

HIGH SCHOOL STUDENTS' PERCEPTIONS OF PHYSICS

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I dedicate this endeavour to my Mother and Father,
Mary and Don Checkley,
Two exceptional teachers, mentors, and parents.

Abstract

There are far fewer high school students enrolled in physics than in chemistry or biology courses within the province of Alberta (Alberta Education, 2007). Students are also completing the highest level math course in larger numbers than those taking physics. It appears that a fear of physics exists within students in our province; this fear seems to be related to a level of difficulty the students associate with physics. Many students either opt to not take physics or enter the course with the expectation of failure. In this study I explored the impact of physics' reputation upon a group of students who chose not to take physics. In addition, I attempted to determine whether the perception of the difficulty of high school physics is accurate. This was done by investigating the perceptions of several students who took physics. I surveyed students from one high school in a small urban school district using group interviews. The students were in grades 10 to 12 and divided into groups of Science 10, Physics 20 and Physics 30 students. The students were interviewed to gain a deeper understanding of what perceptions they have about physics and why they may have them, hoping to identify factors that affect their academic decision to take or not take physics classes. For the students interviewed, I found that the biggest influence on their decisions to take or not take physics was related to their future aspirations. The students were also heavily influenced by their perceptions of physics. The students who took physics claimed that physics was not as difficult as they had believed it to be and they reported that it was interesting, enjoyable and relevant. Those students who had chosen to not take physics perceived it would be difficult, irrelevant and boring. Therefore, a major difference of perception exists between the students who took physics and those that did not.

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Chapter One: Introduction

In ancient Greece, physics was originally known as natural philosophy. The word philosophy itself stems from the Greek “philos” – love or lover, and “sophos” – wise or wisdom; thus the literal translation of philosophy is “lover of wisdom” (Neufeldt & Sparks, 1995, p. 442). Physics, therefore, could be something looked at with admiration; it is the love of the wisdom of nature. Unfortunately, there seems to be a trend in the opposite direction. From the Greek “phobos” it appears that a general “physics phobia” may exist within our society. Perhaps phobia is too strong a term, but from my experience as a high school physics teacher, I can attest that many high school students are afraid of physics. What they are afraid of is what they perceive the difficulty of physics to be. This perception is shaped by a variety of sources including parents, family, friends, and even teachers. However, this perception may not be accurate; in fact, it may not be accurate at all.

The impact that this negative perception can have on high school physics enrolment and in turn the effect that a less scientifically literate population has on a society is the cause of my concern. As a high school physics teacher I have noted that there are far fewer students taking physics than the other sciences at the high school level (Alberta Education, 2007). It could be assumed that this is due to a lack of the necessary math skills; this however is not the major issue since just as many students complete the highest level math classes as chemistry and biology (Alberta Education, 2007). There does seem, however, to be a consensus among students (and people in general, including teachers) that physics is a very difficult subject.

Could it be that the reputation of physics as being difficult instils a fear in students that needs to be suppressed if enrolment is to increase? I explored what creates this perception of difficulty in our students and if this reputation is contradicted by students who take physics. If students who take physics disagree with society's perception, perhaps the mystique of its difficulty can be overcome by sharing physics students' perceptions with other students before they have to make their academic decisions. It is my belief that anyone can succeed in physics; they just need to get past their fear of it first. After all, physics is a powerful tool that has allowed human beings to explore and explain the most mesmerizing of phenomenon; it should be looked at with appreciation and not fear. Educators must work towards this end.

In order to examine and contrast the perceptions of physics students with students that did not take physics, I did group interviews with students from both groups. We discussed the students' opinions about physics, if they found it difficult or irrelevant, and if they felt the subject was interesting or enjoyable. In order to discuss these perceptions with students who had not taken physics courses, I had the students reflect upon their experiences in the physics unit of Science 10, the grade 10 general science course. These students were therefore exposed to some basic physics, but had not been fully exposed to a high school course that was specific to physics. The physics students interviewed had completed either Physics 20 (the grade 11 course) or Physics 30 (the grade 12 course that includes a provincial standardized test).

Rationale

I have noticed that when I ask the average person to describe physics a term they often use is, "hard". Each individual may have a different opinion about what, in

particular, is difficult about physics. Some find the algebraic emphasis difficult, and some find the physical concepts difficult to wrap their mind around. Others comment that the workload, or the level of critical thought required, is intimidating. Whatever the cause, there seems to be a general fear of physics in our society. This fear has negative repercussions. For example, when fewer students take physics it limits the number of people capable of working in technological fields (Angell, Guttersrud, Henriksen & Isnes, 2004, p. 702). Physics is a major part of our everyday experience. Obviously, we cannot escape the forces of nature, but we also interact with technology every day – technology that is based entirely on physical principles. As a teacher, I am aware that students' perceptions about subjects are influenced by their parents, peers, the media, and their teachers. I think it is therefore very important that students are exposed to influences that are directly related to those subjects. Teachers and peers that are involved with high school physics should be communicating their perceptions to students unsure of their academic futures. If students who have taken physics feel that it is no more difficult than other subjects, then we need to share that opinion with students who haven't taken physics. This may serve to dispel a misconception that could be influencing students to not take physics. As a high school physics teacher, I know that physics is not an easy subject to master, but I also know that students can find other academic subjects just as demanding. The intimidating reputation of physics may be creating a barrier for bright minds that keeps them from attempting physics classes. Less than half the students who take Math 30 Pure take Physics 30 (Alberta Education, 2007). There are factors that can explain why more students take Math 30 Pure; for example Math 30 Pure only competes with one other subject (Math 30 Applied), whereas Physics 30 competes with three other

classes at the 30 level (Chemistry, Biology and Science 30). However, with double the numbers in Math 30 pure, and with many students take more than one science, it seems the phenomenon of fewer students in physics classes cannot be blamed solely on math skills.

This study set out to examine what perceptions students have in Science 10 that may turn them away from choosing Physics 20. I explored if they, in fact, perceived physics to be more difficult than other high school classes and if this perception influenced their decision in regards to taking physics. In addition to this, I investigated the reasons many students fail to enrol in Physics 30 after completing Physics 20. I assessed what was influencing this decision and if the level of difficulty of the subject was a prime deterrent. Lastly, within this study, I analyzed if the perception of difficulty with regards to high school physics is warranted. I compared the perceptions of students who took physics to those who did not take physics to examine if a difference was apparent.

Question

How do students' perceptions of physics differ throughout their senior high experience?

Chapter Two: Literature Review

Why Do We Care?

In the year 2000, the Department of Education in the United States of America issued a report that emphasized the need for academic engagement and improvement in math and science. The document was entitled *Before It's Too Late: A Report to the Nation from the National Commission on Mathematics and Science Teaching* (2000). The document states that: "the future well being of our nation and people depends not just on how well we educate our children generally, but on how well we educate them in mathematics and science specifically" (p. 7). The document describes the importance of technology to the age of globalization and the growing dependence of human beings on this technology. It then declares that the data available describes a decline in performance of American students in the subjects of math and science and deems it unacceptable in this new world of technological advances (p. 8). This document details the societal impact of a mathematically and scientifically undereducated population in detail, naming four main components. Firstly, the economic impact of new technology – the economy grows with technology, but without the workforce to fuel the engine, the economy stumbles (p. 15). Many facts and figures follow, but one to highlight would be that 34.6% of all bachelor's degrees and 44% of all master's degrees in mathematics, engineering and information sciences awarded in the United States are given to non-US citizens (p. 16). Secondly, a concern is expressed that a functional democracy would be unable operate if the citizenship is undereducated. The authors question whether people would be capable of making informed democratic decisions if they cannot understand the information they are given (p. 17). Thirdly, the document highlights the dependency of

national security on technology; it is pointless for a nation to outsource its national security needs (p. 17). Lastly, the document highlights the deeper value of math and science which is that it allows us to unlock the secrets of our universe to better understand and cope with the world we engage in (p. 18). In summary, this document shows that the United States is concerned with decreasing enrolment in the sciences in general, but much of what was discussed above relates to a lack of human capital in the physical sciences – engineers and technicians to maintain and improve technology and society as a whole. Though this document is from the United States it is relevant in describing what the economic effects of under-enrolment in the sciences (and particularly in physics) could be on Canada`s society.

Owen, Dickson, Stanisstreet & Boyes (2008) highlight the concern in the United Kingdom over declining numbers of physics students at both the secondary and post-secondary level (p. 113). They point out that a decrease in students enrolled in physics at these levels leads to concerns of sustaining an educated base capable of working in science and technology research, education and industry. This could have a major impact on the economic reality of the United Kingdom and an effect on its general population (p. 113). Dawson (2000) echoes this sentiment, demonstrating that scientific literacy is also considered a necessity in Australia. He states that it serves the greater good of a working democratic society (i.e., informed people making decisions based on critical understanding), and offers potential human capital for the work force.

Lyons (2006) demonstrates that there is a similar anxiety in Australia where there has been a large decrease in students enrolling in science classes. This has created concern about scientific literacy and technological expertise in Australia (p. 285).

Engineers, scientists and health professionals are often drawn from high achieving high school science students. A decrease in the number of students enrolled in high school science decreases the pool to draw scientific professionals from (Lyons, 2006, p. 286). Similar concerns are echoed by Angell, Guttersrud, Henriksen & Isnes (2004) who see a growing concern in western countries related to the decreased enrolment of students in physics. These authors also state that this decrease in enrolment will have the consequence of limiting people capable of working in science and technology, slowing industrial advancement in many western countries (p. 683). Decreasing enrolment rates is consistently highlighted in the literature as affecting the scientific literacy of societies (Lyons, 2006; Owen, Dickson, Stanisstreet & Boyes, 2008). It becomes difficult to pass on scientific knowledge with depleted scientific literacy, as possible science educators become limited. Over an extended period of time this could eliminate scientific literacy within a community.

Osborne, Simon and Collins (2003) also highlight the significant decline in students' interest in science and the growing lack of scientific literacy. They examine the negative impact this has on the United Kingdom's economic, political, and industrial well-being (p. 1049). The authors look at current literature in the field to demonstrate that students taking A-level subjects in math and science (i.e., studying these subjects past the age of 16) decreased by half from 1980-1991 (Osborne, Simon & Collins, 2003, p. 1050). The decline in students taking A-level sciences continued over the next decade as well. More alarming is that the trend is worse for physics than for the other disciplines. In the period from 1990-2001, the number of students examined in physics dropped from approximately 45,000 to under 30,000 (Osborne, Simon & Collins, 2003, p. 1051). The

authors note that similar concerns have been raised in the past without employers becoming overly concerned about a lack of technically capable human capital. The argument is that raising salaries for technicians and engineers can counteract this decline (Osborne, Simon & Collins, 2003, p. 1052). Osborne, Simon & Collins argument against this conciliation is that their society's increasing dependence on technology, matched with a trend of decreasing numbers in the capable workforce, will eventually lead to a insufficient amount of capable workers. Furthermore, they demonstrate that there appears to be a clear correlation between economic success and the number of trained engineers and scientists within a society, and that an increase in mathematical and scientifically literate population could not hurt an economy (2003, p. 1053).

Decreased numbers of scientifically literate students also has an effect on the problem of a lack of females choosing careers in science based industry. A decreased population of scientifically literate people leads to a decreased number of female role models in science. Zohar & Bronshtein (2005) explore the effects of the gender gap in physics as a two-fold problem – one relating to females in particular the other to society in general. Firstly, in regards to females, the authors demonstrate that having fewer females studying physics limits the number of females that can enter several university programs and eventually undertake scientific careers. This maintains the status quo of gender inequality in scientific professions (p. 61). This is a common theme in the literature; physics is a required subject for many important jobs in the sciences and females are limiting their ability to work in these fields (Lyons, 2006; Owen, Dickson, Stanisstreet & Boyes, 2008; Zohar & Bronshtein, 2005; Angell, Guttersrud, Henriksen & Isnes, 2004). Secondly, Zohar & Bronshtein (2005) explore the effect of small female

enrolment in physics generally; they point out that fewer female physics students adds to the problem of fewer physics students in general (p. 62). When females choose to not study physics in high school it leaves smaller numbers of students in general that are available to become scientific professionals. Due to its relevance to technology and infrastructure, physical science tends to limit advances in many areas of scientific study. Limited females in an already limited pool of human capital compounds the adverse effect of decreased physics enrolment can have on society. We will see in a later examination of the gender issue that less female students in one generation can lead to a perpetual decrease in enrolment over future generations.

Schibeci and Lee (2003) also see the negative impact of decreasing enrolment in physics on society. The authors state that people need a basic amount of scientific literacy to make informed decisions in regards to both personal and social well being. If our society's general understanding of science is low, then people will struggle to make proper choices in the political process. A lack of informed decision making could have devastating effects on society, the economy and the environment (p. 177). Duggan and Gott (2002) comment on the importance of scientific literacy in industry, and in turn the economies of nations. The authors explain that a significant portion of the workforce in the UK, almost 30%, claim to use science and math on a daily basis (p. 663). Duggan and Gott (2002) demonstrate that most employers have a desire to hire employees who have problem solving capabilities more than employees with basic scientific content knowledge (p. 661). That is to say they desire employees who know and can use the scientific process rather than spout out scientific facts. Physics at the high school level is truly an exercise in the scientific process. Students are required to analyze and interpret

what the problem is and what information they have been given to solve it. Then the students must devise a means of determining a solution and execute this process. This process is what Duggan and Gott (2002) conclude is the essential lesson of science education for a responsible citizenship. They list 3 necessary outcomes to deliver this:

1. Pupils need to know and understand the principle concepts of evidence and the overarching concepts of validity and reliability.
2. Pupils need to know how to use and apply concepts of evidence such that they can critically evaluate scientific evidence.
3. Pupils need to know how to: access conceptual knowledge which is directly relevant to topical issues; apply and use such knowledge in 'real' issues. (pp. 674-675)

These necessary outcomes seem to be inherent to physics education.

Similar Studies: Perceptions and Enrolment

Lavonen, Angell, Bymen, Henricksen and Koponen (2007) examine some background variables that may explain why students desire, or do not desire, to study physics. The authors also note that little research that has been done on students' perceptions about physics and physics learning (p. 82). These authors demonstrate that there are several factors that seem to affect a student's decision in regards to taking physics and the authors organized these factors into three categories: teaching methods, other classroom activities, and external factors (Lavonen, Angell, Bymen, Henricksen & Koponen, 2007, p. 86). They also note that for the students, much of the physics curriculum is often considered boring. This is where teaching method and classroom activities come into play; if one can make the content delivery interesting, then the

students' interest in the subject should increase (Lavonen, Angell, Bymen, Henricksen & Koponen, 2007, p. 87). In regards to external sources Lavonen, Angell, Bymen, Henricksen and Koponen (2007) see the following factors as major influences on students' decisions about enrolling in physics:

Gender, personality, values and beliefs of individual students, along with those of their peers, friends, parents and classmates, influence their attitudes towards a subject and their choice of subjects. Physics, in particular, is seen as a difficult subject and students give great weight to that when they select subjects for specialisation in upper secondary school. (p. 87)

The authors demonstrate, generally speaking, that boys have a more positive attitude towards physics and are therefore more likely to take on the subject. These authors do, however, note that girls can overcome their mental barrier towards physics if a teacher works to improve teacher-student co-operation (Lavonen, Angell, Bymen, Henricksen & Koponen, 2007, p. 88). The authors demonstrate that the beliefs and values of the students and the people around them shape their idea of physics before ever setting foot in a classroom; many students who take physics seem to have a positive attitude towards physics before taking it. Lavonen, Angell, Bymen, Henricksen and Koponen (2007) report that for both genders of students taking physics, there was a perception that it was a highly interesting subject (p. 97). Therefore the problem becomes a question of how teachers can promote a positive attitude towards physics to students before they get into the physics classroom. Once enrolled in physics, the students are enjoying it, but a negative preconception may be keeping them from getting through the door.

Stokking (2000) did a study in the 1990's that looked at students' reasoning for taking physics in The Netherlands. The author describes four main factors affecting a student's decision to take physics: future relevance (to keep options available to themselves for both post-secondary and occupational aspirations), appreciation of physics concepts, building self-confidence, and, finally, interest (p. 1279). I find it important to note that this author states that the number one factor influencing students' decisions is future relevance (Stokking, 2000, p. 1261). Many students I teach tell me that this is their main reason for taking physics, that they want to "keep their doors open" for the future. Stokking (2000) also highlights that the major deterrents from taking physics were a lack of interest, concerns about marks, and perceived difficulty (p. 1272). These factors were taken into account for my questionnaires and interviews.

Lyons (2006) explores the reasons students in Australia were taking less physical science courses (physics and chemistry) at the secondary level. The author demonstrates that much of the research states that the major factors influencing a student's decision on what classes to enrol in are related to the students own individual variables: "including achievement levels, gender, ethnic identity, personality traits, parents' education levels, and socioeconomic status" (p. 285). The author also notes that the researchers are not entirely sure why these factors are influencing students and that there is a greater need to discuss the academic decisions of the students with the students themselves as little research has been done that displays a student's point of view on their own academic decisions (p. 294).

Lyons (2006) explains that his study looked primarily at high achieving academic students, and that he did this to eliminate the factor of achievement levels so he could

examine why students capable of completing these physical science courses were still not enrolling (p. 286). This relates to my research, as I wanted to investigate why Alberta has more than twice as many students enrolled in its academic grade 12 math course, Math 30 Pure, then it does in its grade 12 physics course, Physics 30 (Alberta Education, 2007).

Lyon's (2006) study used a socio-cultural approach in which he highlights that there are many different worlds a student "lives" in and that these worlds have to be negotiated by the student. This negotiation has influence on the students' decision making process, including what they choose to enrol in. He breaks these worlds into four influencing realms and one central realm. The influences include Family, Peers, School Science and Mass Media and the central realm is titled Self (p. 292). These influences are the same factors I have based my questionnaires around.

Lyons (2006) study consists of two large scale questionnaires that regarded the students' socio-cultural influences and the teachers' opinions about enrolment. This was followed by interviews of thirty-seven individual students about the results of the questionnaires (p. 294). Lyons describes four major perceptions students had of school science that were affecting enrolment decisions. Firstly, he states a common description of physical science as being teacher-centered and knowledge based. This was not something that was deterring students necessarily, but something that was common to the student descriptions (p. 295). The second common theme was that physical science is irrelevant and boring; students who believed this were not enrolling at the next level (p. 295). It is important to note that these students were grade 10 students and, like our grade 10 students, had only taken general science courses to this point. This fact is something I have compared to the opinions of my Science 10 interview groups. The third

common theme was that physical science is difficult, or at least more so than other classes. This perception was also driving students to not take physical science courses. The students pointed to several sources of this belief including their teachers, peers, and parents (p. 296). The negative influence of teachers in this realm is dangerous and concerning. I feel that this could be a bigger factor than teachers realize. Lastly, the students reported that physical science was something one took strategically for post-secondary education. They claimed that these classes keep doors open for you and allow for greater success at the post-secondary level (p. 296). Surprisingly, Lyons (2006) demonstrates that the students' decision to take or not to take physical sciences at the secondary level was not based upon past positive or negative school science experiences. Students who had experienced negative junior high experiences were still enrolling at the secondary level and those with positive experiences were not always enrolling (p. 295). An interesting point was raised when looking at the strategic aspect of choosing to take the physical science courses. Several teachers believed that students were not taking the courses because they saw scientific careers as limited and low paying. None of the students echoed this sentiment; in fact they claimed that scientists must be well paid (p. 298).

Lyons (2006) also examines the family realm and its influential themes. In the family world, Lyons (2006) describes the students' three common spheres of influence. The first is related to parental attitudes towards formal education. This influence related closely to the school world's influence of taking physical science as a strategic incentive. Some of the parental influence to take physics related to parental success, but also some to parental regret. Several parents were encouraging their student to take physical science

to avoid the obstacles or road blocks they themselves had experienced (p.299). The second major influence in the family world revolved around family attitudes towards science. The vast majority of the students choosing physical science could name at least one key family member who continually advocated science in their home. Some were directly related to a scientific profession, others simply shared an appreciation of science (p. 300). The last common theme discovered in the family realm was social capital within family relationships. Here students who had strong family relationships showed a greater chance of taking physical science especially if those family members were advocates of the sciences (p. 302). Lyons also describes a strong correlation between quality of family relationships and high levels of confidence and academic self-efficacy (p. 302). In the end, Lyons demonstrates that the family and school realms can hold influence over each other and can work together to give a student what they need to take physical sciences. Lyons conclusions can be summarized as such: a student is more likely to enrol in the physical sciences if either the student's science teachers or a key family member advocates the physical sciences and/or emphasizes the strategic importance of taking physical science. This help's overcome the student's preconception of the irrelevance and boredom of the subject. It also creates an ability to deal with any fear of the difficulty of the subject (p. 307).

Osborne, Simon and Collins (2003) see that many students perceive the subject matter of physics, and science in general, to be overly difficult. The authors discuss one study in which the level of difficulty of the physical sciences was determined as the major influence on students deciding not to take physics (p. 1070). Osborne, Simon and Collins (2003) also note that students who do end up taking physical science are most

often those who have the highest marks at the lower levels in math and science. Although this may not be something imposed by the schools themselves, it creates the notoriety of physics being only for the most gifted and intellectual (p. 1071).

Angell, Guttersrud, Henriksen and Isnes (2004) conducted a study in Norway that had similar results to the Australian findings. The authors show that students' decisions about course enrolment is affected by several factors; similar to Lyons (2006) they see that parents and teachers have a major affect on the students perceptions of physics and that this affects their course selection (Angell, Guttersrud, Henriksen & Isnes, 2004, p. 684). They also examine student perceptions of physics by contrasting "Physics" students with those that believe that English or Social Science is their most important subject. They state that a major preconception of physics for students both taking and not taking physics is that the subject is "difficult", though this perception is greater for those not taking physics. Students in physics did not conceive that physics is as difficult as those who do not take it. Students not taking physics also saw the subject as only for the most capable, whereas students in physics held the opinion that anyone could study and succeed at physics. There was evidence that students not enrolled in physics reported feeling that physics was both not interesting and not relevant to the real world. This kind of thinking may be a major obstacle to increasing the number of students taking physics. Not surprisingly, students who had attempted physics classes reported opinions conflicting with their peers'; they indicated they perceived physics as both interesting and relevant (Angell, Guttersrud, Henriksen & Isnes, 2004, p. 690). In my own experience parts of society perceive physics as some pseudo math that has no relevance to their daily lives. The general ignorance of the subject matter lends to a negative stereotype amongst

those unexposed. This negative prejudgement, though unfortunate, is something that I expected to discover in this research based on past classroom discussions with students.

Angell, Guttersrud, Henriksen and Isnes (2004) also examine the impact of math on physics enrolment. They explore whether or not the real problem behind declining enrolment rates is based in mathematical difficulty. Their research shows that the physics teachers they studied perceived this as more of a problem than the students did (p. 692). In fact, the authors demonstrate that the students interviewed claimed that the math in physics was not that difficult. They claimed what made the course difficult was the fast progression of topics and the large amount of curriculum content, two realms that obviously influence each other (p. 692). I often hear a similar opinion from my students that they feel the math in physics is not difficult in itself. Realistically, in high school physics, we only use algebra and simple trigonometry. Once students grasp algebra they are usually fine. Where my students have claimed to struggle in the past is in putting the large amount of curriculum all together. I expected that this would be demonstrated in my Physics 20 and 30 interviews groups. Unfortunately, the authors did not investigate what the students not taking physics perceived the mathematical difficulty of the subject to be. This information could have been valuable in understanding the reason we have so many Math 30 Pure students compared to Physics 30 students.

Student Perception Obstacles: Irrelevance of Physics

Owen, Dickson, Stanisstreet & Boyes (2008) noted that high school students enter high school with a generally positive attitude towards science. These students, who are new to high school streaming, still see the subject of science as a whole and not as specific sciences such as physics or biology. The authors discovered a trend in which this

favourable opinion depreciated over the high school experience. Beyond this, the authors noted that as the students began to differentiate between the sciences; their opinions of physics were lower than those of the other sciences. Their study of high school students' opinions of physics showed that by the end of the secondary level, students perceive physics as boring, irrelevant and difficult (p. 114). In a similar study, Lyons (2006) showed that Australian high school students also saw physics as difficult, uninteresting, and irrelevant (p. 285). Unfortunately, neither of the studies compared physics students' perceptions to non physics students'. Angell, Guttersrud, Henriksen & Isnes (2004) also found that some students perceived physics to be boring and irrelevant. They, however, showed that it was students that did not study physics that felt this way; those that were taking physics classes actually claimed it was relevant and interesting (p. 690). The major obstacle to enrolment in physics may be getting students through the door of a physics classroom; once there, perhaps the students' negative perceptions can change. Alternatively, it may demonstrate that only those students who have positive preconceptions of physics are enrolling in physics.

Dawson (2000) did a long term study of junior high students in South Australia in which the author examined the students' interest in the sciences in 1980 as compared to 1997. The findings of the author's study echoed that of much of the literature; both boys and girls have lost interest in science in general over the past few decades and that girls have less interest than boys (p. 561). Again, like the majority of the literature, Dawson (2000) also highlighted the importance of making physics relevant to the students and adapting to their interests when delivering lessons (p. 557).

The Epistemological Barrier

Lising and Elby (2005) examined the impact of students' ideas about knowledge and learning, their epistemology, in regards to physics. This is an important factor that needs to be examined, as it could impact a student's success within physics and their desire to pursue it. Lising and Elby (2005) showed us that students often have conflicting ideas about how physics operates. Some see it as a cluster of unrelated topics and formulas while others understand that it is an attempt to unify our understanding of nature and is therefore interrelated (p. 372). The authors demonstrated that students can also have conflict between their social and individual epistemologies – their views on the learning process and collective knowledge of the physics community can differ from their interpretation of their own knowledge and learning process. In further exploration of this divide, the authors claimed that the students' individual epistemologies seemed to have a bigger impact on their learning and Lising and Elby (2005) focused their study on this idea (p. 373). The authors demonstrated that the human subject has a divide in her epistemology with regards to understanding physics. The human subject demonstrated an opinion that physics can either be explained quantitatively with formal reasoning and techniques or qualitatively through common sense but she failed to see the connection between the two (p. 396). This leads to a barrier in her learning as she attempts to explain physical problems in one realm or the other. If one realm is not working, she abandons that realm and attempts to explain it in the other. If she finds success in one realm that is good enough; she does not see a need to bridge her understanding. The authors showed that the only time she demonstrated an understanding of the relationship between the quantitative and qualitative, she is regurgitating knowledge passed on from her professor.

She failed to make the connections on her own (p. 380). This type of epistemology could lead a student to a view of physics in which they perceive that physical explanations do not mesh with the real world or common sense. This perception is acceptable to the student because they don't attempt to find the connections between physics and the real world, believing that they are non-existent. As Lising and Elby (2005) concluded, this creates a challenge for all physics instructors to find methods to determine student's epistemologies and work with them to break down any barriers they may have formed (p. 381). Epistemologies can exist in students where they believe that they do not learn math or analytical skills well in the formal sense, yet they also believe they use problem solving in day to day life all the time and do it well. The challenge to educators is demonstrating to students that they can bridge their "common sense" with formal analytical work. In order to do this, one may have to explore the student's epistemology and work with them to alter their opinion of their own learning ability.

The disconnect between what students see as their own common sense and the explanation physicists give is also explored by Gray, Adams, Wieman and Perkins (2008). These authors discussed the impact of students' ideas about physics and physics knowledge on their learning. The authors demonstrated that students know what physicists' explanations are, that they can reiterate the knowledge they've studied, but that many of them do not agree with these ideas and therefore do not have a true understanding of the material. This again speaks to an epistemological barrier between what students see as common sense and what they accept as the knowledge of the physics community.

These authors examined the difference between what students think about physics and what they perceive physicists to believe (p. 1). Gray, Adams, Wieman and Perkins (2008) showed that though the students can quite accurately describe physicists' opinions about physics, they themselves do not agree with these opinions. For example, there was a large split in the how students felt about day to day interactions; they believed that physicists would think about the physics of day to day activities while the students do not (p. 5). This lack of connection between ideas discussed in formal physics classes and real world phenomena is highlighted by the authors as a major problem for physics instructors and as a major barrier for physics students (p. 8). The student's failure to recognize the relationship between content knowledge and reality can be reinforced if a teacher's epistemology with regards to physics echoes the student's. Another possible explanation is that the teacher's perception of physics guides the epistemology of the students.

Teacher Perceptions

If understanding students' epistemological barriers is important to encouraging students to take physics, then having an understanding of where students' epistemologies come from is also vital. Mualem and Eylon (2009) discussed the effects of teachers' perceptions on their students, an important area to address when contemplating where students get their preconceptions of physics from. Mualem and Eylon (2009) showed us that although the western educational community believes in the importance of exposing students to physics at the junior high level (p. 135), many junior high students have difficulty understanding physics conceptually and have a fear of physics at the junior high level (p. 136). The authors offered that a plausible explanation for this condition of junior high students in Israel is that many of their teachers also share a fear of physics (p.

136). Mualem and Eylon (2009) noted the importance of knowledgeable and enthusiastic teachers in all subject areas, but admitted that within Israel, junior high teachers lack this characteristic with regards to teaching physics. According to the authors, 80% of junior high science teachers have a background in biological science, and these teachers admittedly have a small knowledge base in physics. These teachers reported that their lack of background knowledge in physics creates difficulty in delivering the curriculum (p. 135). Teachers' content knowledge and curriculum background, especially post-secondary experience can have a major effect on the achievement of students (Telese, 2008, p.11). Mualem and Eylon (2009) showed that at the junior high level in Israel there is a real lack of teacher content knowledge in physics. The authors showed the impact of this deficiency on one the interviewed science teachers they interviewed:

When I teach biology, I can easily bring my students many examples extending the specific topic. My expertise in this domain (biology) allows me to enter my class calmly. This is not the case when I teach physics...I spend many hours in preparing myself for every single lesson and I need to prepare myself for the prospect that I will not be able to answer many of my students' questions in related fields myself, confidence is low and I feel stressed and even nervous.

