

Three students who had completed the survey indicated that they had taken a course which corresponds to our Introductory Algebra or Algebra I course. Also, three of

the students indicated they had taken a Geometry course, one student took an Algebra II course, one took a Pre-Calculus course, and two had taken science courses. Since there were students who had not taken courses that I teach, their data is not included. There were also a number of students who had taken the MAP Test just once during the year, either moving into the school district after the first administration or leaving traditional classrooms after the first administration. The MAP Test scores for the remaining eight students whose courses corresponded with traditional ones are shown below:

Table 3  
*MAP Test Scores for Virtual Students*

Course		Fall	Winter	Spring	+/-	% of Change
<b>Algebra I MAP Test</b>						
Mean	n=3	227.0	234.0	237.3	10.3	+4.5%
Median		226.0	233.0	238.0	12.0	+5.3%
Mode		N/A	N/A	N/A		
<b>Geometry MAP Test</b>						
Mean	n=3	221.7	230.3	223.3	1.6	+0.7%
Median		223	235	223	0	---
Mode		N/A	N/A	N/A		
<b>Algebra II MAP Test</b>						
Mean	n=1	248	252	254	6	+2.4%
Median		248	252	254	6	+2.4%
Mode		N/A	N/A	N/A		
<b>Science MAP Test</b>						
Mean	n=1	229	N/A	219	-10	-4.3%
Median		229	N/A	219		-4.3%
Mode		N/A	N/A	N/A		
N=8						

The table above shows that students who had taken the Algebra I course, for whatever reasons, had made more progress, 4.5% increase as opposed to 2.1% increase,

than their traditional classroom counterparts. The increase by the virtual students was almost double that of the traditional students in the Algebra I course. However, in contrast, students in the virtual Geometry course made half the progress, only improving 0.7% as opposed to the traditional geometry students, who made a 1.5% increase. Again, this may be due to the smaller sample size, or the method with which the courses were presented. In my traditional Geometry course, I approach the curriculum focusing on the application of the tools learned in Algebra I, asking the students to solve geometric problems using their algebra skills more so than the online Geometry course does. Another stark contrast can be seen for the student who took her Algebra II course online. She made an improvement of 2.4%, whereas the students in the traditional Algebra II course only made an overall improvement of 0.9%.

Now, the reader needs to keep in mind that these values are presented for comparison only. There were students in each of my traditional courses who made improvements greater than the average, and vice versa. The standard deviation for the virtual students is greater than that of the traditional, due to the smaller sample size and wider range in values, neither data piece is presented here.

To draw another comparison between data, I will present the available classroom grades here to add validity and triangulate the data presented. The MAP Test scores shown above show that students make progress in the virtual learning environment. But, how do student grades compare between the traditional classrooms and the virtual classrooms? The data table below shows a side-by-side comparison of grades earned by online students with the mean grades earned by students in my traditional courses.

Table 4  
*Student End-Of-Course Grades: Traditional vs. Virtual*

Course	Traditional Courses			Virtual Courses		
Algebra I						
Mean	n=14	76%	C	n=3	84.1%	B
Highest		96%	A		96.3%	A
Lowest		60%	D-		75.0%	C
Geometry						
Mean	n=21	80%	B-	n=3	79.6%	B-
Highest		93%	A		82.3%	B-
Lowest		24%	F		74.4%	C
Algebra II						
Mean	n=22	73%	C	n=1	83.4%	B
Highest		94%	A		83.4%	B
Lowest		24%	F		83.4%	B
Science	n=19			n=2		
Mean		87%	B+		75.3%	C
Highest		95%	A		75.6%	C
Lowest		70%	C-		75.0%	C
	N=76			N=9		

The data table above, Table 4, shows the side-by-side comparisons of student grades, including the mean, highest, and lowest grades for each course. Perhaps not as convincing, but this data, similarly to the MAP Test RIT scores above, shows that the students are successful in the online courses. The mean scores for the three online mathematics courses are equal to or greater than those in the traditional courses. The two students that took the science courses did not take Physics, which is what my traditional course was. One had taken an Earth Science course for credit recovery and the other student, a home-bound student, had taken a Biology course. The courses not being similar, we cannot make a true comparison. However, both students were still successful

