RISK AND HIGH SCHOOL SCIENCE: INSIGHT ON STUDENT DECISIONS ABOUT REGISTERING FOR ADVANCED-LEVEL SCIENCE CLASSES

by

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Abstract

The following study surveys students currently enrolled in advanced-level high school science electives in an attempt to discover what motivates these students to take such classes. Further, the study develops the argument that advanced-level science classes are a risky choice for students compared to offerings from other departments and makes an attempt to identify types of students who will be more likely to accept that risk. Findings suggest that, among other factors, college credit offered for such classes attracts students. Also, personality (as measured using the Meyers-Briggs Type Indicator) does play a role in a student's willingness to take science electives.

Chapter One: Introduction

A Nielson poll for the week of September 21st, 2009 had five broadcast television shows out of the top ten that featured scientists as protagonists (See Appendix A). A writer on USA Today’s web page (“TV, films boldly go down scientific path - USATODAY.com,” 2009) commented on the popularity of science and scientists in both television and film and went on to discuss how the portrayal of science in both venues has come a long way since *Frankenstein* in its realism. This media fascination may help to explain the trend taking place whereby students are taking more advanced science classes before graduating from high school (Ingels, 2008).

This being said, it is the author's finding that a downwards trend has been observed with regards to one particular advanced-level (i.e. college prep) science class: high school physics. This trend has been observed within the school where this study takes place as well as internationally (Barmby, Kind, and Jones 2008). This study explores the idea that taking science electives (and in particular, taking physics) may be a risky choice for students and attempts to determine if a relationship exists between a student's risk tolerance and his or her proclivity towards choosing to take science electives while in high school.

In addition to taking the Myers-Briggs Type Indicator Form M (MBTI), students in the study were asked questions to assess their risk tolerance in registering for an advanced-level science class (physics) . Students in the study come from a small, rural, culturally homogenous high school in Minnesota.

Statement of the Problem

It is the experience of this researcher that certain (and numerous) students, when engaged in various types of inquiry-based activities, will invariably ask the question, “Is this what's supposed to happen?” Statements like these are the students' attempt to check and see if they are getting the “correct” answer. This comes as no surprise as students in this study have had, leading up to high school, a minimal exposure to inquiry-based science activities in their educational experience and therefore have not been exposed to some of the novel concepts one finds when one engages in scientific experiments. Specifically, these students have not entertained the idea that some things (such as science experiments) do not yield “correct answers” but instead yield “results.” The notion of putting forth a hypothesis - one that may be “supported or refuted” rather than “right or wrong” - is quite different from ways in which students are accustomed to thinking.

Consider this: Inherent in inquiry-based learning is a bit of risk-taking on the part of the student. School for many students involves being asked questions and then being rewarded for getting “the right answer.” Getting “the wrong answer” for students can be - especially if it is done in front of their peers - a humiliating experience. Yet, getting the “wrong answer” is a big part of inquiry-based activities; you generally must provide a testable answer to a question (i.e. your hypothesis) and it is very likely you may be “wrong” in the sense that your hypothesis is not supported. Students (in the author’s experience) have difficulty with this.

Need for the Study

Science, as a subject students take when in school, has two very distinct parts to it. One part consists of “science facts” such as “*the atom is made up of protons, neutrons, and electrons.*” In learning these facts, students are exposed to visual models, vocabulary terms, and rules to follow – the same sort of curricular activities the students must perform in other subjects. The other part consists in having the students actively engage in scientific discovery. Having students *do* science is a different sort of activity from having them learn the facts science has produced. The National Research Council has shown that it is this second part that needs emphasis in the science classroom.

> Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative

explanations, and communicating scientific arguments. (National Research Council 1996, p. 105).

Getting students to take more inquiry-based science classes faces (at least) two problems. First, after their ninth grade year, students have more and more freedom to choose their class schedules. What sorts of things do students consider when they choose their elective classes? At the school where this study was performed, the numbers of students signing up for physics had declined to the point where the class was not offered for two years in a row. When students can exercise freedom to choose classes, it is necessary for schools to consider how to make advanced-level science classes an alluring option.

A second problem is student GPA and the fact that it does not necessarily serve as a good indicator of student performance in inquiry-based science classes. If a student's GPA is based mostly upon classes outside the discipline of science, it can hardly be used to predict aptitude for inquiry. Science educators who employ inquiry-based experiments in their classrooms may well find themselves dealing with frustration as discombobulated students - with excellent GPAs - find themselves in unfamiliar territory, parents start to question teaching methods, and administrators try to find answers as the complaints come their way. Situations such as this cannot reflect well upon the science department nor the teachers therein.

Knowing that certain characteristics may allow for the prediction that one type of student will appreciate an inquiry-based science class whereas another type will feel apprehensive towards it would be useful. Knowledge of this sort would be beneficial to middle-level science teachers in that it might allow these teachers the ability to better support identified students. It is these middle-level science teachers that have the important opportunity to form within the minds of their students positive feelings regarding (1) self-concept in science and (2) learning science in school. It is in these two attitude constructs that Barmby, *et. al.* (2008) demonstrate a downwards sloping trend as students go from seventh grade science to ninth grade science. This trend certainly cannot help the cause of those of us who wish to see more students electing to take advanced-level science in high school.

Furthermore, knowledge of how students may behave in situations that involve risk-taking (e.g. registering for an elective, advanced-level science class) may offer insight to a guidance counselor, an administrator, or a science department as to how they might make taking science classes more enticing. For instance, perhaps more students would take physics if the grades were weighted more heavily than other elective classes (i.e. a grade of B+ translates into an A-). Maybe more students would take chemistry knowing that, if they didn't take it, they might not meet the requirements for incoming freshmen at a particular university.

