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Science and Substance Abuse Education: A Needs Assessment for Curriculum Design

Executive Summary

This report summarizes the development, implementation, and results of a needs assessment designed to guide the creation of an innovative addiction science curriculum for middle school students. Research consistently reveals that neither science education nor substance abuse education for the prevention of addictive behaviors is working very effectively. Young people are finding it difficult to understand how the study of science has meaning for their lives. A random sample of 1549 middle school students from the Merrimack Valley Region of Massachusetts were selected as respondents for this needs assessment survey. The results provide evidence that supports the need for a new addiction science curriculum. These results also will guide the development and implementation of this new educational program.

The results of this research reveal that the majority of middle school students have a strong interest in the area of addictions and report that science is one of their favorite classes. Having hands-on science experience increased students' interest in science. In addition, this study found that students from earlier grades had more favorable views of science education than students in later grades. Students reported that they, their friends, and their families were more interested in alcohol & drug education than science; however, they also thought their science teachers were more interesting than their drug & alcohol education teachers. Finally, they thought science teachers were more interested in science than drug & alcohol education teachers were in drug & alcohol education. Science advocates' and science impartials' levels of interest in the study of addictions were more similar than their interest levels in any other area of science education. An unexpected but encouraging finding of this study was that females' science interest did not differ significantly from males'. In addition, female students displayed significantly more interest in learning about alcohol & drugs than did their male counterparts.

Integrating the area of addictions into the science class should prove educationally beneficial. Through hands-on experience, both at school and at home, students' interest in science will increase. In addition, students will improve their ability to apply the scientific method to the problems associated with daily living. Furthermore, science advocacy correlated positively with an increased perception of danger associated with addictive behaviors, and perceived danger was associated with diminished levels of substance abuse. This curriculum, when implemented by trained personnel, should prevent or delay students' use of dependence-

producing substances. This report suggests that by integrating science and addiction studies, drug and alcohol-related problems among young people will decrease as students' interest and understanding of science increases.

Science and Substance Abuse Education: A Needs Assessment for Curriculum Design

"The whole of science is nothing more than a refinement of everyday thinking."
Albert Einstein, *Out of My Later Years*, 1950

Introduction

One of the goals of the Harvard Billerica Addiction Science Education Project (Harvard BASE project)[1] is to invigorate science education at the middle school level by developing state-of-the-art curricula that teach students about the addictions within the context of the scientific method. To reach this objective, we undertook a comprehensive needs assessment of science education issues relevant to middle school students. This document summarizes the extant research on science and substance abuse education, methods of juxtaposing these conceptual areas to improve both areas of study, the results of this needs assessment survey, and, finally, the implications of our findings for new curriculum development.

Needs Assessment for Curriculum Design. Unlike traditional epidemiological needs assessment projects, where researchers attempt to identify the prevalence of a target variable, this project identified and measured target variables that we will be able to respond to through the development of an integrated addiction science curriculum and an associated addiction science corps. In addition, while traditional needs assessment projects identify "needs" that will be reduced by some organized response, this needs assessment project identified needs that can be either increased or decreased. More specifically, this needs assessment project focused primarily on information pertaining to *unmet* need (i.e., science or substance abuse education interests that are not satisfied by the currently available science curriculum) and *demand* (i.e., interest) for science and substance abuse education. Both need and demand are complex concepts when applied to science and substance abuse education; in this circumstance, demand typically is imposed extrinsically by the educational system within which children are educated.[2]

In this project, we operationally defined science education need as the opportunity to increase demand (as defined above). "If we expect students to develop intellectual skills associated with problem solving and decision making, we must give them the opportunities to learn these skills in terms of actual problems and issues" (Hurd, 1984, p. 14). Therefore, met

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[1]The Harvard BASE Project is an outgrowth of an ongoing partnership between the town of Billerica, Massachusetts and Harvard Medical School's Division on Addictions. The partnership began in 1992 and is designed to develop model programs that focus on some aspect of addictive behavior into the 21st century. Currently, this project is supported by funding from the National Institute on Drug Abuse and the Massachusetts Council on Compulsive Gambling.