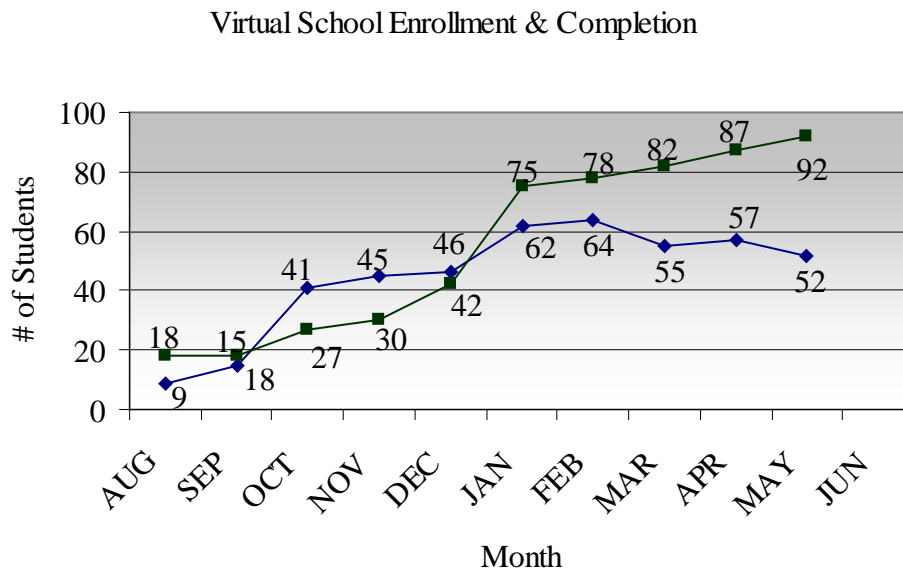
in earning the credit for the courses they were taking, and had also scored a mark greater than the lowest score in my Physics class.

What this data shows is that students who took their courses online did make progress from the beginning of the year to the end of the year. Significantly, online courses may be just as effective at conveying information or helping the students to learn as the traditional courses. Several students commented on this in the survey, comparing their own experiences in traditional classrooms to their experiences in online courses. One student mentioned, “I like the interaction with others but it's also nice to work at my own pace.” Another student remarked, “Because I can take my time and I can study more [in online courses], I seem to have better grades.”

This being said, there were some interesting pieces of information that my research uncovered. This information showed that even though students may have been successful overall in their virtual online mathematics or science courses, some added factors may lead to even more success or perhaps a more positive and meaningful experience than what has been discussed. This will be discussed in greater detail later on.

One thing that speaks to both the student successes as well as to the popularity and student attitudes toward online and virtual learning is the student enrollment numbers. Figure 7 below is a line graph showing the number of students enrolled in virtual classes (blue line). The graph also shows the number of students (cumulatively) who have successfully completed online courses (black line) . This data is not segregated by subject. Thus the data should be viewed subjectively.



