PUTTING THE STUDENT IN THE CENTER:
MOTIVATING INTEREST THROUGH STUDENT RELEVANCY

Action Research Project

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

"We have not yet seen what man can make of man."
– B. F. Skinner, Beyond Freedom & Dignity

INTRODUCTION

Cognitive learning theories, no matter how perfectly realized in classroom instructional design, have been of little effect when students' interests were not addressed. Without curiosity, an impenetrable wall existed between the student and teacher that was only breached with the strictest of behavioral control paradigms. Students strove to meet minimal goals and achieved little if any self-valued learning when taught in rigidly controlled settings without proper motivation.

Students enter the classroom with a diverse set of expectancies of purpose and function for their learning that determine their performance and achievement. These beliefs are based on self-concepts related to their own abilities and the success outcomes they foresee (Bandura, 1977, p. 193). They are also determined by the amount and type of control the students feel in their own learning.

Sixteen years before publishing *Method in Science Teaching*, John Dewey discussed connecting the results of psychology to the practice of educating (1900, p. 108). He stressed that students are denied the power and control needed for true learning when the teacher chooses problems and materials, sets student goals, and gives ready-made solutions disallowing student experimentation. Thus over one hundred years ago, the value of the students' own interests and explorations was seen as essential for instruction.

Purpose of Study

Students who are unmotivated to learn tend to create the largest classroom disruptions. A teacher may *react* to these individuals with changes in behavioral strategies by increasing reinforcement of desired behavior, punishing poor behavior and, where the class as a whole is concerned, strive for tighter control through alternate classroom management strategies. However, this will fail to *respond* to the students' true cognitive requirements. At best this practice will lead to a stifling, rigid classroom devoid of intrinsic motivation.

Intrinsic motivation is described as the enjoyment of learning for its own sake in which interest is a key component. There may be emotional roots impacting intrinsic motivation that stem from early childhood experiences (Myers, 2001, p. 451). However, current models of motivation point to cognitive processes as yielding the best description. Theories on self-efficacy, control and attribution all supply significant predictions for raising intrinsic motivation in the classroom. Raising student interest by increasing the relevance students feel toward their studies is one such prediction.

Instructional material and activities that seem increasingly more familiar to students' own life experiences may generate higher perceptions of ability. Ideas students find particularly meaningful in their own lives coupled with flexible assignments may supply a greater sense of autonomy. As Dewey stated at the beginning of the last century, student control is essential for learning. The successes generated from such an environment may eventually cycle back into increased self-efficacy further generating intrinsic motivation.

A synthesis of current cognitive views on motivation into an organized methodology for the science classroom was conducted. This synthesis culminated in the construction of the *intrinsic motivational learning cycle*. Unlike many other learning cycles (see Blank, 1999, p. 488), this cycle sees learning as a function of student expectations rather than as purely cognitive operations. The intrinsic motivational learning cycle utilizes expectancies of self-efficacy and outcome as a mechanism for learning (Bandura, 1977, p. 193).

An instructional beginning must be determined for practical application of a learning cycle. In terms of a motivationally oriented cycle, the most logical beginning is to generate interest. There can be no initial successes to build efficacy, no increases in student autonomy, and no Socratic dialogue without student curiosity to initially engage in active learning.

This study was concerned with the effects of student-relevancy instructional techniques on student interest and curiosity. Students were shown how content and process knowledge related to their own lives with several different teaching methods. This was done in order to measure increases in interest. The determination of key factors for increasing curiosity was an essential step toward the development and study of the use of practical applications of psychological research on intrinsic motivation.

Rationale

As many teachers have found, many high school students have displayed apathy toward learning, especially in science classes. This lack of interest typically prevented whole classroom engagement that would allow for successful delivery of instruction. Student disengagement often further led to disruption and time loss due to increased management and evaluation of behavior.

Students that are interested in a topic will be more apt to engage in the study of that topic. Interest and enjoyment in high school math and science are more significant predictors of college performance than high school grades (Shernoff & Hoogstra, 2001, p. 76-81). Increased interest allows for the use of cognitive instructional techniques that promote learning. High student interest in a topic strengthens the student-teacher bond as perceptions of the teacher move from that of a controller to that of a helper.

In addition, the cognitive instruction may be evaluated in the absence of often-occurring disruptions. Strong student-teacher bonds and optimization of temporal resources will allow more individualized attention. Instructors may then strive to address the paramount cognitive needs of each of their students.

Disinterested students were often motivated through the use of tangible rewards and positive/negative feedback. This behaviorist approach to learning led to decreased levels of intrinsic motivation (Deci, 1971; Deci, 1972; Harackiewicz, 1979; Lepper & Greene, 1975; Schunk, 1982). External reward systems often promoted minimal achievements (CERI, 2000, p. 28), as well as assumed that students saw themselves as able to accomplish tasks that led to the rewards.

The development of methods for increasing intrinsic motivation in students has been virtually ignored. “There are so few examples of teaching aimed at promoting intrinsic motivation that most teachers and administrators understandably cannot help new teachers learn how to promote it” (Spaulding, 1992, p. 7). Motivation research did not translate into practice due to the many physical, psychological, social, educational factors involved (CERI, 2000, p. 27). This investigation addressed this deficiency by providing a concrete starting point for teachers to use to raise their students’ intrinsic motivation in science.

Statement of Problem

It was desirable to know how students' perceptions of relevance affected their interest. Students found knowledge learned in physics class to be relevant in several levels of generality: globally to science, specific to the class, or very specific to particular tasks or topics in the class. The three domain levels, *science*, *physics class* and *physics assignments*, represented the differing generality of relevance students received from instruction.

Global relevance was found when the overarching themes of science related to students' lives. For instance, a student might have believed that science was important to her future career as a physician or teacher. Another may have enjoyed other fields of science studied previously. Physics class topics not particularly relevant may have met with a larger interest in science.

Students may have found specific personal relevance to physics class itself. Such a student saw physics as more important than other scientific pursuits either due to a direct personal interest or in a more temporal interest, i.e. the current science class taken was more interesting. Such a difference in interest was certainly possible when one differentiates types of interest. Solomon Alao and John Guthrie defined two types: *personal interest* is enduring and domain specific while *situational interest* is short-lived and shared among individuals at that time (1999, p. 245). Development of situational interest was considered more feasible and personal interest more desirable. However, no attempt to differentiate between them was made during measurement.

Additionally, students might have found specific relevance to the given physics assignments in which they were engaged. This was attributed as stemming from situational interest where students found the relevance of the task, and perhaps the rewards of task completion, to have a clear impact on their lives. Examples of activities specifically relating to students' lives include a lab on making speakers (music relation) or analysis of a car engine (transport and social status relation).

Adding personal relevance to the classroom might also have generated emotional responses other than interest. Students evaluate the quality of instructional techniques differently. The potency of or impact from instruction on each student will differ. Students will also vary in how well they feel they understand a lesson. Therefore, these three other important emotional dimensions of evaluation, potency and understandability were examined in addition to interest.

In addition to measuring the emotional dimensions (evaluation, potency, understandability, and interest) across the areas of relevance (science, physics class, physics assignments), gender effects were also investigated. An important aspect of teaching with regard to students' interests required that material be made relevant for all students in the classroom. Significant differences by gender would have demonstrated a kind of inequity in the relevancy techniques that was indefensible against social criticism.

Definition of Terms

Students found a topic *generally relevant* when students connected it abstractly to their own lives in overarching and broad manners. They found a topic *specifically relevant* when they attached concrete and narrowly focused significance to a particular aspect of their lives.