[2]This position does not ignore, however, that some children intrinsically demand science education.

need for science education is best conceptualized as the science education experiences that result from student opportunities to participate in (1) a regular school science curriculum and (2) extra-curricular science education experiences. Absent these opportunities, there is a need for science education reform and the allocation of additional resources (e.g., new curricula, teacher training, family education). The unusual and innovative aspect of this project is that the development and implementation of a middle school curriculum will attempt to *increase demand* and *decrease unmet need*.

Both met and unmet science education need are constructs that educational program developers often assume are present among students at various levels. However, these program developers have paid little if any attention to the student's experience of science education. Currently, science students are relatively ineffective at solving real world problems. If we want students to solve problems, we must give them problems to solve. To illustrate, Yager and Lutz (1994) report that students who perform well academically often cannot apply scientific problem solving skills outside the classroom. Yager and Lutz also report that students stop studying science as soon as it is no longer required and perceive science as unrelated to their daily lives and potential careers. These findings imply that if the goal of science education is to impact contemporary American life, current science teaching strategies leave much to be desired. This conclusion is not new. For example, Matthews (1994) and Raizen (1991) reviewed the history of science education and traced repeated efforts to reform science teaching. The first reform movements began during the eighteenth century. Given the demands on young people to understand and apply constantly evolving technology (e.g., Raizen, 1991) and critical thinking to contemporary problems (e.g., risk taking, substance use), new strategies are necessary to enhance science education and diminish the problems associated with teaching science.

The goal of this needs assessment study is to generate knowledge that will guide the development of new curricula for science education. For example, this needs assessment provides estimates of how many students are interested in specific areas of science and substance abuse education and would make use of these areas if they were available, but currently are not getting them. In this project, we also are interested in identifying current and potential obstacles to science and substance abuse education. By identifying these material, social and psychological obstacles to learning, we can design curricula that minimize or remove these impediments to science education. The result of these efforts will be a more relevant curriculum that better equips students to enjoy and apply science to the problems inherent in contemporary society (Hurd, 1993). In addition, these results will help teachers more effectively apply science education resources to reach the student population.

Science and Substance Abuse Education: Juxtaposing New Ideas. Research consistently reveals that neither science education nor substance abuse education for the

prevention of addictive behaviors is working very effectively (Botvin and Botvin, 1992; Hurd, 1994). Young people are finding it difficult to understand how the study of science has meaning for their lives. Hurd (1984) concluded that "The most compelling argument for reforming science education is that science teaching is currently not responding to the intellectual and knowledge demands of a science/technology oriented society. The proposed agenda for reforming science education would bring it into harmony with the way science and technology relate to human affairs, social progress, and the wider culture" (p. 3). The research literature also reminds us that substance abuse is often considered the number one domestic problem in the U.S. (e.g., Botvin and Botvin, 1992).

Children, as well as the rest of us, need to understand the potential relevance of new concepts, theories, ideas and facts if learning is to be expeditious and enduring. It takes an exceptional person to see the importance of -- or to derive meaning from -- concepts presented in a manner that has little subjective impact. Ideas, thoughts, concepts, theories and hypotheses have impact when we can (1) apply them to our daily lives or (2) recognize that these notions have potential relevance to our future. According to Hurd (1984), for students to hone the intellectual and practical skills associated with daily problem solving and decision making, they must have the opportunities to develop these skills by practicing problem solving with issues relevant to their contemporary experience. This process will require students to become aware of how technological advances and science interact with their culture. Students need to study scientific and technological advances within the context of relevant historical moments. For example, within contemporary American society, the use of intoxicants is recognized widely as one of the most dominant cultural issues; this area of inquiry holds significant potential for increasing the relevance of science education, since young people evidence a natural curiosity about consciousness-shifting experiences (e.g., Weil, 1972).