One might argue that such a tool exists. *Learning preference* could be the indicator we desire. A “thinking”-style learner, based on Kolb’s learning styles, would prefer an expository-style classroom because it is their preferred mode by which to learn. On the other hand, the “feeling”-style learner would prefer at least some aspects of the inquiry-based mode. However, in a study using college-age students, Lawson and Johnson (2002) show that between Neo-Piagetian developmental levels and Kolb learning styles, only one - developmental levels - offers any predictability with regard to ability to do science-based inquiry. In their study, “thinking”-style learners outperformed “feeling”-style learners in both expository and inquiry-based environments. Further, despite the popularity of the Kolb Learning Styles Inventory, concerns regarding its reliability and validity remain (Cassidy 2004).

Statement of Question

A three stage decision-making model for risk tolerance developed by Kowert and Hermann (1997) suggests that certain indicators exist that predict whether a person tends towards risk aversion, risk acceptance, or risk insensitivity. Through the use of the MBTI, their results suggest that someone who scores “judging” (J) and “feeling” (F) will have an aversion to risk especially when the potential for personal loss is great. Risk acceptance increases for those who score J and “intuition” (N) and who recognize a potential for personal gain. Those who score “perceiving” (P) tend to be risk insensitive and may inadvertently take risks.

Accepting the premise that taking an inquiry-based science class is a bit of a risk for students, the following focus question is proposed: Will students with MBTI results of P be more likely to take advanced science electives than those students with MBTI results of J? Further, how will scenarios that offer personal gains/losses to students (as measured by influence on a student's GPA, economic status and other factors) figure in to those students' decisions to register for advanced science classes?

Definition of Terms

Inquiry-based activities: Activities whereby participants may ask questions, plan and conduct investigations, gather and analyze data, think critically and logically about evidence and explanations, and communicate scientific arguments. (NRC 1996). Activities may range in complexity from a "confirmation activity" in which the question, procedure, and results are known in advance to an "open inquiry" where everything (question, hypothesis, procedure, etc.) is left up to the student (Bell, Smetana, Binns 2005).

Likert scale: A unidimensional, 1-to-5 rating scale by which test subjects indicate their attitude towards an item on a survey according to the following:

1 = strongly adverse

2 = somewhat adverse

3 = neutral

4 = somewhat favorable

5 = strongly favorable (Trochim 2006)

Myers-Briggs Type Indicator (MBTI): A personality inventory that measures a person's dynamic type through the use of four dichotomies which are believed to "reflect innate psychological or mental dispositions" (Briggs-Myers, McCaulley, Quenk, & Hammer, 1998).

Prospect theory: A theory which attempts to explain how decisions are made under risk. It predicts that people will generally avoid taking risks when choosing between two prospects they perceive to be personal gains (e.g. people will choose to take $50 for certain rather than opting for a 50% chance at getting $100) but will take risks to avoid what they perceive to be losses (Kahneman & Tversky 1979).

Student Self-concept: What a student perceives their talents in a particular subject area (e.g. science) to be (Barmby, Kind, and Jones, 2008).

Chapter Two: Literature Review

In determining whether it is plausible that taking a high school science class involves some risk-taking on the part of the student, the following literature review explores teacher and student views towards science as a subject.

As was mentioned in the previous chapter, students involved with this study have limited exposure to inquiry-based instruction up until they take ninth grade physical science. One reason for this seems to be the choices made by teachers. Teachers at any level would find that inquiry-based activities, if implemented in the classroom, do not have “right or wrong” answers and often do not have clearly predictable endpoints. Moreover, teachers have difficulty developing inquiry-based activities on their own, in part due to a reluctance to relinquish control within the classroom (Marlow & Stevens 1999). At the lower grade levels, elementary teachers have had very limited coursework in the field of science - making them unprepared to teach the subject (Rice 2005).

Additionally, doing a full scientific inquiry involves mature patterns of thinking on the part of students. Lawson (1995) establishes that in designing and performing a scientific inquiry one may need to use abduction, combinatorial thinking, hypothetical-deductive thinking, identification and control of variables, probabilistic thinking and correlational thinking. Furthermore, he highlights a common theme that hypotheses are “neither proven nor disproven” (p. 44) – a departure from typical school activities which tend to have right and wrong answers.

The complexity of implementing inquiry-based science can be further appreciated by the following lines from Wilke & Straits (2005):

> Inquiry is used to teach science process skills, yet science process skills are the tools by which inquiry is conducted. How can we expect our students to be successful learning by inquiry if we have not provisioned them with the required skills? Instructors should not make the mistake of assuming that all students possess the science process skills required to conduct a full scale inquiry investigation. We have seen in our classes that many students lack the skills necessary to conduct scientific inquiry even at the most simplistic level. When inquiry learning is presented as a complete sequence from problem to conclusions, students, regardless of the number of process skills mastered, will only be as strong as their weakest link. (p. 534)

Other published materials, such as the one referenced above, which share practical ways for teachers to break down and approach these complex activities appear in the literature (Lawson 1995, Bell, Smetana, & Binns 2006, Banchi and Bell 2008). Such materials, one would hope, would aid teachers to expose students gradually to open inquiry and therefore help students not only to think scientifically but to think better of science as a subject.

Student attitudes towards science in school are not generally positive within upper grade levels. It has been shown that student attitudes towards science decline as they approach high school (George 2006, Barmby 2008). In these studies, it appears that of all the potential factors (parental influence, teacher influence, peer influence, etc.), student self-concept in science is the most significant variable that predicts student attitude in science class. Both science self-concept and student attitudes toward science classes trend downwards as students go from elementary school to high school.