A student *evaluated* an idea in terms of its quality when they felt emotionally positive or negative toward the idea. Students described an idea's *potency* as how strongly it impacted them. *Understanding* described how well a student felt they comprehend an idea.

Extrinsic motivation was behavior that was undertaken with some external reward expected for successful completion or performance. *Intrinsic motivation* was the internal drive to engage in an activity when no reward was expected. *Interest* was the amount of measurable curiosity derived from thoughts about an idea indicating cognitive pleasure due to intrinsic motivation.

REVIEW OF RELATED LITERATURE

Any model for motivating learning would be incomplete without addressing the processes that enable learning. The teacher must have in mind some ends to which they expect to direct the students' motivations whether behavioral or cognitive. Explicit or implicit, all teachers utilize their own theories of how students learn best.

Alternatively, no theory of learning should be considered complete without reviewing the differences in drives and desires that influence students' actions and reactions, thought processes, and conceptual reorganization. For instance, John Dewey would find the conceptual change model of learning (described later) incomplete for portraying students as rational, cognitive beings, which does not address the whole person (Wong, et al., 2001, p. 334). Therefore, it is essential to examine how students learn and why they choose to do so. "What researchers are beginning to recognize is that both cognitive and affective aspects of learning are present when constructing mathematical understandings . . ." (Hart & Walker, 1993, p. 23).

How Students Learn

Science education was supplied with its own model of learning when Posner, Strike, Hewson and Gertzog (1982, pp. 212-13) advanced the conceptual change model of learning. Based on their belief that learning is an intelligible and rational activity, they modeled the theory on society's historical epistemology of science and on Piagetian cognitive concepts of learning. They then added qualitative support by interviewing college physics students learning about Einstein's theory of special relativity and their instructors (pp. 216-22).

Society's scientific understanding evolves as new theories outstrip older ones. Individuals utilize prior schemas to assimilate new knowledge, or they experience cognitive dissonance when new experiences do not mesh with current understandings and so are forced to accommodate by developing new schemas (Myers, 2001, p. 127). The conceptual change model was developed to address this later process of accommodation (Posner, et al., 1982, p. 212).

There are four conditions necessary for conceptual change to occur (Posner, et al., 1982, p. 214): dissatisfaction with their present model, intelligibility and plausibility of the new model, and the new model must be perceived to be useful. The student must first find dissatisfaction with their current understanding through their inability to address anomalies that have arisen. This suggests that a teacher challenge student perceptions with anomalous data and discrepant events to create a state of cognitive conflict. For students unsure of their abilities, this process may generate a great deal of stress. It would be optimal that students be prepared slowly for such instruction so that conflicting theories do not appear as obstacles, but rather opportunities for exploration.

A new conceptual model must be intelligible to the student before they can analyze it. In traditional educational settings, this component of conceptual change may have received the largest attention as teachers have expended considerable effort to present new material with clarity and simplicity. The advents of discovery learning, learning by inquiry and constructivism techniques that consider the student as a meaning maker have de-emphasized this role. However, whatever instructional techniques are used, the teacher must be sure that students understand the conceptual model that is to be learned.

Creating conceptual models that appear believable and useful has typically been ignored. It was deemed appropriate for students to accept new ideas from teachers due to their authority status. Insofar as the focus of the course was to deliver knowledge, the least complex type of understanding (Bloom, 1953, p. 18), it was probably not efficient to "convince" the student of basic facts. As technological advancements in the world have increased the need for more complex and complete understandings, students are required to reorganize mental schemas at increasingly deeper levels. Student resistance is natural and can only be overcome by illustration of the new understanding's usefulness and convincing students that such a thing may be true.

It is not the instructor's task to habituate students to the simple acceptance of new theories in the face of information that contradicts their current understandings. This would be seen as a regressive step toward learning science on the basis of authority. It is doubtful that complex schema rearrangements could be made in this fashion regardless. Students should be taught to reflect rationally about inconsistent information (Chinn & Brewer, 1993, p. 31). This can be accomplished best by having the student actively seek out new understanding that resolves paradoxes, and to determine believability and fruitfulness with the teacher's help, but in their own terms, i.e. motivated metacognitive behavior.

In teaching for conceptual change in science, students will not arrive at a complete understanding after abandoning previous conceptions for new ones. Rather, they will move to an intermediate model that lies somewhere between their old beliefs and the desired understanding (Clement, 2000, p. 1042). This implies that for students to move from an initial scientific understanding to the desired conceptual model, they will need to undergo several cycles wherein they experience cognitive dissonance and are presented with a new intelligible, plausible and fruitful model.

It would be impossible for a teacher to design instruction that addressed both the target and intermediate conceptions for every student. Though it is common for teachers to attend to common misconceptions that are in truth shared intermediate models in a class, it is much more desirable for the students themselves to regulate this process. Such activities would require great amounts of metacognition in focusing student attention on the status of their own intermediate models.

Posner, et al. (1982, pp. 214-215) also postulated that the conceptual ecology that determines an individual's attainment of new concepts includes anomalies (that will lead to dissonance), analogies that will enable intelligibility, other knowledge, and beliefs about science and knowledge in general. These concepts exist due to a lifelong natural selection process (Hewson & Hewson, 1984, p. 5). Students will invariably have developed much different conceptual understandings based on their own unique experiences.

Differing prior knowledge is typically the largest problem facing instructors. In measuring fifth grade science students, Alao and Guthrie (1999, p. 251) found prior knowledge to develop new conceptualizations independent of interest, learning goals and strategy use. Prior knowledge allows students to find relevant information and integrate it into schemas. Less developed prior knowledge may not be as debilitating as one would expect if impetus to "catch up" were given.

Most students are typically treated as equally able by their teachers despite differences in prior knowledge. This assumption is rationalized by Piaget's notion of developmental stages; most students will have progressed at more or less the same rate based on internal developments. Though this is not true for students with special needs that have experienced significantly lower rates of conceptual development than their peers, this assumption is accepted so that generating the impetus for conceptual development is the aim of this study.

Since student beliefs about science and knowledge are an important component of their conceptual ecology, some attention has been paid to teaching about the nature of science. In the Columbus Public Schools science curriculum benchmarks, the first three of the first four benchmarks (based on state learning competencies) are 1) evaluation and revision of science models, 2) determining scientific validity of information used in making decisions, and 4) explain how a theory may have changed over time (Columbus Public Schools, 2001, p. 1). These top priorities specifically target students' general views of science showing that "it is the teacher's role to provide instruction in the epistemological nature of science discourse as well as the content of science" (Beeth, 1998a, p. 54).

When the conceptual change model was created, it was envisioned that the teacher would act as model for scientific thought demonstrating the ideal metaphysical scientific beliefs (Posner, et al., 1982, p. 226). The teacher would deliver these traits to the student by acting as a Socratic tutor, challenging attempts at assimilation to force accommodation. Being a Socratic tutor implies the asking of many questions, mostly rhetorical. The evidence for the effectiveness of instructional questioning is ambiguous.

The Taxonomy of Educational Objects (Bloom, 1953) has stimulated a great deal of research into teacher questioning at different levels of complexity. Meta-analysis has been used to show questioning at higher levels of cognitive complexity to demonstrate positive effect on achievement (Redfield & Rousseau, 1981, p. 244), small effect (Samson et al., 1987, p. 294), and no effect at all (Johnston & Haley-Oliphant, 1987, p. 30). It may be that the effects of questioning depend on the goals the teacher has in mind during questioning (Johnston & Haley-Oliphant, 1987, p. 33).