When I'm forced to solve problems that are raised during instruction, I project uncertainty in my answer...I don't like to teach this domain! (Mualem & Eylon, 2009, p. 135)

This has obvious implications on a student's epistemology; if a teacher has fears about physics, is this not projected onto their students? Mualem and Eylon (2009) explored this idea within their research. The authors did interviews with and gave questionnaires to

teachers before, during, and after a professional development opportunity designed to improve the teachers' conceptual (or qualitative) understanding of the physics they teach (p.142). The results of the study had some interesting implications. The commonalities the authors found in the preconceptions of the teachers were that the teachers did not feel that students could relate physics to the students' own worlds, that students do not (or cannot) find physics interesting, and that the subject matter is too abstract for the students to understand (p. 144). It is very important to note that the teachers reported these same interpretations about their own learning and understanding of physics – that they had trouble relating to, being interested in, and understanding physics (p. 144). The implications of the teachers post conceptions were just as interesting. The teachers had changed their opinions drastically after the professional development sessions. No longer did they feel that physics was boring – they could now relate it to their own world; and they no longer saw it as an abstract subject that was difficult to understand (p. 146). There was also the possibility of these teachers applying these new insights about physics to their beliefs about how their students learn. Mualem and Eylon (2009) demonstrated that as the teachers' beliefs about their students' learning matched the teachers' feelings about their own learning in their preconception interviews and questionnaires, their beliefs about their students' learning in the post professional development opportunity surveys also matched their new outlooks. After the professional development sessions, the teachers assumed that their new positive outlook on physics would be possible for their students as well (p. 146). From these findings we see that a teacher's perception of physics will at least have an impact on how they view their students' abilities to learn physics, if not on the students' own perceptions. This has many implications in high

school students' perceptions of physics. What has been their previous exposure to physics? Was a negative perception projected onto them, and if so did this have an impact? While I did not explore these ideas directly in my study I did imagine that teacher influence could come up in my group interviews and therefore felt that this was an important area to examine within the literature review.

The Societal Factor

In addition to the impact of the teacher's image of physics on a student's perception I would also like to explore the impact of societal images, and popular culture, on the student. Popular culture is defined by *The Crystal reference encyclopedia* (2005) as:

a term which, used in a narrow sense, describes mass cultural phenomena, such as soap operas, spectator sports, and pop music; more broadly, it describes the mentality and way of life of most people as opposed to elites. Popular culture is now the subject of serious study, with museums and university courses devoted to it.

The effects of mass media depictions of physics and physicists is something that is necessary to explore, as the average student is exposed to more hours of media in a week than hours of school or time spent with their parents (Ward, 2003, p. 349). Mass media has depicted scientists in many different forms, from heroes to villains, but there are a handful of norms, some that could put a positive spin on science and scientists and others that have a more negative tone. Schibeci and Lee (2003) looked at the portrayal of scientists in all forms of media from literature and film to cartoons. In summary of their findings, there are four major types of scientists depicted: First, the hero scientist, who

determines the cure for a poison, or a means of defeating an enemy, or perhaps a method of getting to a destination. In any form, the hero scientist is the triumph of intellect over evil. Second is the evil genius, who uses his intellect in coherence with evil to plot against the protagonist(s). Third is the mad scientist, whose discovery/invention becomes too powerful for him to control and ends up becoming the problem of the layman, who of course finds victory through force. Last is the socially inept scientist, who may have the gift of intellect but cannot figure out the social norms of society (pp. 179-182). The concern here is that three out of four depictions (that generalized) are negative. What is the implication of students being bombarded with images that depict science and physics as either evil or “for nerds”? Does this impact a student’s decision to take physics? This is something I explored in my interviews.

The societal impact of these depictions is also explored by the authors; they discuss the reality of how people can become turned off towards science due to the portrayal of science in fictional media. In film we see an immediate turn around, the reality of the scientific process is fast-forwarded for the sake of the script. When scientific research has a breakthrough in a field like cancer, the expectation is that a cure and its pharmaceutical agent will be available in weeks. This leads to a societal expectation that science should be quick and overnight, where the reality is that it can take years to transform a breakthrough into medicine that can be used to combat disease (Scibeci & Lee, 2003, p. 179). It makes me think of popular crime dramas on television in which DNA analysis is depicted as being a procedure that can be computed in an afternoon. The reality in Canada is that it takes RCMP weeks to analyze DNA properly (*CBC News Online*, 2006).

Impact of the Teacher's Instructional Methods

Although I did not survey my students on the teaching styles of their teachers and the effect this may have on the students' perceptions, it is important to note that this factor can also have an impact on the students. Viennot (2006) looked at the disconnection between how physicists and physics educators see physics and how this is presented to physics students at the high school level. The author pointed out that most physics teachers see physics as a valuable science full of theories that serve to explain the beautiful and strange phenomena around us in a consistent manner (p. 400). I would personally agree that this is my attraction to the subject, yet this is not often how we present physics to the students. More often than not physics is delivered as conceptual packages (units, chapters, and sections) separated from each other. The links between the concepts are not always made apparent by the teacher, who often uses the excuse that the students lack the critical sense to make the connections (Viennot, 2006, p. 407). In Physics 20 for example, we assume that air resistance is negligible. This helps us to avoid more complicated formulae and, in some cases, calculus based calculations (which most if not all Physics 20 students have no background in). So physics teachers claim that a bullet fired up in the air returns to the ground with the same vertical velocity it left with. Students have a difficult time accepting this; many of them have seen this idea explored on television and do not accept it. The truth is that the claim is not accurate because the bullet is under friction during its entire journey. It's easy enough to explain this reality, but often the problems do not state that we are ignoring air friction and sometimes teachers accept that the students wouldn't catch the error. If we, as physics teachers, hope to share the power of physics with our students, we need to meet their intellectual

satisfaction. To simply state “that’s the way it is” or that the students “wouldn’t understand the math behind it” is not acceptable. As Viennot (2006) pointed out, students who are given the opportunity to understand or explore a concept on a deeper level react very positively to the situation (p. 407).

Owen, Dickson, Stanisstreet & Boyes (2008) did a study in Northwest England in which they explored what impact classroom activities can have on student perceptions of Physics (p. 115). These authors demonstrated that there are three classifications of factors affecting student perceptions of physics: student variables, teacher variables and the learning environment (p. 114). They noted that many of the student variables such as socio-economic status are outside of the teacher and school’s domain and are therefore difficult to manipulate (p. 114). Thus, if schools hope to increase physics enrolment, they need to look at teacher variables that have positive effects on students and remove those variables that do not. The authors demonstrated that students’ perceptions of the quality of their science educators are often the predominant factor on their attitude towards science (p. 114). Owen, Dickson, Stanisstreet & Boyes (2008) study was executed as a Likert-Scale questionnaire in which the students were asked a variety of questions about classroom instructional methods. The students were asked how they felt about different activities they would do in the classroom, generally, how often they did these activities in physics specifically, and how useful they felt the activities were in understanding physics (p. 116). The authors demonstrated that students preferred doing experiments and hands on activities (categorized as construct activities) and social activities to written and passive activities such as copying notes, listening to explanations and doing calculations (p.118). There was a strong correlation between what the students liked and what they

felt was useful as a classroom activity in physics (p. 122). The authors also established that the students spent more time doing written and passive activities than those they enjoyed (p. 120).

Most of the research on student perceptions with regards to physics is related to instructional methods, rather than perceptions of physics as a whole. The literature has generally implied that improving enrolment in physics requires that educators move away from the traditional pencil and paper method of instruction and towards student engaging lessons. Aspects that involve pencil and paper work will still exist, but a balance with hands on activities is the goal. This balance of hands on activity and traditional assessment is described by Borghi, De Ambrosis, Lamberti & Mascheretti (2005) as a teaching-learning sequence (TLS). They have demonstrated that, time and again, groups of students learning physics by TLS achieve a higher level of understanding than groups who have traditional instruction (p. 271). Other “alternative” methods of instruction used to increase success in physics are supported by research as well. Eskin and Ogan-Bekiroglu (2007) have discussed the positive effect of allowing students to use argumentation or rhetorical debate to defend the methods they use to answer questions (p. 5). Another technique that seems to be very successful in the physics classroom is the use of analogies or physical models to describe complex or microscopic phenomena. Both Kovacevic & Djordjevich (2006, p. 554) and Poon (2006, p. 224) demonstrated the effectiveness of utilizing physical demonstrations and analogies to help students comprehend concepts that their “common-sense” disagrees with. This also highlighted the importance of visualization in improving student understanding of physical concepts, a trend noted in the literature. Experimentation and computer simulation are two

important ways of delivering visual representations to students that traditional chalkboard work cannot match. Poon (2006) discussed the importance of learning sequences, with emphasis on observing the phenomenon from multiple angles before discussing the mathematical representations (p. 225). The relationship between allowing students to explore concepts and academic success is also outlined by McBride, Bhatti, Hannan and Feinberg (2004). They described the importance of allowing students time to explore experimentation both as an introduction to and as an expansion of physical concepts (p. 435). All of these techniques are designed to enhance a student's contextual knowledge and help them to visualize these phenomena. They are also described by the students as more enjoyable (McBride, J., Bhatti, M., Hannan, M., & Feinberg, M., 2004, p. 439), which would have to affect their overall perception of physics. Improved visual context works to improve a student's confidence as they overcome their preconceptions of concepts and make sense of phenomena on their own terms, Saglam and Millar (2006) showed that confidence is related to contextual observation and in turn to academic success (p. 564).

Although this research supporting alternative instructional methods is present it has been exposed by Angell, Guttersrud, Henriksen & Isnes (2004) that this research is most often not what is taking place in the classroom (p. 698). It is important to note here that although I did not investigate students' perceptions of their teachers or their teachers instructional methods directly in the questionnaires, I felt the topic could come up in the focus group discussions about the reasons the students had or had not enjoyed physics. I decided, therefore, to use this research to compare and contrast my own findings.

Other Concerns: Gender Issues

Although I did not examine gender differences directly within the questionnaire exercise itself, I assumed that gender issues could come up in the group discussions and, therefore, I addressed gender issues within this literature review. Gender was taken into consideration when forming the interview groups as gender balance was established within each group.

As a high school physics teacher I am aware that there are generally more male than female students in our physics classes. This difference however is not as palpable as one may think. At the school I teach at for instance the percentage of female students is about 45% (Appendix A, p. 135). This is not a unique situation to my school. In the National Education Association journal, *NEA Today*, (2007) the national averages for high school female physics students is given as 47% in 2007, compared to just 39% in 1987 (p. 14). This is an American journal but I assume our national average would be somewhat similar. This is evidence that girls are coming out in large numbers to engage in high school physics classes. In fact, at the high school I teach at, we have some classes where the number of female students exceeds 50% (Appendix A, p. 135). The problem, therefore, is not as much in motivating girls to attempt high school classes. It is a matter of engaging female students enough to induce a desire to become physics majors at post-secondary institutions. In addition to a high percentage of students being female, I have found in my own experience that a majority of my best students (who score 85% or above) are female students (Appendix A, p. 135). Female students are not only attempting high school physics classes but also succeeding. The old adage that physical science is a boy's realm is challenged by these statistics but still seems to affect the

psyche of female students when moving on to the post-secondary level. To gain further insight into this let us now look at the percentage of female physics majors at the three Alberta universities. Although I was unable to get specific numbers, the University of Alberta claims only 9% of its physics majors are female. The University of Lethbridge has a slightly better percentage of 10%. Thirdly, at a much higher rate, female students comprise 20% of the physics majors at the University of Calgary (Appendix B, p. 136). The percentage at the University of Calgary, however, includes both astronomy and physics majors, which may skew the data. This data leads to the question of why there is such an apparent drop off in female interest from high school to university.

From the literature cited, there are two major areas influencing this trend. One revolves around gender issues and the second deals with female leadership or the lack thereof in physics. Gender issues can further be broken down into two subtopics: male influence on female success and interest, and traditional gender roles influence on females, including the aspect of 'play' within physics. I would first like to examine the influence of male students on females and the ways this seems to negatively affect success of female students. Linda Eyre's (1991) research demonstrated how the physical dominance of boys in a classroom can hinder female achievement generally (p. 215). Ding & Harskamp's (2006) research demonstrated the effect of male students on female students within physics classrooms. Their study looked at the effects of gender influence on cooperative learning for female students. To do so, they examined success rates for female students when collaborating with other females versus collaborating with male students. When working with male students the female students were shown to act submissive and "had difficulty in arguing or posing their own understanding" (p. 341). In

contrast, when working with other females the complex seemed to vanish as these female students had a much higher success rate (p. 341). Therefore, a lack of confidence provoked by dominant male partners is an obvious hindrance on the success of female students. From my own experience as a physics major, cooperative learning is a large part of the post-secondary physics curriculum, particularly in experimental physics classes. Ding & Harskamp (2006) found that isolated females can struggle in succeeding at the post-secondary level; the lack of classmates of the same gender affects females in a negative manner (p. 341). Ding & Harskamp's (2006) research also showed that female gender influences actually have a positive effect on male students. The female students kept the male students on task. The study seems to support the idea that more female students involved in the cooperative learning process increases the success of both male and female students (p.342). I have often felt that more females involved in physics would also serve to draw more male students. An increase in female students may serve to fight against the common media stereotype of the 'nerdy physicist', a stereo-type that deters both male and female students.

Traditional gender roles seem to place an emphasis on physics as being a "man's domain", this could dissuade females from looking at professions within the field. Robertson (2006) discusses the role of school communities in discouraging females from entering post-secondary institutions as physics majors. Gender roles push female students away from physics and into biology orientated sciences (p. 178). I can see this in my own experience of teaching Science 10. At the beginning of any semester in which I am teaching Science 10, I ask my students what science courses they intend to take at the 20 level by show of hands. The female portion of these classes almost always focuses on

biology; about half the females choose chemistry and a very limited percentage of females consider physics. Being a physics major, I always try to ensure the students give physics a chance at the Science 10 level, then reconsider when the course is done.

Another author, Hasse (2002), also explores the effect of traditional gender roles on female participation in physics. She sees a difference between education and play within physics as a major roadblock in female desire to undertake physics as a career. This is a very interesting article that raises a valid point: boys play at physics in addition to learning it. She argues that due to gender stereotypes, boys are far more likely to engage in physics play. This includes: science fiction driven video games, playing with physical experiments at home, involvement in science fiction communities, and even making “physics jokes” (p. 253). In reflection on my own experiences I see this in action every day. Many of my male students utilize their free time to build rockets, catapults and potato cannons. Lego is a very popular toy among elementary aged boys; this is a toy that relates very closely to structural dynamics. Almost every high school boy I know is heavily engrossed in the world of science fiction video games that often revolve around physical phenomenon. Another interesting point was raised by Hasse (2002), who enrolled herself in a first year physics program. She found the more she involved herself in physics ‘play’, the more she was accepted by the male physics students (p. 255). This pressure to conform to the male gender role can be uncomfortable for the female students, especially if they have no interest in the particular form of play. This leads to a feeling of non-membership to the cohort and creates barriers for collaboration within the classroom and lab (p. 255). In a survey of women in physics, the journal *Physics Today* found that the main problem for female physicists is that they “continue to face

discrimination and negative attitudes from their colleagues and institutions” (“Surveying Women in Physics”, 2006, p. 29).

Ivie, Czujko, and Stowe (2001) explained how these negative attitudes lead to women rejecting or leaving careers in the field of physics. They cite several difficulties that women seem to face in physics careers based on an international survey of female physics professionals and students. About 1/3 of the female physicists’ they surveyed claimed that they felt they advanced slower than their male counterparts and 1/5 claimed that they received less funding than their male colleagues (pg. 11). The authors also explored how these women felt marriage and family affected their careers. A quarter of the women interviewed were not married and most of these claimed that marriage would end their career. Of those that were married, 40% claimed that marriage had affected their career in a negative way, many specifying the difficulty of finding employment near their husband’s place of work (pg. 12). The statistics given on female physicists with children are even more disheartening. Less than half the women surveyed had children and of the women with children, only 25% claimed that having children had not had a negative impact on their career (p. 15). There is an expectation in the culture of Physics for long hours and international travel; anything that limits this is seen as limiting production in the community. Physics, therefore, appears to be a patriarchal culture; it allows for male physicist to be unaffected by having children (due to traditional gender roles) while having children is detrimental to female advancement in the field. This patriarchal culture leads to an easy understanding of the reasons many women opt out of pursuing careers in physics. Men can pursue careers in physics and have families while women are asked to choose between family and career due to the competitive nature of

the community. The physics culture needs a large adjustment to lure female professionals. One possible way to improve sensitivity towards female needs would be to increase female representation within the leadership of physics.

A major area of concern found in the literature seemed to revolve around the lack of female leadership in the field of physics and this has relevance to my own study. Leadership in physics can be as basic as female high school physics teachers or as prestigious as chairs of physics departments within universities. Williams, Diaz, Gebbie and El-Sayed (2005) explored the problems, strategies and needs of female leadership in physics. Their report summarized the topics discussed at the IUPAP (International Union of Physics and Applied Physicists) conference on Women in Physics. They primarily discussed the reasons there is a need for female leadership in physics. These needs included the importance of physics drawing on the most talented individuals regardless of their gender. An emphasis on the need for female perspective within physics is noted; this is argued as a means of moving forward in areas of physics research that have reached a standstill. The improvement of physical research environments brought on by a feminine leadership approach was also explored. The authors argue that physical research is often very male orientated with no respect given to the natural needs of females (maternity leaves for example). Lack of leadership means a lack of role models for other females to emulate. It also allows for males to continue oppressing women in the field (p. 16).

All of this research demonstrates that there is a large concern about the number of women in science based professions and that society could benefit from more females in physics. Unfortunately, if having more females engaged in physics careers leads to more females taking physics, the reverse can also be true. When we combine declining student

enrolment rates in high school physics with the small percentage of females becoming post-secondary physics majors; the future looks bleak for both reducing the gender gap in physics and improving enrolment rates.

Chapter Three: Research Methodology

Background

In researching high school students' perceptions of physics, I did a case study in which I conducted a series of group interviews with science and physics students in one high school in a small urban school district. I chose to do a case study for my research as the advantages of a case study as described by Cohen, Manion and Morrison (2007) were ideal (p. 256). The first advantage of a case study was related to the economic reality of my research. Since I was lacking any external funding, undertaking a case study within my own school allowed me to vastly limit research expenses. A case study also allowed me to do my research as an individual without the need to coordinate a research team. And lastly, case studies allow a more publically accessible form of research, which is important as I hope to share my findings with other physics educators across Alberta and Canada. I do realize that case studies are limited in several regards; mainly that the results of case studies cannot be generalized and can be considered heavily biased (Cohen, Manion, & Morrison, 2007). This study, however, is not looking for a universal answer; rather I have set out to see how the students within my own school perceive physics. I hope to compare this data with other small and large scale studies from throughout the world to find consistencies that could be used to deal with enrolment issues in physics. Therefore, the inherent weaknesses of case studies should not affect my intended outcome.

The school chosen for the research has a population of about 1500 students and covers a broad socioeconomic spectrum. Before I could begin my research I had to apply to this school district for permission for human subject research. The application process

included an explanation of my research that described my intentions; this form then needed to be approved by both my university and by the school board. Once that permission was granted, my first order of business was determining the number of Science 10, Physics 20, and Physics 30 students the school had enrolled in the 2008—2009 school year (Appendix C, p. 137). To gain this information, I worked with an administrative assistant to determine the number of students in the aforementioned classes as well as other subjects were also relevant to my study. We added up all the students enrolled in each desired subject from the school's mark verification report; this report lists the number of students in each class offered at the high school. The intention in collecting this data was to use the numbers to determine the percentage of students who studied Physics 20 and 30 as compared to Science 10. In addition to this, I collected data on the number of students taking Chemistry, Biology and Math Pure (Alberta's most academic stream of math) to compare this school to the provincial numbers. As was outlined in the introduction, provincially, many more students are taking the other two sciences, chemistry and biology, than physics, and the number of students taking pure math also outnumbers the physics students by a significant margin (Alberta Education, 2007).

This particular school averages ten Science 10 classes per year, four to five Physics 20 classes and three to four Physics 30 classes. Therefore, about half of the capable students, as far as prerequisites are concerned, are taking physics (Appendix C, p. 137). I created groups of students to interview from these three different classes. The students had completed the curriculum for each subject. For the group interviews, I used an interview guide approach, in which the students had an opportunity to work through

and think about the questions before they were asked by the interviewer. Three questionnaires were developed for the group interviews, one for students who had completed Science 10, one for Physics 20, and the third for the Physics 30 students. The questionnaires were developed to be used as a prefatory exercise for the focus groups (Appendix D, p. 138). The students were asked to complete the questionnaires as a launching vehicle for the discussion on high school students' perceptions of physics. The group interviews were split into 6 subcategories, two for each grade level. The subcategories were as follows: one group of students from Science 10 who were planning on taking Physics 20 and one group who was not; one group of Physics 20 students who were planning on taking Physics 30 and one group who was not; lastly, one group of Physics 30 students who was intending to take post-secondary physics and one group who was not. Once these interview groups were formed, it was necessary to send home the appropriate parent letters. The consent for human research policy for the school district I did my research as stated that for this age group, students over 15, parents or guardians needed to be notified of their student's participation in the study but did not have to consent. Once the letters had been sent home, the students and I discussed and determined the possible lunch breaks that we could use for our group interviews. I chose our lunch break as the meeting time for the convenience of both the students and myself; the school buses the vast majority of the students home immediately after school, so lunch hours were preferable. The lunch break is about 45 minutes, which was as much time as I wanted to ask the students to volunteer. Asking students for any more time than a lunch break turns the favour into a chore. If the interview is long and arduous, the subjects lose interest and the information becomes less thought out and valuable (Cohen,

Manion & Morrison, 2007, p. 363). The lunch break worked quite well as the students were thoroughly engaged throughout each group interview. The students and I met in my classroom at the beginning of lunch; I had a table set up at the front of the class with enough seats for all the participants. I had a laptop computer with a video camera and microphone set up to record the discussion aspect of the interview. When the students arrived, I had them pick a seat. In front of them I placed a pen, a consent to research form, a media consent form and a questionnaire. I gave the students about 10 minutes to fill out the forms, and then we used the remainder of the 45 minute lunch break to discuss the answers to their questionnaires.

Sample Selection

The decision to use group interviews for my data collection was due to the possible benefits laid out by Cohen, Manion and Morrison (2007) with the belief that by directly choosing the participants, I could overcome some of the disadvantages. The authors demonstrate that group interviews can lead to powerful counter argument, increased reflection and inspiration of the interviewees. The authors also note that the interviewees can be adversely affected by dominant members, giving the same answer or “public-line” and can also be uncomfortable speaking publically (p. 373). Therefore some interviewees in a group interview may not give the same honest or complete answer as they would give in an individual interview. By using purposive sampling I hoped to minimize the negative effects of group interviews; this is further discussed below.

Cohen, Manion and Morrison (2007) outline some general guidelines researchers should use when determining the sampling they are going to use for their research. The authors note that the following four factors must be addressed: sample size,

representativeness and parameters of the sample, access to the sample, and the sampling strategy to be used (p. 100). My first consideration when determining who would be involved in my group interviews was how many students I intended to include within my study. Originally I had intended for all my group interviews to include 4 – 6 students for each subcategory. After further consideration and a better grasp of the number of available students to do the interviews at lunch time, I decided to include four students for each group interview, two males and two females. There were two exceptions to this intention: I was only able to find 3 Physics 30 students that claimed that Physics 30 was the last level of physics that they were going to study. These students, who had completed Physics 30, had no intentions of studying physics at the university level. The reasons for this decision are presented and analyzed later in this document. In addition to this, I offer possible explanations as to the reasons it was so hard to find more Physics 30 students who did not intend to take university physics. Four of the other five focus groups included four students in the group interview, each with two boys and two girls. The fifth and final group had five students. In this case the reasoning was to make the students more comfortable, basically one of the female students asked that her friend could come, and I already had one other female signed up. The extra student was helpful due to the fact that the population of this subgroup, Science 10 students not choosing to take Physics 20, was the largest (Appendix C, p. 137).

My original intention was to select specific students for each interview from students I had taught the respective subjects to. My reasoning for selecting students in this manner was so I could meet the parameters and representativeness of the sample easily, additionally the ease of access to the sample was appealing. This type of sampling

strategy is known as purposive sampling and is common to case studies (Cohen, Manion & Morrison, 2007, p. 114). I utilized purposive sampling because a relationship had already been established with these students and I hoped that this relationship would make the interview more comfortable and open for the groups. The focus of our study was not on the students' teachers. In fact, I avoided the analysis of teacher influence within the questionnaire and discussion (though students did make comments in regards to teacher influence). Therefore, I felt that my relationship with the students would not interfere in the discussion of their perceptions of physics. Again, there were exceptions to the intention of only interviewing my own students. The vast majority of the students interviewed were from my classes, and the only difficulty came with Science 10 as I did not teach that subject in the 08/09 year. To address the difficulty I faced in finding appropriate Science 10 students I utilized students who I had relationships with from coaching or teaching Math 9 or Science 9.

Another benefit to selecting students who I had taught came in regards to an understanding of their individual willingness to speak in public, one of the necessary parameters for the study. As was discussed above, Cohen, Manion and Morrison (2007) show that some of the disadvantages of group interviews can be the fear of speaking in a group or the influence of one individual's opinion on the rest of the group (p. 373). In choosing from my own students, I could select students who were vocal and not intimidated by their peers, which can be a major problem for high school students. I hoped to find students that would be willing to speak openly and honestly about their experiences in physics classes and units; for the most part I was capable of finding such

students. The students that I interviewed, who I did not teach or coach, were selected due to their classroom nature as described by their teachers.

For concerns about my sample's representativeness, I aimed for a mix of male and female students from varying backgrounds in each group interview. Although I am aware of the impact of gender difference in science education (Hasse, 2002; Ivie, Czujko, & Stowe, 2001; Robertson, 2006), I did not intend to explore this area as it is another study unto itself. In addition, I am aware that socio-economic status can affect the perceptions and decisions' of students (Lyons, 2006). However, socio-economic status will not be where the study is focused. I want to explore what consistencies lie within and between groups and where these interview groups' perceptions differ based on their grade level and academic decisions.

I did still, however, look for varied backgrounds, academically speaking, and balanced gender within each group to try to have a proper sample. For each interview group of Science 10 and Physics 20 students I attempted to have one high achieving (academically speaking within the subject being discussed) male and female and one mid to low achieving male and female. High achieving was considered to be over 80% in their subject while mid to low would be anything below 75%. My approach in separating subgroups at the Physics 30 level was different and, therefore, was more difficult to gain the academic differentiation. In Science 10 and Physics 20 the students were separated along the lines of whether or not they were going to take physics at the next level. In Physics 30 I wanted the two sub groups to be divided amongst students taking physics related majors at university, like engineering, and students whose post-secondary/career path would include no more classes in physics. Many students in Physics 30 would fall in

between these two realms; they may not be looking at a physics related career, but they did still intend, or were required by their major, to take physics classes at the post-secondary level. Since the division here was not as simple, it was difficult to find a high and low achieving male and female for each of these groups. The interview group of students who were not choosing to go on to take physics in university was comprised of only three students; in this group, candidates were more difficult to find. Many students who had taken Physics 30 had intentions of continuing at least to a first year level physics course at the post-secondary level. I, therefore, had a limited number of students to choose from that meet the parameters of the interview group. However, this being the case, the smaller number of population should mean a smaller sample was acceptable (Cohen, Manion & Morrison, 2007, p. 105). The interview group of Physics 30 students going on to pursue physics related careers still had two males and two females, but in this case, all subjects were high achieving academics. It was not possible to find mid to low achieving students for this subgroup; they simply did not exist at the school.

Consent Forms and Teacher Influence

Consent forms were developed for the students to consent both to the study itself and to being filmed. I am noting this here because I had taught some of these students, so within the consent form, I explicitly stated that the students were under no obligation to undertake this study (Appendix E, p. 144). I also talked to each student before sending the parent letter home and stated that they were under no obligation to take part in the interviews; if they felt uncomfortable in any way, it would not bother me or affect our relationship if they declined taking part in the group interview. In addition, I encouraged the students to speak open and honestly both before and during the interview. Again, I

emphasised that their answers would in no way affect our relationship if they didn't care for physics, in general or as a subject. As I have discussed above, I felt that the benefits of knowing the students outweighed the disadvantages. It allowed me to pick subjects who fit my needs for representation, and to find students who were vocal and not intimidated by talking in a group. A further advantage was having a good rapport built with the students I had chosen, this was utilized in the interviews. All of the students chosen for the interviews that I had taught were students I had good rapport with. This helped to make the students comfortable. Research shows that student engagement can improve with the establishment of a quality teacher-student relationship (Demetriou & Wilson, 2009, p. 225). This engagement seemed to translate directly into the interview atmosphere as the subjects were excited to talk about their physics experiences.

Questionnaire Development

Each focus group was asked to complete a questionnaire (Appendix D, p. 138) related to their perceptions of physics. Though the questionnaires were collected as data that could be analyzed, their primary purpose was to help the students brainstorm ideas and give them a chance to reflect on the interview questions before they were asked. The questionnaires contained the same questions that would be used to lead off the different sections of the discussion. The students were, therefore, aware of what questions they were going to be asked prior to the interview. Cohen, Manion and Morrison (2007) describe this as a standardized open-ended interview (p. 353). The questionnaires asked the students about their perceptions of physics and what factors have influenced their academic decisions in relation to physics. The students were also asked to highlight the major factors that have influenced their academic decisions on the questionnaire.

Student conceptions of the difficulty of physics were examined at the three levels of instruction (Science 10, Physics 20 & Physics 30). Additionally, factors such as parental, peer and academic influence were examined. Three different questionnaires were developed for the three grade levels to explore differing perceptions at each level. Several of the questions within the questionnaires were identical; most questions about students' perceptions of the difficulty of physics were universal. Based on Angell, Guttersrud, Henriksen & Isnes' (2002) research, I asked the focus groups to respond to questions related to their perceptions of physics. Although the idea of difficulty is a vast one, I asked the students to respond to whether they felt that the physics they had completed was difficult or not. From this point, they were asked to expand on what they felt was difficult, if they did in fact find anything difficult, about physics.

Angell, Guttersrud, Henriksen & Isnes demonstrated that physics students found the subject both more interesting and more relevant to the real world than non-physics students (2002, p. 690). These are two more concepts I also had the students explore in their prefatory exercise. From the students' responses in regards to interest and relevance, I hoped to be able to see the reason students think physics is engaging or not.

In addition to this, I was looking to understand what the main factors are that influence the students' decisions on taking physics. Every semester I ask my students why they have decided to take physics. Based on common responses to these questions and the literature reviewed the focus groups were asked to identify if any of these factors had affected their decision. I also figured that this questioning might lead them to identifying factors that I had not considered and the literature did not describe. The

questionnaires were collected at the end of the discussion as hard data to be related to the discussion themes.

I think it is important to note that although pedagogical relationships can be a factor in students' decisions (Lavonen, Angell, Bymen, Henriksen & Koponen, 2007; Mualem & Eylon, 2009; Telese, 2008), pedagogical relationships were not explored in this study. There were two major reasons for this: firstly, it is a large topic, one that merits its own examination, and secondly, I was looking at students from within my own school and did not want to affect any collegial relationships.