The case that science classes are amongst the most difficult classes students take could probably be made based solely on the arguments presented in the lines above regarding the complexity involved with performing inquiry-based experiments. That students have a low self-concept in science is probably not helped by the fact that science classes are also graded more stringently than classes in, for instance, humanities or arts (Johnson 2003). Johnson's (2003) conclusions on grading practices include the finding that grades impact enrollment. Might this explain Great Britain's observed trend of a 41% decline in advanced-level physics students between 1985 and 2006 (Barmby 2008)?

Are students simply lazy? Are they avoiding science because they can earn better grades in classes offered by other departments doing less work? Keeping kids in science classes may be about those kids' willingness to accept risk more than it is about their avoiding hard work. The paragraphs above have developed that inquiry-based science is (1) different than other experiences within school, (2) that it is difficult, (3) that students attitudes towards science decrease as their grade level increases and, (4) that students' GPA may suffer as a result of taking science classes.

Let us consider then what a high school student has to gain by taking a science class. Besides knowledge, perhaps prestige amongst peers could be had. Certainly, university admissions departments are going to look for some science credits on a transcript; so, gaining entrance to a post-secondary school of choice is a definite possible gain. As occupations involving science and engineering tend to have high salaries, perhaps obtaining a good-paying job is within reach through taking science coursework in school and would be perceived as a personal gain by students.

What has that student got to lose? It has been proposed that the student could lose the certain comfort level they have achieved within those classes which have right and wrong answers. The student could lose confidence in their abilities as a student (i.e. self-concept). The student could lose points on their GPA moving them down in class rank and even losing out on potential scholarship monies.

Simply weighing the potential gains and losses, their respective probabilities of occurring and the values a particular student may assign to each is, according to Kowert and Hermann (1997), not enough. Personality must also be taken into account. The next chapter will discuss how personality and risk tolerance fit into the research design.

Chapter Three: Research Design

Kowert and Hermann (1997) developed a three-stage model of decision-making under risk which is represented in Figure 1. Some liberties are taken here with regard to

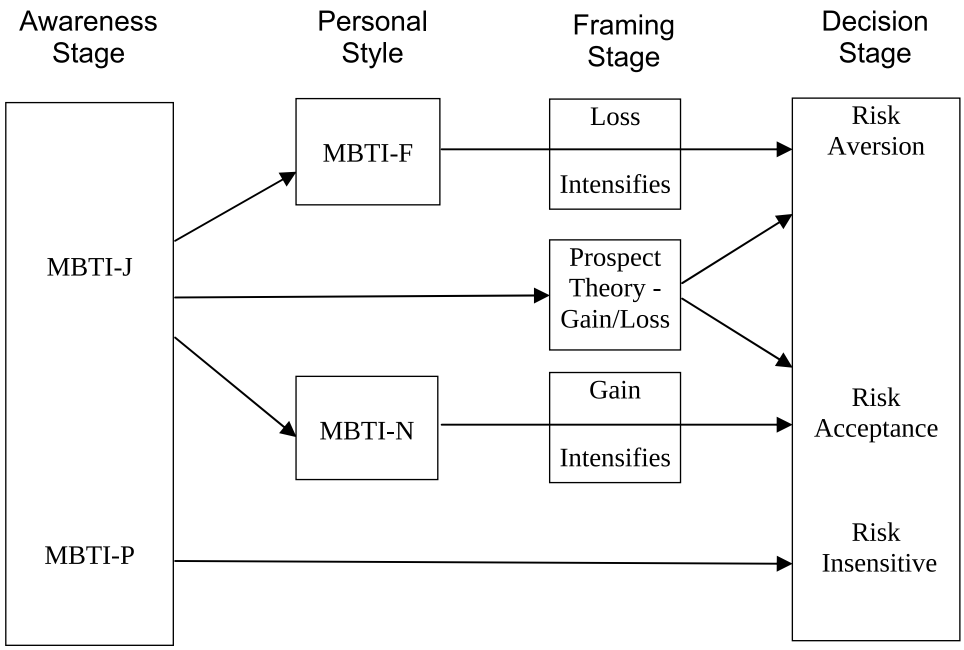


Figure 1: Three-Stage Model of Decision Making under Risk Using Meyers-Briggs Type Indicator (Kowert 1997).

their model in that only the MBTI is represented. In their complete model, they used an additional personality measuring tool called the Revised NEO Personality Inventory in conjunction with the MBTI. For reasons of simplicity, only the MBTI was used in this research.

In order to fully grasp the three-stage model, it is imperative that one understands the MBTI. The third edition of the MBTI Manual (Briggs-Myers, McCaulley, Quenk, & Hammer, 1998) tells us the history of Type Theory. Type Theory is based on the work of

Carl Jung as interpreted by Isabel Myers and Katherine Briggs. Whereas Jung's initial focus was on extraversion (E) and introversion (I), he later expanded his theory to include other descriptors of personality and thus the MBTI includes three more dichotomies. These dichotomies are Sensing (S) and Intuition (N), Thinking (T) and Feeling (F), and Judging (J) and Perceiving (P). All said, these four dichotomies describe 16 types (ISFP, ESFP, INTJ, etc.).

According to Kowert (1997), an FJ-type will find that loss intensifies tendencies towards risk aversion though an NJ-type will accept risk especially when there is a gain perceived to be had. In general, J-types will take risk under consideration following Prospect Theory whereby potential gains are weighed against possible losses. Interestingly, a third possibility exists for P-types. These types tend to be risk-insensitive in that they do not recognize risk in their decision-making – at least not within the economic, medical-related, and political-related frames used in their study.