Questioning may lead to improved metacognition during conceptual change. Fifth graders achieved higher learning outcomes in a study designed to promote metacognition when students were asked to describe the intelligibility and plausibility of concepts (Beeth, 1998, p. 355). Drawing attention to pivotal steps in the learning process with well-placed questions may then lead to better self-regulation in the students.

Helping students learn how to learn may actually be the key to achieving higher levels of cognition in the classroom. Research with seventh grade science students showed that using a learning cycle that emphasizes metacognition led to more engaging and thoughtful classrooms while increasing content retention (Blank, 2000, pp. 493, 503). And when high school students used a metacognitive problem solving technique, their achievement was higher than those using a general heuristic technique and much higher than no technique at all (Oladunni, 1998, pp. 869, 872). These robust benefits were also shown to be equitable since development of metacognitive skills were not just received by students with the highest cognitive abilities (Schraw, 1998, p. 116).

The development of the conceptual change model can be seen as extending Piaget's cognitive model of human behavior to a useful learning theory model. The focus of the conceptual change model is still the individual and their environmental interactions. Albert Bandura's social learning theory, which evolved into the social cognitive theory, is extremely useful in the classroom as it describes learning in connection to other individuals.

Social cognitive theory describes changes in behavior as relying on the two processes of enactive and vicarious learning (also called modeling). Vicarious learning occurs when observers display new behavior that would not have happened without observation (Schunk, 2001, p). This process depends on the student attention to environmental events, their retention of observations and their motivation to perform modeled behavior.

Why Students Choose to Learn

It is interesting that after the acclaim of Taxonomy of Educational Objectives: The Classification of Educational Goals – Handbook I: The Cognitive Domain (Bloom, 1956), which is still influencing teacher questioning techniques today, Handbook II: The Affective Domain (Krathwohl, Bloom & Masia, 1964) was not at all a useful discourse on student interests, attitudes, appreciations, values, and emotions. This was mostly due to the behaviorist vantage taken by the authors going even so far as to describe that affect and achievement are not related (p. 7) or even inversely related (p. 20).

Behaviorists asserted that two students would learn the same amount if they listen equally well despite level of interest; that motivation had no direct effect on learning (Logan & Gordon, 1981, pp. 170-171). Motivation stemmed from learned responses to biological needs caused by expectation of reward (p. 172). This theoretical perspective translated into classroom reward systems utilizing positive and negative reinforcement. There were food, prizes, activities, and social rewards for individuals, and there were token systems, parties, group games, videos, and class trips for groups (Reynolds, Salend, & Beahan, pp. 82-84, 87).

Research into the effects of rewards on intrinsic motivation found an unanticipated result. Students who were initially interested in an activity without the expectance of any external reward who were then rewarded for their behavior showed a decrease in interest.

Four experiments in which college students were given money for completing tasks showed this effect (Deci, 1971, pp. 108-113; Deci, 1972, p. 117). Both performance and task contingent rewards were seen to reduce intrinsic motivation in high school students (Haraciewicz, 1979, pp. 1358-1361). In that study, performance rewards had greater adverse effect on interest, especially when they revealed the current quality of the student's performance. These results could not be explained through behavioral paradigms.

Three theories were very useful in investigating these results. Self-efficacy theory aided in determining how beliefs about one's abilities form. Control theory addressed views of self-determination to show what students feel they have the power to change. Attribution theory described how the results of actions are interpreted.

Determining one's ability is important since acting on misjudgments of ability generates undesirable results (Bandura, 1982, p. 123). Self-efficacy is determined by performance attainments, vicarious performance experience, verbal persuasion, and physiological states (Bandura, 1982, p. 126), though performance attainments are the most critical (p. 126). Personal success in the face of low self-efficacy will lead to its improvement (Bandura, 1977, p. 194). Therefore, generating successes leads to intrinsic motivation through self-efficacy improvement.

Students may also feel better about their own abilities when they see peers accomplish tasks. However, seeing others succeed with less effort can damage self-efficacy. Students may be persuaded that they are able to succeed, but if failure accompanies their efforts, then it is unlikely they will be so trusting in the future.

Students may doubt their abilities when they experience physiological arousal. Such arousal may accompany testing situations or unpredictable activities where students are unsure what is expected of them. Therefore, alternate assessments and detailed explanations should be ever present in the classroom to limit nervousness and fear.

Self-efficacy can be measured by its value (high or low), how generally it applies and how strongly the beliefs are held (Bandura, 1977, p. 194). The value of self-efficacy determines effort and persistence when encountering obstacles (Bandura, 1982, p. 123). Low self-efficacy leads to dwelling on coping deficiencies and viewing new situations as dangerous (Bandura, 1982, p. 137). The generality of self-efficacy may depend on prior knowledge. For instance, a high school student may say she or he is “bad at math,” while a biologist might believe they are only poor at calculus. The strength determines the length of time and amount of effort a teacher will spend to extinguish poor efficacy expectations and create positive ones.

The use of rewards should not be abandoned since they lead to improved self-efficacy, especially during activities where students are not intrinsically motivated (Bandura, 1982, p. 133). Young math students that were verbally reinforced every eight minutes with the statement that they had been working hard showed increased achievement and self-efficacy (Schunk, 1982, pp. 550-552). This has suggested a potential tradeoff between the use of extrinsic rewards and the maintenance of intrinsic motivation. Without the rewards to extrinsically motivate uninteresting activities, no self-efficacy will be created to bring about intrinsic motivation. Practice and drill are necessary for increased competency that will raise self-efficacy so making practice as interesting and engaging as possible is essential (Anderson, Reder & Simon, 2001, p. 42).

Bandura and Schunk (1981, pp. 586-587) suggest that self-efficacy be improved through the metacognitive technique of subgoaling: setting proximal goals and selfevaluating progress. Subgoal attainment indicates mastery and strengthens ability and perceptions of ability at how well a student can integrate component skills into complex actions (p. 587). Such proximal goals are more intrinsically motivating than distal goals since successes occur infrequently and are linked less solidly to effort. Belief that school is for career success degrades the intrinsic value of education Centre for Educational Research and Innovation (CERI), 2000, p. 34), and it also established long-term goals that are mostly intangible. When young mathematics students were given proximal subgoals in learning subtraction, they showed a strong increase in self-efficacy, persistence and interest (Bandura & Schunk, 1981, p. 591-593).

There are two processes in which students may control their learning, they may manipulate their environment to meet their needs or they may change their needs to suit their environment (Rothbaum, Weisz, & Snyder, 1982, p. 8). Operating on the environment is defined as primary control and changing oneself as secondary control. Additionally, there are four types of control: predictive, illusory, vicarious, and interpretive (p. 12). A student who feels they have primary control will work toward success utilizing any of the four types.

Secondary control begins when a student feels that they cannot arrange for their own success, but still seeks some measure of power over their life through the four types (Rothbaum, Weisz, & Snyder, 1982, pp. 10-12). Predicting events so as to not be disappointed shows how a student not able to manipulate her environment manipulates herself (pp. 12-16). The illusory type of control is chance-determined. A student will ascribe success or failure to luck (p. 16-20). The vicarious type of control is seen when students associate with those they see as having primary control to seek some pleasure or security from their successes (pp. 20-24). A student will seek interpretive control when they attempt to feel some sense of power by at least explaining the reasons for her or his failures (pp. 24-27).

The definition of primary control demonstrates the importance of self-efficacy since it can only exist if the student sees himself as having the ability to control his environment. Oppositely, secondary control is not desirable since it does not lead to active pursuit of success, but rather adaptation to not obtaining goals. For instance, some students may enjoy the ability to choose their own groups since aligning with more knowledgeable peers is a form of secondary control.