Intoxicant use has immediate impact on both individual users and reference groups that surround them. Psychoactive substances elicit immediate subjective feedback that influences experience directly: for some this translates to shifts in consciousness (e.g., "the buzz"). As a nation, the populace uses psychoactive substances to recreate, stimulate, escape, or erase experiences. It is difficult to grow emotionally and intellectually at a "normal" pace when energies are spent avoiding or erasing the experiences that drive human development. Learning, growing, and working toward achieving our fundamental human potential can be -- and perhaps should be -- exciting. Students need to be stimulated at least as much in the classroom as they are "turned on" in the street.

We believe that an integrated science and substance abuse education curriculum will stimulate and excite students more than the current modes of science education. Within this type of science education, students will experience science as more personally relevant to their daily

lives than they do currently. Integration of these two content areas into one curriculum also can enhance a teacher's ability to instruct within both areas: as a result of this integration, (1) substance abuse education gains relevance and enhanced exposure by being incorporated into a core curriculum of required student study rather than merely being a time-limited add-on or elective health course; and (2) science education gains enhanced relevance and clarification through the illustrative impact of addiction-related experiments and applications of content concepts. For example, case studies and hands-on participation are key elements of substance abuse education; these activities can be used easily to clarify abstract concepts encountered in the life and physical sciences. Science, as a human activity, can benefit from bridges to subject areas that examine the human condition.

Through the process of problem solving and the experience of achievement, children and adolescents grow into mature, competent adults. Successful problem solving provides one path to enhanced self esteem (Herdman, 1994). By attaining knowledge and applying that knowledge, children become empowered. By handling responsibility successfully, children attain freedom (Herdman, 1994). However, currently "...aversion to science is not merely socially acceptable among high school students, it is positively hip" ("Teaching Real Science," 1992, p. 100). New educational initiatives must shift the interests and attitudes of students if science, math and other intellectual endeavors are to compete with the range of alternatives that currently are more chic (e.g., Herdman, 1994). If science education is to improve, it is not sufficient simply to spend more time studying a specific subject area (e.g. physics, chemistry, or biology), add reading or facts to be covered in a curriculum, improve the administration or teaching of science, or provide more laboratory or computer resources. The social context of learning science must change (Hurd, 1984); social values must shift so that study and hard work are valued anew. Maya Angelou reminds us that work is "Something made greater by ourselves and in turn that makes us greater" (1977). Education, like work, is something we make meaningful that in turn makes us greater.

Current Science and Substance Abuse Education

Both science and substance abuse education are in crisis; both activities require change to be successful.[3] The process of science education reform is not merely a process of choosing between one of the national curricula, developing the most interesting curricula, or offering the most "hands-on" experiences. The reform process requires reformers to regard science teaching anew. These efforts require change in the way students are being taught and in the way teachers are being taught to teach.

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[3]A review of this national crisis is beyond the scope of this paper. Information on the history of science education reform can be obtained upon request from the authors.

Integrating Substance Abuse Prevention with Science Curricula: A Promising New Strategy for Drug and Alcohol Prevention

"We must never forget that schools are in the education business" (Gonet, 1994, p. 99). The Harvard Billerica Addiction Science Education Project (Harvard BASE Project) has as its mission the simultaneous goals of increasing student interest in the sciences and decreasing student interest in abusing psychoactive substances. These goals are not independent of each other. Indeed, if either goal is accomplished, the result will have a positive effect on other areas in the student's life, since it appears that the current state of school-based drug prevention education is somewhat analogous to the condition of science education. Both types of education suffer from (1) lack of teacher preparation and knowledge; (2) a constant influx of new technologies and societal responses to be ingested; (3) reform movements that have been launched in response to crises rather than designed through careful methodology; and (4) inattention to paradigm shifts in how students should be taught in order to master the flood of information surrounding them -- information that will certainly affect career decisions and opportunities, if not behaviors that could lead to life or death circumstances. It is fair to state that there are promising ideas and, in some cases, practices that can be derived from the reform movements in both science and drug education. However, we can conclude that both of these areas in education must change before either can help students meet the evolving demands of an increasingly complex society.