Science 10 Questionnaire

The Science 10 questionnaire began with a question that asked if the students are taking Physics 20. Although the students had already been separated into the appropriate groups, this was done to keep the questionnaire consistent for both groups. The second set of questions related to what influences played a major role in the student's decision to take or not take Physics 20. Time-table issues, peers, parents and marks were offered as possible sources of influence. In addition, the students were allotted a space to describe other influences that may have come into play in their academic decision. The next question asked if the students enjoyed the physics unit of Science 10. The purpose behind this question was to see if any relationships existed between the students' enjoyment of physics and whether or not they found it to be difficult. The next question asked if the students felt the subject was difficult; the students were then asked to describe why they did or did not find it difficult. Though difficulty is a broad term, I will attempt to gain some insight into what students find difficult about physics by examining the responses to this question. As Angell, Guttersrud, Henriksen & Isnes' (2002) research

demonstrated, students who choose not to take physics feel that physics is a difficult subject (p. 690). What the students find difficult about physics is, unfortunately, never discussed by the authors; I hope to shed some light on this. To differentiate between the mathematical aspects of physics and the conceptual aspects, the next question was specific in asking if the students found the mathematical aspects of physics difficult. This question was used to compare to the former question; did all students who found physics difficult also find the math difficult or were some more troubled by the conceptual aspect? The next two questions looked at how the students perceived physics in terms of relevance and interest. These questions, again, stemmed from Angell, Guttersrud, Henriksen & Isnes' (2002) research. Through these questions I examined if students who were not studying physics did in fact find it less relevant and interesting than those who do study it. As well, I hoped to explore if any of the students who found physics difficult still managed to find physics relevant and interesting. The last section of the questionnaire had the students list the influences upon their decision to take or not take Physics 20 in order of most to least influential. From this data I examined any commonalities or differences influencing students to not take physics and those factors that are causing students to take physics.

Physics 20 Questionnaire

For the most part, the Physics 20 questionnaire mirrored the Science 10 questionnaire. The questions were identical in order and appearance, with minor exceptions in which Physics 20 was substituted for Science 10. Some of the questions developed for the questionnaires had more relevance for one group of students than the other group, but for the sake of analysis, both questionnaires placed the same emphasis

on each question. For example, time-table issues are probably more likely affect a grade 12 Physics 20 student than a grade 10 Science 10 student and a factor like peer influence may have a greater impact on the younger students. The intent of the questions on both questionnaires was the same: to find similarities and differences among answers of students going on to take the next level and those that chose not to.

I also compared the answers of the Physics 20 students to those of the Science 10 students. For example, I examined if time table issues played a bigger role in the Physics 20 group's decisions than in the Science 10 students'. In addition, I explored the role of grade scores as a comparison between the two grade levels; did the older students closer to graduation pay more attention to this concern? I then examined whether the students choosing not to go on to the next level were displaying the same concerns; did students choosing not to take physics 20 give similar responses to the students choosing not to take Physics 30? I inspected whether students who had taken Physics 20 have different feelings about the difficulty, relevance or interest created by Physics 20. Here again I was hoping to relate back to the research of Angell, Guttersrud, Henriksen & Isnes (2002). I also explored whether the students interviewed showed the same tendencies towards their perceptions of physics as the authors study showed. How did my interview groups feel about the interest and relevance of physics? I compared those choosing to go on to those not choosing to go on using responses of both in students in Science 10 and Physics 20. Lastly, my study examined if there were notable differences in perceptions between students taking physics and those who have chosen not to or have yet to attempt it, comparing the Physics 20 students' responses in general to those of the Science 10 students.

Physics 30 Questionnaire

As the division of the two Physics 30 groups was slightly different than that of the Science 10 and Physics 20 interview groups, the questionnaire also differed in a minor sense. Since I was now looking at students who had completed the high school curriculum, some of the questions from the previous questionnaire were not as relevant. On the Physics 30 questionnaire, the students were not asked to describe how peer, parental, mark or time-table influence affected their future decision as these students had now completed high school physics. Therefore, I asked questions in a summary manner, seeking the students' perceptions of physics now that they had completed the curriculum.

The first major difference between the Physics 30 questionnaire and the other two was that the students were asked to comment on whether they felt that taking high school physics had helped them in their other classes. This question was designed to examine if students saw external advantages to taking physics. It was an important question for the students who had not chosen to take physics at the post-secondary level; perhaps they felt that physics gave them an advantage in math, or chemistry or some other high school subject. This could prove to be valuable information when encouraging students to enrol in physics.

The second major difference on the Physics 30 questionnaire was that the students were asked to reflect on their entire high school physics career rather than their latest exposure to it. The idea behind this was to have a sense of high school students' culminating perception of physics once they had completed the high school curriculum. This information was used comparatively with the Science 10 responses, in particular with those students in Science 10 who had chosen not to take physics. Again, some

information could be gained from this comparison to assist in encouraging students to take high school physics. In addition, the summary opinions of the Physics 30 students were used to examine relationships between the Physics 30 responses and those of the Physics 20 students. The relationships were examined to seek out differences of opinions between those two levels, perhaps yielding results that can be used to encourage students to continue from Physics 20 to Physics 30.

The third major difference between the questionnaires is related to the students' perceptions of the relevance of physics. An additional question was asked to the Physics 30 students in this section, in hopes of summarizing the high school experience. The students were asked if they felt that the problem solving skills they had learned in physics could be transferred to their day to day life. This question was designed to determine if students saw any external rewards to physics education. Life is full of day to day problems and I believe that physics problem solving skills can be used in an abstract way to deal with and solve these problems. I use these responses to examine if the students also recognize that their problem solving skills, learned in physics, are transferable. The results of this examination may lead to data that could be helpful in recruiting students into the physics classrooms.

The Physics 30 students were split into two groups: one felt their physics career was now complete; the other was looking at pursuing a career in physics. This division was slightly different than the split for the other two grades in which we simply looked at students moving on in physics versus students who were finished at that level. In Physics 30, the split wasn't simply yes or no as far as moving on with physics was concerned; for the Physics 30 groups the students who were moving on also had to have aspirations of

pursuing a career in physics. The reasoning for this was that I wanted to have data gathered from students who really connected with physics and had a passion to pursue it further. I wanted to know what made it work for these students, what influences drove them to take on a career in physics. Hopefully, some of that data can be used to encourage students to undertake physics. The other group was still comprised of students who did not intend on taking any more physics. I needed data on what caused students to end their pursuit of physics, both to compare and contrast to those who were continuing on with physics, and to compare their perceptions with those who never chose to take physics in the first place. I examined if the students going on to a career in physics have opinions that differ from those who feel their physics career is done. If physics truly is a difficult subject in comparison to other high school subjects, one would expect that these responses should differ. I was curious to see if those choosing not to take physics at the post-secondary level were doing so because they disliked physics or found physics difficult or irrelevant, or if they were simply choosing a career that did not require it. I also examined whether these students' perceptions differed from the students who chose to not take high school physics at all. If Physics 30 students are choosing not to take physics at the post-secondary level because their career plans do not require it, but they actually found the topic interesting and relevant, then perhaps I can establish some evidence that students who do not think they need physics for their future endeavours can still take the course, enjoy it and gain skills that are valuable to life. At the end of the questionnaire I still had the Physics 30 students list what their biggest influences were in their decision on taking post-secondary physics. Again, this information can be analyzed to contrast the two groups of Physics 30 students, but also to examine the relationships

between all of the “yes” groups and all of the “no” groups and also the students who took physics versus those who did not.

Case Study: Group Interviews

On the day of each group interview, the group of students met in my classroom at the start of the lunch break. I had all the students sit at a table where their consent forms and questionnaires were laid out for them. I sat at a student desk facing the students. I instructed the students to take about 10 minutes to fill out the consent forms and work through the questionnaire. Once the students had completed the questionnaire, we discussed what each student had come up with in their prefatory exercise. The questionnaire was used in an attempt to help avoid peer influence from blocking discussion or swaying opinions. In addition, with each student sharing their thoughts, I felt what they shared could inspire similar or contrary comments from other students.

With the students engaging in the exercise before speaking I hoped to focus their thoughts and give them speaking points. As discussed previously, this preparatory exercise served to alert the students of what the questions would be in the interview; therefore, it is defined as a Standardized Open-Ended Interview (Cohen, Manion & Morrison, 2007). The strengths of this type of interview are described as making the data more comparable if the same basic questions are asked; the data collection is complete and organized for each desired topic, which aids in analysis of the topic; interview bias is reduced; and the instrumentation (in this case the questionnaire) can be evaluated. The major weakness highlighted by the authors is that this form of interview can limit the natural progression of questions and answers (p. 353). To combat the weakness of this style of interview, the questionnaire’s questions were used as a launching point for each

part of the interview, but probing questions were also asked where appropriate to go beyond the data of the questionnaires in search of deeper answers. The discussions were video recorded and transcribed; this information was then examined to determine the themes within the students' perceptions of physics.

Science 10 Interviews

Using the questionnaire as a starting point for the interview we discussed what role, if any, peers, parents, grades and time-table issues played in the students' academic decisions, in particular with regards to Physics 20. I then asked the students if there were any other influences on their decisions. From here we looked at what the students' general perceptions of physics were by examining whether they enjoyed their physics unit in Science 10. I also had the students compare the unit to the other three units of Science 10 that related to biology, chemistry and earth science. We then discussed how difficult the students perceived physics to be, and specifically if they felt the mathematical aspect to be difficult. To extend on these questions, I also had the students compare the level of difficulty of their physics unit with the level of mathematics they were in at the time they were taking Science 10. From this data, I examined whether students felt that math is a more difficult subject than physics at the same level or vice versa. We discussed whether the students felt that the physics they learned was relevant to their world. I also asked the students if they felt physics was interesting. For the questions relating to interest and relevance, I had the students comment on how they felt about the physics they learned in Science 10 and how they felt about physics in general from any external knowledge they might have. From this data, I examined whether the subject matter being discussed within Science 10 created the same perceptions as physics

in general; is there evidence that suggests students find physics interesting or relevant but do not feel the same way about the physics they learned in Science 10? Lastly, I had the students describe their most influential factors in deciding to take or not take physics and we discussed the similarities and differences amongst their answers.

Physics 20 Interviews

As the Physics 20 questionnaires closely matched the Science 10 questionnaires, so did the process of the interviews. I followed the same line of questioning and asked the same additional probing questions. I asked about other influences on their academic decisions with regards to Physics 30, and we discussed any differences between the students' perceptions of physics as a high school subject versus physics as a whole. I also had these students compare the level of difficulty of physics with regards to the mathematics they were taking at the time they were taking Physics 20. In addition, I had the students compare Physics 20 to Chemistry and Biology 20 if they had taken those subjects. They were not comparing the difficulty of the mathematics, but rather, the difficulty in general. When discussing this, I made sure they extended their responses to explain the reasons they felt one subject was more difficult than another. I examined this information to determine any trends the students might have about the level of difficulty of the three sciences. If it is true that a perception of difficulty is what is keeping students from taking physics (Angell, Guttersrud, Henriksen & Isnes, 2004, p.690), then I was interested in investigating whether students truly do feel that physics is the most difficult science. If students are not finding physics to be the most difficult science, then this is more information that could be used to break down the barriers to physics enrolment. I also asked these students to compare their preconceptions of Physics 20, how they felt

coming into the subject, to their post conceptions after completing the course. From this information, I explored whether any common transformations of opinion occurred over the process of completing the course.

Physics 30 Interviews

As the Physics 30 questionnaires differed more from the previous two questionnaires, the interviews also involved some differences, but the approach was the same. Again we used the prefatory exercise as a guide to our discussion but also added probing questions when there was more to discuss. The major difference was that the students were asked to look back at their entire high school physics career to answer the questions as a summary of their high school physics experience. The first topic that we discussed was whether the students felt the subject of physics helped them in the other subjects they studied. This question required some probing follow-ups as we discussed the reasons students felt physics helped them in other classes. We then discussed their perceptions of the difficulty of high school physics. We examined whether the students had any change in their perspectives as they moved through physics; what, if any, were the differences between their preconceptions and post conceptions of high school physics. Additional questions were asked to explore what the students felt were the sources of their preconceptions. In regards to difficulty, I had the Physics 30 students compare the mathematical difficulty of Physics 30 to the highest level of math they took. We also discussed the difficulty of physics as compared to other high school sciences and subjects. I had the students describe the reasons they felt other subjects were more difficult than physics, and we discussed the similarities and differences of the opinions in the group. This information was valuable in discussing what students' opinions really are

about the subjects that they take in high school after they have completed them and how physics compared.

We then discussed relevance and interest in regards to physics. An additional question was asked that was not included in the Physics 20 or Science 10 questionnaires or interviews. We discussed whether the students felt that the problem solving skills they learned in physics could be transferred to other areas of their life. Additional probing questions were required to have the students elaborate on instances and situations where they felt they used the problem solving skills of physics to tackle obstacles in their everyday lives.

Lastly, we discussed what influenced the students' decisions to take or not take physics at the post-secondary level. This information is important at this level of reflection to examine the role of students' career choices as compared to their perception of physics after completing the high school experience. Were students not taking physics because they wouldn't need it or because they did not like it, does the curriculum need to change or become more relevant, or are students enjoying physics but have other interests they wish to pursue? These are all questions that are examined and discussed within this document.

Chapter 4: Results

Interviews Part 1: Science 10 Students Not Taking Physics 20

Student Profiles

As was stated earlier, this interview group consisted of five students. For the sake of their confidentiality, I do not use their names in this document; the students are referred to as students 1 through 5. This group of students included two students whom I had never taught, but I did gain some background information on their academic abilities from their science 10 teachers.

Student 1 is a grade 10 female student that I taught in Science 9. This young lady is coded as having a learning disability and can struggle academically; she would be considered a mid to low achieving student by the standards discussed in the methodology section (less than 75%). This young lady is, however, quite a hard working student who puts plenty of effort into her school work. This student intends to enrol in Science 20, the general science course, at the grade 11 level.

Student 2 is a grade 11 male student who I taught in Math 9 and who I coach in rugby. This young man struggles academically. He is considered a mid to low achieving student. Due to his performance in Science 9, this young man had to take Science 14 (a less academic grade 10 science class) before being able to take Science 10 and hence is a grade 11 student who has just completed Science 10. This student also intends to enrol in Science 20 at the grade 11 level.

Student 3 is a grade 10 female student who I have not previously taught. Her Science 10 teacher described her as a mid to low achieving student. This student intends to enrol in biology at the grade 11 level.

Student 4 is a grade 10 female student who I have not taught. Her Science 10 teacher describes her as a high achieving (above 80%) student who struggled with physics but still maintained a good grade through their physics unit. This young lady also intends to enrol in biology at the grade 11 level.

Student 5 is a male grade 10 student who I had taught in Science 10. He would be considered high achieving by the standards discussed. This young man intends to enrol in chemistry and biology at the grade 11 level. As an additional note about this student I feel it is important to highlight that he, more than any other, seemed had a real distaste for physics. As is discussed further on, this student expresses how he sees physics as extremely boring and irrelevant, though he succeeded at it.

The Interview

I began this interview by ensuring that all the students were not intending to enrol in physics in high school and they all assured me that was the case. As discussed in the methodology section, the second question related to the students influences on this decision. This is explored here and also at the end of the interview as a summation of their reasoning for not taking physics. The first possible influence that was explored was whether the students felt that time table issues played a role in their decision. I was curious to know if the students felt that a lack of room in their schedule played a role in their decision, if they were concerned about being overwhelmed with science courses or if they were choosing to take only one science to allow for other subjects. All of the students claimed that they were somewhat influenced by this concern; mostly they felt that they didn't need to take all three sciences and did not want to overload themselves (Appendix F, pp. 146-148).

The next section of this question related to the influence of parents on the students' decision to not take physics; the students all answered that their parents played no role. The third part related to grades. I was curious to know if a fear of doing poorly in physics played a role in the students' decision. All five of the students commented that grades had played a major role; they all had concerns that taking physics would bring down their overall average. The next part related to the influence of peers. Were the students not taking physics because their friends were not? Again we had a consensus within the group. Like the lack of influence of parents, the students all reported that their peers played no role in their decision. Student 2 raised an interesting point about the idea of taking classes with friends as being a distraction (Appendix F, p. 150). The last point of this question allowed the students to comment if there were any other major influences in their decision to not take physics. Student 4 spoke out about this, claiming, "It's hard and there is too much math" (Appendix F, p. 150). Student 5 didn't share this opinion but he did have another motivation to not take physics: "It's not that it was difficult. It was more that it was boring", adding, "It was tedious; I have fallen asleep in class" (Appendix F, p. 151).

This moved us along to the third question. Here, I explored whether the students enjoyed their physics unit. There were some interesting responses to this question. Although the students did not intend to study physics, many of them commented that there were aspects of the unit that they did enjoy. For the most part, they disliked the math but enjoyed learning the conceptual side. Student 1 commented: "It was understandable, that's why I liked it" (Appendix F, p. 152). Student 5 was the only student who seemed to find no enjoyment in the topic. He claimed he felt that: "It was

just boring, I don't need to know how much joules it takes to twitch my finger or throw a ball across a room, I'll never have to use that" and that "I'm not (going to) take out a calculator and calculate like how many joules it took for that person to throw the ball at that speed at that trajectory" (Appendix F, p. 153).

I then examined the students' perceptions of the difficulty of their physics unit with the fourth question. The students commented highlighting that they had more difficulty with the mathematical aspects of the physics unit than with the conceptual aspects (Appendix F, pp. 153-154). The answers covered the next question, number five: Did the students find the mathematical aspects difficult? To explore further, I asked the students to compare the level of mathematical difficulty of their most recent math class with their physics unit. All of these students found that the mathematics of their physics unit was more difficult than their current math class. It is important to note that Students 1 through 4 were comparing Math 10 Applied (the less academic math course) to their physics unit and Student 5 was comparing Math 10 Pure. To expand, I asked the students how big of an influence their dislike for the mathematical aspect of physics was on their decision. Student 3 commented, "Yah, the thought of math just freaks me out and if I have to do lots of it, I just don't have a good time in class and I dread that class and then I just don't do good in it" (Appendix F, p. 157)

We then explored the students' perceptions about the relevance of physics. This question had three parts; the first related physics to the students' day-to-day life. None of the students claimed that they noted the relevance of physics to daily interactions. Student 3 did comment however, "When I first took the, like when physics was done, I did kind of a little bit I would notice things but like no not anymore" (Appendix F, p. 157).

In the second portion of this question I asked the students to comment on whether they related technology to physics or not. I explained that the technologies that many students rely on, like cell phones and iPods, are constructed and operate on physical principals. The students all seemed to agree that they understood that physics was involved in these technologies; they just had no idea how it actually worked. Student 3 had an interesting comment in regards to this: “Well I find it interesting to know, like I’d like to know, but I’d like someone who tells me how it works not really go and figure it out on my own” (Appendix F, p. 159). Based on this comment, I probed further by asking the students if they would be interested in learning about the physics of the technologies they use, on a conceptual level, not mathematically. The students all commented that this would interest them.

The last part of this question asked if the students saw the relevance of physics in explaining the world around them. I explained that I was asking if they thought of physics when observing natural phenomena; I also pointed out that they were not limited to the earth, but could consider the universe as well. Some of the students claimed that they would like to learn more about the natural universe: “I’d like to know but I wouldn’t want to have to put in the effort to figure out the math behind it” (Appendix F, p. 160). Others were unaware that the laws of physics governed our universe: “I didn’t really know that it was related to physics though” (Appendix F, p. 160).

The last question asked if the students felt that physics was an interesting subject. The students had a variety of answers to this question, but most claimed that physics could be both interesting and uninteresting. With the exception of Student 5, who disliked everything about physics, the students’ comments again highlighted that the

concepts explored in physics could be interesting to the students but that the mathematical aspects were neither interesting nor enjoyable (Appendix F, pp. 160-161).

The last thing I had the students do was comment on what the biggest influence was for them to not take Physics 20. Students 1 and 2, who were going on to take Science 20 which does have a unit of physics, commented that they were happy to do a little more physics but had no desire to undertake an entire semester of physics classes (Appendix F, p. 162). Student 5 had his own major reasoning: “Just no need to take it, that and that it’s like a second math class to me, like I took math first semester I don’t want to take math in second semester only in a different form with a different name” (Appendix F, p. 162).

This idea was seconded by Student 4: “Yah, don’t need it, and I’m not really motivated to do such things” (Appendix F, p. 162). Student 3 had a very different major influence; she didn’t think she would qualify for enrolment in Physics 20. I informed this young lady that the only pre-requisite for Physics 20 was a passing grade in Science 10. She believed that there was a math pre-requisite, but neither our school nor Alberta Education has such an expectation (Appendix F, p. 163). Following these explanations, I had the students summarize their biggest influence. Four of the students claimed it was the fact that they did not need to take physics for their future endeavours, while one student stated that it was simply “Too hard” (Appendix F, p. 163).

In summary, it appears that these students were motivated to avoid physics by two major factors: firstly, that they did not require Physics 20 for their future endeavours; secondly, that they claimed the mathematical aspect of physics would be too difficult. In general, these students failed to see the relevance of physics and found it to be uninteresting (Student 5 in particular). They were, however, primarily avoiding physics

because they did not feel they could handle the mathematical aspect or did not want to put the effort forth that would be required to succeed. Therefore, this group of students' perception of high school physics could be presented generally as being mathematically difficult and not relevant to their individual futures.

Interviews Part 2: Science 10 Students Taking Physics 20

Student Profiles

This interview group consisted of four students. Again, for the sake of confidentiality, I refer to the students as Students 1 to 4. I have had or do have a pedagogical relationship with each of these students, and they were selected because they met the parameters of the interview groups. Though I have some experience with each of these students, I did not teach any of them the physics unit of Science 10.

Student 1 is a male grade 10 student who is in my advisor class. I have not taught this young man academically but as his advisor, I was aware that he is a gifted student who is considered to be high achieving academically by the standards of this study. This student intends to enrol in all three sciences at the grade 11 level.

Student 2 is also a male grade 10 student in my advisor class. I have not taught this young man academically but do know he is considered a mid to low level achieving student in science from my role as his advisor. This student also intends to enrol in all three sciences at the grade 11 level.

Student 3 is a female student in grade 10, and I taught her Math 9 last year where she was a strong student. This young lady is considered to be a high achieving student in Science 10. Like her two male counterparts, she too intends to enrol in all three sciences at the grade 11 level.

Student 4 is also a female grade 10 student who I taught in Math 9 last year. This young lady would be considered a mid to low level achieving student academically with regards to Science 10. This student also intends to enrol in all three sciences at the grade 11 level.

The Interview

The first question of the interview asked the students if they were indeed going to take Physics 20 as this was the reason they were asked to be a part of this interview group. The students all agreed that this was the case and we moved on to the second question that related to what influenced this decision. The first possible influence that was offered to the students was whether they had any timetable issues that affected their decision. I explained to the students that this would more likely play a role in the decisions of students not taking physics, but I still asked this question in case this played any role in their decision. As I had suspected, all four of the students claimed that time table issues played no role in their decision.

The second part of the second question examined any role that parents may have played in the students' decision to take Physics 20. The students were split in their responses: two claimed that their parents played a major role; two claimed that they had played no major role (Appendix F, p. 165).

We then discussed the influence of marks; I hoped that this would expose an interesting comparison. Since the students who chose not to study physics were influenced not to study physics by the fear of hurting their overall academic average, I was curious to see if the students going on to take Physics 20 saw the class as an opportunity to improve their overall average. I was also curious to see whether the

students going on to take Physics 20 worried about the grades they may receive in the course but chose to take it anyway. None of the students claimed physics would hurt their grade and two of them claimed it would improve their grade (Appendix F, p. 166).

The next part of this question examined the influence of peers on the students' decision. The students not taking physics all claimed that peers played no role on their decision, but I suspected that it may be different for those students taking Physics 20, that perhaps they would have more desire to take a class with friends and therefore take physics to be in class with friends. It turned out that only one of the students was influenced in this manner (Appendix F, p. 167). The last section of the second question dealt with other influences the students may have had in their decision that were not included in the question so far. The students added two factors: one that they wanted to keep their options open for the future; another was that the math was quite simple so they claimed they would be successful (Appendix F, p. 167).

We then moved on to the third question which asked the students if they had enjoyed the physics unit of Science 10. The students all agreed that they had enjoyed the physics unit, some because it was easy, others because they found it interesting (Appendix F, p. 167). The fourth question was directed at whether or not the students had found the physics unit difficult. From their responses to the previous questions, the students had all made it clear that they had not found the unit difficult. I quickly checked that this was true with the students and moved on.

The fifth question asked if the students had found the mathematical aspects of their physics unit difficult. As the students had just claimed that the unit was not difficult in general, I had the students approach this question in a different manner. I instead asked

the students to compare the difficulty of the math in the physics unit of science to the level of difficulty they felt their last math class had been. I was curious to know how they would answer. The students who were not going to take Physics 20 all said their math class was easier, but most of those students were comparing Science 10 to Math 10 Applied. This group of students were all in Math 10 Pure, the more academic grade 10 math class. They all claimed that the math in Science 10 was easier, some a lot easier, than the math in Math 10 Pure (Appendix F, p. 168).

From this point, we moved into the students' perceptions of the relevance of physics. This question contained three parts, the first of which asked if the students recognized physical principles at work in their day-to-day life. The students all claimed that they made connections between what they had learnt in class and what they saw in reality (Appendix F, p. 169). We then examined whether the students made connections between the technology they use, like iPods and cell phones, and the physical principles they operate on. Like the other group of Science 10 interviewees, they recognized that physical principles were involved but did not feel that they fully grasped what was happening. Due to this similar response, I also explored if these students felt that they would appreciate a course or a unit that explored the technology they use rather than some of the technology examined in Science 10 (like the evolution of the steam engine). This probe brought on some interesting responses; the students all claimed that a more relevant topic would inspire more interest. The students were adamant that they would find this type of topic more engaging and therefore easier to understand (Appendix F, p. 172). The last part of this question examined if the students saw physics at work in their natural environment, in the world and universe around them. All the students claimed that

they did indeed witness this and contemplate it from time to time, which gives evidence to their perception of physics as being relevant to natural processes.

In the last question I asked the students if they felt that physics was an interesting subject. I wanted to explore whether the students perceived physics as interesting or if they were simply taking Physics 20 out of necessity. Some claimed it was deeply interesting; others just enjoyed parts of the subject (Appendix F, pp. 172-173). I then asked the students to examine what they had written earlier as their major influences and to reflect on our discussion. I wanted them to come up with what they felt was the biggest factor in influencing them to take Physics 20. The students all had a similar answer which related to their future considerations. They all claimed taking Physics 20 was necessary in order to keep their options open or to gain the occupation they desired. What intrigued me about their answers was the source each student claimed this idea of “keeping doors open” had stemmed from. These students all had a desire to take physics with their futures in mind, so the question then became, what influenced them to be so conscientious of their futures? One student claimed it was his teachers that had inspired his future forethought, while two others claimed their parents had influenced them, and Student 4 claimed that she was influence by personal reflection (Appendix F, pp. 173-174).

Generally speaking, these students did not perceive physics as difficult and they did find it somewhat interesting. They also seemed to have a little understanding of the relevance of physics.

*Interviews Part 3: Physics 20 Students Not Taking Physics 30**Student Profiles*

This interview group consisted of four students; the students are referred to as students 1 to 4 to preserve their anonymity. All four students were taught Physics 20 by me in the same semester. All four students were encouraged to take Physics 30 but chose not to take it.

Student 1 is a female grade 12 student. This young lady is a high achieving student by the standards of this document. She was a strong student in Physics 20 and it is my opinion that she would have been quite capable of succeeding in Physics 30. This young lady enrolled in biology and chemistry at the grade 12 level.

Student 2 is a female grade 12 student. This young lady fit into the mid to low achieving academic standard. Although she struggled with certain concepts within Physics 20, her work ethic allowed her to do quite well in the course and I feel she would likely have succeeded in a similar fashion in Physics 30. This young lady studied biology at the grade 12 level.

Student 3 is a male grade 12 student. This young man falls in the high achieving category. He attained one of the highest grades in his class for Physics 20, and I therefore believe he would have been quite successful at the Physics 30 level. This young man enrolled in both chemistry and biology at the grade 12 level.

Student 4 is a male grade 12 student. This young man is considered to be a mid to low achieving academic student with regards to Physics 20. He was a unique interview subject and I feel it should be noted that his highest level of mathematics was Math 24 (this is a grade 11 level math course at the lowest academic math level the school offers).

He took Science 14 in grade 10, then upgraded to Science 10 in grade 11 and had just completed Physics 20 with a very respectable grade. I truly believe this young man could have completed Physics 30 as well.

The Interview

I began the interview by making sure this group of students were not intending to enrol in Physics 30, which they all agreed was the case. We then moved on to the second question, which included five parts, the first of which dealt with timetable issues. I asked the students if they had chosen to not take Physics 30 because they had no room in their time table or because they felt they needed a spare period to keep up with their other courses. This factor played a role in two of the students' decisions. They claimed they would have been overloaded in taking physics in addition to several other diploma courses (Appendix F, pp. 176-177). Diploma courses are classes at the grade 12 level that include a standardized test that comprises 50% of their final grade.

The next part of this question asked the students if their parents had played any role in their decision. I expected more responses to this question from students actually enrolled in physics, parents influencing the students to take physics rather than influencing against, and I explained this to the group. Three of the students stated that their parents played no influence in their decision while one student commented that she went against her parents influence by not taking Physics 30, her parents had wanted her to take Physics 30 (Appendix F, p. 177).

The question moved on to the role of marks, or concerns of overall average, on the students' decision to not take physics. I asked the students if they were concerned about getting a low mark in Physics 30, that perhaps they were concerned that a low mark

may hurt scholarship or post-secondary ambitions. Although marks were considered by all the students, this factor only seemed to affect Student 1's decision (Appendix F, p. 178). The next section dealt with peers. I was curious to know if these students had chosen not to take Physics 30 because their friends were not taking it. Perhaps they had attempted Physics 20 without their friends and decided they did not want to take another course of physics without having a friend involved to work with. None of the students claimed that this was a concern and Student 3 pointed out, "My friends are taking it" (Appendix F, p. 178).

The last section of this question allowed the students to comment on any other major influences that they felt had made an impact on their decision. I suspected for these students that another factor could be the fact that they did not require physics for their post-secondary endeavours and therefore decided not to take the course; I offered this as an example. The students all agreed that this was an influence and two of the students also mentioned the ability to take a Physics 30 equivalent at the post-secondary level if they needed the course in the future. One student also mentioned the pressures of Diploma exams as an influence (Appendix F, p. 179).