Self-determination is the perceived amount of primary control a student has. There are several benefits to generating self-determination in the classroom. A California high school was able to increase attendance and decrease drug use and probation by training the staff to respect and value student ideas and suggestions (Greene, 1989, p. 80). After extensive qualitative study of 11th grade biology students, it was found that despite high levels of intrinsic and extrinsic motivation, low student autonomy prevented deep involvement (Hanrahan, 1998, pp. 743, 748-749). Self-determination may also improve perceptions of ability since predictability and controllability are conducive to improving self-efficacy (Bandura, 1982, p. 126).

Most of all, primary control is associated with intrinsic motivation since the student will always tend toward their interests when given the choice. Lack of control leads students to the view learning as forced. Measuring the effect of adult surveillance and external rewards on young children revealed them to both have the same detrimental effect on interest (Lepper & Greene, 1975, p. 483). This shows that lack of control will destroy intrinsic motivation and force teachers to resort to extrinsic motivators.

Self-efficacy is essential for self-determination since students who do not perceive themselves as able to take control of their situation are very unlikely to do so (Spaulding, 1992, p. 21). Successes that increase self-efficacy also enhance students' sense of internal control if they are attributable to effort rather than ability. Development and recognition of competencies was needed to change feelings of futility when self-efficacy was poor (Bandura, 1982, p. 140).

Students' views of control can explain many types of common learning behaviors. Students perceive ability as inert and unchanging while their effort is clearly based on their own decisions. Underachievers want success but fear failure due to their ability while over strivers work hard but fear the demands of success will eventually expose their low ability causing both to lower their expectations or cheat (Stone, 1984, p. 688). Most students feel they have no control over their ability, but rather it is an inert characteristic of themselves. Therefore, it is imperative to use self-efficacy development to also demonstrate that ability can be improved or at least to link effort to success.

Female learning in science and math was undermined when issues relating to intrinsic motivation were not taken into account. Meta-analysis showed that despite equality in ability, female high school students had more negative affect and attitude toward mathematics (Hyde et al., 1990, pp. 310-312). Similarly, female high school science students had a lower self-perceived ability than male students regardless of achievement level (DeBacker & Nelson, 2000, p. 251). Verbal reinforcement was seen to affect female students adversely (Deci, 1972, p. 117) indicating that if not carefully maintained, what is said in the class may be interpreted differently between the sexes. Thus, instructional strategies were possibly a large source for gender bias in perceived efficacy and determination.

Motivation in the Standards

In examining current national standards, it is evident that student interests have been taken into account. The National Council of Teachers of Mathematics (NCTM) has made many recommendations for students to work on tasks that "[…] engage and challenge students intellectually," "pique students' curiosity and draw them into mathematics" and "may be connected to the real-world experiences of students" (NCTM, 2000, p. 18). The American Association for the Advancement of Science (AAAS) has emphasized that activities should "serve to stimulate curiosity" (AAAS, 1993, Ch. 1) and "use data that interest them …" (AAAS, 1993, Ch. 9). These standards realize the importance of relating the content to the students' interests.

The AAAS has further stated "Children are curious about things from birth. Curiosity does not have to be taught" (AAAS, 1993, Ch. 16). It described utilizing student curiosity to motivate problem solving. Unfortunately, this assumption of curiosity as a fundamental motivating factor for all students is as limited as Edward Deci's view that all intrinsic motivation is self-determination (Reiss, 1998, p. 105). There is evidence for at least 15 fundamental motivating factors ranging from social contact and honor to independence and vengeance (p. 104). The writers of the standards were wise to continue to address general student relevancy issues and allow students to establish the links to their own personal motivating factors.

The Combined Theories

The literature on motivation points to an initial synthesis for instructional application. Figure 1 provides a graphical depiction of the combined theories into an intrinsic motivation learning cycle. This learning model centers on four sequential components for an individual's successful learning: self-efficacy, self-determination, goal setting and strategy development, and successful implementation of strategies to achieve goals. The teacher must utilize specific instructional techniques at each transition between these components.

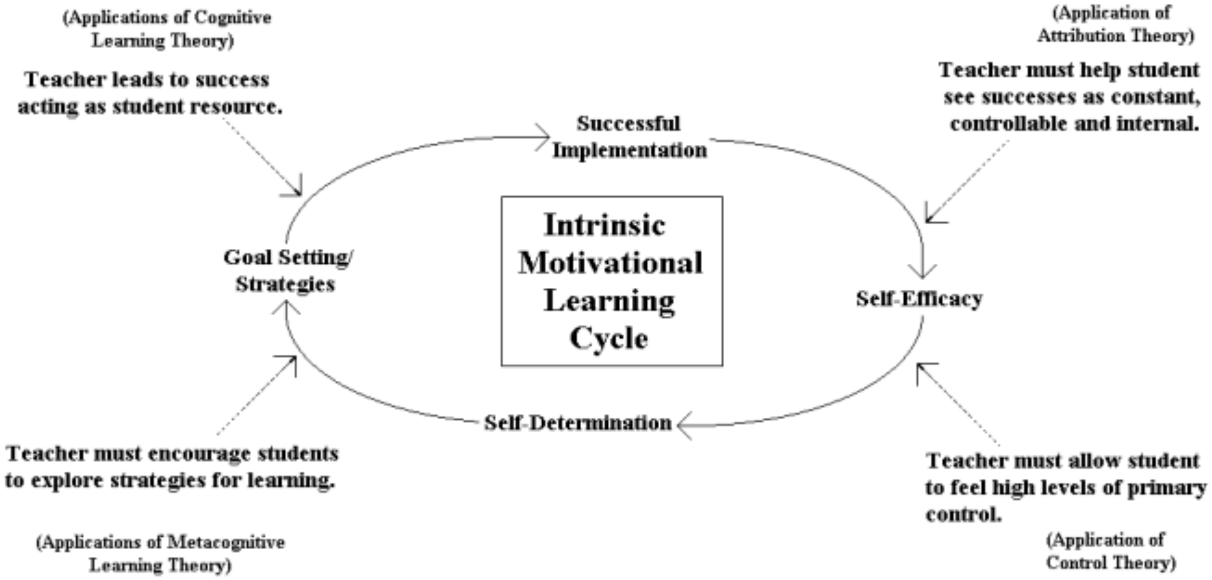

Figure 1. The instructional application of motivational and cognitive learning theory.

For students to raise their self-efficacy, they must attribute their successes to their efforts (Bandura, 1977, p. 194). Effort is a characteristic that is controllable by the individual. Success with hard work has nothing to do with luck, and students who recognize this will realize the importance of effort (Spaulding, 1992, p. 24). Effort levels may then be raised to meet more difficult challenges (Bandura, 1982, p. 123).

The teacher must make every attempt to facilitate students' attributions of success to their efforts. Assessments must focus on determination of effort and allow multiple levels of success. Feedback should center of the students' efforts rather than achievements. Time should be spent examining the learning that has occurred so that students may understand their gradual learning progress.

With the knowledge that they can succeed in place, students should then be given the autonomy to begin seeking success. This can be achieved by allowing the students to observe the curricular framework for the course and to reflect on the types of problems such a curriculum might contain. Such knowledge about the design of their class will give students predictive control and allow for them to plan a course of action (Rothbaum, Weisz & Snyder, 1982, p. 12).

A method for obtaining student input should be in place. Student input must then result in instructional changes so that true autonomy is observed. Students who lose some autonomy due to poor choices must continually be given chances to resume primary control of their learning.