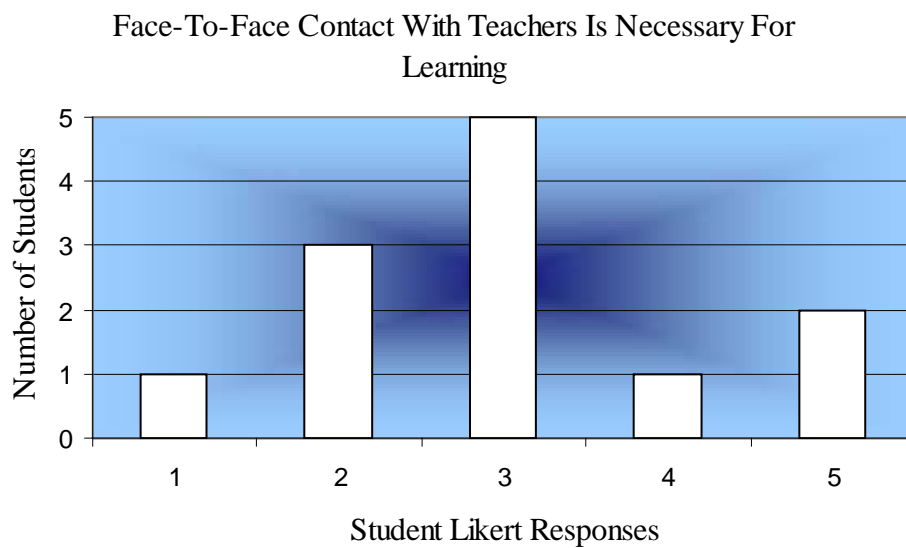


*Figure 7.* Virtual School Enrollment and Student Completion Numbers. Provided by Rawlins High School Administration, 2011. The blue line represents the enrollment and the black line the number of students who had completed their course.

The line graph above shows that over the course of the 2010-2011 school year, a total of 92 courses were completed successfully by students. These are courses that would not normally have been completed had it not been for the virtual school. It also means 92 more credits that students are not lacking. From this point of view, the virtual school was also successful, at least in part, in accomplishing one of its goals; to help students succeed where they had not previously.

The next information and data is perhaps more telling than the data presented above on student grades and MAP Test scores. I will return to the hybrid survey for a moment that was administered to the online students for a few items of information. Although the students generally had positive experiences with their online courses, there were a few things that were mentioned by them as things they missed from the traditional courses they had taken in the past.

One student remarks in her interview, “When I did get stuck on a quiz or needed a reset, sometimes I would have to wait a million years to get it.” Another student gave a short response when asked which style of course she preferred. She said, “Traditional, there’s more interaction.” This shows that one thing students miss from their previous traditional classroom experiences is the face-to-face communication between teachers and themselves. Data for this is shown below in Figure 8.



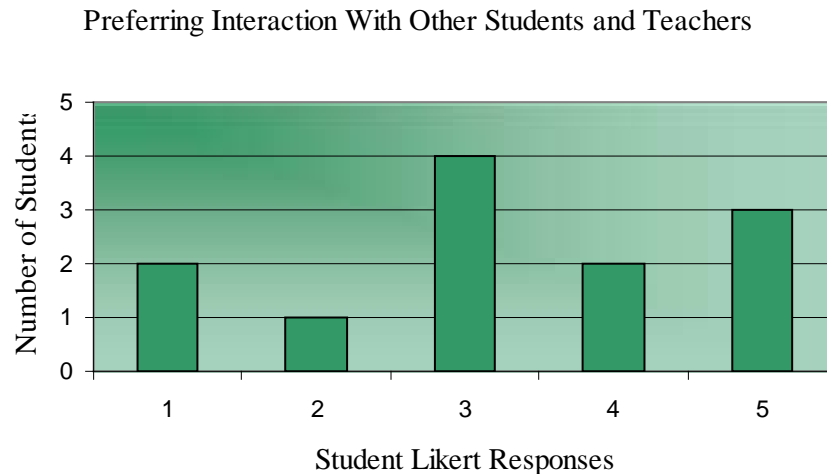
*Figure 8.* Face-to-face contact with teachers is necessary for learning ( $N=12$ ). From the Student Exit Survey, Appendix A. 1 = Strongly Disagree and 5 = Strongly Agree.

Even teachers remarked about the need for more interaction. Their comments however were limited to electronic communication, but still emphasized the need for more communication. One teacher remarks,

I would require the students to check into their class so many times per week and even encourage the students to correspond with me more frequently, and not just when they needed help. Sort of a weekly progress report from the student to me.

Another teacher suggests as a way to improve the quality of the experience for his students, “I would like to add a chat function or make the discussion boards something the students would use more often.”

The need for more interaction is emphasized with student responses to another of the Likert-scale questions from the survey. Regardless of the success of students in their virtual school courses, students overall still prefer face-to-face contact with other students and teachers. Nine of the students, a convincing 75%, either agreed or strongly agreed to the statement.