One of the most important factors associated with successful education programs is the development and implementation of an enriched, exciting, learning environment. The science education reform movement has recognized this fact over the past ten years and appears to be in the process of adopting initiatives that will make science more relevant to students. Philosophical areas of the Science/Technology/Society (STS) education reform movement (Yager, 1993) provide some guidelines to consider when attempting to design more personally relevant science curricula. Science curricula incorporating these areas could be effectively integrating science and substance abuse education. According to Pedersen (1993) these philosophical areas include:

> Presenting the relationships among technological and scientific developments and socially relevant issues clearly, early, and in compelling ways to capture attention;
> Considering the mutual influences of technology, science and society on each other;
> Developing learners' understanding of themselves as interdependent members of society and of society as a responsible agent within the ecosystem;
> Including a balance of differing viewpoints about the issues and options;
> Helping learners to venture beyond the specific subject matter to broader considerations of science, technology, and society;
> Engaging learners in developing problem-solving and decision-making skills;

Encouraging learners to become involved in a societal or personal course of action after weighing the tradeoffs among values and effects drawn from alternative options.

Many of these philosophical areas are congruent with areas that are presented in substance abuse education. Bridges between science and substance abuse education are easily built using philosophical approaches similar to those outlined above. Although uncommon, the idea of integrating substance abuse education and science education is not a new one. The novelty of the subject integration that the Harvard BASE Project will promote, compared with previous science and substance abuse integration attempts, lies in the scope, comprehensiveness, adaptability, and perpetuity of the proposed integration. We view the integration of substance abuse and science curricula as an ongoing, self-perpetuating process -- influenced as much by how teachers deliver the curriculum as it is by curriculum content.

Previous Attempts at Program Integration. Over the past fifteen years, three substance abuse prevention programs (i.e., marijuana and hashish, alcohol and drunkenness, and smoking) have been integrated successfully into core student science curricula. All three of these programs were developed in Israel. Based on the success of the program "Marijuana and Hashish", which was implemented in 1981, "Alcohol and Drunkenness" (AAD) was developed to deal with primary prevention and focused mainly on excessive drinking and related problems among youth. Moore and Weiss (1985) developed the AAD program in an Israeli school system for use specifically within the science curriculum. This program offers education modules that are used in chemistry, biology, and psychology classes. These modules use cognitive, affective and decision-making skills with non-conventional teaching methods. Consequently, the teacher training for AAD is extensive: teachers are expected to "demonstrate certain characteristics far beyond those that one has to demonstrate within conventional courses, in order to accomplish successful implementation" (Moore and Weiss, 1985, p. 265).

An example from the AAD chemistry module illustrates how this curriculum integrates alcohol and science studies to provide a progressive learning experience that can prevent intemperate alcohol use. In this section of the program, students determine the percent of alcohol in beverages by constructing an alcohol meter in the laboratory. Students also distill alcohol from alcoholic beverages, build a working breathalyzer model in the laboratory, ferment glucose, discuss the production of alcohol, and examine the relationship between alcohol and the energy crisis (Moore and Weiss, 1985). The efficacy of AAD has not been evaluated using random clinical trials, but it has been field tested with encouraging preliminary results (Moore and Weiss, 1985).