Participants

Students in this study attend a small, rural high school in Southeastern Minnesota. All of the students have registered to take an advanced-level science course. The three courses from which students were selected are chemistry, advanced biology, and anatomy & physiology. Anatomy & physiology is a college-level course offered in high schools in which college credits are offered to those students earning a satisfactory grade. None of the students in the study have taken and few (approx. three) attempted to register to take physics.

Data Collection

Participants' personality was assessed through administration of the MBTI Form M. Additionally, a survey was given to each student (see Appendix B) to assess both why they chose to take the advanced-level science class they did, as well as why they did not take physics. The survey was designed using a Likert scale. Included in the survey were four questions framed in terms of a gain for students, and four questions framed in terms of a loss to avoid. In Kowert's study (1997), the questions described a scenario and then offered subjects two choices: one with a relatively certain outcome and one that was considered risky. Moreover, there were pairs of questions that were equivalent - one framed in terms of a gain, and another framed in terms of a loss. Some examples are included in the appendix of their paper of which two are shared below for clarification.

> *(Gain Frame) Suppose that, to attract new customers, a local store is offering the following promotion. Every customer may choose one of the following: (a) a gift certificate for $20 or (b) a 50% chance of winning a gift certificate for $40. A salesperson will simply flip a coin so that, on average, half of the people who choose the second option will win the $40 certificate and half will get nothing. Which option would you prefer?*
>
> *(Loss frame) Suppose that you recently lost a bet with someone, who you now owe $20. You have the following two options: (a) pay the $20 or (b) make another bet for "double or nothing" (i.e., if you lose, you pay $40, and if you win, you owe nothing). Which would you choose?*

Taking an advanced-level physics class is the "risky" choice this study aims to examine and so no "certain" options were provided to the test subjects. Otherwise, each of the questions were modeled after the examples provided by Kowert (1997).

Procedure

Subjects were assigned a number which they wrote on both the MBTI and on the survey. Both forms were collected after the subjects had finished. The instructions were followed for scoring the MBTI and the survey results were tabulated. Gain/loss neutral questions were tabulated separately to establish any outside factors that may have played a role in the choices subjects made regarding class selection.

The results were analyzed to see if any one group (i.e. P's, NJ's, and FJ's) was over-represented. A comparison of gain frame questions was made between three different groups: those subjects that were NJ-types, those who were FJ-types, and those who were P-types as determined by the MBTI. This same approach was repeated for loss frame questions. Finally, a difference in mean scores of gain-frame questions and mean scores of loss-frame questions was calculated and compared between the three groups. Statistical analysis was performed by calculating the t test, and probability.

Chapter Three: Results

The participants (N=33) in the study were high school juniors and seniors in advanced-level science electives. Advanced Biology and Anatomy & Physiology were taught by one instructor and Chemistry by another. Students who were concurrently enrolled in Advanced Biology and Chemistry were counted as Chemistry students. As

Table 1: Breakdown of participants

Classes	N	males	females	J-types	P-types
Advanced Biology	5	3	2	2	3
Anatomy & Physiology	7	3	4	3	4
Chemistry	21	10*	10*	7	14
Total	33	16*	16*	12 (7 NJ, 9 FJ)	21

*One participant did not report gender

seen in Table 1, the numbers of males and females were nearly equal in each of the three classes. The number of "Judging" types (J-types) and "Perceiving" types (P-types) were determined through the administration of the Meyers-Briggs Type Indicator Form M. There were twenty-one P-types and twelve J-types. Seven of the twelve J-types reported "Intuition" (N) as a preference and nine of the twelve reported "Feeling" (F) as a preference (Note: Being an N-type does not exclude one from being an F-type and vice versa).

First Survey: Values

The first survey given to participants explored what they value in the context of selecting elective classes. Overall, participants reported that they valued *utility* - agreeing that the advanced-level science class in which they were enrolled would "be useful" and "would help [them] in college". Furthermore, participants reported overwhelmingly that they value good grades (see Table 2).

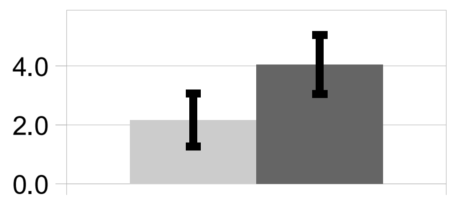
Table 2: Values held by participants (5 point Likert Scale)

	Mean	σ	Mode
I think this class will be useful to me.	3.9	0.9	4
I feel this class will help me in college	4.5	0.5	5
I value good grades.	4.5	0.8	5
I registered for this class because I want others to respect me.	2.4	1.1	2
I would still have registered for this class were it taught by another teacher.	4.0	1.0	4
The classes my friends take influence what classes I register for.	2.3	1.2	1

Certain items were not valued by the participants. For instance, participants did not tend to be influenced to enroll in advanced-level science classes by social incentives. They placed little value in (1) "want[ing] others to respect [them]", (2) which teacher was teaching the class, and (3) what classes their friends take.

It should be noted that significant ($p < 0.0005$) differences exist between J-types and P-types in two categories (as shown in Figures 2a and 2b). Unlike P-types, J-types in this study did tend to exhibit preferences for the teacher in registering for classes. The J-types also tended to agree that the classes their friends take influence their decision-making process whereas P-types did not.