*Figure 9.* I prefer interaction with other students and teachers ( $N=12$ ). From the Student Exit Survey, Appendix A. 1 = Strongly Disagree and 5 = Strongly Agree.

Still another student mentions that she prefers, “Classroom courses, because the one-on-one help is easier to get.” And to close this topic, one of my colleagues shared his experiences with the following comment:

I have taken virtual classes in college and they are much more interactive.

Students are able to communicate with other students and share the learning

experience. I would like to see a virtual program that is more than just reading material and then answering questions.

The same colleague shared an opinion of his on how the virtual school has affected him. He says, “The hardest part has been trying to manage my regular classroom time with the virtual school, and balancing the two.” Another facilitator states that “Time was definitely an issue.” The teacher facilitators were given an extra preparation hour during the first semester, but that was taken from them during the second semester, and the time commitment became difficult to take care of. The students often times would have the teacher’s cell phones or emails and send texts asking for teachers to reset a quiz for them if they failed to pass it on the first few tries.

Another issue with time was the teacher scored tests. At the end of each major unit, there were exams the students needed to print up and answer the questions to. Often times, a facilitator would go weeks without any Teacher Scored Tests (TSTs) to grade, then receive several that needed graded all at once. One teacher remarks, “The most challenging aspect was keeping up with grading the Teacher Scored Tests. There were times there were so many to grade, that I would get behind on them.”

It seems the overwhelming affect on teachers is the time commitment. Teachers often bring work home with them, but being a teacher in a virtual school means that work travels not only to one’s home, but everywhere. This is true especially for teachers who care for the students and their progress and success in any classroom.

In summary, much of the data shows that students can receive a level of education comparable to that which can be gained in traditional classrooms. However, students still lack much of the “human” touch or personal contact with instructors and

other students that they feel is important in their educational experiences. Teachers also feel the need for more contact and communication with their virtual students. Teachers as facilitators are also affected mostly by the time commitment necessary to teach both traditional and online courses.

## INTERPRETATION AND CONCLUSIONS

Online education has the potential to bring quality education to those students who may not be able to find it in a traditional classroom. By helping these students receive their educations despite varying circumstances, we will be helping to reduce the dropout rate as well as encouraging students to complete their education, and perhaps go to college. Students with differing circumstances were enrolled in online courses at Rawlins High School in Rawlins, Wyoming. These students were monitored during the course of the 2010 – 2011 school year, and their progress was measured and compared to progress made in traditional courses.

In my research, I chose to examine the progress of all students who successfully completed one or more online mathematics and science courses. Their data was then compared with the data from the students enrolled in my traditional mathematics and science courses. This data was then used to answer my research questions.

What are the potential benefits of online education for high school math students? 20% of the students who took the survey suggested that one benefit of online education included the ability to work at one's own pace in order to complete the required schoolwork. Another benefit was the ability to do the work on one's own time schedule. A large proportion of students, six of the twelve, cited the style of work as a major

benefit of the online courses. These included the study guides, quizzes, and the overall amount of assignments required for the credit. In a post-survey interview, a student mentioned that, “the quizzes were multiple choice, so the answers were easier to figure out.” When asked why the quizzes may have been easier, another student remarked that the study guides were helpful in answering questions on the quizzes and tests, saying simply, “The study guides were helpful.” The teacher’s who were surveyed suggested that one important benefit was that virtual schooling gave students opportunities to finish or further their education who otherwise would have found reason to drop out.

What are the potential downfalls of online education for high school math students? Comments for this question were varied, but some common themes occurred. Students mentioned that their lack of self-motivation left themselves distracted while using the internet, and less likely to focus on their online studies. The fact that the course was online allowed them to be “easily distracted sometimes” to the point where one student mentioned that, “instead of doing my work I would be on Facebook.” Another problem came in that students did not have access to an instructor while working on their coursework, and that the need for an instructor in their education was important.