We then moved on to the third question, which asked the students if they enjoyed Physics 20. In asking this question, I was hoping to expose the students' perceptions of physics as an enjoyable course, and to examine if this had played a role in their decision. Were they not taking Physics 30 because they did not enjoy Physics 20? I was glad to hear from this group of students that this was not the case, that they all had enjoyed Physics 20. Two of them commented that it was their favourite academic class of that semester (Appendix F, p. 180). Though this was pleasing to hear, both as their educator

and as an example that students who take physics seem to enjoy it, it demonstrates a possible bias within the study. As I had taught the physics students involved in this study, the students may have felt obligated to state that they had found physics interesting and that they had enjoyed their teacher. Although I did inform the students that I wished for them to answer the questions honestly, they may not have divulged their true feelings due to my presence in the interview.

The fourth question asked if the students found Physics 20 to be difficult in general. Three of the students commented that they found some of the conceptual ideas difficult to master, while one claimed the course was fairly simple. The students all claimed if there was something difficult about Physics 20, it was related to the conceptual side or to the deciphering of questions to determine what they needed to calculate. The mathematical evaluation involved in Physics 20 was not the difficult aspect for these students; they all confirmed this (Appendix F, p. 181).

As I had done in all the interviews, I then asked the students to compare the mathematics involved in their physics course with that of the mathematics they were taking at the same time as the course or the highest math they had taken prior to Physics 20. This generated some interesting responses as the students had an array of different math levels at the time of Physics 20. Students 1 and 3 were in Math 30 pure at the time while Student 2 was taking Math 20 Applied and Student 4 had taken Math 24. Interestingly enough, they all found that the math in Physics 20 was either easier or on par with their math course (Appendix F, pp. 181-182).

Question 6 explored the students' perceptions of the relevance of physics in three parts. Firstly, I asked them if they made connections between their physics course and the

experiences of their day-to-day life. The example I offered to these students was the idea of coefficient of friction and manoeuvring around an unbanked curve in a vehicle in the winter time. The concept comes from the circular motion unit and states that the maximum speed one can round a corner at is dependent on the coefficient of friction between the road and the tires. The students all commented that they had indeed reflected on this idea (Appendix F, p. 183).

We then discussed the relevance of physics to the everyday technologies that students interact with. These students, like the others I had interviewed, understood that physical principles were involved, but they did not understand the way their technology operated. I asked the students if they felt they would take interest in learning about the operations of the technology they use on a daily basis. They all agreed that this would be interesting and enjoyable. The last part of the question asked if the students saw the relevance of physics to natural phenomenon, if they made the connections between classroom topics and natural interactions that may or may not have been discussed. Three of the students claimed that they had an appreciation for the interactions of the cosmos, while Student 4 did not feel he made the connections (Appendix F, p. 184).

We then discussed question 7, which asked the students if they found physics to be an interesting subject. This generated some of the most intriguing answers of the whole study. Although these students did not enrol in Physics 30, they all seemed to find the subject matter stimulating. In fact, one of the students commented that although Physics 20 was her favourite class and she was very successful at it, she still didn't take Physics 30 because she "thought it would be super hard" (Appendix F, p. 184). Another student commented that she had some regrets about taking not taking Physics 30: "I kind

of wish I could have taken Physics 30” (Appendix F, p. 185). Again, these two responses may have been influenced by my presence as the interviewer. The students may have felt obliged to comment positively to me about their experiences in Physics 20 as I was their teacher.

I then asked the students to consider what they felt was the biggest reason they did not take Physics 30 and to comment on that. They had similar reason, that they did not need the course for their future considerations (Appendix F, p. 185). Next, I asked the students to consider the hypothetical situations in which they needed physics for their career or in which they had more room in their schedules. In either case, would they have enrolled Physics 30? They all agreed that they would have. Further, I questioned whether any of them would say the main reason they didn’t take physics was because they felt it was hard, irrelevant or boring. None of the students in this interview group claimed that this was the case (Appendix F, p. 186).

The last thing I had these students do was compare their perception of physics prior to Physics 20 to their perception now that they had completed it. I wanted to see if their opinions had changed through the experience, if they were surprised by the difficulty or simplicity of the subject, or if they had any other comments about the development of their perceptions of physics. Three of the students claimed that they had expected Physics 20 to be very difficult and all of them agreed that the subject turned out to be fairly simple (Appendix F, pp. 186-187).

In summary, these students reported that they had a positive experience with Physics 20 and the major influence to not take Physics 30 stemmed more from their future aspirations than any dislike of the subject or concern over its difficulty.

Interview Part 4: Physics 20 Students Taking Physics 30

Student Profiles

This group interview had four participants. As in the previous interviews, they are referred to as Students 1 to 4. I taught all four of these students Physics 20 in the same semester. Two of these students are grade 10 students who took Physics 20 in the second semester of their grade 10 year; the other two students are grade 11 students. These students were selected for this interview group because they fit within the parameters of the group selections.

Student 1 is a female grade 11 student who I also taught in Science 10. This young lady is considered a mid to low level achieving student by the standards of this document. She is intending on completing all of her sciences to the grade 12 level.

Student 2 is a female grade 10 student. This young lady is considered a high achieving academic student with respect to Physics 20. She also intends to enrol in all three sciences to the grade 12 level.

Student 3 is a male grade 10 student. This young man hovers at the top end of the mid to low academic achievement level with respect to Physics 20. He also intends to enrol in all three sciences to the grade 12 level.

Student 4 is a male grade 11 student. This young man achieved a grade at the top of his class in Physics 20 and is considered high achieving academically with respect to Physics 20. He intends on enrolling in all three sciences to the grade 12 level.

The Interview

Again, I began the interview by ensuring that all these students did intend to enrol in Physics 30, which they all confirmed. We then moved on to the second question which was separated into five parts. The first part of the question asked if the students felt that their decision to take Physics 30 was influenced by timetable issues. I explained that this was perhaps more of an influence on students not taking physics but offered the idea that perhaps they were intending to study Physics 30 because it fit into their schedule well. None of the students claimed that time table issues had played any role in their decision.

We then moved on to the second part of the question in which I asked the students if their parents had influenced them to enrol in Physics 30. Two of the students claimed this was a major influence, while another claimed that his siblings played a bigger role (Appendix F, p. 189).

We then moved on to the third part of the question, which asked if the students felt their marks or concerns about their overall average played a role in their decision. As has been demonstrated in previous interviews, concerns about grades can sometimes have an adverse affect on a student's desire to pursue physics. With this interview group, however, I was curious to know whether the students were taking Physics 30 because they felt it could boost their overall average. A couple of the students claimed that they could improve their overall average with physics while the other two didn't see marks as playing a major role (Appendix F, p. 190).

The fourth part of this question asked if peers played a role in their decision to take Physics 30. These students claimed they were influenced by their peers. They,

however, stated that the influence affected their decisions on when to enrol in physics rather than whether or not to study it (Appendix F, pp. 190-191).

The last part of this question asked the students if any other factors influenced their decision to take Physics 30. When I posed this question to the students, the two females claimed that they had other reasons while the two males claimed they did not. The girls both claimed that their decision was career related. I then offered the idea of “keeping your doors open”, enrolling in physics with consideration towards future academic options. This was an idea that they all agreed was an influence on their decision (Appendix F, p. 192).

The third question asked the students if they had enjoyed Physics 20. I asked the students to explain what it was that they had enjoyed or not enjoyed about the course. All the students said that they had enjoyed physics and made a variety of comments about what they had enjoyed in particular. An interest in learning new theories and understanding how things worked coupled with the work time made available in class to undertake assignments and improve understanding were the dominant themes in what the students had enjoyed (Appendix F, pp. 192-193).

We then examined how the students felt about the difficulty of physics. I explained that I wanted to know if they felt the course was difficult in general, as compared to other courses; and if they had found it difficult, I asked them to elaborate on what aspects about the course were difficult. The students claimed that the mathematics of physics was fairly simple; the carrying out of the formulas was not a problem. Where they encountered difficulty was in deciphering what the question was asking and setting up a means of solving for it, remembering the conceptual aspects that must be considered

when executing their solution (Appendix F, p. 193). This covered the next question in which I asked the students if they felt that the mathematics of physics was difficult.

I then asked the students to compare the mathematics that they were doing in Physics 20 to that of the math involved in their most recent math class, either the class they had taken in unison with Physics 20 or the course they had taken prior. This was an interesting question because in this group of students we had two who were comparing Math 10 Pure, one comparing Math 20 Pure and one comparing Math 30 Pure. I didn't know what to expect, but due to what had resulted from the other interviews I thought perhaps the Math 10 Pure students would feel their math course was less challenging and the two higher levels would feel their math course was more difficult. This did not turn out to be the case. Interestingly, the only student who claimed the mathematics involved in Physics 20 was harder than that of her current math class was the student in Math 20 Pure, the grade 11 level course (Appendix F, p. 194).

We then discussed the students' perceptions of the relevance of physics by examining whether or not they made connections between what they had learned in class and what they witnessed in their day-to-day life. I offered the same example for this question as I had for the previous Physics 20 interview group, asking about the relationship between the coefficient of friction between a car's tires and the road while turning around an unbanked curve. The students all admitted that they had pondered this concept while driving. We then discussed whether the students had made connections between the technology they use and physical principals. This group of students did not seem to make this connection when asked about their cell phones; they all said that they are simply happy when their cell phones work. However, when I asked the students if

they would be interested in learning about how their cell phones work, they all responded that they would (Appendix F, p. 195).

In the last part of this question I asked if the students felt that physics was relevant in explaining the world around them. I explained further that they could consider the universe as well, that the question was directed at their interpretations of physical phenomenon and whether or not they attempted to understand them using physical concepts learnt in class. The students did not feel that this was a common reality in their lives though a couple of the students did feel it may have happened to them (Appendix F, p. 196).

The next question asked the students if they felt that physics was an interesting subject. All four students claimed it was an interesting subject, so I pushed further and asked the students if they could compare Physics 20 to the other subjects they had taken in high school. Did they find Physics 20 to be more or less interesting than their other classes? The response was unanimous; these students all claimed that physics was their most interesting subject (Appendix F, p. 196).

I then asked the students if they could describe their pre and post perceptions of physics. I asked them to think back to what they felt physics was going to be like before they had their first class of Physics 20 and then to reflect on how they felt about the subject after completing the course. Interestingly, three students in this group thought that Physics 20 was going to be easy. I asked them where this perception had come from and they all claimed that they had been influenced in this regard due to peers that had taken Physics 20, not from external sources (sources not directly involved in Physics 20). Student 3 claimed he had felt it would be a more difficult class than it was; he then stated

that he had gained this impression from his parents, an external source (Appendix F, pp. 197-198).

Continuing on this path, I asked the students if they felt that physics had a reputation in society as being a difficult subject that is meant to be taken by the most intellectually capable. The students were split on this question. Two students saw that physics was for “smart people” while two others didn’t get that impression (Appendix F, p. 197).

Lastly, I asked the students to define what they felt was their biggest influence in taking Physics 30. There were three main influences: keeping options open; the enjoyment of taking a class with friends; and the pedagogical relationship shared with the teacher (Appendix F, p. 198).

In summary, these students claimed they had enjoyed physics and found it interesting, though they did not seem to be especially aware of its relevance. They were taking Physics 30 primarily to keep their doors open and because they had enjoyed the class.

Interviews Part 5: Physics 30 Students Not Taking Post-Secondary Physics

Student Profiles

This interview group consisted of only three students, who are referred to as Students 1 to 3. I taught all three students Physics 20 and Physics 30; all three students are grade 12 students. Although it was my goal to find individuals that fit within the parameters laid out in the methodology section of this document, I was unable to find participants who met all the characteristics. They did not exist. Specifically, I was unable to find a high achieving academic male who wasn’t intending to study physics at the

post-secondary level. Two of the other students may take physics in the future but are unsure whether or not they ever will and were not planning on doing so at the time of the interview.

Student 1 is a grade 12 female student who is considered a mid to low achieving academic with regards to Physics 30. This young lady is the only student in the group who was positive about not taking post-secondary physics courses. She studied all three sciences at the grade 12 level.

Student 2 is a male grade 12 student who is considered a mid to low achieving academic with regards to Physics 30. This young man is not currently planning on pursuing physics classes at the post-secondary level but he also does not rule out the possibility of it happening in the future. He studied chemistry at the grade 12 level.

Student 3 is a female grade 12 student who is considered a high achieving academic with regards to Physics 30. When I began looking for students to participate in this study this young lady was certain that she was going to become a nurse practitioner. As the semester wore on and she completed Physics 30 she began to think that engineering might also be a possibility for her future. She still intends to enrol in the Nurse Practitioner program next year but has informed me that if she does not enjoy the program in the first year she will likely switch to the pursuit of an engineering degree. She studied all three sciences at the grade 12 level.

The Interview

I began by asking the students their intentions at the post-secondary level with regards to physics. Unlike the other interviews, in which my belief that the students fit well within their category were confirmed, this interview held a surprise. Student 2

informed me that he may take physics at the post-secondary level in the future, but that he had no intentions of doing so in the next few years. In addition to this, I did know in advance of the interview that Student 3 had been reconsidering her future aspirations of becoming a nurse practitioner and may take physics in the future as part of an engineering program. We discussed this information as part of question 2, which for the Physics 30 interviews asked if they were intending on pursuing a physics related career. At that point the students agreed that this was not the immediate case, so they did still fit more or less into the group I had intended to form.

We then discussed the third question, in which I asked if the students felt that taking Physics 30 had helped them in completing other high school courses. I explained that this advantage may have been more noticeable in math and science courses but could include any subject they could think of. The students all claimed that they had gained an advantage in other classes, particularly in Math 30 and Chemistry 30 (Appendix F, pp. 199-200).

Question four asked if the students had enjoyed Physics 30. I asked the students to expand on what they had enjoyed about the course or what had disappointed them if they had not enjoyed it. The students commented that the course was interesting and therefore enjoyable (Appendix F, p. 200).

In question five, I had asked the students if they had felt the subject was difficult, again I encouraged them to expand on their answers. The students had found the conceptual side more difficult than the math involved (Appendix F, p. 200). The student responses to this question served to answer the next question, whether the students felt the mathematical aspects of Physics 30 were difficult. Since we had the question covered,

I asked the students to compare the difficulty of their highest level math course to the mathematics involved in Physics 30. The students all claimed that their grade 12 math class was more difficult than the mathematics involved in Physics 30 and that Physics 30 was less difficult in general. I then asked them to compare Physics 30 to their other grade 12 core courses as far as what they felt was more difficult. The students reported that physics was no more difficult than their other grade 12 level courses (Appendix F, pp. 200-201).

Next, we examined the students' perceptions of the relevance of physics. The students had all experienced awareness of physical interactions related to topics that had been discussed in Physics 20 and Physics 30 (Appendix F, p. 202). They further commented that taking physics at the high school level had increased their desire to understand the physical phenomenon they experience every day. These students admitted that although they did not completely understand the inner workings of a cell phone, they did feel that they would be very interested in learning about such technology, and that they felt other high school students would be engaged by this as well. We then discussed if the students had related anything they had learned in class to the physical world and universe around them. Student 3 remembered a particular example: "Yeah, especially after that video that you showed us with like the string theory and the earth is like creating that dip and that was the gravitational thing. I found that really interesting" (Appendix F, p. 204).

I then explored a fourth point to this question, one which was not included in the previous interviews with the Science 10 and Physics 20 students. I asked the students if they felt that the problem solving skills that they used in physics were relevant to real

world problems. That is, could those skills be used to deal with the problems that we face as humans on a daily basis, not limited to physical problems, but in social situations as well? I explained that I often used my basic problem solving steps, gained from years of practicing physics, in dealing with social situations that had created an obstacle for me, usually with success. I asked if they could see themselves doing, or if they had done, similar problem solving actions in daily life. All the students claimed that they did in fact do this. I then asked if they felt, therefore, that physics lessons apply to life even if students do not continue to study physics; if they felt that it was not a waste of time completing these courses even if they did not intend on ever taking another physics course. The students commented taking physics was in no way a waste of time, and that they were glad that they had taken the course (Appendix F, p. 205). These students saw plenty of value and relevance in physics and are glad to have studied it even if they are not continuing on with physics.

The last question on the questionnaire asked the students if they felt physics was an interesting subject. The students all found the subject interesting as it explained phenomena they previously did not understand (Appendix F, pp. 205-206). I then asked them to compare Physics 30 to the other subjects they had taken in high school. Did they feel that this subject was more or less interesting than other courses they had taken? The relevance or the purpose of physics seemed to give it an edge over other subjects in these students' minds (Appendix F, p. 206).

Next, we discussed what the students felt were their biggest influences in not pursuing physics further; restating that I meant they did not intend on pursuing it in the near future rather than never. The students all had their own reasoning; none, however,

claimed it was because they did not find physics interesting, enjoyable, difficult or relevant (Appendix F, p. 207).

I then asked these students to look back on their high school career and think about their perceptions of physics before they ever studied it and to compare those perceptions with their perceptions now that they had completed high school physics. I also asked them to consider where they felt their original perceptions of physics may have been rooted and comment on that. Some of the students had an external source influencing them to see physics as a difficult subject, but when they completed the courses, they commented that they felt that the subject was relatively simple (Appendix F, p. 208). I expanded on this by examining whether they felt that societal biases existed towards physics. The students' stated that they did perceive a societal bias towards physics being a difficult subject. These students also commented that some of physics' societal reputation had permeated their own perceptions of physics (Appendix F, p. 209).

I closed out our discussion by allowing the students to comment on their high school physics experience in general. The students commented again that they were glad that they had taken the course and that it was enjoyable and surprisingly less difficult than they had expected. Student 1 commented: "I think it was worth it, definitely" leaving a sense that the students were very pleased they had taken the course even if they were not going to use it for future endeavours (Appendix F, pp. 209-210).

In summary, these students all found physics to be relevant, interesting, enjoyable and not too difficult. These students are not intending to take physics in the near future but they all demonstrate an appreciation for the courses and do not have any regrets in taking the subject.

*Interviews Part 6: Physics 30 Students Taking Physics at the Post-Secondary Level**Student Profiles*

This interview group consisted of four grade 12 students who are referred to as Students 1 to 4. I taught three of the students Physics 30, the other student took Physics 30 from another teacher. All of these students are planning on taking physics at the post-secondary level and, in addition, are considering careers in physics related fields. These students are all high achieving academics in regards to Physics 30. As was discussed in the methodology section, it was impossible to find students considering careers in physics related fields that were not high achievers.

Student 1 is a female grade 12 student who I taught in Physics 30. This young lady took all three sciences at the grade 12 level. She is planning on studying pre-engineering and considering a career in civil engineer.

Student 2 is a male grade 12 student who I taught in Physics 30. This young man took all three sciences at the grade 12 level. He is also planning on studying pre-engineering and he is considering a career in electrical or biomedical engineering.

Student 3 is a female grade 12 student who I taught in Physics 20 and Physics 30. This young lady took all three sciences at the grade 12 level. She is planning on taking pre-medicine at the post-secondary level, and is considering a career in optometry which includes a large amount of physical optics.

Student 4 is a male grade 12 student. This young man's high school physics teacher stated that he is a high achieving academic student. He also took all three sciences to the grade 12 level. He is planning on taking pre-engineering and hoping to find a career in the field of civil or mechanical engineering.

The Interview

I began this interview in the same manner as the others, by ensuring these students fit into the category that defined this interview. The first two questions dealt with the students' intentions to study physics at the post-secondary level and to pursue a career in the field. The students all agreed that they were indeed interested in studying physics and in pursuing a physics related career. In answering these questions, the students commented on their future aspirations. As was outlined above, three students were interested in engineering careers and another in a medical field with close ties to physics.

We moved on to the third question, in which I asked the students if they felt that taking Physics 30 had been helpful in their other high school classes. I was curious to know whether the students perceived physics as a valuable course in helping them to grasp concepts in other high school courses. The students, like the other Physics 30 students, claimed that there were some connections to their math classes (Appendix F, p. 212).

Next, I asked the students to review question four, in which I had asked them if they felt that Physics 30 was an enjoyable class. I asked the students to expand on what they had found enjoyable about the course if they had enjoyed it. The students stated that they had enjoyed learning the laws of nature, and learning how the universe operates (Appendix F, p. 212). I was interested to learn that the students enjoyed physics because it had helped them to understand how the universe operated. To further this idea, I asked the students if they had always been curious about how nature and technology operate, or if taking physics had sparked this interest. The students commented that they had always

had this interest, but that physics had furthered this interest and fuelled their desire to understand (Appendix F, p. 213).

In the fifth question, I asked if the students felt that Physics 30 was a difficult course. Again, I asked the students to expand on which aspects they found difficult. Like in the other interviews, there seemed to be a consensus that the conceptual side of physics was what was difficult, not the mathematical aspects (Appendix F, pp. 213-214). The next question, which asked if the students felt the mathematical aspects were difficult, had already been covered by the students' responses.

Like in the other interviews, I then asked the students to compare the mathematics in their physics course to the mathematics involved in their most recent math class. The majority of the students claimed that their math class was more difficult, that they had to work harder in math to succeed. In discussing their comparisons between math and physics, the students recognized that there is a misconception prevalent in students that high school physics is more difficult than it actually is (Appendix F, p. 214). The students also commented that the math involved in physics is quite simple. They explained that the mathematical concepts they used in physics were learned at lower grades; the concepts were not the more complex ideas they were exploring in Math 30 (Appendix F, p. 215).

We then discussed the students' perceptions in regards to the relevance of physics. These students all claimed that they had applied knowledge learnt in class to something that they had observed in their daily life, though they said that this was on a variety of levels. One student had applied the knowledge to the construction of a ballista,

while another student had used this knowledge to impress their friends (Appendix F, p. 215).

The next question dealt with the relevance of physics to the technologies the students use. All of these students recognized that their technology, like cell phones, is based on physical principles. These students also claimed that they witnessed physics in action around them while observing natural phenomenon.

In the next section, I asked the students if they felt that they could apply the problem solving skills they had developed in physics to other areas of their lives. As I had done with the other Physics 30 class, I offered the students an example of what I meant in using problem solving to analytically attack day-to-day problems that arise in my life. The students did feel that they could use this approach but not all of them agreed that they did in fact do this (Appendix F, p. 217).

Next, I asked the students if they had found physics to be an interesting subject. I also asked them to compare physics to other subjects they had taken in high school. How interesting had they felt the subject was in comparison to their other core classes? All of the students claimed that physics was one of their most interesting classes. Student 1 commented, "Out of all the other sciences I've taken, you can relate the most to physics" (Appendix F, p. 217)

I then asked the students to explain what the biggest influences were for them to continue to pursue physics as both a subject in their post-secondary experience and as a career path. The students listed a variety of influences including parents, future considerations and interest (Appendix F, p. 219).

Lastly, I had the students reflect on their entire high school physics experience. I asked them to think back to their perceptions of physics before they ever had taken one class of Physics 20, and to compare those perceptions to their understandings of the subject now that they had completed the curriculum. The students all believed originally that physics was going to be very difficult, but after completing Physics 30, they claimed that that was an inaccurate perception. Student 2 commented: “I also thought it was going to be extremely hard from what I had heard from family and friends ... I thought it was going to be harder, but it turned out a lot easier than I expected” which summarises the consensus (Appendix F, p. 219).

I explored the reasons the students had originally felt that physics was going to be such a difficult topic, and the sources from which that perception had come. Two of the students said this perception had originated from their parents, while another didn't know from whom the perception had originated but had developed the perception that physics was going to be difficult anyway (Appendix F, p. 220).

Lastly the students made some closing comments about physics and society. The students stated that there is indeed a societal bias towards physics; that physics is a difficult subject that is only for the most academically capable. They however also claimed that this public perception was inaccurate and one student even commented on his desire to eradicate this perception by encouraging his peers to take physics by explaining that the courses are not as difficult as is often projected (Appendix F, p. 221).

In summary, this group of students found physics interesting, enjoyable and relevant. Further, they did not feel that it was the most difficult subject they had taken.

They do believe a public perception exists in which physics is perceived as difficult, but they claimed that this perception is inaccurate.

Chapter Five: Discussion and Conclusions

In Alberta we currently have far fewer students studying physics than the other sciences (Alberta Education, 2007). This is a problem when given the importance of technology to our daily lives. A decrease in the scientific literacy of society, and a shortage of human capital for the technological workforce, are some of the problems that could arise from a society in which people are not studying physics. Why are high school students not taking physics? Could it be that students perceive the subject to be difficult, boring, or irrelevant? This study set out to examine what high school students' perceptions of physics were and how those perceptions differed as the students were exposed to more physics through their high school career. I examined whether students who had studied physics had the same perception as those that did not to determine if the students not studying physics had fair and accurate perceptions.

Conclusion One

The student participants in this study were influenced in their physics enrolment decisions by several factors, but the major influence was their future considerations.

Within the Science 10 interview groups all of the students had based their decision about physics enrolment upon future considerations. The two interview groups had differing reasoning about what their futures required. For the group of students not taking Physics 20 there was a consensus that they only needed to study one or two sciences to accomplish their future goals. These students all admitted that they did not want to take more science classes than they needed, therefore, they did not need to enrol in Physics 20. The students planning to enrol in Physics 20 were of a different mindset; all of these students were planning on enrolling in all three sciences. Two of them

claimed that the belief that they needed to take all three sciences stemmed from their parents, while another claimed teacher influence in this regard. The last one claimed she had determined this course of action on her own. So there is a split between these Science 10 interview groups in regard to how many science courses they believe are necessary for their futures. One group of students is enrolling in the minimum number of science courses, while the other group intends to study all three sciences.

As was noted above, all of the students choosing to take Physics 20 were choosing to take all three sciences. This choice was motivated by the students' desire to maintain as many options as possible. All of the Science 10 students taking physics either said that they would need physics or that they were unsure of what they wanted to do so they were taking all three sciences; we could therefore say their choice was influenced by future considerations. In a similar fashion, all of the students not taking physics claimed that they would not need physics for their future endeavours and were therefore not going to take it. Thus, a major influence in all of these students' decisions was their future considerations. This is important to note. If students are not taking high school physics mainly because they do not need it for their careers, it could prove quite difficult to inspire enrolment simply by changing perceptions of the difficulty and relevance of physics. Whether or not students truly know what they want to do as a career in grade 10 can be argued, but the idea that students are not enrolling in physics due to what they anticipate their future career will be, needs to be taken into account. This is especially important if their parents, teachers, or counsellors are not checking their academic decisions. A student could be wrong about which courses they need for a given post-secondary program or they could be unaware of what a profession entails. When the idea

of future considerations was further discussed with the students at the end of their interviews, most reported that it was their biggest factor in deciding not to take physics. Others were more concerned about grades and the difficulty of the subject.

The Physics 20 students were influenced in their decision about Physics 30 by a combination of factors, most of which included future considerations. For example, all of the students not taking Physics 30 stated that scheduling issues played a role in their decision. Student 1 was influenced by scheduling concerns because she didn't want to overload herself; she was worried that Physics 30 would be too difficult and time consuming. Students 2 and 3 had similar feelings, though they were more concerned with the number of diploma level courses they were taking in their last semester of high school than with the difficulty of Physics 30 itself. If either of these students had taken Physics 30 they would have filled their last semester with four diploma level courses. Both students had a final semester where they had to make a choice about not taking one grade 12 level core class. Their decision to not take physics was now influenced by their future considerations; neither student needed Physics 30 for their post-secondary program, but they did need the other courses. The final student of this group was also influenced by a combination of scheduling issues and future aspirations; he had to take three courses, but also wanted to make sure he had a spare period to complete school work. Since Physics 30 was not required for his post-secondary program, he decided to not enrol in the course. The students not studying Physics 30 did not feel that their parents had influenced their decision; no parent influenced their child in a negative manner such that the child would choose not to study physics. In fact, when I asked Student 1 if her parents had influenced her in her choice not to study physics, she commented: "No, not at all, they would have

been happy if I took it” (Appendix F, p. 177). In this study, there is no evidence that parents are pushing their students away from physics. They may have lead them to believe that the subject is difficult, but I did not see any incidents in which parents told their son or daughter that they were not capable. When I asked the students taking Physics 30 if they felt their parents had influenced their decision I saw results in line with Lyons’ (2006) study. All of the students continuing to study physics said that their parents had played some role in their decision. The students described their parents’ influence as encouragement to take all three sciences to keep their options open for the future.

I had expected that some of the students choosing not to take Physics 30 would be influenced by a fear of not succeeding based on their Physics 20 experience; this did not turn out to be the case. Students 2 and 4 struggled with Physics 20 and were the male and female mid to low achievers for that group. Interestingly, neither of them claimed that fear of failure was a concern, or that it had deterred them from taking Physics 20. Student 2 commented on grades as an influence: “No, I mean it probably would have been tough but that’s not the big reason” (Appendix F, p. 178). She demonstrated that her experience in Physics 20 didn’t scare her away from Physics 30 like one might assume. Her reasoning was based more on her scheduling issues, while Student 4 saw physics as unnecessary for his future.

The Physics 20 students all offered their future considerations as an influencing factor on their Physics 30 decision. As with the Science 10 groups, the students enrolling in the next level claimed that they were doing so as a means of either keeping their post-secondary options open or to pursue their desired career. Among the students not moving

on, there was a consensus that not needing Physics 30 for their desired career or program was a primary influence. Both of these groups brought future considerations to light when we discussed the major influence on their decision about Physics 30. The students taking Physics 30 all commented that they either needed this course or were unsure of their future, and along with enjoying Physics 20, this concern for the future was their biggest influence. The students not studying Physics 30 all responded that they were not taking Physics 30 because they did not need it and that it would have added undue stress to their final semester. I asked these students if they felt their decision would have been different if they had needed the course or if they had been in an easier semester. These students all responded that they would have taken Physics 30 in either of these cases. Therefore, there was consensus among the students who were not taking Physics 30 that their biggest influence in this decision was that they did not need the course.

The Physics 30 students' claimed their decisions about post-secondary physics were also influenced greatest by future considerations. The Physics 30 students who are not studying post-secondary physics all stated that the major reason for this had nothing to do with their enjoyment of physics, but that it was because physics was not required by their program or future plan. This is interesting because it shows that low enrolment in physics courses at the university level (Appendix B, p. 136) is affected in a similar manner as enrolment in high school courses. The students I interviewed chose not to study post-secondary physics because they didn't need to, not because they didn't want to, a similar sentiment to the Physics 20 students' feelings about Physics 30. One of the Physics 30 students pursuing physics commented that she was glad that physics was a required course because otherwise she might not have taken it. This example

demonstrates that some students are less inclined to study a given subject due to enjoyment or interest and are more motivated by the requirements of their future aspirations. The other students taking post-secondary physics were planning to become engineers. Therefore, physics was required for their program.