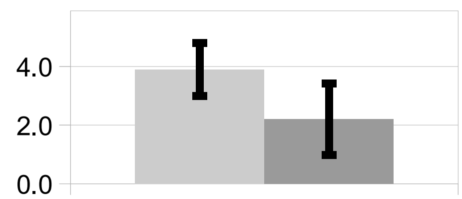
Figure 2a : Agreement from students that the teacher is not a factor in class selection.



	J-types	P-types
Mean =	2.2	4.0
Mode =	2	5
σ =	0.94	1.00

T test = 5.22
dF = 31
p < 0.0005

Figure 2b: Agreement from students that friends influence class selection.

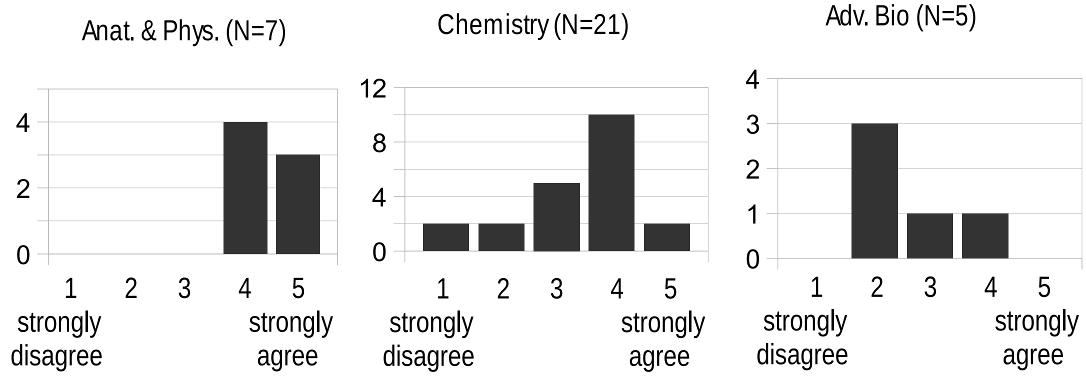


	J-types	P-types
Mean =	3.9	2.2
Mode =	4	1
σ =	0.90	1.22

T test = 4.39
dF = 31
p < 0.0005

The complete analysis of the first survey can be viewed in Appendix C. One other finding will be shared here with regard to college credit. Figure 3 shows how college credit influenced the decisions made by those participants in the Anatomy & Physiology class to enroll as compared to the other participants for whom college credit was not available. No incentive to directly earn college credit exists for students in chemistry or advanced biology (though chemistry is a prerequisite for anatomy & physiology).

Figure 3: Participants who agree that earning college credit influenced their decision to enroll in the class (breakdown by class).

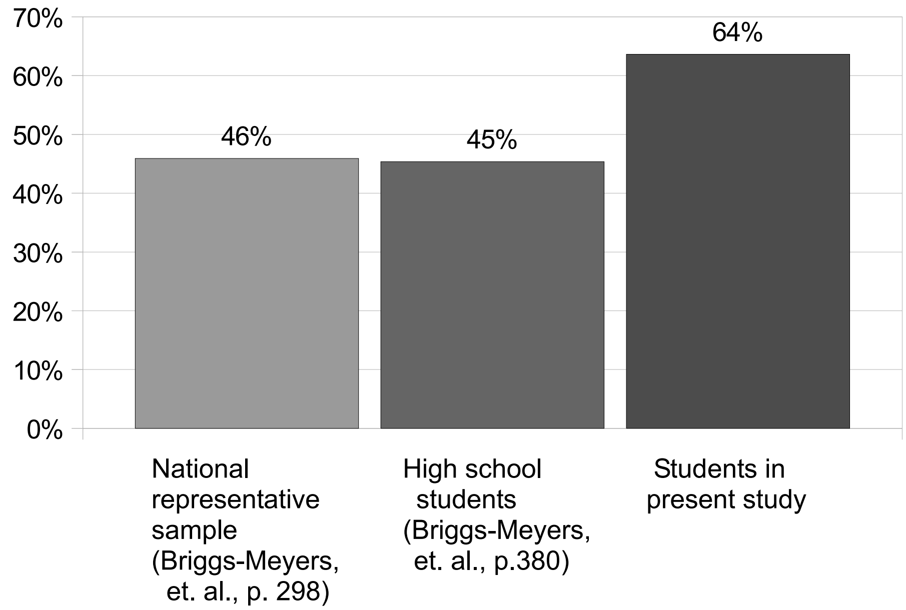


Survey Two: Risk Tolerance

Participants were presented with eight scenarios in which a decision had to be reached by them as to whether or not it was worth taking high school physics. The data collected showed little difference between subgroups. J-types and P-types showed no statistically significant differences in the ways they expressed their decisions. Of the eight scenarios presented, participants expressed (on average) that they would accept what this study suggests is the risky choice (i.e. taking physics) in all but two cases. In fact, over half of the participants stated that they either “agreed” or “strongly agreed” that they would choose to take physics in six of the eight scenarios. Appendix D shows the breakdown for how participants responded to each of the eight scenarios.

The results from the second survey do little to either support or refute the idea that the two subsets of J-types (NJ's and FJ's) will accept or reject risky scenarios depending on whether personal gain or personal loss may be realized. There simply are too few of these types in the pool of participants. However, one interesting result did emerge that

Figure 4: Representation of P-types in study compared to population



would, within the context of the three-stage model of decision-making under risk (Kowert and Hermann, 1997), tend to support the idea proposed that science electives are risky choices. A comparison of the sample of participants to the population as a whole shows an over-representation of P-types (see Figure 4). P-types were found, in the Kowert/Hermann study to be risk-insensitive.