The teacher next will work to enhance students' metacognitive abilities by helping the students establish goals and strategies to reach them. Students should set goals for their desired level of success in advance of working in order to determine their needed effort level. A great deal of time should then be spent classifying problems, creating example problems, developing and sharing strategies, and discussing why doing such things is important. These techniques increase and improve metacognition (Hewson, Beeth & Thorley, 1998, p. 206; Schraw, 1998, p. 193).

Lastly, the teacher will act as a resource as students go about enacting their strategies supplying the necessary elements for successful conceptual change. This stage of the learning cycle contains the usual teaching strategies such as presenting notes, giving demonstrations and answering questions in order to promote conceptual change. But these are now conducted as part of students' success strategies, often at students' requests, not always for every student, and always with reflection as to the purposes of conducting such instruction.

Curriculum content should be structured in such a connected manner that assessment should ease the transition from one topic to the beginning of the next (CERI, 2000, p. 40). This seamless instruction will allow for continued high levels of intrinsic motivation. Where high connectedness of curriculum is not possible or where intrinsic motivation is difficult to sustain, it may be necessary to extrinsically motivate students from time to time with external rewards (Bandura, 1982, p. 133). This will ensure long-term use of the intrinsic motivational cycle is possible.

External rewards should be short-lived. Children bribed into an activity will become interested if they attribute involvement to their own choices (Myers, 2001, p. 451), which they are bound to do out of habit when intrinsic motivation is the rule and extrinsic motivation the exception.

METHOD

In this study, students in two physics classes were compared after special instruction was delivered to one of the classes. This special instruction was designed to increase student curiosity and interest in nuclear physics by relating subject matter to the students' own lives. Controlled areas for instruction were activities selected, content selection and assessment methods.

Participants and Setting

This study was conducted at an urban high school that offered two sections of yearlong physics containing 45 students total. These two classes were comprised of 36 seniors, 8 juniors and 1 sophomore, and were ethnically and socioeconomically diverse. Courses were offered in four 80-minute blocks daily; the two classes studied occurred during the second and fourth blocks. The second block was chosen to be the control group and the fourth block the experimental group.

There were 24 male students and 21 female students in these classes. The second block contained 13 female and 11 male students, and the fourth block contained 8 female and 13 male students. Therefore, the percentage of female students enrolled was 16 percentage points lower in the fourth block than the second.

Data Sources

Three 5-point semantic differentials were created to evaluate students' perceptions across three relevancy domains of *science*, *physics class* and *physics assignments*. A semantic differential allows one to infer the perceptions and attitudes towards a certain subject (White, 1998, p. 2). Each domain was measured across the following four emotional dimensions: *evaluation*, *potency*, *understanding*, and *interest*. Each concept domain had 12 bipolar word pairs divided evenly between the four emotional dimensions. Each word pair was scored from 1 through 5, indicating the level of endorsement of each emotional dimension (see Appendix A for each scoring guide). The semantic differentials were filled out after the experimental instruction was given to the fourth period.

Procedure

For five consecutive school days, students in fourth period physics block received additional instruction about nuclear physics. This additional instruction lasted approximately 30 minutes each day. This instruction always took place during the last 30 minutes of class time leaving the first 50 minutes for usual instruction.

The availability of such time in the fourth block class was due to several causes. Instructor improvement from one class to the subsequent class typically saved 10 minutes (13% of class time). As the end of the school year approached, time at the end of instruction to begin homework increased. The fourth block class was most often demonstrated less persistence in homework tasks due to the time of day. Lastly, during the study, temperatures were unusually high, more so for fourth block in the late afternoon. This tended to settle the students allowing for better utilization of instructional time.

The first day of instruction focused on the true story of Michigan high school student David Hahn who created a miniature, working model of a nuclear breeder reactor in his mom’s shed. As he worked fast food to finance his research, he fell behind in school doing poorly in math and reading. In the end, David enlisted in the navy while his mom’s shed was taken away to nuclear waste storage. This was selected since the use of personal anecdotes has been shown to increase interest in content reading (Mathison, 1989, p. 78).

Students read passages and shared comments for about 15 minutes. They were then asked to construct a diagram or flowchart showing the series of substances David used to arrive at his working reactor. This assignment took the remainder of the class. This lesson focused on reading comprehension skills and presented some content knowledge, but the purpose was to demonstrate how nuclear physics might exist in the life of any person so inclined.

The second day of instruction utilized the results from actual radon test measurements. Explanatory content about types of decay and the radon decay path were provided with the data, and students investigated the health risks of radon due to multiple decays. The assignment was a worksheet with interesting facts and questions. This lesson sought to connect complex content information to the life of the teacher whose radon data was used.

The third and fourth day involved open laboratory work using Geiger counters and radioactive samples. Students also measured radioactivity in various types of rock. The open-ended assignment was to write small lab reports describing the uses of the Geiger counter rationalized by their experimentation. This lesson was designed to give students the feeling of being a technician and to enable them to witness radioactive decay in their hands rather than their minds.

On the final day, students were presented information about beneficial uses of radiation in cancer treatment, radiotherapy. Some historical perspective was given with discussion about Marie and Pierre Curie and the medicinal use of radium soon after its discovery. The assignment this day was to write a one-page reflection about medicinal radiation therapy. This purpose of this lesson was to dispel unnecessary fears of radiation and promote historical interest by describing the lives of Curies.

Data from the semantic differentials was collected at the end of each class on the final day of the special instruction. Students who were absent on the day of collection were measured the next school day at the beginning of class.

Data Analysis

Posttest measurements were taken to compare differences between the control and experimental sections. Student responses were scored on a 5-point scale with 5 representing the most emotional response. Data were then coded into the Statistical Package for the Social Sciences (SPSS) for Windows – Release 10.0.5: Standard Version. Evaluation involved usual descriptive statistics, two-tailed t-tests (α = 5%) for significance, and Pearson correlation statistics for interaction measurements.

RESULTS

This differential survey measured three relevancy domains across 4 emotional dimensions. This produced 12 unique domain-dimension subscales. Internal consistency was found to be a problem with so few items for so many subscales. Cronbach's alpha was calculated to measure reliability in Table 1. Results showed that only one subscale met the criteria for internal consistency: science-potency. Another subscale, physics assignments-evaluation, showed acceptable internal consistency for exploratory research.

Table 1
Cronbach's Alpha for Internal Consistency of Subscales

	Dimension				**Combined**
	Evaluation	Potency	Understand	Interest	**Dimensions**
Domain					
Science	0.55	0.71**	-1.52	0.49	0.69*
Physics Class	0.52	0.55	0.39	-0.04	0.38
Physics Assignments	0.69*	-0.03	0.46	0.32	0.55
Combined Domains	0.78**	0.72**	0.53	0.37	0.83***

* $\alpha>0.6$, ** $\alpha>0.7$, *** single scale reliability

What was being measured becomes questionable with such low reliability. All subscales were combined into a single measurement instrument of emotional response to all relevancy domains. This yielded a reliable scale with $\alpha = 0.83$. Similar logical aggregations of subscales often showed internal consistency. Reliability results of this are shown in the last row and last column of Table 1. Therefore, the specificity of the conclusions drawn from data could be traded for more valid but less specific conclusions.

Adequate internal consistency was found when measuring the combined emotional impact in the domain of science (α=0.69). Reliability was also found when the emotions of evaluation (α=0.78) and potency (α=0.72) were each measured over all domains combined.