All of the students interviewed, therefore, commented that their future considerations played a role in their decisions about studying physics. At the end of Science 10, students must decide whether or not they are going to take high school physics. This research has demonstrated that for these students, this decision is influenced by many factors; but the main factors relates to what the students intend to do after high school. Most of the students interviewed concluded that their future aspirations, what their desired career was or what they wanted to study at a post-secondary institution, was the most influential factor in deciding to take physics or not. For some of the students, their perceptions of physics influenced their desire to pursue a physics related career, but for the most part, the students were studying physics because of a desired post-secondary program or career rather than being influenced to pursue a career because of physics.

Conclusion Two

The students who studied physics, and those that intend to study physics, hold perceptions of physics that were contrary to the perceptions of the students who will not study physics.

The two groups of Science 10 students had the greatest differences in their perceptions of high school physics out of the three grade levels. The grade 10's moving on to take Physics 20 generally believed that physics was an interesting and enjoyable subject, while the students not planning to enrol in Physics 20 had a much different

perception of physics. For example, one of the Science 10 students who was not going to enrol in Physics 20 had this to say about physics: “It was just boring, I don’t need to know how much joules it takes to twitch my finger or throw a ball across a room, I’ll never have to use that” (Appendix F, p. 153). A student choosing to take physics had a much different view: “I liked it because you see how things work around you in like everyday life” (Appendix F, p. 167). The student not studying physics failed to see any relevance in the subject. The student taking physics saw it as the complete opposite; physics explained how the universe operates. In general, the Science 10 students choosing not to study physics were more inclined to see the subject as difficult, irrelevant and boring. These perceptions appear to be keeping some students from taking Physics 20, but I note that future considerations was indicated as the major factor in the majority of these students’ decisions. The students choosing to take Physics 20 seem to find the subject interesting, enjoyable and not overly difficult. The factors driving these students into physics revolve around the ease they have with the topic, the interest it has sparked and future considerations.

Unlike the Science 10 students choosing not to study physics, all of the Physics 20 students interviewed stated that they enjoyed physics. The students all found relevance in the topic in some form, and as a group, they found far more relevance than the Science 10 students. This is not surprising if one considers the depth and time the students study physics in each course. Lastly, all of the students found great interest in the course. As I stated above, all of the students not taking Physics 30 commented that if their situations had been different, they would have taken the course.

The Physics 30 students commented that they had enjoyed Physics 30. Most of them stressed that they had deeply enjoyed it. When I asked both groups to expand on their comments, they spoke about the ability of physics to explain events that happen around them, which sparked their interest and increased their enjoyment of the subject. Although many of these students claimed they had always had a curious nature, they said physics served to stimulate this passion. The Physics 30 students had the best understanding of the relevance of physics. This is to be expected, as these students have been exposed to more of the physics curriculum. The students from both groups recognized physics in their day-to-day lives, in the technology they use and in the natural interactions occurring around them. Within this study, therefore, the perceptions of physics held by physics students were contrary to that of students choosing to not take physics.

In addition to analyzing the differences in my own results, I compared my findings to the similar studies I examined in my literature review. As my study is based on only one school, my results are only relevant to the interview subjects involved and cannot be generalized. It is therefore important to contrast my findings against large scale research to see if my results concur with the findings of those studies.

Angell, Guttersrud, Henriksen and Isnes (2004) compared high school students' perceptions of physics by separating students into two main categories. They analyzed the difference in opinions of students taking physics versus those who did not. Their findings can be summarized as two conclusions; firstly, students who studied physics found it difficult but also interesting and relevant. Secondly, students who did not take physics saw the subject as more difficult and not nearly as interesting or as relevant as the

physics students (p. 690). The findings of this study are very similar to my own findings, the one exception being that the authors' study showed that the physics students found their subject difficult. It is important to note however that the physics students in Angell, Guttersrud, Henriksen and Isnes' (2004) study did not rate the difficulty of physics as high as those who were not taking it. My students were primarily asked to compare their physics class with their math class and although most of them claimed that their physics class was "easier" than their math class, it does not mean that they did not have any trouble with their physics classes. All of the students interviewed for my study commented about the difficulty associated with understanding the conceptual aspects involved in physics. Angell, Guttersrud, Henriksen and Isnes (2004) also noted that many students will choose not to take physics due to a concern over being unable to succeed at the course (p. 689). This finding was mirrored by my own interview with the Science 10 students who were not going to take Physics.

The students interviewed in Science 10 who have decided not to take physics have a negative perception of the subject. The students used terms like "boring" and "hard" repetitively to describe the subject and made comments such as, "Converting units too, was difficult" (Appendix F, p. 154) and "I don't see the point in taking physics" (Appendix F, p. 148). These students had an obvious distaste for physics and some of them got frustrated just discussing it. Although these negative perceptions may have been shared by the Physics 20 and 30 students before they took physics, they are very different than their perceptions after taking the courses. The physics students expressed a positive perception and used terms like "easy" and "interesting" in their descriptions and made comments like, "I found it easier than lots of my other classes, I enjoyed it", and, "I

found it really interesting” (Appendix F, p. 206). In regards to their altered perceptions the physics students made statements like “I was like wow, it’s going to be a good semester” (Appendix F, p. 220) and “it wasn’t that bad” (Appendix F, p. 186). When I asked the Physics 20 students that were not enrolling in Physics 30 to reflect on what they thought about physics before they studied it versus what they felt about the course after completing it, Student 4 commented, “I didn’t really know what to think” (Appendix F, p. 187). This was a common response from the students in the study when asked about their preconceptions of Physics 20, that they did not really know what physics was from their experience of Science 10. Although many of the students commented that they didn’t know what physics was, many followed up by claiming that they still expected it to be hard. Therefore, the vast majority of the students had the perception that Physics 20 was going to be a very difficult course. Yet those that proceeded to take the course all claimed the fear or concern they felt prior to the course was unwarranted. This obvious difference between what students think about physics before and after studying it is a major concern.

From my research, the students interviewed said that this initial negative perspective had come from friends and family, or society in general, factors I consider to be external. This perspective needs to be overcome if physics enrolment is to improve and I am convinced that communicating physics students’ views about physics to students in lower level sciences could affect this change. In fact, some of the students interviewed said they believed physics would be easy due to the influence of their peers who had taken physics. Although the students feel that their peers do not influence their academic decisions directly, it is apparent that peers can influence their perceptions of the

subject. It is my opinion that the students' peers do have influence over their decisions about taking physics as their decisions are partly based on their perceptions of physics.

Overall, the results of Angell, Guttersrud, Henriksen and Isnes (2004) study echo some very important sentiments of my own. Firstly, both studies demonstrate that students who are not taking physics have a negative perception of the topic, seeing the subject as irrelevant and boring. Secondly, it has been shown by both studies that the students who choose physics find it interesting and relevant. These different opinions demonstrate a great divide in the perception of physics. The fact is many students who take physics feel good about the subject and are not overwhelmed by its difficulty, while many people who have not been adequately exposed believe physics to be boring, difficult, and only for the most capable. Both my study and the work of Angell, Guttersrud, Henriksen and Isnes (2004) demonstrate that later perception is heavily absorbed and accepted by the students within our studies.

Lavonen, Angell, Bymen, Henricksen and Koponen (2007) examined the factors that influence students' decisions to take or not take physics. Their study concluded that students are affected in their decision making process by both external and internal factors. They describe the internal factors as the teacher's actions within the physics classroom and the external factors as influences that are beyond the teacher's control. They argue that these influences serve to create a perception of subjects, and that these perceptions play a large role in a student's decision to take a subject. They also note that students perceive physics as a difficult subject and that this plays a large role in the student's decision to take or not take physics (p. 87). These findings were apparent within my study, as all of the Science 10 students who were not going to take physics

commented both on the level of difficulty they assumed physics to have and on the impact this belief had on their decision to not take physics. When I asked the students if they were concerned about the marks or grades they would achieve if they attempted Physics 20, all of them claimed that they would struggle. This implies a concern over the perceived difficulty of the course. When I asked for each student's foremost reason for not enrolling in physics, one of the students stated that it was the difficulty of physics (Appendix F, p. 163). Obviously, within our studies, the perceived level of difficulty is impacting students' decisions about taking physics.

Lyons (2006) concluded his study by stating that when we look at the reasons students are not taking high school science courses; perhaps we are missing the key issue. Like this study, the author examined external factors for their impact on physics enrolment. He noted that although these factors have a minor impact, the problem with enrolment lay more within the culture of school science (or internal factors) than the external factors. Lyons (2006) observed that there was a greater impact generated by the inner workings of the classroom, the manner in which the teacher delivered the curriculum, and the curriculum itself, than by the external factors (p. 295). It is difficult to compare my study to these findings as I avoided analyzing teacher influence of respect for my colleagues, and because it could be another study unto itself. Nonetheless the author raised a salient point when concluding with the question "why should they?", the students, take physics (p.308). The question highlights the idea of bringing more relevant curriculum to our students. If students want to learn how cell phones work and don't care about the history of the steam engine then perhaps it is the question that needs to be asked. Although none of my interviewees mentioned teacher or classroom influence as a

major factor in their decision, I must note that my study was related to one school in southern Alberta. A larger scale study of all Alberta physics and non-physics students may yield results that include classroom influence as a factor more in line with Lyons' (2006) findings with respect to teacher influence.

I did find harmony with Lyons' (2006) study in other areas. The author noted that students often take physics as a strategic move; this echoed my finding related to future aspirations (p. 296). Both our studies found that students are often not taking physics because they do not need it. Lyons stated that Australian post-secondary programs are making physics a pre-requisite less often, and this is having a negative effect on high school physics enrolment (p. 308). If Albertan and Canadian institutions follow this route, it could create even less enrolment in high school physics. Lyons (2006) also noted the impact of the perceived difficulty of physics on the students' decisions to take physics. Students believe they are not capable of succeeding, and that physics is the most difficult class. The author found that these beliefs stem from a variety of sources including teachers, parents and peers (p. 296). Unfortunately, the author did not highlight whether or not the peers or teachers were involved with physics. Regardless, Lyons (2006) demonstrates that the perception of physics being a difficult subject is also apparent in Australia, and that it has an impact, as in my findings, on students' enrolment.

Stokking (2000) looked at the reasons students are enrolling in physics. The author found that there were four main factors affecting student decisions: future relevance, appreciation of physics concepts, self-confidence and interest (p. 1279). The author found that the biggest factor was future relevance (p. 1261). This is extremely relevant to my findings as I too saw that students chose to take or not take physics based

on their future aspirations. In addition to this Stokking (2000) also noted that another major deterrent for students in regard to studying physics was their perception of the difficulty of the subject (p. 1272). While this study was conducted in the Netherlands, another study conducted by Osborne, Simon and Collins (2003) in the United Kingdom demonstrated that physics is perceived as difficult by students and that this perception decreases enrolment (p. 1070). It is apparent that this perception pervades the western world and students from around the globe share the belief that physics is a difficult subject before they are exposed to it. This belief impacts the number of students enrolling in physics in the industrialized world. As was laid out in the literature review, many authors believe this generates problems with the number of capable people available to work within the technological workforce and a scientifically illiterate society (Duggan & Gott, 2001; Schibeci & Lee, 2003; Lyons, 2006; Owen, Dickson, Stanisstreet & Boyes, 2008; Zohar & Bronshtein, 2005; Angell, Guttersrud, Henriksen & Isnes, 2004).

When comparing my findings to these studies, I found two themes. Firstly, students who choose to study physics enjoy it, find the material interesting and relevant, and do not find it as difficult as their peers who do not study it perceive it to be. Those who choose not to take physics often do so because of a perceived difficulty that persuades them they would not be successful. These students also believe that the subject is neither interesting nor relevant. The second commonality is that a major factor, if not the major factor, influencing students' decisions about taking physics is based on their future aspirations. If students do not need physics for their post-secondary programs, it seems to be very difficult to persuade them to consider enrolling in the courses.

Conclusion Three

Many of the students interviewed do have a fear of the difficulty of physics, and this fear has an impact on physics enrolment at all levels.

Within all of the interview groups, there were students who demonstrated some fear of the difficulty of physics. Each group contained at least one student who had concerns about the difficulty of the next level of physics. In some cases, the perception of difficulty deterred the students from enrolling in more physics; while in other cases, the students chose to continue on.

All of the Science 10 students choosing not to take Physics 20 demonstrated the disabling effect of this perception of difficulty. These students had concerns over the grades they believed they would receive if they took Physics 20. The students all commented these concerns had an impact on their decision not to take Physics 20. Student 4 stated that her perception of the difficulty of physics was her primary deterrent from enrolling in Physics 20.

There were some interesting comments made by the Physics 20 students when we discussed the students' feelings about the difficulty of the course. The students claimed that if anything was difficult about Physics 20, it laid in remembering the conceptual aspects of what we were learning and applying that information correctly. This sentiment was expressed by students in both groups, as was a sentiment that nothing about the course was difficult. When the students were asked to compare the difficulty of Physics 20 with their most recent math class, only one student considered Physics 20 to be more difficult. That student was from the students enrolled in Physics 30. Although this young lady found Physics 20 more difficult than her math course, she clearly felt capable of

continuing on to Physics 30. It is essential to note for this group of students that there were two Math 10 Pure students, one Math 20 Pure student (the young lady just discussed), one Math 24 student, one Math 20 Applied student, and three Math 30 Pure students. Out of this wide array of mathematical backgrounds only one student claimed that physics was more difficult.

Although the majority of the Physics 20 students did not find the course difficult, some of these students were still demonstrating a fear of the difficulty of physics. A high achieving Physics 20 student was deterred from taking Physics 30 due to a concern over her grades. This young lady admitted that she feared taking Physics 30 because she had heard that it was more difficult than Physics 20. Her fear of Physics 30 is important to reflect on because even though this young lady had found great success in Physics 20, she was still impacted by the reputation of physics as being a difficult subject. Her continued fear of physics is a troubling factor as it shows the immense influence a subject's reputation can have on students. Her fear demonstrates that students are not always convinced that physics isn't as difficult as is perceived by the general public, even after they study it and find it relatively easy.

The group of Physics 20 students enrolled in Physics 30 also reported that their decision was influenced by grades. Some of these students had positive anticipation toward their grades while the others had concerns over how they would perform in Physics 30. Students 3 and 4 from the group taking Physics 30 believed that they would be able to bring up their overall average. They reported feeling that the success they had found in Physics 20 would transmit to the next level. The other two students studying

Physics 30 were both expecting the course to be more difficult, but this did not dissuade them from taking it. They saw it as a challenge.

There were two conflicting perceptions about the difficulty of Physics 30 offered by the Physics 20 students. I find it interesting that each perception was found within each interview group. The positive perception dispels the myth of physics' extreme difficulty. This perception is created by the student's success in Physics 20. A confidence instilled by this experience allows the students to believe they will be successful in Physics 30. The negative perception offered by the Physics 20 students is that physics will get more difficult. Even with success in Physics 20, some students allow physics' reputation as a difficult subject to permeate their experience and intimidate them. This intimidation was enough to keep some students from taking the Physics 30. It is interesting to note that in this study, the split in perceptions is also a split in gender; the females did not gain as much confidence as the males even when the females were as successful (or more successful) than the males and continue to fear physics.

With regard to the difficulty of Physics 30, all of the students said that the more difficult aspect of physics was the conceptual side, i.e., understanding and remembering theory. Student 2 from the group of students planning to study physics at the post-secondary level summarized this feeling: "I didn't find the physics difficult, the theory more so than the math, more memorization" (Appendix F, p. 213). All of the Physics 30 students agreed that the mathematics involved in physics was not particularly difficult. This fact is important to highlight, as students, like Student 3 from the Science 10 students not enrolling physics, often fear that they do not have the mathematical capability to succeed in physics. The impression left by the Physics 30 students

interviewed is that they had more difficulty in remembering concepts than calculating answers.

Although the majority of Physics 30 students did not find the course difficult, there was evidence in both interviews that these students still held a fear of the difficulty of physics. Student 1 from the Physics 30 students going on to take physics stated: “in Physics 30 it’s not that difficult, but I think that when I continue it’s going to get tougher” (appendix F, p. 219). This is a student who has had success in physics, is continuing on to pursue a career in a physics related field, but still perceives that the subject must be difficult. Student 1 from the group of students not taking post-secondary physics made this comment when asked if concerns about the difficulty of physics courses had affected her decision: “Um, kind of, (be)cause I heard it gets harder and it kind of scares me to hear that” (Appendix F, p. 207). Again, we see the reputation of physics as a difficult subject influencing a student’s decision. Even though she enjoyed the high school course and found it very interesting, she’s still scared by what she “heard” about physics.

Several of the students interviewed, have had, or do have, the perception that physics is difficult. The influence of this perception is affecting students at all levels. In Science 10, Physics 20, and Physics 30, a fear of the difficulty of physics has influenced students into not enrolling in the next level. Although most of the physics students interviewed have had positive experiences in physics, and found success at the prior level, some students are choosing not to study physics further. This choice is influenced by their perception of the difficulty of physics.

Conclusion Four

The Science 10 curriculum may be more complex than is necessary and appears to do a poor job of demonstrating the relevance of physics to students' daily lives.

There was agreement, among the two groups of Science 10 students, that their foreseen grade in Physics 20 played a role in their decision. The students choosing not to take physics all expressed concerns over the grades they might get in Physics 20, while two of the students in the other group claimed that their Physics 20 grade was likely to improve their overall averages. The concern expressed by the students not taking physics was orientated around their performance in the physics unit of Science 10. All five of the students commented that they had struggled with and felt overwhelmed by the unit and that it had hurt their overall Science 10 grade. It leads me to wonder if perhaps the physics unit of Science 10 has more complex mathematics than it needs. These students, unlike their counterparts in the other interview groups, have yet to grasp the subject as relevant. This leads me to two major concerns about the Science 10 curriculum as a deterrent to taking physics. Firstly, I am concerned that the mathematical aspect is unnecessarily overemphasized for this level; secondly, that the curriculum fails to utilize the technological obsession of these students to demonstrate the relevance of physics. If we want to change the perceptions of students toward physics, we need to utilize what they feel positive about.

One of the Science 10 students I interviewed thought she couldn't take Physics 20 because she was in Math 10 Applied. She felt, from her experience in Science 10, that her math skills were not sufficient to be successful in Physics 20. Yet a student in Math 24 claimed that the mathematics involved in Physics 20 was not overwhelming for him.

Why are so many Science 10 students overwhelmed by the math of the physics unit? I believe it is due to the number of concepts we expect the students to learn, apply, and perform calculations for, in one Science 10 unit. The concepts of that unit are covered by three different units in Physics 20 (Alberta Education, 2005; Alberta Education, 2008). It concerns me that some Science 10 students believe that they do not possess the necessary math skills to succeed at Physics 20. I believe those skills can be taught and developed if sufficient effort is put forth by the student. Student 4 from the Physics 20 students not taking Physics 30 is a perfect example of that (he is the student who had taken Math 24).

When the Science 10 students were asked if they felt physics was difficult, there was a consensus among the students in each group but not between the two interview groups. Students choosing to study Physics 20 did not find any of the aspects of the unit difficult while the students choosing not to take physics claimed that the mathematical aspects were more difficult. Again, this leads me to consider the level of mathematical difficulty involved in Science 10. This was further highlighted when I had the students compare their latest math class with the mathematics involved in the physics unit of Science 10. All of the students choosing to go on to Physics 20 claimed that their math classes were more difficult than their experiences of physics in Science 10. The other group all reported that the opposite was true; they claimed their math classes were less difficult than the physics. This is a significant difference between these groups of grade 10 students until you consider another major difference between these two groups: all of the students planning to study physics had completed Math 10 Pure; while the majority of those not taking physics had completed the less academic Math 10 Applied (one of these students took Math 10 Pure). Math 10 Pure is not a prerequisite for Science 10 or Physics

20 but it would seem from these results that the students in the less challenging math class had struggled far more with the mathematics in Science 10. I have to question whether the mathematics could be less intensive in Science 10 to allow the students a chance to develop their math skills in the physics unit rather than expecting the presence of those math skills and overwhelming them. This feeling of being overwhelmed played a role in each of the students' decisions to not take Physics 20, yet there is no need for such a large amount of skill to be gained in Science 10 as the math is revisited in the Physics 20 curriculum. Therefore, I think the Science 10 curriculum could be altered so that teachers can concentrate more on building the basics and making connections between the students and the subject than asking the students to apply mathematics in such an extensive manner. This may serve to scare fewer students away from taking physics courses.

When I discussed the relevance of physics with the Science 10 students, I believe I gained some insight into the reasons many of them take little interest in physics courses; they don't realize the relevance of the subject. The students that had chosen not to take physics admitted that they did not see the relevance of physics to daily interactions, the technology they use, or the world around them. Some of these students were almost angry about how they were being forced to study physics as they saw the subject as irrelevant. Student 5 was particularly troubled by the idea of making connections between physics class and his day to day life: "A roller coaster is a roller coaster. To me there is no potential or kinetic energy – it's just fun" (Appendix F, p. 158).

The Science 10 curriculum begins the physics unit by discussing the history of the steam engine. Although steam engines are helpful in the discussion of work it fails to

grasp the attention of the students or allow them to make connections to today's technology. The Science 10 students not enrolling in physics discussed this idea with me; they reported feeling that the history they learnt was neither engaging nor relevant to them. This led me to ask if they would have more interest in learning about the technologies they use everyday like their MP3 players or cell phones. All of the students agreed that this would be preferable as long as they didn't have to learn the calculations that go along with it. The students do not need to calculate problems related to fluid dynamics or pressure to understand what they are taught about steam engines, so I proposed that a similar explanation of cell phones could be made. The students all claimed that this would be something they would be very interested in learning. The response of this interview group, the Science 10 students not studying physics, prompted me to ask all of the interview groups to consider if they would enjoy learning about the technology they use.

The students enrolled in Physics 20 had made slightly more connections between physics and the world with which they interact, but still claimed they felt that the course could use more discussion of what is relevant to them. These students had enjoyed the mathematical aspects of the physics unit, because it was "easy" (Appendix F, p. 168), but not the history. Many of the Science 10 students became disinterested in physics because they discussed technologies from decades or even hundreds of years ago instead of something that the students use every day.

Students use computers, and micro-waves, play video games and send text messages; all of these devices are based on physical principles and are objects students consider to be "cool". We should be exploiting this technological fascination to

emphasize the relevance and importance of physics. Perhaps students would then be more interested in the topic and not consider physics an irrelevant subject. I fear we are intimidating students in Science 10 by overwhelming them with mathematical requirements instead of intriguing them by emphasizing the relevance of physics to their daily lives.

When I asked the Physics 30 students if they felt that taking physics in high school had helped them in other courses, all of the students commented that their experience in physics had paid dividends. This question was asked of the Physics 30 students specifically. I wanted to know what their reflection was on the value of taking physics. I was curious to know if they felt that it had been advantageous to take Physics 30 even if they did not need it for their post-secondary or career aspirations. All of the students recognized that taking physics had assisted them with other high school courses. Most of them said that this impact was greatest in their mathematics courses but chemistry was also mentioned. Student 3 from the group of students not moving on with physics gave specific examples: “just things like half-life and graphing and things like that, and for calculus too, because they were both related” (Appendix F, p. 200) while Student 4 from the other group remembered using physics to help him out in a test situation: “I actually forgot like a question. I just used physics formulas to do it” (Appendix F, p. 212). It is valuable to share this point with students as they reach higher grade levels; these students saw physics as an asset that helped with other classes rather than a burden that hurt other areas of study. The fear of being overwhelmed that faced both the Science 10 group not taking Physics 20 and the Physics 20 group not taking Physics 30 should be countered with this information. Students develop skills in physics

that can be utilized to attack word problems in math, which comprises a large part of the high school math curriculum and is an area that many students struggle with.

I asked the Physics 30 students to compare physics to the other subjects that they took in high school with regard to the level of interest the subjects inspired. The students from both groups all said physics was one of their most interesting subjects. The students either ranked the subject as the most interesting or in the top two or three. Both groups were in agreement, which leads to a conclusion that students who take Physics 30 find it very interesting. Using this conclusion, we can demonstrate to students are not inclined to take physics after Science 10 that they would be missing out on something their peers found to be very interesting.

My results demonstrate that the Science 10 students taking Physics 20 are not anxious about the math involved; while those that are not taking physics are intimidated by the level of math they faced in Science 10. The results also show that both groups of students would like to discuss technologies that they deem more relevant. As this is the case, something might need to change within the Science 10 curriculum. The intensity of the mathematics involved, and the relevance of the subject matter, needs to be addressed. If addressed, the physics unit of Science 10 may represent the nature of high school physics in a more accurate manner.

Conclusion Five

A student's perception of physics can change drastically over their high school experience.

To compare high school students' perceptions of physics, I examined the students' responses in regard to the difficulty, interest, and relevance of physics. I

evaluated and compared the grade levels as well as the interview groups at each level. In addition, I asked the Physics 20 and 30 students to comment on their preconceptions of physics as compared to their perceptions after completing their courses. In both cases I found a progression from negative perceptions to positive perceptions as the students were exposed to more physics.

The sentiments of the Science 10 students who chose not to study physics were unanimous. All of these students perceived Physics 20 to be a very difficult course and they all had concerns about their ability to be successful in the course. In addition, the students struggled to see the relevance of the subject and did not consider the topics interesting. These opinions were different from the Science 10 students who chose to take Physics 20. These students reported that the subject was not difficult and the topics were interesting. These students, however, failed to make many connections between physics and their world; they did not fully understand the relevance of physics. The Physics 20 and 30 students commented that they felt physics was not overly difficult; that it was no more challenging than other high school classes. They all agreed that the subject was interesting. The students who had taken the physics courses also made many more connections between physics and their world and appreciated the relevance far greater than the Science10 students. When comparing the Physics 20 students to the Physics 30 students, the perceptions were the same, but the Physics 30 students felt more strongly about their opinions. The Physics 30 students grasped the relevance of physics to a greater degree and they were more interested in it.

The Physics 20 students' preconceptions of physics compared to their feelings after completing the course, demonstrated a common evolution of perceptions of physics

for high school students. Many of the students said they thought the course was going to be very difficult and found that it was easier and more enjoyable than they had expected. Most of these students claimed that the idea that physics would be difficult had come from their parents or family. One student didn't know what to expect before taking physics but claimed that it was pretty simple. Interestingly, three of the students enrolled in Physics 30 said that they had heard Physics 20 was easy, which was also how they described the course. These were the only students I had in the entire study that claimed their preconception of Physics 20 was that it would be easy. These students had gained this insight from students who had taken Physics 20. This fact is important because it played a role in influencing these students to take the course, an example of peer influence also represented by Lyons' (2006). Perhaps the students are not influenced by their friends directly; they are not simply registering or not registering in Physics 20 to mimic their peers. They are, however, influenced by their peers' perceptions of the difficulty of physics, and this perception influenced these students to take physics. It is essential to share the experiences of Physics 20 and 30 students with Science 9 and 10 students to dispel common misrepresentations of high school physics, and hopefully, inspire more students to take the course.

The Physics 30 students had all completed their high school physics careers and were being asked to reflect on that experience. I suspected that some of the students within the interview group that were not planning to enrol in physics at the post-secondary level would have had some negative perceptions about physics, but this did not prove to be the case. In fact, the only question these students differed on was their future plans. The Physics 30 students all shared a positive outlook towards physics. I asked the

Physics 30 students to compare their preconceptions of high school physics to their post-conceptions. Almost every student commented that they had been concerned that physics would be quite difficult. Those who claimed this was their preconception credited this belief to their parents or family. Two of the students said that they had heard conflicting opinions on the topic, but noted that it was their peers who led them to believe physics wasn't difficult. All of the students' post-conceptions were that the subject was easy or not as bad as they had expected. It has become thematic in this study that the students had mixed preconceptions of high school physics, but it is evident that the fears associated with the difficulty involved came from sources that are not directly involved with the physics curriculum.

When I asked the Physics 20 and Physics 30 students to reflect on their high school physics experience, a common change in perception was apparent. I asked them to describe their perceptions of physics prior to taking Physics 20 and their perceptions of physics after the course or courses they took. The majority of the students claimed they felt concern over the difficulty they would face in Physics 20, concern that they would not be capable of succeeding. This was true even of students who admitted they had little idea of what physics was before they started Physics 20. As these students moved through their physics careers, their concerns turned to enjoyment and they became engaged. Their perceptions evolved into an affectionate relationship with a subject that became their favourite or one of their favourites. None of these students reported that their physics experience was overwhelming; they claimed this subject was no more difficult, and in some cases easier, than their other high school subjects.

As the Physics 20 and 30 students moved through high school, their perceptions of physics changed from a negative view to a positive view as they increased their knowledge and understanding of the subject. Students who have taken physics enjoy it and take interest in the topics, while those that do not take the subject believe it would be difficult, irrelevant and boring. Therefore, the perceptions of physics held by the students I interviewed who were not studying physics could be misguided or inaccurate. In the conclusion of my Physics 30 interview with students planning to pursue physics, Student 4 said it best:

I'd say the biggest threat was the word itself... physics. When I think of it, I think of a brainiac kind of guy in glasses and a lab coat... It's got that misconception that it is for the genius...I try to encourage other people to actually go and do it because it's not (as difficult as its reputation leads us to believe).

(Appendix F, pp. 220-221).

Chapter Six: Limitations

This study was limited to a single high school in a small urban center in Southern Alberta. Therefore, the findings of this study cannot be generalized for all students in Alberta. However, the results of this study have agreed with many conclusions drawn from similar studies completed elsewhere. Therefore, the results can expose what Alberta high school students' perceptions of physics might be. The findings can also highlight some factors that are affecting students' decision making in regard to studying physics. This research could be extended to a larger sample to examine if the findings accurately describe the reasons students are not taking physics in Alberta. This study could also be expanded to attempt to find ways to improve enrolment in physics. Neither the impact of gender nor the impact of the classroom teacher on the students' perceptions were analyzed in this study. I acknowledge that both of these topics have relevance in influencing a student's perception of physics, but I feel that these topics are studies that could stand alone and therefore were not specifically examined within this study. Gender balance in the study was established, however, within each interview group. This study was designed to examine a small group of students' perceptions of physics at different places in the high school experience.