Chapter Five: Conclusions

In an essay by Martin Schwartz (2008), he relays the story of a former Ph.D. student in the sciences who dropped out of graduate school , enrolled in Harvard Law School and went on to become a successful lawyer. Her reason for switching fields of study was due to the fact that science made her feel stupid. Schwartz argues that science education must do a better job of (1) conveying to students the difficulty of doing research and (2) teaching students how to be “productively stupid”. Clarification of this second point comes in his conclusion.

> Focusing on important questions puts us in the awkward position of being ignorant. One of the beautiful things about science is that it allows us to bumble along, getting it wrong time after time, and feel perfectly fine as long as we learn something each time. No doubt, this can be difficult for students who are accustomed to getting the answers right. No doubt, reasonable levels of confidence and emotional resilience help, but I think scientific education might do more to ease what is a very big transition: from learning what other people once discovered to making your own discoveries. The more comfortable we become with being stupid, the deeper we will wade into the unknown and the more likely we are to make big discoveries.

Students cannot transition to “making their own discoveries” without engaging in inquiry-based science. And they probably will not engage in such activities if they do not elect to take science classes that can guide them through this difficult process. It has been the aim of this study to explore whether or not certain types of students are more likely than others to take advanced science classes and to discover also what sorts of things might serve as motivating factors to get more students to take high school physics.

One finding is that college credit earned by high school students is a motivating factor for the participants in this study. It should be noted that as the results from this study were being tabulated and analyzed, a new school year brought a new course offering to the school where the study took place. The class was a University of Minnesota College in the Schools course called Physics by Inquiry. Students who take the class are concurrently enrolled at The University of Minnesota and earn college credit while on their high school campus. Fourteen students are just finishing up their first semester as these words are being typed.

Further study into this subject should involve polling larger groups so as to achieve more numbers of each of the personality subgroups allowing for more meaningful statistical analysis. It would be perhaps even more interesting, as a follow-up, to survey those students who do not opt to take science electives. Here, it would be predicted that a wider variety of responses would be seen in the administration of survey number two which explored which sorts of scenarios students will and will not entice them to take physics. Another thing that was not explored in this study was the idea that there is competition within the schedule of courses offered to students between and within academic departments; students must choose between, for instance, physics and *economics* or *short stories* all offered perhaps second period. A small school such as the one in which this study was performed does not have the luxury of being able to offer more than one section of some classes. Did the fourteen students who elected to take physics this year do so because of the college credit they could earn or because, it just so happened, there were not so many good alternatives offered at that particular period? Further research could attempt to answer such a question.

Thinking back to the introduction of this paper and the role of Hollywood in all of this, one should not completely disregard the possibility that a blockbuster movie featuring a theoretical physicist in its starring role could fill the seats of physics classrooms across the country. However, what the results of this study seem to communicate is that certain students (P-types) tend to gravitate towards science classes and others (J-types) may need to be recruited. There are, discovered through these surveys, some effective ways to do that recruiting. In addition to offering concurrent enrollment classes, findings suggest that at least three other things would motivate students to take physics. The simplest among the three to implement is to educate students about what universities have as entrance requirements, making the students aware that completing physics coursework may be a requirement. A more complicated implementation process would face those who try to employ some type of bribery schemes either through (1) a system of weighted grades or (2) paying students money for taking physics. With regard to the second and perhaps more controversial of these two propositions, numerous studies have been done that suggest that in best case scenarios paying students for performance works for girls more than boys and also for students who are most often hardest to reach (Ripley, 2010).

Appendix A

Broadcast TV - United States
Week of September 21, 2009

Rank	Program	Network	Rating	Viewers (000)
1	NCIS	CBS	12.4	20,600
2	DANCING WITH THE STARS	ABC	11.3	17,794
2	NCIS: LOS ANGELES	CBS	11.3	18,730
4	GREY'S ANATOMY-THU 9PM	ABC	10.9	17,034
5	NBC SUNDAY NIGHT FOOTBALL	NBC	10.7	17,469
6	DANCING W/ THE STARS-9/22(S)	ABC	10.1	15,367
7	DANCING W/STARS RESULT SP(S)	ABC	10.0	15,356
8	HOUSE	FOX	9.8	17,156
9	CSI	CBS	9.7	16,009
10	60 MINUTES	CBS	9.6	14,884
10	CRIMINAL MINDS	CBS	9.6	15,841

Source: The Nielsen Company. Viewing estimates on this page include Live viewing and DVR playback on the Same Day, defined as 3am-3am. Ratings are the percentage of TV homes in the U.S. tuned into television.

Appendix B

List of survey questions used

Part one: Questions about the class for which students registered.

5 4 3 2 1 I registered for this class because I could earn college credit.

5 4 3 2 1 I feel this class will help me in college.

5 4 3 2 1 I registered for this class because I felt it would help me get a good job.

5 4 3 2 1 I think this class will be useful to me.

5 4 3 2 1 I registered for this class because I want others to respect me.

5 4 3 2 1 I don't see myself as very good at science.

5 4 3 2 1 I would still have registered for this class were it taught by another teacher.

5 4 3 2 1 The classes my friends take influence what classes I register for.

5 4 3 2 1 I value good grades.

Part Two: Questions regarding Physics Class.

Loss-frame questions

You have been informed that a change has occurred in your class schedule and you must now make a decision between two classes to take to replace the one that was dropped.

5 4 3 2 1 I would take physics to avoid having to take a class which I have heard has a great deal of homework in it.

5 4 3 2 1 I would take physics to avoid having to take a class that I knew I would have a 60% chance of earning no higher than a C for a grade.