How does student success in online math classes compare to that in traditional classrooms? Student successes can be measured in a variety of ways. Based on student responses in the survey, many students marked that they had either completed the course successfully or were still in the process of completing the course. As for RIT scores, there were four students who benefited greatly from the online courses, improving their RIT levels by more than 12 to 13 points. Still there was one student who made no progress at all and even digressed by three points from beginning to the end of the school

year. This is not that different from traditional courses. In three traditional mathematics courses, I had 8 of the 76 students whose RIT scores digressed from beginning of the school year to the end. In both cases, approximately 11% of students did worse in the third administration of the MAP Test than in the first.

What are student attitudes and concerns toward online education? As stated above, students typically enjoyed their online courses for a number of reasons. The data from the survey suggests that eleven of the twelve students are willing to take other online courses in the future, and 75% of them would recommend online courses to their friends. Their concerns dealt some with the ease of the course and others with the difficulty. Largely, students still prefer to have some contact with instructors and other students.

What are the impacts of online education on the teachers? Teachers remarked that the time spent monitoring students in the courses was not an issue on their time. However the requirement to grade Teacher Scored Tests (TSTs) was somewhat of a burden. It was also mentioned by teachers that they would also prefer more contact with their students, either face-to-face or in discussion boards or regular electronic communications.

What is the impact of online education on student achievement at the high school level? At the conclusion of the 2010 – 2011 school year, it was determined that students enrolled in online mathematics and science courses made sufficient progress. However, student comments and data suggested that a hybrid-type online course may be more effective and better accomplish the desired goals for students with exceptional circumstances.

## VALUE

At the conclusion of this research, I find myself with several questions as well as answers. Some of these questions I have answers for and others are still waiting to be answered. For me, what I learned most by going through the process of preparing this capstone was not about the subject matter, but about the process of writing a paper. I've never been one to accept and deal with receiving feedback, especially when it's negative. However, I've learned to treat such feedback as constructive, no matter how it was initially received, and to build and strengthen my own thoughts based on the suggestions of others. I've also learned a great deal about the process of data gathering and analysis. As I prepare to continue studying this topic, I will be better prepared to gather data at appropriate times and with more efficient methods.

I've always considered myself to be a physics teacher by nature and a mathematics teacher by trade. I've found it easier to encounter teaching positions in mathematics than in physics. With the growing world of online and virtual learning, I am having more and more opportunities brought to me to expand my ability to teach both math and physics. This research has brought some details of my classroom teaching as well as my online teaching to the forefront of my thoughts. Mainly, the student data I encountered about what students feel they are missing in online learning. As John Dewey suggests, students at the high school level are still developing their social skills. Personal interaction is a valuable part of that. In the future of my online teaching experience, I will strive to make student experiences more positive by increasing the amount of interaction. Whether it is through classroom discussions, chats, cell phone texts and conversations, or via social networking, my virtual students deserve as much



interaction with me and their peers as my traditional classroom students receive daily in my classroom. I will make my virtual classrooms a place where students can not only learn about the subject matter but about life skills as well, thus turning the virtual classrooms into more positive learning environments.

I also plan to continue my research and data gathering in this area. Besides my many curiosities and fascinations in physics, I am also a great supporter of technologies and especially their uses as mobile learning devices. I believe it is as important to teach students the ability to find answers to their questions as well as to teach them the mathematics and science with which the technologies function and work. I was only able to sample a small population of students for this paper. I am now more curious to know what will happen to the data once I have a chance to increase the student population size. The school district will be continuing their investment into virtual learning, and I will have many more opportunities to interact with online learning students.

I will be sharing my current research with my school district as well as my intentions to continue the process. I will continue to use the hybrid survey, and will continually add to the data I've gathered thus far. I will also increase the amount of student-teacher interaction with the online learning students and compile the feedback I get from them during and after completion of their courses. As with any learning environment, be it online or traditional, it is important to receive feedback on what can be done to enhance the student's abilities to learn and grow intellectually.