In this case study, I used my own physics students in the interview groups. The rationale for this decision was outlined in Chapter Three: Research Methodology. I wanted to use students with whom I had background knowledge, to easily meet the defined parameters. This study was also limited in its financial resources. My own students, therefore, seemed to be a logical choice. It was also fitting to use my own students as I could select students who I felt would speak openly about their perceptions of physics. In

doing so, I created interview groups with whom I had good rapport and who would provide in-depth answers. The limitation that was inherent in the decision to use my own students however was the impact of teacher bias. I have stated that I had strong relationships with most of the students interviewed. In one regard, this may have served to elicit honest answers, but in another, the students may have withheld or altered their true perceptions of physics, over a concern with their academic relationship with me. The students could have been reporting feelings that they believed their teacher wanted to hear, as students have been trained to do in the school setting. I did work to limit this bias by explicitly stating in the pre-interview conference, and consent forms, that I hoped the students would share honest answers with me. I attempted to ensure the students had a clear understanding that their responses would have no impact on our relationship, or on my opinion of them. I recognize that the pressure of answering questions about a class you have taken, asked by the teacher who taught you, could easily cause a student to misrepresent their true feelings for a variety of reasons. In stating this, I again recognize that the conclusions of this case study cannot be extrapolated to generalities. The conclusions of this research, however, could be used to design quantitative research that examines the perceptions of a larger sample. If done, it could be possible to utilize the findings to improve physics enrolment at both the high school and post-secondary levels.

It must be noted, that the students' future considerations were the major influence in most of their decisions. This influence must also be addressed in any further study; future considerations may be more important to a student's academic decision than the student's appreciation of physics as a subject. Even if students enjoyed physics and found it relevant after their experience with it in Science 10, they may still choose not to take

physics if they do not foresee a need for it in their future academic or career endeavours.

However, if they do enjoy the subject and find it to be relevant it could become something they choose to pursue due to their experience.

Chapter Seven: Implications

Three major implications arise from my research. Firstly, the Science 10 curriculum seems to do a poor job of representing the relevance of physics to students. Students should be exposed to the importance of physics in the technology they use. Every single student I interviewed in this case study, claimed that they would value learning about the technologies they use on a daily basis. If the students' technology was addressed, perhaps students would see the subject as more relevant and take more interest in it. Secondly, from the results garnered, it is apparent that students who do not enrol in physics believe that the subject is tedious, difficult, and irrelevant. These beliefs are contradictory to the perceptions of physics students. Teachers and school councillors need to address these beliefs, and let students not studying physics know how their peers actually describe physics. Potential physics students should hear what physics students have to say about the difficulty of high school physics. The potential students should also be exposed to how physics students compare physics to their other classes, how interesting they find it, and how relevant. This should provide a means to dispel the negative preconceptions of the subject. Thirdly, many students are not enrolling in physics because they do not intend on pursuing post-secondary programs or careers that require physics. It could be useful to demonstrate to these students that physics students see value in taking the courses, even if they have no future intentions involving physics.

What I have learned in this research has had impact on my own teaching practice. I now utilize cell phones and iPods in my physics and science classes at all levels. I use this technology to help bring relevance to the topics I am teaching, be it energy, waves, electricity, or electromagnetic radiation. The desire students have to learn about their own technologies is something I have discussed with colleagues and curriculum leaders within

my school. I hope to communicate this at the district and provincial levels as well. The conclusions of this study could be valuable for teachers when developing activities within the current curriculum, and developing new curriculum. This technology should be emphasised to maximize student engagement, and to display the relevance of physics to the students' daily lives, which will hopefully improve the general appeal and perception of physics.

The Physics 20 and 30 students interviewed enjoyed physics and were not deterred by its difficulty. This reflection is important to share with Science 10 students, who think the course is irrelevant and difficult; it may be possible to influence them into attempting physics if they hear the reflections of their fellow students. All of the Physics 20 students stated that they were very happy with the Physics 20 course. The students that did not take Physics 30 did so primarily due to scheduling issues and their future aspirations. When I asked the Physics 20 students if they felt that physics was hard, boring, or irrelevant, they all stated that this was definitely not the case. I did this to compare their answers to the study of Angell, Guttersrud, Henriksen and Isnes (2004) and to the responses of the students in Science 10 who chose not to enrol in Physics 20. The Physics 20 students echoed the findings of the study, that physics was interesting, relevant, and not overly difficult. The Physics 20 students' answers contradicted the beliefs of the Science 10 students not enrolling in physics. The Science 10 students' perceptions matched up with the students not taking physics in Angell, Guttersrud, Henriksen and Isnes' (2004) study. The agreement between our studies demonstrates, again, that it is important to share physics students' perceptions with Science 10 and Science 9 students. When these students are considering which sciences they may take in

the future, it would be good for them to hear what experienced students have to say about physics. It could serve to alter perceptions that younger students have of physics and help to improve enrolment.

The Physics 30 students interviewed held common perceptions of physics. From their preconceptions to their post conceptions, a unified idea prevailed that physics wasn't as difficult as society would lead one to believe. These students, like the Physics 20 students, found the subject relevant, enjoyable and interesting. Many of these students considered physics their favourite, or one of their favourite, high school classes. Whether they plan to continue with physics or not they saw value in taking the courses and are not disappointed they took them. This information needs to be shared with students who are contemplating taking physics. From this study, it is apparent that many students have a perception that physics is difficult when they finish Science 10. These students need to know that the students from this study who have experienced physics firsthand have a very different, and decidedly positive, perception of physics. The group of Physics 30 students included both high and mid to low achieving students, and all of the students claimed they had greater difficulty with the conceptual aspects. Students, who succeed in subjects like biology and social studies, are often very capable of memorizing and applying concepts; these students need to be informed that physics includes this aspect as well as a mathematical component. The Physics 30 students also agreed that their math classes (which included Math 30 Applied) were more difficult than Physics 30. Many of the students who complete Biology 30 also complete Math 30 Pure or Math 30 Applied (Alberta Education, 2007), but, as has been discussed, some of these students believe that they do not have the mathematical capability to attempt Physics 30. If Physics 30

students who are in Math 30 Applied do not find the math in physics overwhelming and struggle more with the conceptual side, then a successful Biology 30 student who is capable of completing Math 30 Pure should have little difficulty in completing and succeeding in Physics 30. In fact, one of the students, Student 3 from the group of students not pursuing physics, claimed that biology was a more difficult subject: “I found it the easiest and then chem[istry] and then bio because bio is like strictly memorizing and physics is like actually learning it and applying it not just being like read this, do this” (Appendix F, p. 201).

All of the Physics 30 students found physics to be an interesting subject. Student 4 from the group enrolling in post-secondary physics stated the following: “I see basically physics as the basis of all the other subjects anyways, so I find it the most ground breaking and interesting” (Appendix F, p. 218). This student also claimed that physics was his favourite subject in high school. That fact might not be surprising, considering that this student is planning to study engineering, but similar responses came from the other group of students as well. Student 1 stated: “Yah I think so, cause when you like study physics you don’t realize that it’s all happening right in front of your eyes and once you learn about it you’re like wow that’s so cool” (Appendix F, p. 205). Student 3 had an interesting comment about her level of interest in the subject:

Because it’s like more real to me, because in like math you’re learning about things that really when am I going to have to find out the log of 2.19 and graph it, where in this it’s like actually happening and if I do go on to be an engineer this will really help me and I find that interesting. (Appendix F, p. 206)

This student is enrolled in nursing for next year, something she has long aspired to do, but due to her experience in high school physics and the interest it sparked, she is now considering studying engineering if she does not enjoy her first year of nursing. This student is an example of someone who only took physics because it was a requirement for her program, but then she enjoyed it enough to consider changing her career aspirations. This is a story that Science 9 and 10 students should hear before declining to take physics without being adequately exposed to it. Students may not think that they want a career that is physics orientated in grade 10, but this opinion can and should be free to change in response to the student's life and school experiences. Students should be encouraged to consider this possibility before they make their very important academic decisions. As this study has shown, this encouragement does not always come from parents or guardians. Therefore, educators need to raise this awareness.

The main reason the students did not enrol in physics at the next level is because they had no intention of pursuing physics related careers. If this is the case, what I do to instil an appreciation of physics in class may have little impact on the students' decisions to continue with physics. I examined if the Physics 30 students not studying post-secondary physics felt that taking physics would be valuable to them in the future, even though they did not need it for their career. I asked the students if taking Physics 30 had been a "waste of time" (Appendix F, p. 205) since they would not use it directly in the future. None of the students said that taking physics had been a waste of time and they all agreed that the knowledge they had gained from taking high school physics was a good basic subject to have. One of the most common reasons given by students within this study for not taking higher levels of physics was that they did not need them. The

responses of the students who took Physics 30 even though they had not needed to, demonstrate that students see value in taking physics even if it is not a necessity. This fact should be shared with students that are deciding whether or not they will study Physics 20 or 30. It should be expressed to prospective physics students that students who have taken physics feel that it is a valuable course to take to gain meaningful life skills, and to assist in the study of other subjects.

I believe the negative perceptions that students who do not study physics hold could be impacted by exposure to the opinions of students who have taken physics. Schools, councillors and teachers could influence physics enrolment by exposing students to the views of their own physics students, the conclusions of this case study, or the conclusions of the literature examined within this study. Schools could also serve to improve enrolment by exposing the relevance of physics to the technology that students use. Students are engaged by their technology, perhaps they would be engaged in learning how it works.

As a society we can continue to ignore the low number of students enrolling in physics, but as has been outlined within the literature review, this could lead to difficult economic, political and technological problems. Communicating the conclusions of this study to science teachers and prospective students is a simple action that could have an immediate impact on physics enrolment.

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Appendix A

Data from Physics Classes

Percentages of Students with 85% or Above

# of Female Students	# above 85%	Percentage	# of Male Students	# above 85%	Percentage	Semester
16	14	88%	20	11	55%	Fall 07
10	7	70%	2	6	33%	Spring 06
10	6	60%	26	9	35%	Fall 06
36	27	72%	48	26	54%	Totals

Total % female students in classes
= 43%

Total % female students of students with 85%
or above = 51%

Appendix B

Data from Alberta's Universities - 2007

1. University of Alberta

Percentage of Undergrad Physics Majors that are Female – 9%

Source: Department of Physics – U of A

2. University of Calgary

19801 – Undergraduate Students

10716 – Female Undergrads

54% - % of Female Undergrads

159 – Undergrad Physics Majors (physics, astronomy)

33 – Female Undergraduate Students

21% - % of Female Undergraduate Physics majors

Source: Judy Roche, Analyst

Office of Institutional Analysis – U of C

3. University of Lethbridge

7,935 – Undergraduate Students

30 – Undergraduate Physics Majors

3 – Female Undergraduate Physics Majors

10% - % of Female Undergraduate Physics majors

Source: Mandy Moser, M.B.A.

Senior Institutional Analyst – U of L

Appendix C

Number of Students in Physics, Other Sciences and Math at the Research High School

2008		2009		
Class	Students	Class	Students	% eligible
Bio 20	249	Phys 20	143	49.65
Bio 30	190			
Chem 20	191			
Chem 30	156			
Math 20P	179			
Math 30P	151			
Phys 20	143			
Phys 30	107			
Sci 10	288			
Sci 20	42			
Sci 30	11			

Appendix D
Questionnaires
Science 10

1. Are you intending on taking Physics 20?

2. What were the major influences in this decision? Did any of the following play a major role:
 - a. Time table issues?

 - b. Parents?

 - c. Marks, concerns about your overall average?

 - d. Peers?

 - e. Other?

3. Did you enjoy the Physics unit of Science 10? Why or why not?

4. Did you find the Physics unit difficult? What about it was difficult?

5. Did you find the mathematical aspects difficult?

6. Do you see Physics as being relevant to the real world:

- a. In your day to day life?

- b. In the technology you use?

- c. In explaining the world around you?

7. Do you consider Physics interesting?

Please rank the factors that influenced you to take or not take Physics 20 in order from greatest influence to least (you can list more or less than 6 factors):

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Physics 20

1. Are you intending on taking Physics 30?

2. What were the major influences in this decision? Did any of the following play a major role:
 - a. Time table issues?

 - b. Parents?

 - c. Marks, concerns about your overall average?

 - d. Peers?

 - e. Other?

3. Did you enjoy the Physics 20? Why or why not?

4. Did you find Physics 20 difficult? What about it was difficult?

5. Did you find the mathematical aspects difficult?

6. Do you see Physics as being relevant to the real world:

- a. In your day to day life?

- b. In the technology you use?

- c. In explaining the world around you?

7. Do you consider Physics interesting?

Please rank the factors that influenced you to take or not take Physics 30 in order from greatest influence to least (you can list more or less than 6 factors):

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Physics 30

1. Are you intending on taking Physics at the post-secondary level?
2. Are you considering a career in a Physics related field?
3. Do you think Physics helped you in other high school courses?
4. Did you enjoy high school Physics? Why or why not?
5. Did you find Physics difficult? What about it was difficult?
6. Did you find the mathematical aspects difficult?
7. Do you see Physics as being relevant to the real world:
 - a. In your day to day life?
 - b. In the technology you use?
 - c. In explaining the world around you?
 - d. Do you think you will use the problem solving skills developed in Physics in other areas of your life?

8. Do you consider Physics interesting?

Please rank the factors that influenced you to take or not take Physics at the post-secondary level in order from greatest influence to least (you can list more or less than 6 factors):

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Appendix E



STUDENT PARTICIPANT CONSENT FORM

High School Students' Perceptions of Physics

You are being invited to participate in a study entitled High School Students' Perceptions of Physics that is being conducted by Doug Checkley. Doug Checkley is a Graduate Student in the Faculty of Education at the University of Lethbridge and you may contact him if you have further questions by phone at (403) 332-3684.

As a Graduate student, I am required to conduct research as part of the requirements for a Masters degree in Education. It is being conducted under the supervision of Rick Mrazek. You may contact my supervisor at (403) 329-2452.

The purpose of this research project is to determine high school students' perceptions of physics. Research of this type is important because I may be able to shed some light on why fewer students are taking physics as compared to the other sciences.

You are being asked to participate in this study because you are a Science 10, Physics 20 or Physics 30 student at Lethbridge Collegiate Institute (LCI) who is willing to discuss your academic experience in physics at LCI. If you agree to voluntarily participate in this research, your participation will include completing a questionnaire and a 30 minute group interview. There are no known or anticipated risks to you by participating in this research. Your participation in this research must be completely voluntary. If you do decide to participate, you may withdraw at any time without any consequences or any explanation. If you do withdraw from the study your data will not be used in the analysis.

The researcher may have a relationship to potential participants as their teacher. To help prevent this relationship from influencing your decision to participate, the following steps to prevent coercion have been taken: If you have received this consent form I have already informed you that you can decline taking part in this study at any point. I stress that you should not feel any pressure from me as your teacher to take part in the study. In terms of protecting your anonymity your name will not be asked for when completing the questionnaire. Your confidentiality and the confidentiality of the data was protected by the investigator who was the only one to analyze the data. The videotaped interview may be used in the Thesis defense. The written data from this study was disposed of by being shredded and the electronic files of the videotape was deleted within five years of the data collection. It is anticipated that the results of this study was shared with others in the form of a thesis dissemination at the University of Lethbridge.

In addition to being able to contact the researcher [and, if applicable, the supervisor] at the above phone numbers, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Chair of the Faculty of Education Human Subjects Research Committee at the University of Lethbridge (403-329-2425).

Your signature below indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researchers.

Name of Participant

Signature

Date

A copy of this consent was left with you, and a copy was taken by the researcher.



Parent Information Letter

High School Students' Perceptions of Physics

Your son/daughter is going to be invited to participate in a study entitled High School Students' Perceptions of Physics that is being conducted by Doug Checkley. Doug Checkley is a Graduate Student in the Faculty of Education at the University of Lethbridge and you may contact him if you have further questions by phone at (403) 332-3684.

As a Graduate student, I am required to conduct research as part of the requirements for a Masters degree in Education. It is being conducted under the supervision of Rick Mrazek. You may contact my supervisor at (403) 329-2452.

The purpose of this research project is to determine high school students' perceptions of physics. Research of this type is important because I may be able to shed some light on why fewer students are taking physics as compared to the other sciences.

Your son/daughter is being asked to participate in this study because they are a Science 10, Physics 20 or Physics 30 student at Lethbridge Collegiate Institute (LCI) who is willing to discuss their academic experience in physics at LCI. If your son/daughter agrees to voluntarily participate in this research, their participation will include completing a questionnaire and a 30 minute group interview. There are no known or anticipated risks to your son/daughter by participating in this research.

Their participation in this research must be completely voluntary. If they do decide to participate, they may withdraw at any time without any consequences or any explanation. If they do withdraw from the study their data will not be used in the analysis.

The researcher may have a relationship to potential participants as their teacher. To help prevent this relationship from influencing their decision to participate, the following steps to prevent coercion have been taken: If your son or daughter has received this letter I have already informed them that they can decline taking part in this study at any point. I stress that your son or daughter should not feel any pressure from me as their teacher to take part in the study, if you have any concerns about this please contact me. In terms of protecting your son or daughter's anonymity their name will not be asked for when completing the questionnaire. Their confidentiality and the confidentiality of the data was protected by the investigator who was the only one to analyze the data. With the students' consent the videotape may be used in the thesis defense. The written data from this study was disposed of by being shredded and the electronic files of the videotape was deleted within five years of the data collection. It is anticipated that the results of this study was shared with others in the form of a thesis dissemination at the University of Lethbridge.

In addition to being able to contact the researcher [and, if applicable, the supervisor] at the above phone numbers, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Chair of the Faculty of Education Human Subjects Research Committee at the University of Lethbridge (403-329-2425).

Appendix F

Interview Transcriptions

Science 10 Students Not Taking Physics 20

Interviewer: So question number one we've kind of all ready discussed, it's the reason that your here, is that none of you are intending on taking Physics 20 correct?

Student 1: Yes

Student 2: Yes

Student 3: Yes

Student 4: Yes

Student 5: Yes

Interviewer: Number two says: what were the main influences in your decision; did any of the following play a role? For A) I put time table issues there, the idea behind that one is are you not taking physics because you are taking bio and chemistry and you want to keep a spare or are you just planning on taking one science cause you want more room for options and things like that. Is there a timetable that influenced your decision as far as taking

Student 1: Well I have an IPP so I can't really take that many courses that are harder so I'd have to limit myself to one science

Interviewer: Do you feel that that is true or where did that come from that idea that because you have an IPP you should take less courses, do you think that you shouldn't do it?

Student 1: It's not that I shouldn't do it, it's just so much harder to do homework and stuff and keep focused, I like to keep myself challenged but not overwhelmed.

Interviewer: So a timetable issue is a bit of a factor?

Student 1: yah a little bit

Interviewer: Because you don't want to have too many heavier or core classes

Student 1: Yes

Student 2: Just need one science when you graduate and I'm not going to do anything with physics later on in life, don't plan on doing anything later on after I graduate and you only need science 20 to graduate.

Interviewer: So you're just planning on taking the bare minimum for science? So it's a bit of a timetable but also diploma issue.

Student 2: Yah I'm not really gonna need it

Student 3: It's pretty much the same for me, I'm not really interested in physics or chemistry I think biology is all I'll take next year cause I only need one science to graduate.

Interviewer: And are you planning on going on to post-secondary.

Student 3: Uh yah probably.

Student 4: Kinda the same, I don't have any interest in physics, and my grades, and I don't need it for my career either.

Interviewer: Okay so are you taking biology though, or chemistry?

Student 4: Yes, not chemistry

Interviewer: Just bio?

Student 4: Yes

Student 5: I don't really see the point in taking physics when you're going into what I'm going into biology and stuff like that, I'm taking bio and chem and I don't see the point in taking physics.

Interviewer: So you're taking bio and chem, do you know what you want to do?

Student 5: Palaeontology

Interviewer: Palaeontology

Student 5: And I don't think there is much physics involved there

Interviewer: Okay I'm going to leave that at that but that is a very interesting point.

Interviewer: Okay parents as far as influence is concerned this is usually a bigger influence on students who are going to take physics 20, there usually is an influence there but perhaps your parents influenced you saying don't take physics it's really hard. Or don't take physics because we don't think you're going to succeed. I don't know they may have said something along those lines so if there is any influence along those lines did your parents influence your decision to not take physics.

Student 1: No

Student 2: No

Student 3: No

Student 4: Negative

Student 5: No

Interviewer: And were any of your parents upset when you said you didn't want to take physics?

Student 1: I didn't tell my parents what classes I was taking

Interviewer: That's really interesting because in the literature a lot of the times it states that parents play a very large factor on their kids decision and I've actually found from the other groups I've interviewed so far that parents actually don't seem to play so much of a influence on your guys decisions.

Interviewer: What about C) here Marks, are you guys concerned that if you were to take physics that it would bring down your overall average?

Student 1: I think so

Student 3: yah

Student 3: yep

Student 4: yes

Student 5: Yah it brought it down this semester

Interviewer: So you think it would affect your overall average? Possibly taking biology is a better route because you might have a higher average at the 30 level to get into post-secondary education?

Student 3: Yah like physics in science 10 this year dropped my mark like drastically of chem and bio so

Student 1: Really, I found that chemistry was hardest

Student 3: Um I think it was just like remembering equations and stuff for physics that really like messed me up and that's why it dropped my mark a lot so

Interviewer: Okay fair enough

Interviewer: Peers, this again I'm usually looking at students who are taking physics, but it could also be that your friends' aren't taking physics so you're like: I don't want to take physics I'll be in that class al by myself. Did that play a role at all?

Student 1: No actually many of my friends actually are taking that class

Student 2: No. Less friends, less distractions

Interviewer: That's smart

Student 3: No

Student 4: No

Student 5: No

Interviewer: So your friends are taking physics for the most part?

Student 3: I don't really know but that really wouldn't determine what classes I take so
yah, I take what I want to take

Student 4: Yah

Student 1: Yah

Interviewer: When you're answering these you can answer these specifically to physics
but you can also answer it just generally in course decisions

Student 5: No

Interviewer: No affect at all hey.

Interviewer: And then lastly here other, some examples students take physics because
they want to keep their doors open is kind of the phrase so that's one of the things I've
gotten for others but then again you guys are my first group of No's so I don't know if
there are any other influences you felt besides

Student 4: It's hard and there is too much math

Interviewer: It's hard and there is too much math, that's key, that's exactly what I need to
hear

Student 1: Well I'm taking just regular Science 20 so there's probably going to be a little bit of physics in there

Interviewer: Yep there is

Student 1: And I get a little bit of everything not just physics

Interviewer: okay so there is an attraction to that, to get a little bit of everything but only have to take one class to do it

Student 1: yah, exactly

Student 2: yah the one course covering everything rather than having to take all the courses

Interviewer: Okay do you guys have anything else other than its hard?

Student 5: It's not that it was difficult. It was more that it was boring.

Interviewer: Okay, that's important to distinguish some people find it difficult some people find it boring

Student 5: It was tedious; I have fallen asleep in class

Student 3: Um also like when in our class like when we did the physics lab we had like an intern teacher, and so sometimes like things were really confusing cause like he was really good but sometimes things aren't explained well enough

Interviewer: Yah because it's his first time that will have an effect for sure

Student 4: and like for experiments we didn't get to do anything like super wicked

Interviewer: Like recording how fast the cart went down the hill or whatever

Student 1: Yah

Student 5: yah

Student 3: yah we didn't get to do anything cool

Student 2: We go to throw eggs

Student 3: yah there were interesting parts too but

Interviewer: Well that kind of leads into the next question did you enjoy the physics unit of Science 10, why or why not? So I mean if there was nothing that you liked comment but if there were parts that you liked comment on that.

Student 1: It was understandable, that's why I liked it

Interviewer: Understandable, it made sense to you.

Student 1: Yes

Student 2: I don't like mathematical equations

Student 3: Yah

Student 4: Me neither

Student 3: I liked it except for the math parts

Interviewer: So you liked the conceptual side of it? Like understanding why things happen

Student 3: Yah

Interviewer: But not so much the calculations?

Student 3: Yah

Student 4: They should do the math and just let us soak it in

Interviewer: Understanding why things happen the way they do but not needing the calculations

Student 4: Cause like how often are you actually going to whip out your calculator and be like calculating

Interviewer: But it is nice to sometimes know what's happening?

Student 3: yah like to an extent I like to know, like the jist

Interviewer: As opposed to the actual calculation

Student 4: Yah

Student 3: Yah

Interviewer: That's a great answer

Student 5: It was just boring, I don't need to know how much joules it takes to twitch my finger or throw a ball across a room, I'll never have to use that

Interviewer: I'm loving your honesty, so feel free to unleash

Student 5: Like she said, I'm not gonna take out a calculator and calculate like how many joules it took for that person to throw the ball at that speed at that trajectory

Student 2: yah I'm not going to walk up to some random person on the street and say hey I know how many joules that took.

Interviewer: Alright, good to know, good to know

Interviewer: And then here the next part, these questions all kind of melded into each other. Did you find the physics unit difficult and what about it was difficult? So just in general.

Student 1: In general, the memorization of each individual formula and what they were for

Student 3: Yah

Student 4: Yah

Interviewer: Okay so you guys didn't have to remember the formulas themselves but remembering what each part of each formula represents kind of thing.

Student 1: yah

Student 5: And like some questions having to use multiple equations just to find out something for another one

Interviewer: So multiple step questions

Student 5: yah joining formulas together to get one answer

Student 3: And converting units too, was difficult, you had to convert them

Student 4: oh I hate converting units

Interviewer: because you guys are working on thermodynamics right now aren't you, so it's kind of similar

Student 1: yah

Student 4: yah

Student 3: yah

Interviewer: Thermodynamics really is an aspect of physics so

Student 4: Math is hard

Interviewer: Did you find it difficult because you said it was boring, so did you find it difficult?

Student 5: No I didn't really find it difficult it was just boring, I really had no interest in it

Interviewer: cool, all right

Interviewer: The next one here five is did you find the mathematical aspects difficult, I guess basically what I'm getting at is comparing this to the math class that you are in, was this harder or easier math then say Math 10 pure or Math 10 applied if that's what you're in. Maybe if you could state what math you take and then say whether you felt it was more difficult or less difficult than your last math course

Student 1: I think my math class was easier

Interviewer: Than physics?

Student 1: Yah

Student 2: Yah, easier

Interviewer: Sorry did you guys take math 10 applied or pure?

Student 1: Applied

Student 2: I did both, my teacher for pure sucked

Interviewer: but you still felt both of those were easier than the physics unit of Science 10?

Student 2: Yah

Student 3: I'm in math applied and I found that the math I'm actually doing is easier than the science math

Student 4: Me too

Student 3: I'm actually thinking about exempting my science exam this year too because I think that I'd do better doing the math exam than the science cause the math was just way too hard for me in the science, in physics mainly

Interviewer: Physics mainly, okay that's very important here

Student 5: Yah I liked math better, I did worse in math than I did in science but with science not only do you have to deal with the equations, but you also have to deal with the factors, like the equation to calculate acceleration but you're also supposed to memorize how much weight is the regular force of gravity or stuff like that, I just don't like storing that much information

Student 2: 9.81

Interviewer: Right, right, so did you but did you do math 10 pure or applied

Student 5: Pure

Interviewer: Pure and which one did you find more difficult not necessarily which one you did better in, but which one you found more difficult

Student 5: Science

Interviewer: You found the science more difficult

Student 5: Yah

Interviewer: That's very interesting, just to let you guys know the other science 10 kids that I talked to that said yes all felt that the physics was way easier than their Math 10 class, so that's interesting the all felt math was much harder so I just think that's interesting

Student 4: Science just comes to some people

Student 3: I think there is more math like if you're like math is the base of things and if you just understand math than things just come easy but if you don't then everything else just kinda falls apart

Interviewer: I just think interesting because you guys are all Math applied except for you and you guys all felt the math (in physics) was more difficult the math pure kids all felt the math was easier, that was leading them to want to take physics, and this is leading you to not want to take physics is part of it. How big a factor would you guys consider the difficulty of the math aspect as being a deterrent for you from physics is that a big part of your decision not to take physics?

Student 1: Quite a bit

Student 4: Yah

Student 3: Yah, the thought of math just freaks me out and if I have to do lots of it, I just don't have a good time in class and I dread that class and then I just don't do good in it.

Student 4: It's like a lot of like applying it right like in math you just have the concept of it but you know you have to apply it to problem questions I guess but that's all you get in science really

Interviewer: Do you find that ironic that you guys are in Math 10 applied but finding that in physics you have to apply math more

Student 3: Oh for sure I see the direct correlation

Interviewer: I just think it's interesting, this is great guys, what you have to say is awesome

Interviewer: Number 6, do you see physics as being relevant to the real world so in your day to day life have you looked at anything since you did Science 10 or even Science 9 the physics aspects of that, do you ever look at something and say hey this is look there's potential energy being converted into kinetic energy has that ever crossed your mind?

Student 1: No

Student 2: No

Student 5: No

Student 4: No

Student 3: When I first took the, like when physics was done, I did kind of a little bit I would notice things but like no not anymore

Interviewer: Since it's been done you don't think of it at all

Student 4: I'd say it to be an ass but that's about it, if I noticed it

Student 5: A roller coaster is a roller coaster. To me there is no potential or kinetic energy – it's just fun

Student 2: And we don't care about it at rugby practice either we just want to play

Interviewer: Fair enough

Student 4: Yah I'm not seeing a roller coaster as potential energy, I just want to do something fun

Interviewer: So when you look at the technology you use do you think that's based on physical principals?

Student 1: Yah

Interviewer: Your Cell phone

Student 3: Yah

Interviewer: Your I-pod

Student 4: You just kind of know that, just that there's more to it

Interviewer: Right, but you have no interest in understanding how that works?

Student 1: No

Student 2: No

Student 3: No

Student 4: We just use it

Student 5: No

Student 2: There's common sense and more sense

Interviewer: And you're content with that, you don't have any desire to know how your cell phone works or why your I-pod works or anything along those lines

Student 5: No

Student 1: No

Student 2: No

Student 3: Well I find it interesting to know, like I'd like to know but I'd like someone who tells me how it works not really go and figure it out on my own

Interviewer: But you would be interested in that

Student 3: I would

Interviewer: This is something that I'm delving into here for maybe future research, do kids, is there a want for a physics class that eliminates the mathematical but really concentrates on the conceptual, the things that are happening. Would you find it interesting to find out this is how a cell phone works, this is how, without having to do all the calculations that go along with it?

Student 4: Yah

Student 2: Yah

Student 1: Yes

Student 5: Yah

Student 3: I would definitely, definitely

Interviewer: That would, that would, what you guys are finding boring is that it's just calculations and you're not doing something that's relevant to you

Student 4: it almost confuses me more because I have no idea what they are talking about, that's how a cell phone works, what?