Aggregated data for the control and experimental classes is provided in Table 2. Data showed only minor differences from the neutral response value of 3.00 in each of the domains and dimensions. There were very significant deviations in the science domain and potency dimension. This suggested that the a student selected from these classes was most likely to feel somewhat more strongly about the domains and to have positive emotions toward science. There was also a significant positive difference in the evaluation dimension indicating that the average student felt that the domains are more good than bad.

Table 2
One-Sample t-Test of Various Means at 95% Confidence Interval with Test Value of 3

	Mean (N=34)	**Significance**
Domain		
Science	3.34	0.000**
Physics Class	3.10	0.103
Physics Assignments	2.99	0.861
Dimension		
Evaluation	3.24	0.041*
Potency	3.49	0.000**
Understandability	2.94	0.457
Interest	3.03	0.651

* $p<0.05$, ** $p<0.001$

Data grouped by class (Table 3) demonstrated no significant difference in any of the dimensions. But students in the experimental group exhibited significantly more favorable emotions in the physics assignments domain. This revealed that the activities students performed in the experimental group caused perceptions of homework and activities in the class to be higher than their peers in the control group. Figure 2 graphically shows the class differences across the relevancy domains in which the experimental group shows more favorable emotion toward physics assignments than the control group.

Table 3

Independent Sample t-Test of Various Means at 95% Confidence Interval by Class

	Control (N=18)	**Experimental (N=16)**	**Difference**	**Significance**
Domain				
Science	3.29	3.40	-0.11	0.485
Physics Class	3.09	3.10	-0.01	0.890
Physics Assignments	2.84	3.15	-0.31	0.036**
Dimension				
Evaluation	3.16	3.33	-0.17	0.464
Potency	3.44	3.54	-0.10	0.530
Understandability	3.00	2.88	0.12	0.433
Interest	2.91	3.17	-0.26	0.063*

* $p<0.1$, ** $p<0.05$

Table 3 also showed a nearly significant positive experimental effect on student interest. This trend indicated that the primary aim of the study was accomplished: instructional techniques to generate interest were developed.

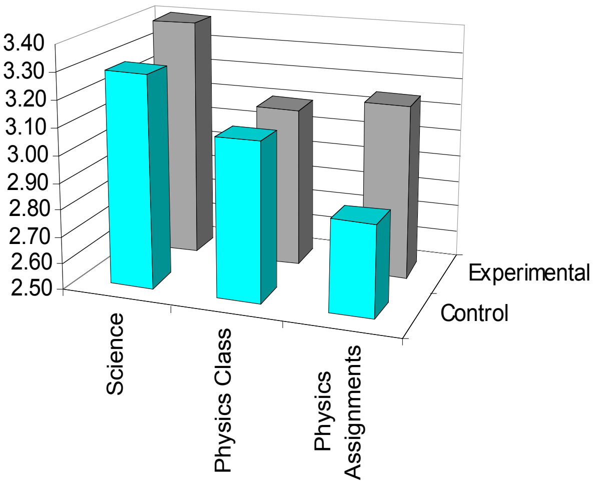

Figure 2. Domain Means by Class

Pearson correlations were computed in Table 4 in order to determine interest interactions with each of the relevancy domains. While the control group demonstrated a significant interest interaction with the science domain (r=0.669), the experimental group showed interest interactions with the other two domains, physics class (r=0.632) and physics assignments (r=0.668). These later correlations showed that the experimental instructional activities generated interest in a specifically relevant manner; students found the class and activities more relevant and thus interest in them increased.

The experimental instruction did not cause interest enhancement by relating to students in a more general manner. In fact, the results of the control group indicated that by making physics specifically more interesting, correlations between interest and science in general were undermined. No explanation for this effect is provided.

Table 4
Effects on Interest: Pearson Correlation to Interest Dimension

	Control (N=18)	**Experimental (N=16)**
	Correlation (Significance)	**Correlation (Significance)**
Domain		
Science	0.669 (0.002*)	0.279 (0.295)
Physics Class	0.400 (0.100)	0.632 (0.009*)
Physics Assignments	0.400 (0.100)	0.668 (0.005*)

* p<0.01

The results in Table 3 also showed a significant difference between the two classes in emotion toward physics assignments. This stimulated a secondary analysis that is tabularized in Table 5. Here it was seen that for students in the experimental section there was a very strong correlation between physics assignments and the other two domains. Meanwhile, there was no such correlation in the control group.

This unanticipated domain interaction demonstrated that students who enjoyed the experimental activities also enjoyed the class and felt positively about science in general. The control group did not experience this domain interaction since they did not participate in the experimental activities. This indicates that the instructional technique developed created interest in science and physics class by providing enjoyable assignments.

Table 5
Domain Interaction: Pearson Correlation to Physics Assignment Domain

	Control (N=18)	**Experimental (N=16)**
	Correlation (Significance)	**Correlation (Significance)**
Domain		
Science	0.121 (0.631)	0.670 (0.005*)
Physics Class	0.174 (0.489)	0.733 (0.001*)

* $p<0.01$

Figures 3 through 6 graphically represent the relationship between physics assignments and the other domains, science and physics class. For each class, a least squares regression line is provided to depict correlation between domains. These figures make clear the greater correlation in the experimental section between the physics assignment domain and the other two domains.

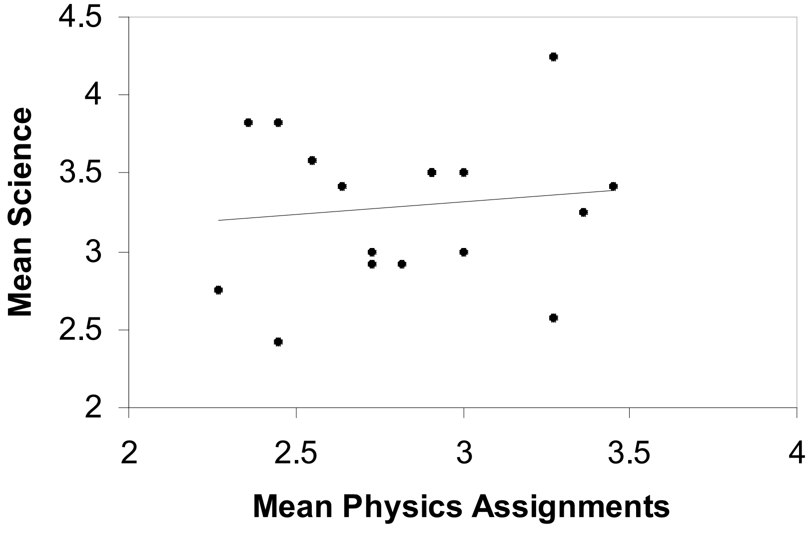

Figure 3. Control Group Domain Correlation with Linear Regression: Science and Physics Assignments

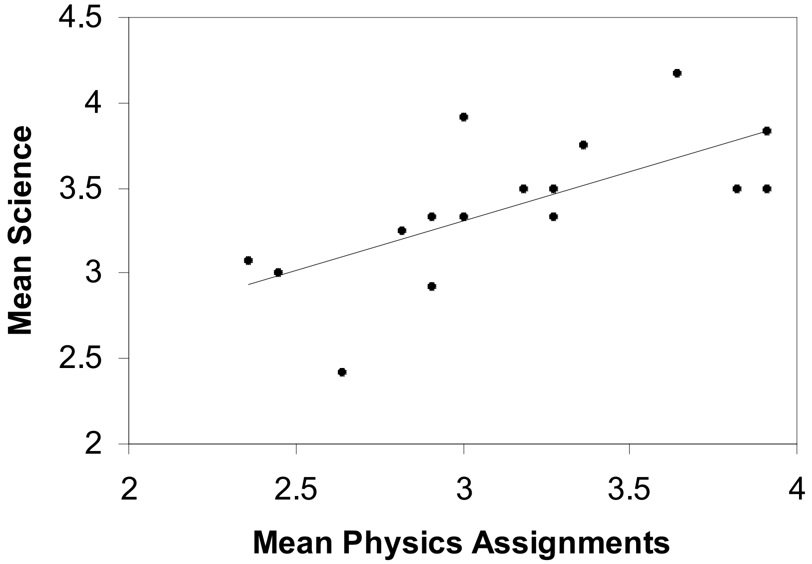

Figure 4. Experimental Group Domain Correlation with Linear Regression: Science and Physics Assignments