Never before having been involved in research of this caliber left me with much to learn about the process, as mentioned above. What I could have done differently is what I plan to do in the future of this research. It is easier to gather and process data

when it is gathered a bit at a time instead of in large chunks, or at the end of the process. There is data that can only be gathered at specific times of the year, but much of the qualitative data that gives depth to a study can be gathered each day from students. This is the formative assessment that teachers use every day. It is the type of assessing that we use as educators to drive and direct our instruction. This is the intended path I will take to not only improve my teaching but to also improve the quality of instruction for my online students and my traditional classroom students.

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APPENDICES

APPENDIX A

STUDENT ONLINE EXIT SURVEY

## Virtual & Online Learning Course Exit Survey

Please answer each of the following questions. Your answers are important, and will be used to help the program to become better for future students. Make sure to respond to all the questions. Fill in bubbles completely and write any handwritten responses legibly. Participation is voluntary and participation or non-participation will not affect your grade or your standing in the virtual learning course.

### Section I: Information About You.

1. What is your gender?  
 Male                       Female
2. What is your primary language?  
 English                       Spanish                       Other: \_\_\_\_\_
3. What grade level are you currently in?  
 8<sup>th</sup> or Under                       9<sup>th</sup>                       10<sup>th</sup>                       11<sup>th</sup>                       12<sup>th</sup> or Over

### Section II: Your Online Education Experience

4. Including this course, how many online courses have you taken?  
 1                       2                       3                       4                       5 or more
5. What was your primary reason for taking this online course?  
 Credit Recovery  
 Schedule Conflict  
 To Get Ahead or Begin Taking College Courses  
 Distance To School  
 Employment Reasons  
 Personal Reasons (bullying, pregnancy, etc...)
6. How many hours did you spend working on this class each week, on average?  
 1 – 3                       4 – 6                       7 – 9                       10 – 12                       13 or more
7. How many hours do you spend online each week, on average?  
 1 – 3                       4 – 6                       7 – 9                       10 – 12                       13 or more
8. Do you also attend other classes on campus?  
 Yes                       No

9. What are your immediate plans after graduation?

- Trade School  
 2-Year College  
 4-Year University  
 Part-Time Employment  
 Full-Time Employment  
 Other: \_\_\_\_\_

10. What subject was this course taken for?

- Math Foundations  
 Fundamental Math  
 Algebra I  
 Geometry  
 Algebra II  
 Pre-Calculus  
 Science Course: \_\_\_\_\_

**Section III: Course Evaluation (5 = Strongly Agree & 1 = Strongly Disagree)**

	1	2	3	4	5
11. This course was challenging.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. This course was helpful.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. I would take another online course.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. I am comfortable communicating electronically.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. I can access the internet regularly.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. The course objectives were clear.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. The assignments were relevant to the course.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. The amount of work required was appropriate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. The instructor/facilitator was available to help.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. The software was easy to navigate and use.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. I would recommend online courses to a friend.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. As a student, I enjoy working independently.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. As a student, I enjoy working with others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24. I feel that face-to-face contact is necessary to learn.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
25. Learning is the same in class and at home on the internet.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
26. I prefer interaction with other students and teachers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Section IV: General Comments**

27. What were the overall strengths of the course?

28. What were the overall weaknesses of the course?

29. What could be done to improve the course and your experience?

30. Do you prefer taking traditional classroom courses or online courses? Why?

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Thank you for your time. The answers you have provided us will help to make the program ever better for future students.



APPENDIX B

PARENT/GUARDIAN CONSENT FORM

STUDENT/SUBJECT & PARENT/GUARDIAN CONSENT FORM  
FOR PARTICIPATION IN HUMAN RESEARCH

Research: To determine the impact of virtual & online education on high school students.

Participation: Completion of an end-of-course survey.

Description: You are being asked to participate in a research study that has the goal of determining the *impact* of online education and virtual learning on high school students. This study may help us to determine the *advantages* as well as the *disadvantages* for students involved in online education and may also help to determine if *student success* in a virtual learning environment is *comparable* to that of a traditional classroom. You are being asked to participate because you are or have been enrolled in an online course at Rawlins High School.