The university you have decided is your first choice to attend after high school has a requirement that incoming students *should* have physics on their transcript. You also have learned that they only accept a certain number of students each year.

5 4 3 2 1   Knowing this, I would take physics to avoid potentially not being accepted.

The university you have decided to attend after high school has changed its policies. It now requires all students to take a freshman physics class unless students enter the university already having taken the course in high school.

5 4 3 2 1   I would take physics in high school to avoid having to pay the tuition I/my family would have to pay to take it at university.

Gain-frame questions.

You discover you are eligible to take part in a nation-wide push to get more kids to take physics. The Bill and Melinda Gates Foundation is offering $35 to students who earn at least a B in high school physics and $100 to students who earn an A.

5 4 3 2 1   I would take physics to be a part of a program like this.

Wabasha-Kellogg is implementing a policy change where it is going to offer weighted credits for certain classes. Physics is to be the first class offered with weighted credits whereby whatever grade you earn in the class, an additional half point will be added on your transcript (for instance, a B would be a B+ and an A would go to an A+).

5 4 3 2 1   I would take physics if such a policy existed.

A new AP physics class is going to be offered in place of the current class at Wabasha-Kellogg. Historically, approximately 60% of the students who take the AP test pass it with a 3 or higher.

5 4 3 2 1 I would register for AP physics if it were offered at my school.

A new college-in-the-schools physics course is being offered at Wabasha-Kellogg. Passing the class ensures you earn college credit. The grade goes on your college transcript.

5 4 3 2 1 I would take physics if I could earn college credit for it.

Appendix C

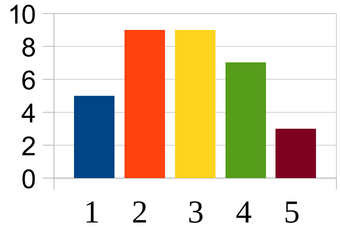
Results from survey number one with descriptive statistics.

	I registered for this class because I could earn college credit	I feel this class will help me in college	I registered for this class because I felt it would help me get a good job	I think this class will be useful to me.	I registered for this class because I want others to respect me.	I would still have registered for this class were it taught by another teacher.	The classes my friends take influence what classes I register for.	I don't see myself as very good at science.	I value good grades.
Overall average	3.48	4.52	3.27	3.94	2.36	3.97	2.30	2.67	4.55
Overall SD	1.12	0.51	0.72	0.90	1.06	0.95	1.16	1.11	0.75
Mode	4	5	3	4	2	4	1	3	5
AdvBio avg	2.60	4.40	2.40	4.20	1.60	3.80	1.40	2.40	4.60
SD	0.89	0.55	0.55	0.84	0.89	0.84	0.55	1.14	0.89
Mode	2	4	2	4	1	3	1	2	5
Chem avg	3.38	4.52	3.48	3.81	2.52	4.24	2.52	2.81	4.57
SD	1.12	0.51	0.60	0.98	1.12	0.94	1.21	1.17	0.75
Mode	4	5	3	4	3	5	2	3	5
A&P avg	4.43	4.57	3.29	4.14	2.43	3.29	2.29	2.43	4.43
SD	0.53	0.53	0.76	0.69	0.79	0.76	1.11	0.98	0.79
Mode	4	5	3	4	2	3	1	2	5
J-type avg	3.58	4.50	3.42	4.17	2.25	2.17	3.92	2.42	4.67
SD	1.00	0.52	0.79	0.58	0.87	0.94	0.90	1.08	0.49
Mode	4	4	3	4	2	2	4	3	5
P-type avg	3.45	4.55	3.18	3.86	2.45	4.05	2.23	2.91	4.50
SD	1.17	0.51	0.62	1.01	1.12	1.00	1.22	1.11	0.92
Mode	4	5	3	4	1	5	1	3	5
male avg	3.31	4.44	3.38	4.13	2.38	4.19	2.25	2.25	4.50
SD	1.14	0.51	0.72	0.62	1.02	0.83	1.00	0.86	0.63
Mode	4	4	3	4	2	5	2	2	5
female avg	3.63	4.63	3.19	3.81	2.44	3.75	2.38	3.19	4.56
SD	1.15	0.50	0.75	1.11	1.09	1.06	1.36	1.11	0.89
Mode	4	5	3	4	3	4	1	3	5

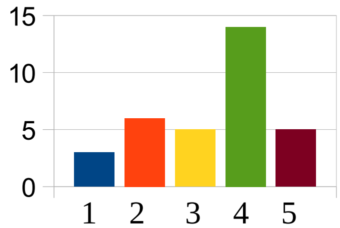
Appendix D

Results from Survey No. 2 (Five-point Likert Scale).

1) You have been informed that a change has occurred in your class schedule and you must now make a decision between two classes to take to replace the one that was dropped.

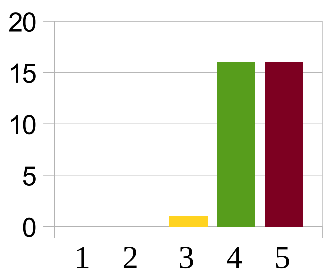


(a) I would take physics to avoid having to take a class which I have heard has a great deal of homework in it.



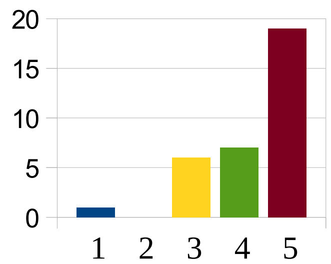
(b) I would take physics to avoid having to take a class that I knew I would have a 60% chance of earning no higher than a C for a grade.