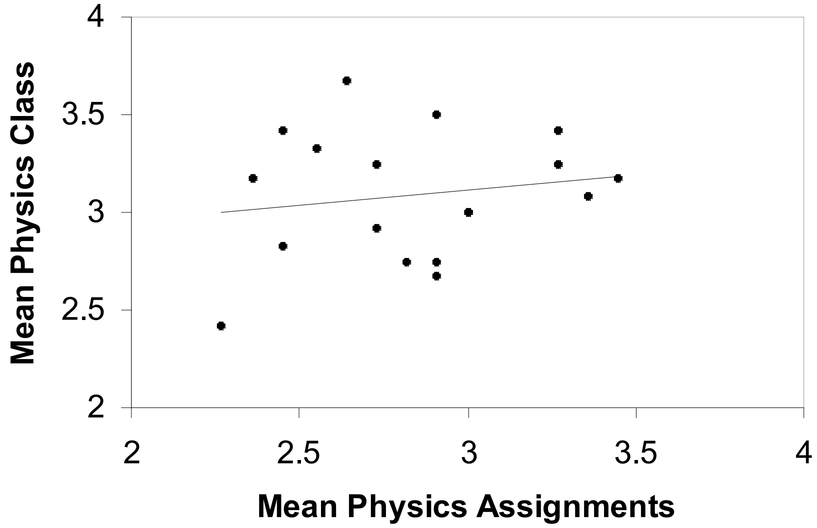

Figure 5. Control Group Domain Correlation with Linear Regression: Physics Class and Physics Assignments

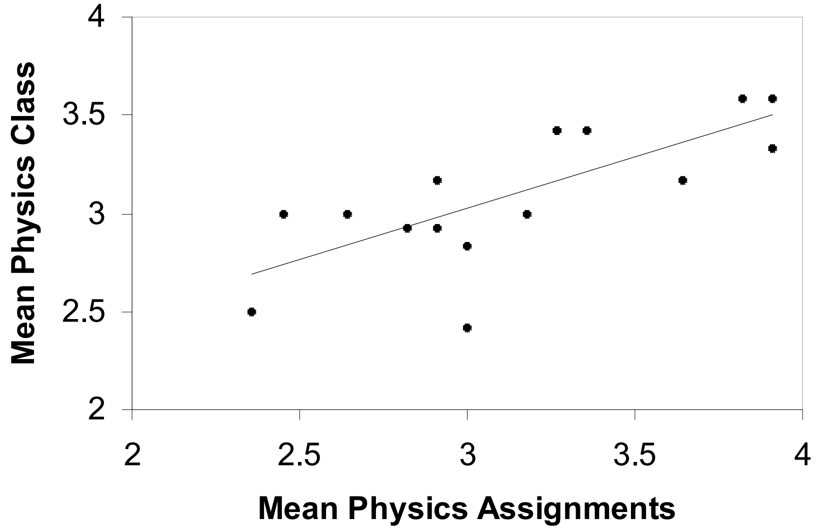

Figure 6. Experimental Group Domain Correlation with Linear Regression: Physics Class and Physics Assignments

No significant gender effects were measured (Table 6). Additional calculations were made to examine gender differences within each class (not shown). Neither class exhibited any significant gender effects.

Table 6
Independent Sample t-Test of Various Means at 95% Confidence Interval by Gender

	Female (N=17)	**Male (N=17)**	**Difference**	**Significance**
Domain				
Science	3.34	3.33	0.01	0.950
Physics Class	3.01	3.18	-0.17	0.159
Physics Assignments	2.93	3.05	-0.12	0.427
Dimension				
Evaluation	3.18	3.30	-0.12	0.587
Potency	3.46	3.52	-0.06	0.735
Understandability	3.00	2.89	0.11	0.460
Interest	2.92	3.14	-0.22	0.123

CONCLUSION

Instructional strategies that link content knowledge to relevant topics in the lives of students were seen to increase interest. This study was limited by many factors including low instrument reliability, small sample size and nonrandom selection. Future research will overcome these limitations with more students and instrument items. Despite these limitations, this study strongly suggests using instruction that focuses on linking the content to the student's own life, and giving assignments that are novel and allow for students to make choices.

Conclusions and Discussion

The results indicate that the methods developed here for teaching for relevancy most likely increase student interest in the specific subject domain. They also show how positive feelings toward assignments transfers to the specific class and generally to the field of science. This method appears not to generate any gender differences.

The content material about nuclear science in this experiment was abstract and in many ways unconnected to previous course material. Yet by making student relevancy the center of the instructional focus, student interest increased. This increase in interest represents a positive change in students' intrinsic motivation.

The proposed mechanisms for raised intrinsic motivation from this relevancy technique are its desirable impact on perceptions of self-efficacy and self-determination. Self-efficacy may have been improved by allowing for self-efficacy transfer from other relevant domains as postulated by Bandura (1977, p. 195). Using relevancy as such might also have created a less threatening learning environment thereby lowering student physiological arousal. This disallows student reaction to seeming distress in the body that lowers self-efficacy.

Finally and most importantly, assignments that generated student successes and limited the perceived potential for failure strengthened students' beliefs about their ability to succeed. Student self-efficacy increased with raised expectancy of successful performance on assignments. It should also be noted that students were sometimes reminded of their ability to succeed by their teacher or peers. Since this verbal persuasion was presumably infrequent and not measured in the study, this may or may not have contributed to raised self-efficacy.

The nature of the assignments themselves raised student interest in the class and science itself. Assignments that allowed students to make meaningful choices coupled with positive self-efficacy probably increased perceived self-determination. Such choices move students away from secondary control coping mechanisms to a role of primary control (Rothbaum, Weisz & Snyder, 1982, pp. 6-7).

There are no perceivable gender bias effects from the use of student relevancy instructional techniques. Specific techniques that relate content material to the students' lives does interest male and female students alike. Gender neutrality is of paramount importance for maintaining classroom and later on societal equity.

Assumptions and Limitations

Some of the instrument subscales lack reliability. This inconsistency disallowed more detailed analysis of experimental effects. During the final month of school, classroom absenteeism for the second block averaged 21.4% while fourth block averaged 25.4%, each with a 0.20 standard deviation (demonstrating wide attendance variations). During the 5 days of the study, the second block absenteeism dropped to 10.0% and was stable with 0.07 standard deviation while the fourth block continued to be high at 23.8% with large swings measured (standard deviation 0.24).

It may be that the absence of a higher percentage of students with low interest from the fourth block led to the witnessed increase of interest. Or perhaps more low interest students present in the second block led to the results. The impact of attendance on the results is impossible to state without a detailed analysis of each students daily attendance record.

However, the stable and high rate of attendance of the control group (second block) should improve the value of their contribution to the results. Meanwhile, the volatile and lower rate of attendance of the experimental group (fourth block) should have actually masked the study effects. Therefore, it is more likely that the absenteeism rates experienced during the study weakened the experimental results rather than caused them.