Student 5: Not only do they teach you the term for gravity, they teach you the formula and all that kind of stuff, what number is this, it's just uhh

Interviewer: The third one there explain the world around you or the universe around you again are you seeing or thinking physics when you look at the stars above the moon changing it's phases things like that?

Student 2: uh-uh

Student 5: No

Student 1: Just pretty little things in the sky

Interviewer: You have no concern of how they got there or why they're there.

Student 4: I'd like to know but I wouldn't want to have to put in the effort to figure out the math behind it

Student 2: It's just one of the things that people just wonder and I'm good with that

Student 3: Well like I wasn't very interested in it that much but then I went to Ecuador at Easter and then we learned the whole like and then we went to the clear and that kind of interested me and I kinda wanted to know more about it, but I didn't really know that it was related to physics though

Interviewer: So again it would be nice to have more of that real world reasoning behind things rather than calculations, that's very interesting

Interviewer: And then I guess the last one 7, based on your Science 10 physics unit do you consider physics to be interesting?

Student 1: Yes and No

Interviewer: Yes and No, could you elaborate at all

Student 1: Well um, it's like interesting to a point, with the math it's not interesting, but it is if it's not

Student 2: I don't like the math but certain concepts are like if we're explaining why this happens and how just don't want to do equations

Student 3: Um, I said that yes cause overall I think that it is interesting and I find it interesting but I just get caught up in the math part because I get confused and then when you are confused with something you don't really care as much about it anymore and then, but I think the concepts behind it are interesting

Student 4: I said yes too but I also got distracted by how hard it was, I was asking her the whole time, do you get this, do you get this, no I don't get this, how could I really fully enjoy it if I don't get it

Student 5: It's really not all that interesting, just in general

Student 2: In general it sucks

Interviewer: Okay and you know its key for me to hear this because you guys are almost the more important aspect of my research, its good to know what students are liking about physics but it's more important to see what your guys' perceptions are because the funny thing is all of you guys have commented on how you don't like the math but physics itself is actually going in a direction at the high school levels of more conceptual stuff and less, less mathematics. The last unit of Physics 30 for example has very, very, little math it's a lot of conceptual stuff understanding the nature of the atom and how everything in our universe works so there are there is some of that there, but your perception of Science 10 if I'm reading you guys right is that is too much math right.

Student 2: right

Student 3: Uh-hum

Interviewer: And that's nothing against you guys cause that's what we give you, that's what we concentrate on right, is giving you guys a bunch of math so very important to say.

Interviewer: Just quickly last if you guys have your factors that influenced you to take Physics 20 or not to take Physics 20 rather, what they the biggest ones were for each of you, so what the biggest reason was

Student 2: Not good at physics

Interviewer: So, but just the fact that you didn't want to not succeed or that you were concerned about grades

Student 2: Grades and you can just take it all together in smaller, like you don't have to do a full semester of that, just that, just like a few weeks

Student 1: Just physics

Interviewer: But you don't mind doing a little bit of it

Student 2: yah

Interviewer: But you don't want to be sitting there for a full semester doing it

Student 2: Yes

Student 1: Yes I agree

Student 5: Just no need to take it, that and that it's like a second math class to me, like I took math first semester I don't want to take math in second semester only in a different form with a different name

Interviewer: Fair enough

Student 4: Yah, don't need it, and I'm not really motivated to do such things

Student 3: Yah, um I don't really have high enough grades to get into it any ways even though I wanted too

Interviewer: High enough grades meaning what?

Student 3: Like for the Physics 20 like my math isn't good enough and

Interviewer: To be completely honest all you need to get into Physics 20, see now this becomes an aspect of you being unaware for whatever reason that is, we're not going to get into pointing fingers but the requirements the pre-requirements are, all you need to go into Physics 20 is Science 10 with 50%, you just need to have passed Science 10 to go into Physics 20. So there's a conception that you have that you don't have high enough marks to go into Physics 20

Student 3: So I guess that I could be in it but I don't think that I would do very well in it

Interviewer: So that's a concern about your marks then

Student 3: Yah

Interviewer: So if you guys could summarize in one or two words the biggest reason you are not taking Physics 20

Student 3: It's not a necessity for my career so

Student 4: Too hard

Student 5: No need to take it

Interviewer: And that's a bigger reason than boring

Student 5: Yep

Student 2: Yah, I don't need it for the future

Student 1: Yah, don't need it

Interviewer: Okay, that's interesting because the kids that are the biggest reason seems to be because they do need it or they want to have it just in case they do need it and you guys are all like I don't need it

Student 4: It's probably a good idea, there's nothing bad about having it, it's like you know, if you could endure it

Interviewer: You have an interesting conception and that's good, that's key, because that's what I expect to see, that students who don't want to take physics are not taking it because they think it's going to suck, that it's going to be hard, that they aren't going to be successful and that's what I've expected to see so that's interesting to hear that. So it's good, thank you very much guys that was very helpful, really liked your input.

Science 10 Students Taking Physics 20

Interviewer: So the first one I guess you probably have all said yes to, because that is why you are in this group.

Student 1: Yes

Student 2: Yes

Student 3: Yes

Student 4: Yes

Interviewer: The second question, what were the major influences in this decision, did any of the following play a major role, firstly time table issues, as I was explaining earlier this is more are you taking or not taking physics because it fits into your schedule or it doesn't fit into your schedule?

Student 1: It didn't

Interviewer: It didn't play an influence at all?

Student 1: No

Student 2: Yah it didn't play

Student 3: No

Student 4: No

Interviewer: The second thing there, parents, did that, is there parental influence as far as your parents think you should take it or they think you should keep your doors open so therefore you should take it or they want you to be a doctor so you must take this kind of thing?

Student 1: No

Interviewer: No parental influence?

Student 1: No

Student 2: Yes my parents influenced me that I should take it for the job I want.

Interviewer: For the job you want, which is sorry?

Student 2: Dentist

Student 3: No, I don't, my parents don't care what I take

Student 4: Mine did, they wanted me to take it just to keep my options open if my like what I wanted to be didn't fall through

Interviewer: Cool, Uh, C) Marks, concerns about your overall average, so are you taking physics to improve your grade or you worried about taking physics because it may have a negative effect on your overall grade?

Student 1: Well I haven't taken it but I guess I would take it to improve my grade, but I would just do my best in it

Interviewer: But you would take it thinking you would be successful at it?

Student 1: Well I guess based off Science 10

Interviewer: Based of Science 10

Student 2: No, not a problem

Student 3: No

Student 4: I think I'd take it just to bump my overall grade

Interviewer: Because you think you'll be successful at it?

Student 4: Yah

Interviewer: Peers, are you taking Physics 20 because your friends are taking it?

Student 1: Yep

Interviewer: So you have a lot of friends who are taking Physics 20?

Student 1: Well it's been pretty much the same people that have been in the Science 10 and a lot of my other classes and they said they were taking it so I was like okay and I took it

Student 2: Nope

Student 3: None of my friends are taking physics, anything hard

Student 4: None of my friends are taking it but I want to

Interviewer: And then any others, any other things that are influencing you

Student 1: Just that like open up your options for university, stuff like that yah

Interviewer: But that is an idea coming from you and not your parents

Student 1: yah

Student 2: Nope

Student 3: I'm good in Math, so it'll be easy

Student 4: Yah same, I enjoy doing math so I thought why not take physics

Interviewer: Okay, thirdly did you enjoy the physics unit of Science 10, why or why not?

Student 1: Um, yah I liked it because it was pretty straight forward, just because it was Science 10 so it was just pretty basic

Student 2: I liked it because you see how things work around you in like everyday life

Student 3: Yah, I thought it was easy it was kind of like Math 10, Math 9 sort of combined so it was pretty straight forward with formulas and all that it wasn't very difficult

Student 4: I thought it was really easy and I enjoyed learning about it

Interviewer: So 4, you guys kind of covered that but did you find the physics unit difficult, nobody here found it difficult?

Student 3: No

Interviewer: As far as the mathematical aspect, it's kind of a redundant question but 4 was more talking about concepts and it does get more complicated in Physics 20 and 30 but as far as the mathematical aspects are concerned some students find that particular part of it difficult but the conceptual stuff easy for other students it's the opposite, it's the math that's easy the conceptual stuff is difficult. As far as you guys are concerned, you didn't find anything about the unit difficult or anything in particular about the mathematical aspects?

Student 1: It was pretty easy

Student 3: Yep

Interviewer: Would you say then, touching on that, that you found the physics unit more or less difficult than Math 10?

Student 1: It was easier

Student 2: It was a lot easier

Student 3: A lot easier

Student 4: Easier

Interviewer: You guys are all in Math 10 pure?

Student 1: Yes

Student 2: Yes

Student 3: Yes

Student 4: Yes

Student 3: It was a lot easier

Interviewer: Do you see Physics as being relevant to the real world? So do you, say since you learnt about work, energy or gravitational potential energy, do you look at something that's moving quickly, even if it's a joke to a friend, that object has a lot of kinetic energy or whatever? Look at the work I'm not doing when you're pushing on something that's not moving, do you ever think about it, make a joke with your friends that sort of thing? Does it ever cross your mind, something that you learnt in class and see. If you have an example that'd be cool.

Student 3: Yah

Student 1: Well if it's something that, if it something that I'm not really sure what is happening then I would think about it but most of the stuff is like pretty like just moving something is kind of common sense really, But if it's something that I don't understand then I'd think about energy and stuff like that

Interviewer: the physics of it?

Student 1: Yah

Student 2: In day to day life you don't really think about it too much but when I was at my house my little brother was jumping on the trampoline and then I'm like when he's up at the top when he's at maximum height he's got 100% gravitational potential energy

Interviewer: Okay perfect, yah and that's what I'm saying are you ever seeing it

Student 4: Yah

Student 3: Yah I don't know, sometimes yes sometimes not so much, I don't know it depends

Student 4: Yah I think I do think about it, I really like to compare like energy which one takes more sometimes

Interviewer: Next one is a big one because all the technology you guys use, you guys are the technological generation, more so than any generation before you and all technology is based on physical principals. So you are using cell phones, I-pods, computers, do you think about the physics implications, this one might be a little tough because what you have done in Science 10 doesn't relate as much to what's actually happening there but have you ever thought about how this is all physics and that's kind of cool?

Student 1: I would think more about the technological aspect like in computer software and stuff like that I think about what's happening that way but not really physically that way because it's just like computer chips and stuff like that I would just think about stuff that way instead of what was happening physically

Interviewer: So when you're turning it on your not thinking what all must be going in there, your just thinking what the actual software is doing?

Student 1: Yah

Student 2: Yah, It's kind of like the computer program and like the memory stuff

Student 3: Yah, I don't know, I think it is cool how everything is just compacted and how much science it does take to use technology and how much it keeps growing and growing

Student 4: Yah I think like before I went into Science 10 I never really thought about any of that but now that teachers are bringing it up and about that like using energy and stuff I think about it a lot more

Interviewer: Would you guys appreciate more, more of a technological relevance in Science 10 course, do you think that that would be something that students would get something out of?

Student 3: Oh Yah

Student 4: Yah

Interviewer: Instead of talking about the steam engines, talking about what is happening in a computer system or something like that

Student 2: Something that we use everyday

Student 3: Cell phones, I-pods, lap-tops stuff like that

Student 2: I think that's a big cause in most people you're learning about stuff that happened in the past

Student 3: Then it gets boring and no one cares

Student 2: You lose your concentration

Interviewer: If we increased kind of the more relevant to your day to day life, technology that you use we might get more kids interested on physics, then you could actually understand how a cell phone works instead of just turning it on and oh hey it works, but actually saying this works because of physics and that's interesting

Student 4: Yes

Student 3: It makes it a lot more interesting

Student 1: Easier to understand

Student 3: Cause no one cares how a steam engine works

Interviewer: Okay C) in explaining the world around you, again at the higher levels physics will talk about phases of the moon, why these things happen. Do you think about, I guess when you see natural processes happening in the world not so much interactions between human beings but interactions between objects do you think about the physics of that?

Student 1: Sometimes, like in sports kind of thing, like if you see like a ball or a hockey puck moving you could think about the energy and stuff like that

Student 2: The input and output

Student 3: Yah

Student 1: The transfer of energy, stuff like that

Student 3: Sports, that's about it

Interviewer: Number 7 overall, do you guys think physics is interesting at this point? And be honest, I want you guys to be honest.

Student 3: Yes and No

Student 1: Yes I guess

Student 2: I think it's pretty interesting

Student 4: Yah

Interviewer: So yes and no

Student 3: It would be a lot more interesting if it was 20th century and more relevant to what technology we use

Student 4: I like the math aspect of it more than the actual physics because I like math a lot so

Student 3: Yah like the history and that it just doesn't seem relevant to me

Interviewer: You just find it interesting in all aspects of it?

Student 2: If you don't know anything about it it won't concern you but if you know about it you can be like I know the reason why that did what it did

Interviewer: It's nice to understand, you enjoy understanding

Student 1: Well if you see something happening it kind of sparks your interest, it's kind of unknown, and you get curious of course and you can use physics to understand it and it's just sort of a feeling of accomplishment I guess

Interviewer: Then this is just the last one if you could maybe just go around quickly and if you could maybe just comment on what your number 1 factor would be for taking Physics 20.

Student 1: Well my number one was just opening up more options in a post-secondary education just cause teachers have always told us that if you, you should take as many classes, core classes, and all the sciences, like cause right now there is no definite as to what you are going to be when you grow up so you just want to have as many classes as you can just so you can choose

Interviewer: That idea you are saying is stemming from teachers, not so much from your parents; it's coming from your teachers?

Student 1: Yah, well it's always been listen to what the teachers tell you so I just followed that

Interviewer: That's an interesting point because I've done this with my Physics 20's and almost every single one of them said it was to keep doors open but they never really commented on where that idea came from. Is it a societal thing, is it a teacher thing or a parent thing why are students thinking that or is it just that they are coming up with it on their own.

Student 2: It's mainly for the job I want because my dad as I was growing up he kind of, I got to come to his office a couple times and see how he did stuff and it sparked my

interest in dentistry and my parents just looked into it and said what you need to get and then so I just took it

Interviewer: So the big picture is the goal of the job?

Student 2: yah

Interviewer: But you had your parental influence, you've had the attraction to that job and the requirements that you have to get that job all of those things kind of played into your decision

Student 3: Mine's the same way, cause I want to be a doctor or a nurse and it just requires me to have physics and I don't know I think it's interesting so it makes me want to be a doctor or a nurse even more

Student 4: And mine's for my career, like to keep my options open but it wasn't ever really my parents or my teachers that made me think that.

Interviewer: it was just something that kind of something that came to you?

Student 4: Yah and I think that now people don't really do that people don't really do that, they're mostly just get it done and over with and get out of high school the easiest but I've just always wanted to

Interviewer: Keep your doors open, do you have a particular career you want or to keep your doors open for because you don't

Student 4: No I do but I don't really know what's going to happen in my future so I might as well cause I don't really want to take physics in university and stuff cause I've heard it's a lot harder

Student 3: and it costs money, a lot more money

Student 2: And for me it doesn't hurt to get more education

Student 3: Yah

Student 4: Yah

Physics 20 Students Not Taking Physics 30

Interviewer: Okay our first question here you've kind of already answered, it's why you are in this group. As far as I understand none of you are planning on taking Physics 20, right?

Student 1: Yah

Student 3: Yes

Student 4: Yep

Interviewer: Okay then moving along to number 2, what were the major influences in this decision, did any of the following play a major role; first one is time table issues. So here I was thinking that maybe you chose not to take Physics 30 because you maybe had too many classes or it didn't fit with other courses you needed or perhaps you wanted to leave room for a spare. So did time tabling have any major role in your decision?

Student 1: No, not really

Student 3: Yah it did for me cause I did want to take Physics 30 but I also had 3 other diploma courses this semester and I don't need it for my career so I thought you know that I would be better off having a spare

Interviewer: What career were you thinking?

Student 3: Law

Interviewer: Okay fair enough

Student 4: No, I just wanted a spare

Interviewer: Okay next one, oh here's (Student 2). You just missed the first couple questions so lets go back and do them, you can just fill in as you go. It's my understanding that you are not going to take Physics 30 right?

Student 2: Right

Interviewer: Okay, the next one as I was saying to these guys is about what influenced you to not take Physics 30, the first one has to do with timetable issues, so were you influenced in your decision by anything timetable related like you had to many core classes, or it just didn't fit, that kind of thing?

Student 2: I already had 3 diploma courses this semester plus choir so I just thought it would be overwhelming

Interviewer: So like (Student 3) you thought it might be better to have a spare, that kind of thing?

Student 2: Yah, like I struggled a bit with Physics 20 and I just thought that I didn't really need it so why would I you know put myself through all that stress

Interviewer: Cool, alright next one here B) did your parents play any type of role in this decision? I guess this might be more for the students who are taking Physics 30, like their parents might be pushing them to take it, but I don't know maybe your parents were all like don't take Physics 30 you won't succeed or whatever, I don't know but did your parents play any factor at all, that you can think of?

Student 1: No, not at all, they would have been happy if I took it

Interviewer: So it was like reverse influence, they actually wanted you to take it

Student 1: Yah but they understood

Student 2: No not at all

Student 3: Nope

Student 4: No

Interviewer: Okay, next one is marks or concerns about your overall average; did you guys have any concerns there? Were you worried if you took physics it might cost you a scholarship or something like that. Maybe you were afraid it would bring you down that sort of thing, maybe you struggled in Physics 20 and were afraid about Physics 30 being harder

Student 1: Well I put yes because I didn't really know how well I would do, like I did good in Physics 20 but I wasn't sure that I would be able to do as well in Physics 30 cause I heard it was a lot harder and I had some trouble so you know I just kind of thought it might hurt my average, and I didn't need it so

Student 2: No, I mean it probably would have been tough but that's not the big reason

Student 3: No, I did good in Physics 20, I think I probably would have been fine

Student 4: No, didn't really

Interviewer: Okay, awesome guys, next we have peers, this might be more orientated towards students that are taking Physics 30 but maybe you had influence, this is an interesting one because it seemed to play a role in the research but from the students I talked to most of them felt that peers was irrelevant. So are you maybe not taking Physics 30 because your friends aren't?

Student 1: Nope

Student 3: My friends are taking it

Student 2: Not at all

Student 4: No

Interviewer: Okay that's kind of what I expected from the other groups and all, the last one on here is others, so did you have any other reasons besides those listed here, I mean

for students choosing to go on they usually say something like keeping their doors open but maybe you guys aren't going to do it because you know what you want to be or whatever

Student 1: Well it's kind of like that for me, like I don't think I'm going to need it right now, for my program or whatever so I didn't take it but if I like needed it later I could always upgrade in university if I had to

Interviewer: What are you going to take?

Student 1: Languages

Interviewer: Yah okay I suppose that's not really physics related hey

Student 2: Well again I had a lot going on this semester and I guess I just really didn't want the added stress of a 4th diploma course and I don't need it for my program either

Interviewer: Which would be?

Student 2: Music

Student 3: Yah again I don't need it for my career, or at least what I think I want to do, and like (Student 1) said I could always upgrade it if I needed it for something else

Student 4: Yah, didn't need it

Interviewer: What do you want to do?

Student 4: Mechanic and I just needed 20 so that's what I did

Interviewer: So basically you guys all didn't take it on some level because you don't need it for your career or for your post-secondary program kind of thing

Student 1: Yah

Student 2: Yah

Student 3: Yah

Student 4: Yep

Interviewer: Cool, alright next on here 3) did you enjoy Physics 20, why or why not, so if you felt that it was awful just be honest and say why or whatever. Don't worry I won't be offended

Student 1: Um, I actually really enjoyed Physics 20, like it was a hard but I figured most of it out and did good, it was interesting and I learnt a lot about how stuff works and all that and I enjoyed being in the class, I liked coming to it, it was like my favourite class last semester

Interviewer: So it was challenging but worth it, almost rewarding?

Student 1: Yah

Student 2: I really enjoyed Physics 20, it was my favourite like academic or whatever core class. I liked learning new things and I liked the atmosphere of the class and stuff like that, I just really loved Physics 20.

Student 3: I thought it was good, I liked the topics we learned about, they were pretty interesting and I did pretty good

Student 4: Yah I enjoyed physics, like I'm not really good at math but I didn't feel real stressed about it because we had lots of help and time and stuff

Interviewer: Great, okay the next question 4) asks if you found Physics 20 difficult, this ties into 5) a bit but I'm more getting at what was difficult, like did you find the concepts themselves difficult or just the math or both or whatever, okay?

Student 1: Well yah I found some of the concepts hard, but not the math so much

Interviewer: Can you think of an example?

Student 1: Well like the slope questions, not slope but like

Interviewer: Inclined planes?

Student 1: Yah those, setting up those and like circular motion were tough to understand

Student 2: Yah I had trouble with some of the concepts or whatever, like understanding what the question was actually asking, once I had that it was easy but sometimes I couldn't get what the question wanted or all the parts or whatever

Student 3: No I didn't really find it hard at all

Student 4: I had trouble with the concepts on my own, like if you knew what the question was it wasn't so bad but I had trouble setting up the equation by myself sometimes cause I'd forget something or whatever

Interviewer: Okay, that's good so you guys would say you struggled more with the concepts than the math?

Student 4: Yep

Student 2: Yah

Student 1: Yah

Interviewer: Which is really what the next question is but here also I want you to answer in general which you kind of already have but can you also compare it to your current math class or the course I guess that you were in when you were taking Physics 20?

Student 1: I didn't really have any trouble with the math, it was easy, the concepts and setting it up maybe but the math was easy

Interviewer: Easier than the math you were in?

Student 1: Yah

Interviewer: Which was?

Student 1: Math 30

Interviewer: Pure

Student 1: Yah pure, sorry

Student 2: I'm only in applied math but I still found the physics math easier as long as I could set up the equation right, after that it was easy the rearranging and stuff

Student 3: I was in Math 30 Pure and the math in Physics 20 was way easier

Student 4: I only did Math 24 so at the start I had trouble but after I got some help and like figured it out it wasn't so bad

Interviewer: Would you say that's because it was like the same math that you were using

Student 4: Yah

Interviewer: So once you wrapped your mind around it it started to come easier?

Student 4: Yep

Interviewer: Cool guys, this is great. So you would all say that the Math that you were in or did was easier or about the same as the level of math you did in Physics 20

Student 1: Yah, easier

Student 2: Yah

Student 3: Yah

Student 4: About the same I guess, I don't know they were different

Interviewer: Awesome, okay flipping over let's talk about 6), some of these tie into each other but basically I'm wondering if you make connections between what you learn in physics and what you do in your life. So in your day to day life do you think about physics? Like I think the best example for Physics 20 is probably, or has to do with winter driving, like going around a corner in cold weather are you thinking about the coefficient of friction?

Student 1: Yah I always think about what you said about big trucks when they go flying by me and how weight doesn't matter

Interviewer: Mass

Student 1: Yah mass sorry, how they can't turn any faster

Student 2: A little bit maybe, like for sure that, but I don't know what else

Student 3: I wouldn't say I'm doing calculations

Interviewer: No that's not what I mean; I mean are you seeing the physics you learned in action around you

Student 3: Oh ya

Student 4: Yah I guess

Interviewer: The next one is kind of a big one because you guys are like the most technologically driven generation ever, with like I-pods and cell phones and lap tops and such. So I'm wondering if you see the physics behind the technology you use. So do you look at your I-pod or whatever and think wow that's all based on physical principals or do you think that hey I turn it on and it works for me kind of thing?

Student 1: Just kind of turn it on, like I get there's something more but I don't think about it

Student 2: Yah just turn it on

Student 3: I don't know I think about it I guess like I know that the electronics and stuff is physics but I don't really know how it works

Student 4: Yah kind of the same

Interviewer: Okay, so do you think that you would be interested in learning about that, like if we taught you about the inner workings of say a cell phone is that something you,

or is that something you think high school students would enjoy, something more orientated towards technology you use?

Student 1: Yah I think so

Student 2: Yah, probably

Student 3: Yah

Student 4: Yah

Interviewer: Okay, cool, next one C), in explaining the world around you, so maybe this should say like universe instead but now say you've learnt Newton's Law of Universal Gravitation do you think about that when you look at the stars and the planets and the moon or are you just like hey it's night and there's the moon kind of thing

Student 1: I don't think like always, but yah sometimes

Student 2: Yah sometimes

Student 3: For sure

Student 4: Just a Moon

Interviewer: Alright, moving along here, last one did you consider Physics interesting and again maybe if you could think like how it would compare to other classes you have taken in high school, like other core courses like math, sciences, social and english.

Student 1: Physics 20 was like my favourite class

Interviewer: Yet you still didn't take 30?

Student 1: Well, I don't know, I just thought it would be super hard

Interviewer: but you did great in Physics 20

Student 1: Yah, well, I don't know I guess I just got scared

Interviewer: Scared by what

Student 1: What other people said

Interviewer: Interesting, no that's good, I'm not picking at you, it's just very interesting that even after Physics 20 you still had a fear of doing Physics 30.

Student 2: Physics was very interesting, like all the new stuff I learnt, I kind of wish I could have taken Physics 30

Interviewer: But you didn't, okay not going to pick on you too, just interesting

Student 3: Yah I found it very interesting, one of my top classes

Student 4: Yah it was good

Interviewer: interesting, it sounds like most of you would have enjoyed taking Physics 30, but didn't. So let's talk about that, what would you say for the last bit here was the biggest reason you didn't take Physics 30?

Student 1: I guess I was scared it would drop my average and the diploma and stuff but I guess mainly because I didn't really need it

Student 2: Yah I didn't need it, I would have taken it but it would have been too much

Student 3: Didn't need it, too many diplomas

Student 4: didn't need it

Interviewer: Okay so it seems like, if I'm understanding you guys, that you all didn't take Physics 30 because it wasn't something you needed for your career

Student 1: Yes

Student 2: Yah

Student 3: Yah

Student 4: Yep

Interviewer: But maybe, and I'm just throwing this out there, you would have taken it if you had needed it or if you had more room in your schedule?

Student 1: Oh yah

Student 2: For sure

Student 3: I really did want to take it

Student 4: Yep

Interviewer: So none of you would say you didn't take physics because it was hard, boring, irrelevant or uninteresting

Student 1: No

Student 2: Not at all, I loved physics

Student 3: No

Student 4: Nope

Interviewer: That's great, thanks guys, one last thing, if you can think back to before Physics 20 and think about your preconception of physics, so what you thought about it after Science 10, and then think about after taking it, how do those conceptions compare. So did you think it was going to be hard and it was, or that it was going to be easy and it was or that it would be hard and it wasn't or vice-versa or whatever, so how did those two perceptions, before and after, compare?

Student 1: Well I thought it was going to be real hard, and in the end it wasn't that bad

Interviewer: Just like you think Physics 30 would be real hard? Just kidding, okay so real hard where do you think that came from

Student 1: Like my friends and my family I guess

Student 2: Yah I heard that physics was like the hardest course and like a ton of math and I'm like not so good at math so I was really scared but it turned out to be pretty good, I mean there were tough parts but I think I got most of it and I was pretty proud, I guess, of that

Student 3: Yah I heard it was hard but it really wasn't at all

Student 4: I didn't really know what to think but it wasn't too bad

Physics 20 Students Taking Physics 30

Interviewer: Okay the first question, are you intending on taking Physics 30, the reason that you guys are in this interview is that it is my understanding that you are intending on taking Physics 30 so we don't have to answer that individually but yes we are all yes on that one.

Student 1: Yes

Student 2: Yes

Student 3: Yes

Student 4: Yes

Interviewer: Okay so let's move into number two, what were the major influences in this decision, did any of the following play a major role? First one time table issues, this is generally more for people who decided not to take Physics 30, Physics 20 students who didn't go on to take Physics 30 a lot of the time it's their grade 12 year and they have so many diploma's that their just like you know what I've got two other sciences I don't need to take a third one but here maybe the reason that you're taking Physics 30 is because you needed to fill a spot I don't know, probably is a no but did anybody have anything to say about that?

Student 1: No

Student 2: No

Student 3: No

Student 4: No

Interviewer: No's all around. B) this one probably will apply a bit more, did your parents play a major role in you deciding to take Physics 30?

Student 1: Yes because they encouraged me to complete and finish all my sciences to succeed in the future

Interviewer: Okay so they thought that it was a good idea for you to have all three sciences?

Student 1: Yep

Student 2: Yah same here but they really didn't have a major role in it, it was more my decision

Interviewer: Maybe like an influence but not the overall influence

Student 2: Yes

Student 3: Yah my parents suggested it so I could succeed in the future

Interviewer: And was that again to keep all your doors open or just to take physics in particular

Student 3: Yah to keep all my doors open

Student 4: My parents didn't really have as much of an influence as my siblings did, like (SIBLING) he just thought I should take everything that he took to keep all my options open

Interviewer: Did he take all three sciences as well

Student 4: Yah

Interviewer: Marks or concerns about your overall average, here again if students aren't intending to take Physics 30 maybe they didn't do so well in Physics 20 so that's why they are not taking Physics 30, but for the flip side maybe you're taking Physics 30 because you did well in Physics 20 and you're hoping that that will again mean you'll do

well and that'll give you a nice, maybe that will bring up your Grade 12 mark average?

Did that play a role?

Student 1: My mark in Physics 20 is alright but I thought I'd take it to challenge myself

Student 2: Yah, I don't know, I wasn't really concerned about well if I had a lower mark in Physics 20 I don't think that I wouldn't of taken it, unless I was failing then I couldn't of taken it, but I think I would of taken it either way

Student 3: My mark in Physics 20 is pretty good so I just thought Physics 30 would be a good idea and be relatively easy.

Student 4: Just taking it for, to compensate for all the classes that I'm not doing as well in, just to keep my average up

Interviewer: So in that sense it's a positive influence on your decision?

Student 4: Yep

Interviewer: Peers, this one was interesting because in the research a lot of the students would say that their peers played a major role in students decisions in what they've taken and every group of students that I've talked to has basically said to me that it didn't play a very big role but did it play a very big role for you guys? Because your friends are taking it is that why you are taking it?

Student 1: No

Student 2: For me yes, well that's why I decided, I was going to take it either way but that's why I decided to take it this year.

Interviewer: Okay, fair enough

Student 3: I was going to take Physics 30 any way but it's always good to have friends in your class it makes it funner.

Student 4: Yah I only came into this class because my friends were in it.

Interviewer: You only came into this class because my friends were in it?

Student 4: And I like the teacher

Interviewer: No seriously you only took Physics because you knew your friends were in it

Student 4: Well, this semester

Interviewer: Was that a major influence on you or just an influence?