If you agree to participate, you will be asked to complete an End-Of-Course Survey when you finish your course. The survey should take no more than ten (10) to fifteen (15) minutes to complete, and includes thirty (30) questions or statements. The survey will ask you to share your *experiences* and your *opinions* of the course you took or are taking, but will not ask you for any identifying information, therefore your comments will remain *anonymous* and *confidential*.

As your participation involves *only* the completion of a short and anonymous survey, there are no *risks* or direct *benefits* to you as the participant. Your participation is *encouraged*; however, you will receive no negative feedback should you *choose* not to participate. If you have any questions regarding the research, the survey, or this form, you may contact the high school.

Parent/Guardian: I have read the above and understand the purposes and the requirements of this study. I, \_\_\_\_\_ (*name of parent or guardian*), related to the student/subject as \_\_\_\_\_ (*relationship*), agree to the participation of \_\_\_\_\_ (*name of student/subject*) in this research. I understand that the subject or I may later refuse participation in this research and that the subject, through his/her own action or mine, may withdraw from the research at any time. I have received a copy of this consent form for my own records.

\_\_\_\_\_  
Parent/Guardian Signature

\_\_\_\_\_  
Parent/Guardian Print

Student/Subject: I have read the above and understand the purposes and the requirements of this study. I, \_\_\_\_\_ (*name of student/subject*), agree to participate in this research. I understand that I may later refuse to participate, and that I may withdraw from the study at any time. I have received a copy of this consent form for my own records.

\_\_\_\_\_  
Student/Subject Signature

\_\_\_\_\_  
Student/Subject Print

Parent/Guardian was contacted by phone, and permission to administer the survey to the student was granted.

SUBJECT CONSENT FORM FOR PARTICIPATION IN HUMAN RESEARCH

APPENDIX C

SURVEY RESPONSE RECORD SHEET

### Survey Response Record Sheet

Hybrid Survey Response Record						
1	What is your gender?	Male:			Female:	
2	What is your primary language?	Eng:		Esp:	Other:	
3	What grade level are you currently in?	< 9	9	10	11	12 >12
4	How many online courses have you taken?	1	2	3	4	5+
5	What is your 1 <sup>st</sup> reason for taking this course?	CR	Sched.	Advance	Distance	Job Pers
6	How many hours did you spend working on this class each week, on average?	1-3	4-6	7-9	10-12	13+
7	How many hours do you spend online each week, on average?	1-3	4-6	7-9	10-12	13+
8	Do you also attend other classes on campus?	Yes			No	
9	What are your immediate plans after graduation?	Trade	2-Yr	4-Yr	Part-Time	Full-Time
10	What subject was this course taken for?	MA	SCI	R/WR	SS	Elec
11	This course was challenging.	5 3	4 7	3 5	2 3	1 2
12	This course was helpful.	5	4	3	2	1
13	I would take another online course.	5	4	3	2	1
14	I am comfortable communicating electronically.	5	4	3	2	1
15	I can access the internet regularly.	5	4	3	2	1
16	I can access the internet regularly.	5	4	3	2	1

17	The assignments were relevant to the course.	5	4	3	2	1
18	The amount of work required was appropriate.	5	4	3	2	1
19	The instructor/facilitator was available to help.	5	4	3	2	1
20	The software was easy to navigate and use.	5	4	3	2	1
21	I would recommend online courses to a friend.	5	4	3	2	1
22	As a student, I enjoy working independently.	5	4	3	2	1
23	As a student, I enjoy working with others.	5	4	3	2	1
24	I feel that face-to-face contact is necessary to learn.	5	4	3	2	1
25	Learning is the same in class & home on internet.	5	4	3	2	1
26	I prefer interaction with other students & teachers.	5	4	3	2	1
27	What were the overall strengths of the course?	Student comments in this column:				
28	What were the overall weaknesses of the course?					
29	What could be done to improve the course and your experience?					
30	Do you prefer taking traditional classroom courses or online courses? Why?					

APPENDIX D

TEACHER/FACILITATOR INTERVIEW QUESTIONS