Students in the second block consistently scored higher on exams and achieved higher grades during the second, third and fourth quarter. However, the opposite occurred during the first quarter. Therefore, it may be that the classes were of equal ability, but that there were significant time of day effects for students in the fourth (and last) block of the school day as the school year progressed.

The end of the school year is a busy and distracting time. The effects on student morale will vary from student to student. Since the severity of this effect for each student is very likely to be randomly distributed between the two classes, this is *not* considered a limiting factor in the study. However, this effect impacted each class differently since external disruptions such as assemblies were at hand. The one week length of this study may not sufficiently average out such effects.

The strength of the results may have been greatly improved if a pre-test measurement had been given. This would have allowed for comparison of averaged amounts of change between the two classes rather than averaged values. This does not mean that the current findings are less reliable (absent concerns random assignment), but that more findings may have been determined from the use of a pretest. Therefore, the scope of the study was limited by the absence of a pretest.

Many of the students scheduled for AP courses that were offered only once at specific times of the day. Therefore, students' schedules were likely to be greatly influenced by their course of study. This indicates that students were not randomly selected between the second and fourth block physics classes. This is a large limiting factor in this study, especially with the absence of a pretest.

A common occurrence in action research is that no control group may be established. Results from such studies are suspect since it is difficult to determine the true cause of effects in the presence of innumerable variables. The presence of a control group in this study strengthens the conclusions drawn.

One fourth of the students were underclassmen. It is assumed that students close in age and ability respond to instruction the same. Therefore, no attempt was made to examine the effects of class rank or student age on the study.

In the second block of 24 students, 19 were present or chose to respond with one incorrectly completed survey. There were 16 correctly completed surveys from the 21 students in the fourth block. Therefore, three quarters of the students in each class were measured. This limits the reliability of the results since it is unknown whether respondents were randomly selected from each group.

Implications for Classroom Practice

The classroom has always been a center for learning. In the recent past, there has been an additional emphasis on learning to learn through metacognitive reflection. It is now evident that emphasis be placed on the desire to learn itself. This study promotes doing this by relating the content to the student's lives and natural interests as much as possible. The results show that such a strategy can increase interest, a basic component of intrinsic motivation.

Furthermore, it is highly recommended to find assignments that give the student high levels of autonomy, the ability to make important decisions. By doing this and making assignments that are creative and require reflection, students' perceptions of their class will improve.

One problem with the specific methodology developed here is that it assumes the teacher knows what relations exist between the student and content, and that all students have mostly the same relations to the content. It may be most beneficial to allow the student to generate her or his own relevancy, perhaps by directed journaling or in small group brainstorming sessions. By putting the onus for relating content on the student, not only is natural learning described by John Dewey more closely approximated, but also the student develops an important metacognitive skill. Metacognition about self-relevancy will create a sense of self-determinism in the student as they seek their own place in the curriculum.

Recommendations for Future Research

Since this research was explanatory, the measure was divided into 12 subscales. Internal consistency could not be achieved with so few items and respondents. It would be best to next focus on interest emotional dimension with only one or two domains. This would allow for greater internal consistency without increasing the number of items, causing an undesirable time expenditure in the classroom.

Attendance difficulties could be overcome by performing research with larger numbers of students or several by conducting the same research many times during the school year. This would also average out any time of year effects.

Lastly, it is essential that future research extend the study to measure the effectiveness of the proposed intrinsic motivational learning cycle. That is, measures will need to be established that record the increase in achievement, self-efficacy, self-determination, metacognitive skills, and outcome expectancies. Such measures may be developed for the classroom ad hoc and refined over several trials. Once measures are created, studies may be conducted to evaluate the new instructional methods for motivation.

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APPENDIX A: SEMANTIC DIFFERENTIAL WITH SCORING KEY

SCIENCE

helpful ___5___ : ___4___ : ___3___ : ___2___ : ___1___ detrimental
(Evaluation)

deep ___5___ : ___4___ : ___3___ : ___2___ : ___1___ shallow
(Potency)

pleasant ___5___ : ___4___ : ___3___ : ___2___ : ___1___ painful
(Interest)

complicated ___1___ : ___2___ : ___3___ : ___4___ : ___5___ simple
(Understandability)

heavy ___5___ : ___4___ : ___3___ : ___2___ : ___1___ light
(Potency)

boring ___1___ : ___2___ : ___3___ : ___4___ : ___5___ exciting
(Interest)

harmful ___1___ : ___2___ : ___3___ : ___4___ : ___5___ beneficial
(Evaluation)

surprising ___1___ : ___2___ : ___3___ : ___4___ : ___5___ predictable
(Understandability)

logical ___5___ : ___4___ : ___3___ : ___2___ : ___1___ irrational
(Understandability)

bright ___5___ : ___4___ : ___3___ : ___2___ : ___1___ dark
(Evaluation)

small ___1___ : ___2___ : ___3___ : ___4___ : ___5___ large
(Potency)

closed ___1___ : ___2___ : ___3___ : ___4___ : ___5___ open
(Interest)

PHYSICS CLASS

mysterious___1___ : ___2___ : ___3___ : ___4___ : ___5___ understandable
(Understandability)

strong ___5___ : ___4___ : ___3___ : ___2___ : ___1___ weak
(Potency)

tool ___1___ : ___2___ : ___3___ : ___4___ : ___5___ toy
(Interest)

miserable ___1___ : ___2___ : ___3___ : ___4___ : ___5___ pleasant
(Evaluation)

dirty ___1___ : ___2___ : ___3___ : ___4___ : ___5___ clean
(Evaluation)

explored ___5___ : ___4___ : ___3___ : ___2___ : ___1___ unknown
(Understandability)

jump in ___5___ : ___4___ : ___3___ : ___2___ : ___1___ hold back
(Interest)

soft ___1___ : ___2___ : ___3___ : ___4___ : ___5___ hard
(Potency)

connected ___5___ : ___4___ : ___3___ : ___2___ : ___1___ scattered
(Understandability)

tasty ___5___ : ___4___ : ___3___ : ___2___ : ___1___ distasteful
(Evaluation)

hot ___5___ : ___4___ : ___3___ : ___2___ : ___1___ cold
(Interest)

gigantic ___5___ : ___4___ : ___3___ : ___2___ : ___1___ tiny
(Potency)

PHYSICS ASSIGNMENTS

delicate ___1___ : ___2___ : ___3___ : ___4___ : ___5___ rugged
(Potency)

factual ___1___ : ___2___ : ___3___ : ___4___ : ___5___ curious
(Interest)

valuable ___5___ : ___4___ : ___3___ : ___2___ : ___1___ worthless
(Interest)

wild ___1___ : ___2___ : ___3___ : ___4___ : ___5___ tame
(Understandability)

bad ___1___ : ___2___ : ___3___ : ___4___ : ___5___ good
(Evaluation)

scared ___1___ : ___2___ : ___3___ : ___4___ : ___5___ brave
(Potency)

organized ___5___ : ___4___ : ___3___ : ___2___ : ___1___ messy
(Understandability)

valuable ___5___ : ___4___ : ___3___ : ___2___ : ___1___ worthless
(Evaluation)

loud ___5___ : ___4___ : ___3___ : ___2___ : ___1___ quiet
(Potency)

cruel ___1___ : ___2___ : ___3___ : ___4___ : ___5___ kind
(Evaluation)

familiar ___5___ : ___4___ : ___3___ : ___2___ : ___1___ strange
(Understandability)

sharp ___5___ : ___4___ : ___3___ : ___2___ : ___1___ dull
(Interest)

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