Student 4: Just an influence

Interviewer: And then other was there any other reason you can think of that made you think I need to take physics 30?

Student 1: Career related

Student 2: Yah same here and I like enjoy learning about physics and doing it

Student 3: Nope

Student 4: Nope

Interviewer: for you two what's the career you're thinking of doing?

Student 1: Um

Interviewer: Or is it just to keep your doors open?

Student 1: Yah

Student 2: Um something more about designing and building

Interviewer: Okay so maybe something more like engineering or architecture?

Student 2: Yah

Interviewer: Something that other students have commented on here as an other is to keep their doors open, would you consider that you're taking Physics 30, part of the influence

is you're wanting to keep your doors open because you are not 100% sure what you want to do in the future?

Student 1: Yah

Student 3: Yes

Student 2: Yah

Student 4: Yes

Interviewer: All you guys would say yes. That seems to be actually one of the biggest influences that I've seen from talking to students about why they're taking physics, is to keep their doors open

Interviewer: 3, did you enjoy Physics 20, and why or why not? So maybe it's just yes but maybe you have reasons.

Student 1: I learnt a lot of new things, theories and stuff about how things work

Interviewer: And you enjoyed that?

Student 1: Yah

Interviewer: Did you have a curiosity prior to physics about how things work, like have you always kind of been the kind of person who wanted to understand how things work the way they do?

Student 1: Kind of

Student 2: I liked Physics 20 because I had a good teacher and that helps a lot when you're trying to learn something, and we had a lot of work time to work on things

Interviewer: So you enjoyed that aspect that you had time to work and learn how to do it yourself?

Student 2: Yah

Student 3: Yah I enjoyed that aspect too about getting your own time to do it and enjoyed (teacher) and how he taught, and I just thought it was a fun class

Student 4: I enjoyed it but because like I had a lot of my friends in here and I just like knowing how things work, even if I use it or not I Just like knowing how they work.

Interviewer: Number 4, did you find Physics 20 difficult? What about it if you did?

Student 1: I found it fairly easy but like some of the units once you figured them out and understood it was, I caught on fast.

Student 2: Some of the mathematical things were difficult at times and like pulleys and things with a slope and stuff

Interviewer: Okay was it the math, doing it, or the setting up of the math?

Student 2: The setting up of the math, the arranging. Figuring out which formula to use

Interviewer: What I'm getting at mathematical aspects I'm meaning here's your equation you need to substitute in did you find that difficult

Student 2: No

Interviewer: Or did you find, that's more the conceptual side, coming up with what the relationship is, so you'd say more difficulty with the conceptual side of understanding where you needed to start from?

Student 2: Yah

Student 3: Yah I thought Physics 20 was a pretty good course, the only hard part was the formula thing but it wasn't even that hard, the math was pretty easy

Student 4: Yah I thought it was all pretty easy; I'm really good at math so it came to me

Interviewer: That leads into 5; did you find the mathematical aspects difficult? So maybe comment on that first but then also in addition to that just comment on the level of math

that you're currently in and whether you felt that this course was harder or easier than the math level that you're at right now, if you're not taking math right now, your last math course if you are the math you are taking right now.

Student 1: I'm good at math, rearranging formulas they were okay but some of them were tricky, Math 20 I took last semester and I thought that Math 20 was a bit easier

Student 2: Um the last math that I took was Math 10 and found it more difficult than this

Student 3: Yah um the last one I took was Math 10 too, I'm taking it this semester and the math in physics is easier than the math in Math 10

Student 4: Right now I'm taking Math 30 and this is a lot easier than that

Interviewer: Number 6, do you see physics as being relevant to the real world, in your day to day life? So any of the principals that we've learnt in here do you ever find yourself thinking about them or reflecting on them as you're doing something in your day to day life?

Student 1: Kind of, I don't really say it out loud to myself, but once you slide around a corner

Student 2: Yah I do think about it

Student 3: Yah same, the car thing in the winter when you're sliding around you're like oh I know why that happens

Student 4: Yah every once in a while you know you just think about it and it comes out

Interviewer: Okay this next one is kind of an important aspect, the technology you use, when you look at your cell phone or your I-pod or your computer or whatever it may be because you guys are really a technological dependant generation do you look at that and think this thing is based on physical principals even if you don't understand what they are

do you understand that it's physics that's at work there or do you just kind of like I turned it on and it works and that's all that matters to me?

Student 1: Yah

Interviewer: You just turn it on and it works

Student 1: Yah

Student 2: Yah kind of the same thing, sometimes I think about how everything works but it's more just about whatever

Student 3: Yah I just turn it on and it works

Student 4: Just as long as it is working

Interviewer: Would you find it interesting if we dissected a cell phone and how a cell phone works?

Student 1: Yah

Interviewer: If you don't know how it works you don't really associate it with physics but do you think you would find that interesting?

Student 1: Yah

Student 2: Yah me too

Student 3: Yah it'd be interesting to find out how it works

Student 4: Yah

Interviewer: And the last one C), it relates a little bit into A) in explaining the world around you but what about the larger sense of why the stars are out, are you thinking about Newton's Law of Universal Gravitation, does that kind of thing come into play at all or do you just see the moon and there's the moon?

Student 4: There's the Moon

Student 1: Yah well then you think of why everything moves and how it does

Student 2: I don't really think about it

Student 3: yah I don't think about it but it's still cool to know about it and how it works and stuff

Interviewer: And lastly do you consider physics to be an interesting subject?

Student 1: Yes

Student 2: Yes, I do

Student 3: Yah I thought the class was fun and interesting to learn

Student 4: Yah because I like to know how things work

Interviewer: Now comparatively to the other classes that you have in high school or other core classes, which I want to concentrate on, do you find it more or less interesting than your other sciences, math, english, social kind of thing

Student 1: More interesting

Student 2: Yah, way more interesting

Student 3: Yah a lot more interesting

Student 4: Yah

Interviewer: All four of you find it more interesting. If you can think of the preconception you had coming in to Physics 20, so you only know physics as far as Science 10 is concerned, and your post conception now that you have finished Physics 20, do you feel that that conception changed?

Student 1: I thought it would be easy, I thought it would be a lot easier than but I caught on pretty fast so it wasn't that bad

Student 2: Yah same here I thought it would be easier than it was just cause everyone was like oh it's so easy

Student 3: I thought it was going to be harder because I always thought physics was the hardest science but it was easier than I thought it would be

Student 4: I thought it was easy and it turned out easy

Interviewer: That conception, well you thought it'd be harder, you three thought it was going to be easy, that conception, where do you think that preconception came from? From your friends?

Student 1: Yah

Student 2: Friends

Interviewer: Or your Science 10 experience?

Student 2: Just other people saying it was easy

Interviewer: And you thought it would be difficult, where did that come from?

Student 3: My parents actually

Interviewer: Do you see a conception or do you feel there is a conception of physics out there that it's for smart people, nerds, that kind of thing do you see that conception portrayed by society?

Student 1: Definitely smart people

Student 2: No, not really

Student 3: Yah, smart people

Student 4: No, just whoever wants to take it

Interviewer: The last thing is just for you to talk about what your major influences were as far as why you decided to continue on and take Physics 30?

Student 1: Good teacher, because if you have somebody who is more into the class and is teaching and always walking around rather than somebody who just is writing it down and saying here you go, I think that influenced me a lot and then it was interesting to learn and career related, just to keep my options open

Student 2: Yah mine was good teacher and I enjoy doing physics and for future things and career

Student 3: Yah my future just to keep all my doors open and a good teacher, I agree with (Student 1) that if the teacher is involved in the class and stuff and also my friends are taking Physics 30 so I like having class with my friends

Student 4: Yah a lot of my friends are taking Physics 30 so and then good teacher too if like you have to have someone who will take time and help you figure things out if you don't understand it

Physics 30 Students Not Taking Post-Secondary Physics

Interviewer: First question, are you planning on taking Physics at the postsecondary level, my understanding is you guys, well that you two are not and you are possibly

Student 1: Yes

Student 2: Possibly

Student 3: Yes

Interviewer: Possibly down the road but not a for sure thing, next year you are not going out of high school to go right into it. Are you considering a career in a physics related field, so are you taking physics through university to actually pursue a doctorate in physics, or are you doing engineering or are you doing radiology or something that is related mostly to the field of physics

Student 1: No not even close

Student 2: I may take a course but I don't know

Student 3: possibly engineering

Interviewer: But right now you are pursuing

Student 3: Nurse Practitioner

Interviewer: Okay 3rd Question, do you think physics helped you in other high school courses? So the idea here is probably more relevant to math or chemistry but could be anything, any other high school courses that you've taken. In doing physics did it make anything easier for you?

Student 1: I think chem. made it easier, well this made chem. easier

Student 2: Um, Math 30

Student 3: Yah Math 30 because I took chem. before I took physics.

Interviewer: Ok so it made Math 30 easier, what kind of concepts were made easier

Student 3: Um, just things like half-life and graphing and things like that, and for calculus too, because they were both related

Interviewer: Did you enjoy high school physics? So as a whole was it something that you were like hayed every minute that you had to come to it or comparatively to your other classes did you find it enjoyable?

Student 1: I found it interesting because I learned a lot of new things

Student 2: Yah I liked it

Student 3: Yah I really liked it, um I thought it was interesting and fun and I thought that you really taught us the material well and like in an easy way and you weren't just teaching us to like to teach us you were there for us for any questions and I thought you made a big difference too. I really enjoyed it.

Interviewer: Did you find physics difficult and if you did what about it was difficult for you?

Student 1: Just remembering some concepts, but I found the math part easy

Student 2: The theory, and then the math was easy

Student 3: I thought it was all relatively easy, some things could be difficult but if you could think it through it wasn't that bad.

Interviewer: Did you find the math hard and what about it was difficult, most of you have already answered to that so no, not, and then more importantly compare that to your Math 30, whatever your Grade 12 level math was, which one did you think was more difficult Math 30 or Physics 30.

Student 1: Math 30 I think

Student 2: Math

Student 3: Math

Interviewer: So none of you felt that it was particularly difficult in math and compared to Math 30 you found it to be not that difficult, what about compared to your other sciences?

Student 1: Found it, I don't even know because I took chem. and it's pretty similar in difficulty I found

Interviewer: It was about the same?

Student 1: Yah

Student 2: Yah

Interviewer: Same?

Student 2: Yah

Student 3: I found it the easiest and then chem. and then bio because bio is like strictly memorizing and physics is like actually learning it and applying it not just being like read this, do this

Interviewer: So you found that the biology, that memorization aspect, was more difficult for you

Student 3: Yah because it's more

Interviewer: it requires more work?

Student 3: Yah, this I can just listen and pick up concepts and do it instead of having to memorize everything

Interviewer: So you're understanding why you're actually are doing it instead of just memorizing information?

Student 3: Yah

Interviewer: 7, some of these questions kind of overlap but do you see physics as being relevant to the real world? So in your day to day life do you ever look at things and analyze them in say a physical nature so maybe you're looking at an interaction of something and you're thinking that is a gravitational interaction or an electrostatic interaction or anything along those lines? Does that happen to you, or has it happened to you more since you've started taking physics.

Student 1: Well yah it's happened to me more, I didn't think of it before cause I didn't really know anything so

Student 2: Yah

Interviewer: I'm not necessarily saying that you're going around calculating things, but you're thinking about say one example I like to use with my Physics 20's is going around a corner on an icy day

Student 3: I do that every time I go around a corner, I think about centripetal force

Interviewer: Yah and thinking about your coefficient of friction and things like that and being like oh it's icy out today so I have to go a little bit slower because the coefficient of friction has decreased, like that kind of thing is kind of what I was getting at there.

Student 1: Yah

Student 2: Yah

Student 3: Oh yah, definitely

Interviewer: What about in the technology that you use, do you see technology that you use as being based on physical principals? Or do you just turn it on and it works and that's what it is to you?

Student 1: Yah, pretty much

Interviewer: Which one sorry

Student 1: The second one, just turn it on and I'm like oh yah

Interviewer: So you're not thinking about electricity and magnetism being at work, when you're using your technology?

Student 1: No

Student 2: It just turns on

Student 3: Sometimes, depends on what kind of mood I'm in

Interviewer: Do you ever have, do you ever question or has maybe taking physics inspired you to maybe try and understand what is going on inside a cell phone or an I-pod or something like that, or are you just happy with it working?

Student 1: Yah, happy with it working

Student 2: Yah, it's definitely opened up more curiosity

Student 3: Yah, same

Interviewer: Do you think that it would be something that would be interesting to students if we did talk more about the real world technology that you do use, like if we talked about how a cell phone works or how an I-pod works or if we looked at some of that information on as deep a level as you could with high school students. Would that be something you would be interested in?

Student 1: Yah

Student 2: Yah

Student 3: Probably yah

Interviewer: C) in explaining the world around you, so maybe more like the physical world stemming back to Physics 20 even, planets and planetary motion and things like that do you kind of look at that with a little bit of a different perspective than you did before you started taking physics?

Student 2: Yah

Student 1: Yah

Student 3: Yeah, especially after that video that you showed us with like the string theory and the earth is like creating that dip and that was the gravitational thing. I found that really interesting

Interviewer: Yah it's just a different way of looking at things, pretty revolutionary

Interviewer: The 4th one here, did you think that you do or do think that you will use the problem solving skills developed in physics in other areas of your life? This is kind of a broad question so to give you an example a good friend of mine who is an engineer and I were having a talk a few months back about how even when life problems affect us in our day to day life so say I get in a fight with my girlfriend or something like that, a lot of the times I will look at it very analytically as far as what do I know, what do I need to find out and what are the tools that I have to get there, then develop a plan and use that plan. So do you think that you've done, used that kind of analytical skill that you developed in physics in your life?

Student 1: Yah, yah oh, yah, definitely

Student 3: I've done that before physics but now definitely

Student 2: Yah

Interviewer: So it is something that you can see as applying even if you don't go on to do physics, so you don't feel that, maybe this is what I'm getting at, taking physics in high school was a waste of time for you?

Student 1: No

Student 2: No

Student 3: No, definitely no

Interviewer: It's a good basic thing to have

Student 1: Yah

Student 3: Yah

Interviewer: And then I guess 8, we'll try to piggy-back on that but that's like do you consider physics to be an interesting subject? So firstly just as a whole and then comparatively to other courses that you have taken.

Student 1: Yah I think so, cause when you like study physics you don't realize that it's all happening right in front of your eyes and once you learn about it you're like wow that's so cool

Interviewer: Now you know why that is that?

Student 1: Yah why everything happens and yah

Interviewer: It's interesting to see a physical phenomenon and then have someone explain why that happens, something as simple as passing light through a diffraction grating and it spreads out why does that happen, but now you have an understanding for why you would get those maxima and minima and that kind of thing.

Student 1: Um-huh

Student 2: Yah

Student 3: Yah

Interviewer: Did you find physics to be interesting and then compare it to your other classes in high school.

Student 2: I found it easier than lots of my other classes, I enjoyed it

Interviewer: So you enjoyed it, and that therefore was more interesting?

Student 2: Yah

Student 3: Yah I found it really interesting, definitely top two or three, I liked all the sciences but this is good, way better than social or math.

Student 1: Oh yah

Interviewer: What is the aspect of it that I guess that you enjoyed?

Student 3: Because it's like more real to me, because in like math you're learning about things that really when am I going to have to find out the log of 2.19 and graph it, where in this it's like actually happening and if I do go on to be an engineer this will really help me and I find that interesting

Interviewer: Lastly here, this is kind of almost one of the most important things how you made your decision to go on, well to not go on to, you're still possibly thinking about doing physics at the post-secondary level but why you have not gone on to do it immediately, why you're not going into engineering right now kind of thing so even if you're thinking about doing it down the road why, what's stopping you from doing it immediately?

Student 1: My main factor is just the career I want, like I don't need it for jewellery design and don't know why I would take it, I like don't know just kind of a money factor too.

Interviewer: Does it seem like it would be a challenging course in university so perhaps that would affect that decision or is it?

Student 1: Um, kind of, cause I heard it gets harder and it kind of scares me to hear that so yah

Student 2: The school aspect of it

Interviewer: You're still not ready to go to school yet

Student 2: Yah

Student 3: Um, I'm really torn because like medicine and engineering they're both, like they're both really interesting to me, they both come easy to me and they both have good money but the thing is that I found a program here that lets me stay here for 4 years and then Calgary for two or three years, then I'm basically as good as a doctor whereas I'd have to go away all 4 or 6 years depending on what I want to do to like Calgary or Edmonton.

Interviewer: For Engineering

Student 3: Yah

Interviewer: So that's the main factor in influencing you, and I mean that's what we're getting at here.

Interviewer: Now the last thing that's not even on here but I'd just kind of want to ask a couple questions that relate to your overall perceptions of physics. So if you could remember prior to Physics 20 what your feeling was about what physics was going to be whether it was going to be hard or easy or you had no idea what to expect to being, or have gone through the entire physics curriculum how do you feel about physics now as far as high school physics is concerned. So did you come in thinking it was going to be

hard and say wow that was really not nearly as bad as I had thought it was going to be or did you come in thinking it was going to be easy and you found it hard or thought it would be easy and was easy or that kind of thing.

Student 1: We'll I came in thinking it was going to be real hard because I didn't know what to expect but once I went through it it was pretty simple I found

Interviewer: So you would say that you had a preconception that it was going to be very difficult

Student 1: Yep

Interviewer: Do you know where that preconception came from?

Student 1: I don't know, just because I didn't know what to expect like when you think physics you're like I don't know really what that means

Interviewer: Just the word itself

Student 1: Yah

Interviewer: But you felt still yet that this was going to be hard?

Student 1: Yah

Interviewer: and was that from sort of word of mouth or

Student 1: Yah my brother, but I shouldn't really trust him so

Student 2: I didn't really know what to expect but I found it easy

Student 3: I heard that it was hard, but then they started telling me what it was about and it was kind of like math so I was like well that can't really be that hard and it really wasn't so you hear that it's hard but I guess

Interviewer: Would you guys feel that there is sort of a social perception of physics that it's a difficult subject?

Student 1: Yah

Student 2: Yep

Student 3: Yah, like I always heard that it's the hardest science that it's the hardest science, but you're like it's probably one of the easiest

Interviewer: Do you guys think that there is kind of a, again a societal bias towards physics that it's for the elite though, like the academic elite?

Student 1: Yah, I don't know, I actually don't even know

Student 2: I don't think so

Student 3: I think so, because the people that I talk to um, either they do Physics 20 and no way that was too hard and they drop it and I don't know I think they should just give it a chance because it's really not that bad

Interviewer: The other preconception that seems to be out there is that it's very nerdy, do you think that, did you have that kind of preconception prior to coming into physics, like from the Simpsons or something like that, like say that physicists are nerds.

Student 1: No

Student 2: No

Student 3: No

Interviewer: I guess all I have left to ask is if you have any final kind of closing comments to make about your experience with physics in high school, as far as like perceptions what you think about why students aren't taking physics

Student 1: Well I think they are just scared cause if they hear that it's hard they wouldn't want to do it because they're like oh I'll fail and whatever and be worried about it. But I think it was worth it, definitely.

Interviewer: And in the end you didn't actually think it was that hard

Student 1: No and in the end I was like oh well yah I'm glad I did it

Student 2: I thought it was a good course to take

Student 3: I thought it was good because before physics I had never even thought about engineering like I was probably one of the people that thought of them as being nerdy, like engineering why are you doing that. I'm very glad that I took it, and now it's made me confused but oh well.

Physics 30 Students Taking Post-Secondary Physics

Interviewer: Question number one for you guys is pretty straight forward, it's why you are in this group here, you are all intending on taking at least some physics at the post-secondary level right?

Student 1: Yes

Student 2: Yes

Student 3: Yes

Student 4: Yes

Interviewer: The second one, are you considering a career in a physics related field? So if you could maybe just comment on that, doesn't need to be lengthy

Student 1: Yah I'm considering a career in physics, I think I'm gonna take, well I'm going into pre-engineering and then eventually take civil, probably

Student 2: I'm also going into pre-engineering and then I want to go into electrical or bio-medical

Student 3: Um, I'm doing pre-med and I think I want a career in medicine, somewhat physics related

Student 4: I'm doing the pre-engineering and I don't really know exactly, I'm interested in the civil engineering as well as mechanical

Interviewer: Third question here, did you feel that physics helped you in your other high school courses. So in doing physics did it help you say in your math class or anything else so maybe just comment if you can make one at all.

Student 1: Mostly in probably calculus it helped

Student 2: Math in Math it helped

Interviewer: So it did help as far as the math classes

Student 1: Yah

Student 2: Yah

Student 3: Oh Yah

Student 4: I actually forgot like a question. I just used physics formulas to do it

Student 3: Graphing and stuff like that

Interviewer: So it was valuable to you as a help

Student 4: Oh yah

Interviewer: Did you enjoy high school physics and why or why not?

Student 1: I enjoyed it because it is interesting to learn about it and you get an understanding of why things are happening

Student 2: I had the same thing written down that just understanding why things work the way they do and all the laws governing the world

Student 3: I said it was like interesting like where as math you always think where am I going to use this in the future but with physics its more down to earth kind of thing

Interviewer: More real world application

Student 3: Yah

Student 4: It actually gives a use for it

Interviewer: Have you always been curious to how things work or did physics kind of help spark the curiosity as far as that was concerned? Or have you always kind of been the person who took stuff apart?

Student 3: Yah

Student 2: Yah

Student 4: Yah

Student 1: Yah, it may have sparked more of an interest, like once you learn one concept you want to learn another one cause it just like builds on each other

Student 4: A desire to discover kind of thing

Interviewer: Did you find physics difficult, the courses that you took in high school, and what about it did you find difficult?

Student 1: I found Physics 20 more difficult, maybe because it was an introduction to it kind of thing, I'd never taken a course in physics before

Interviewer: Okay was it conceptually that was difficult for you or was it the mathematical aspects that was difficult?

Student 1: Um the math wasn't difficult but I seemed to always be making these human errors but now it's more corrected it after a while

Student 2: I didn't find the physics difficult, the theory more so than the math, more memorization

Student 3: Yah it wasn't very difficult

Student 4: The hand rule and forgetting a negative was basically it, I think that what you're kinda going for here is that in like math or Science 10 there was hardly any real physics that we did in Physics 20 and so it was kind of a big step but there is more chemistry and bio in Science 10 than there was physics.

Interviewer: You felt that was kind of a big jump there

Student 4: Yah

Interviewer: So maybe a little difficult at the start of Physics 20 because you weren't really sure what you were getting into?

Student 4: Playing catch-up

Interviewer: Question number 6, I almost, you can almost, you can compare Physics 30 to Math 30, so which one did you find to be more difficult of a subject Math 30 or Physics 30?

Student 4: I'd say Math, trig

Student 2: I agree Math, it was a lot harder

Student 3: Yah

Student 1: I don't know I'm getting the same mark in both of them, like

Interviewer: I don't mean mark, I'm not getting at your mark; I'm getting at what has been harder for you to wrap your mind around? Which one did you have to work harder at?

Student 1: I'd say math I had to work harder at

Student 4: I didn't study for either

Student 3: I actually have to say I have to work harder in physics than math

Interviewer: When you have students like yourself saying actually I thought Math 30 was harder then you can kind of get that understanding that it might not be that bad

Student 4: Misconception

Interviewer: Yah it definitely can be a misconception because in my mind the mathematics in physics comes down to algebra and trigonometry not really much past that right like it was calculus once you get to university but high school level physics is algebra and trigonometry so if you can wrap your mind around that it's not really a lot of different types of math, you're doing the same sort of thing over and over again

Student 4: I thought it was just mostly substitution

Student 2: It's the simple part of trig, it wasn't the difficult part

Interviewer: Not like trig identities and stuff like that

Student 2: No it was definitely the easy stuff

Interviewer: All right question number 7 on here says do you see physics as being relevant to the real world, in your day to day life? Do you look at things and analyze them in a physical sense ever?

Student 4: Occasionally

Interviewer: Can you think of any example where you would do that?

Student 4: I built a ballista about a month ago, and just kinda put some of that info in there, figuring out how far, how much force went into how far I'm shooting this piece of steel

Student 3: Sometimes when I want to be like smart and impress my friends or something

Student 2: Not really other than for the use of technology, how they've come up with

Student 1: I don't really put it into use but like if you see something happening like throwing a rock into water and look at the waves and think I learnt that

Interviewer: That's kind of what I'm getting at, or even a rain bow and you're thinking hey that's refraction of light does that ever enter into your head kind of thing

Student 4: Oh yah

Interviewer: And that fits in here in a couple of places like part C), but B) in the technology you use. Do you, and this is kind of an important question to ask as you guys have kind of gone through understanding electricity and magnetism, EMR, things like that, do you know kind of look at technology and understand hey that's based on physical principals it's not just a magic box that you turn on and here's television but that is

something that is physically built. With lots of you guys going into engineering do you look at stuff and have a sense now that that's all based on physics principals?

Student 4: Um huh

Student 2: Yah

Student 1: Yah

Interviewer: So you guys would say that you recognize the technology you use is based on physical principals

Student 1: Oh yah

Student 3: Yah

Interviewer: Some of which you understand and more you hope to learn to understand

Student 4: Yah I want to understand

Student 2: Yah

Student 1: Yah

Interviewer: And then in explaining the world around you, that, this is more like physical phenomenon like a rainbow or why is the sky blue versus when the suns above us and red at night when it's going down things like that. Do you think about that after learning about that kind of thing in physics?

Student 1: Yah

Student 3: Yah

Student 2: Occasionally yah

Student 4: Yah

Interviewer: Um lastly do you think that you will use the problem solving skills developed in physics in other areas of your life?

Student 4: Oh yah, definately

Student 2: Yah

Student 3: Um, I don't really know where

Interviewer: This is what, I'll kind of give you guys an example, I have a good friend who is an engineer we were talking one day about how when we have problems in our lives, no matter what it is, we almost approach them like a physics problem in the essence of what do I know? What do I need to figure out, or need to find out to solve my problem? And what are the things that I have to solve that problem, and how am I going to do it? Building a plan like that, so when you look at your life problems do you just go oh I'll figure it out later, or do you try and analyze them and be analytical about it I guess is what I'm saying.

Student 4: Take a mechanical approach to it, like I've got this and this but this doesn't really add up to this so why should it count?

Student 1: I'm more of a procrastinator

Student 2: Definitely more of a procrastinator

Interviewer: Then I guess the last question here 8, Do you consider physics interesting? Would you consider comparatively to the other subjects you have taken in high school was physics an interesting subject?

Student 4: Absolutely

Student 2: Yah

Student 3: Yah

Student 1: Out of all the other sciences I've taken, you can relate the most to physics

Student 4: I see basically physics as the basis of all the other subjects anyways, so I find it the most ground breaking and interesting

Interviewer: If you could say, out of the high school courses you took, if you could rank Physics 30, where would that fall on your scale?

Student 1: Probably Math 30 and Physics 30 would be the two most interesting for me

Student 2: Probably about second most interesting class

Interviewer: second too?

Student 2: Uh, languages

Student 3: Second to math

Interviewer: So you enjoyed math more

Student 4: I'd say physics would be more than probably calculus and stuff like that I'm more of a math type person

Interviewer: And then the factors that influenced you to take, this is actually really the key here for what were getting at so what has made you or led you to decide that you want to go on to do more physics? And that can be as simple as it's the career I want to do, so that you know I'm going to make good money or something along those lines or it could be hey I found I was interested in it and I wanted to keep doing it, so what do you got?

Student 1: Um, yah I said I have a great interest for it and then pursuing your career in it and also my dad helped me develop my interest because he's an engineer so it's kind of

Student 2: It's the same with me my dad's also an engineer, so and career orientated, I also wanted to get into a between engineering and the medical field so I needed both

Interviewer: So both of you would consider that your parents were a fairly big influence as well?

Student 1: Yah

Student 2: Yah

Student 3: Yah basically just because it's a part of my major, and it's not like I don't want to take it but I'm just glad I can take it actually, they're making me take it otherwise I might not

Student 4: I'd say basically to keep my doors open to every possible opportunity I can take is there, get the best job I can have my ideal life presented to me because I know what I know

Interviewer: Then the last thing I have for you guys is if you could think back to prior to Physics 20 so not Science 10, but prior to Physics 20, going in how did you think physics was going to be versus how you feel about Physics 30 now that you've completed it? So maybe you thought hey it was going to be easy and it was, maybe you thought it was going to be real hard and it wasn't, maybe you thought it was going to be easy and it was hard, whatever, how did those two perceptions compare?

Student 1: I thought it was going to be real hard, um the concepts are kind of hard to understand but to the level that we like learned them in Physics 30 it's not that difficult, but I think that when I continue it's going to get tougher

Student 2: I also thought it was going to be extremely hard from what I had heard from family and friends they said it was really difficult but they also didn't enjoy math the mathematic side which I had no problem with so I thought it was going to be harder, but it turned out a lot easier than I expected

Student 3: Oh yah I thought it was going to be really hard, because I didn't know what to expect cause Science 10 was just not really my favourite subject at all, and I went into physics mainly just because I wanted my three sciences and then I decided to continue because it wasn't that bad and

Student 4: Um, I kind of asked people what was easier or hard and I had mixed feelings about both sides and uh I kind of thought it'd be just a bit challenging but when I got in I was like wow, it's going to be a good semester

Interviewer: You guys all said that you kind of thought it was going to be difficult, where were you getting that idea from, would you say? Where did you get that feeling that physics was going to be difficult?

Student 1: Probably just like family and things, I don't know their more saying that engineering is going to be difficult and so it's making me really nervous

Student 2: They said it was a lot of work, more so than other classes where you actually had to work at it and become, you can't just do something once and grasp the concept you have to do something multiple times

Interviewer: Which to a point is true

Student 3: Just because I didn't know what we were going to be learning I didn't even know what physics was in Science 10

Interviewer: Any last comments?

Student 4: I'd say like the biggest threat was the word itself like physics. When I think of it, I think of a brainiac kind of guy in glasses and a lab coat, like I thought that biology would be the easiest because I think of plants and animals outside having the broad picture not having to focus on the tiny like the quantum stuff, and then chemistry being a

level up from that and then physics being the most complicated, intricate, most pathways to different ways to go

Interviewer: So you would say that there's almost a societal bias towards physics as being this nerdy or difficult or

Student 4: Just yah like, I don't know how to explain it, it's just more of a, it's got that misconception that it is for the genius

Interviewer: For the very bright, it has that whole aura around it that it's for the very bright

Student 4: Yah

Interviewer: But after going through it do you buy into that aura as much?

Student 2: Not at all

Student 3: No

Student 4: I try to encourage other people to actually go and do it because it's not as we said.