2) The university you have decided is your first choice to attend after high school has a requirement that incoming students *should* have physics on their transcript. You also have learned that they only accept a certain number of students each year.



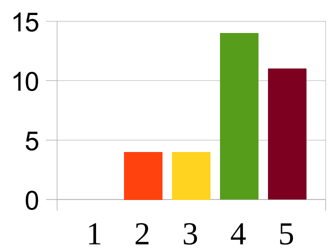
Knowing this, I would take physics to avoid potentially not being accepted.

3) The university you have decided to attend after high school has changed its policies. It now requires all students to take a freshman physics class unless students enter the university already having taken the course in high school.



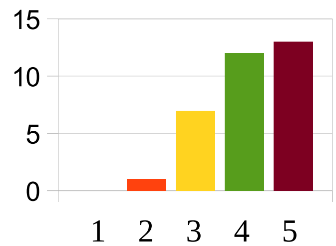
I would take physics in high school to avoid having to pay the tuition I/my family would have to pay to take it at university.

4) You discover you are eligible to take part in a nation-wide push to get more kids to take physics. The Bill and Melinda Gates Foundation is offering $35 to students who earn at least a B in high school physics and $100 to students who earn an A.



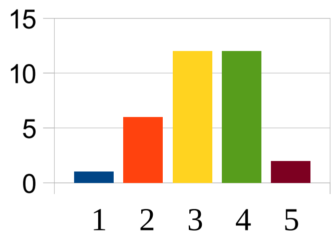
I would take physics to be a part of a program like this.

5) Wabasha-Kellogg is implementing a policy change where it is going to offer weighted credits for certain classes. Physics is to be the first class offered with weighted credits whereby whatever grade you earn in the class, an additional half point will be added on your transcript (for instance, a B would be a B+ and an A would go to an A+).



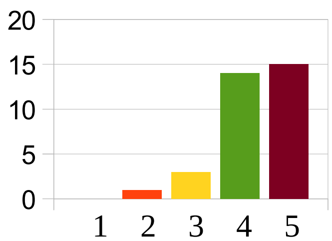
I would take physics if such a policy existed.

6) A new AP physics class is going to be offered in place of the current class at Wabasha-Kellogg. Historically, approximately 60% of the students who take the AP test pass it with a 3 or higher.



I would register for AP physics if it were offered at my school.

7) A new college-in-the-schools physics course is being offered at Wabasha-Kellogg. Passing the class ensures you earn college credit. The grade goes on your college transcript.



I would take physics if I could earn college credit for it.

Bibliography

Barmby, Patrick, Per M. Kind and Karen Jones (2008). Examing Changing Attitudes in Secondary School Science. *International Journal of Science Education*, 30(8) 1075-1093.

Briggs-Myers, Isabel, McCaulley, Mary H., Quenck, Naomi L. and Hammer, Allen L. (1998). *MBTI Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator*, *Third Edition.* Palo Alto, CA. Consulting Psychologists Press, Inc..

Cassidy, Simon (2004). *Learning Style: An overview of theories, models, and measures.* Educational Psychology, 24(4).

George, Rani (2006). A Cross-domain Analysis of Change in Student's Attitudes towards Science and Attitudes about the Utility of Science. *International Journal of Science Education*, 28(6), 571-589.

Ingels, S.J., and Dalton, B.W. (2008). Trends Among High School Seniors, 1972–2004 (NCES 2008-320). *National Center for Education Statistics*, *Institute for Education Sciences, U.S. Department of Education*. Washington, DC.

Johnson, Valen E. (2003). *Grade Inflation: A Crisis in College Education.* New York. Springer-Verlag.

Kahneman, Daniel and Tversky, Amos (1979). Prospect Theory: An Analysis of Decision Under Risk. *Econometrica*, 47(2), 263-291.

Kowert, Paul A., Hermann, Margaret G. (1997). Who takes risks? Daring and caution in foreign policy making. *The Journal of Conflict Resolution*, 41(5), 611-637.

Marlow, Michael, and Ellen, Stevens (1999). Science Teachers Attitudes About Inquiry-based Science. University of Colorado at Denver. Denver, CO. (ERIC Document Reproduction Service No. ED466350).

National Research Council. *National Science Education Standards*. Washington, DC: National Academy Press, 1996.

Owen, Siân, Dickson, Dominic, Stanisstreet, Martin and Boyes, Edward (2008). Teaching physics: Students' attitudes towards different learning activities. *Research in Science & Technological Education*, 26(2), 113-128.

Rice, Diana C. (2005). I didn't know oxygen could boil! What preservice and inservice elementary teachers' answers to 'simple' science questions reveals about their subject matter knowledge. *International Journal of Science Education*, 27(9), 1059-1082.

Ripley, Amanda (2009). Should Kids Be Bribed to Do Well in School? *Time,* April 8, 2010. Retrieved December 17, 2011 from http://www.time.com/time/magazine/article/0,9171,1978758-1,00.html.

Schwartz, Martin A. (2008). The importance of stupidity in scientific research. *Journal of Cell Science*, 121, 1771.

Trochim, William M. K. (2006). *Research Methods Knowledge Base* (Measurement). Retrieved August 1, 2010 from http://www.socialresearchmethods.net/kb/scallik.php

TV, films boldly go down scientific path - USATODAY.com. (2009). Retrieved from http://www.usatoday.com/tech/science/2009-03-25-hollywood-science_N.htm

Wilke, R. Russell and Straits, William J. (2005). Practical Advice for Teaching Inquiry-Based Science Process Skills in the Biological Science. *The American Biology Teacher*, 67(9).