Zoller and Maymon (1989) incorporated a smoking-prevention program within the science curriculum of an Israeli school system. The program, "Smoking and Cigarette Smoke" (SACS), uses cognitive, affective and behavioral techniques, including decision making and

values clarification. SACS is an interdisciplinary modular chemistry and biology curricular unit that fills 25 to 35 class hours. It is directed toward junior high and high school students. The authors stress: "There is no moral preaching within the unit. Students are allowed to draw the conclusions that may affect their future smoking behavior (i.e., to join the smokers or to refrain from smoking) based on this block of study (for 4-8 weeks) incorporated within ongoing biology, chemistry, or general science courses in secondary schools" (Zoller and Maymon, 1989, p. 388). Zoller and Maymon assessed this program by examining shifts in adolescent attitudes toward health, peer pressure, and social image in relation to smoking behavior. Although student attitudes were significantly changed in the "desirable" direction (i.e., away from smoking) as a result of this intervention, no evaluation of behavioral change (i.e., smoking) was conducted. Therefore, we cannot conclude whether SACS successfully influences smoking behavior or, like so many other prevention programs, simply influences youths' knowledge and attitudes. Other prevention curricula related to substance abuse (e.g., AIDS/HIV prevention education) that may be integrated into a science curriculum are discussed in the following section.

AIDS/HIV Prevention Education in the Science Classroom. Susan Speece delivered a clarion call to American science teachers in 1992 regarding AIDS education in the science classroom. She considered life science teachers to be particularly well suited to teaching about AIDS, since they had a deeper understanding of the immune system and the nature of viruses (Speece, 1992). Furthermore, the increase in AIDS cases, as well as the possibility that as many as 50% of all persons with full blown AIDS encountered the virus during early adolescence, suggests that limiting AIDS/HIV education to one health class is insufficient at best, and dangerous at worst (Speece, 1992). While Speece does not provide a specific AIDS/HIV-life science curriculum module, a group from Framingham State College and the Harvard School of Public Health has developed an AIDS risk educational software program (AIDSRISK) for an AIDS/HIV education and prevention curriculum (Rothberg, Sandberg and Awerbuch, 1994). AIDSRISK is educational software developed for high school students. Students can explore, via computer simulation, their own risk of acquiring an HIV infection given certain sexual behaviors. Users can calculate their chances of becoming infected based on the decisions they make. The developers of AIDSRISK believe that use of the program will personalize the risk of HIV infection and thus increase concern and awareness among software users. The developers also understand that knowledge alone is not sufficient to change adolescent behavior; therefore, they highly recommend embedding the use of AIDSRISK within an appropriate curriculum (Rothberg et al., 1994).

Summary and Conclusions. As we approach a new millennium, Americans seek both education reform and the capacity to regulate substance abuse among young people. The Harvard BASE Project is striving to develop curricula that can help students achieve higher academic

performance while simultaneously diminishing psychoactive drug using patterns that compromise our collective futures. Unfortunately, relevant research reveals that there are few current attempts to revitalize science education in a way that actively incorporates or integrates substance abuse prevention and education. We believe that incorporating appropriate scientific subjects into substance abuse education could make those scientific subjects more relevant to the lives of students. By establishing and implementing an integrated addiction science curriculum, we are attempting to increase student interest in science; concurrently, we are hopeful that this initiative will prove a favorable strategy to decrease the prevalence of psychoactive substance use among students. This needs assessment research represents the first major step toward the development and implementation of new science and addiction education. The following section will examine the objectives of a needs assessment for curriculum design.

Needs Assessment for Curriculum Design*: Developing an Instrument*

The primary purpose of this needs assessment for curriculum development was to identify the student characteristics associated with "unmet need" (e.g., interest in more hands-on science experience) regarding the newly established performance criteria for middle school science education. In addition, this needs assessment was intended to identify students with unmet need in their existing science education experience. This needs assessment also was intended to identify student characteristics that already have been associated with an increased or decreased likelihood of achievement at the newly targeted levels for science education. More specifically, this needs assessment aimed to:

- distinguish students who endorse from those who do not endorse the new science education standards;
- identify key obstacles that interfere with science learning;
- associate key demographic factors with interest or lack of interest in the newly established goals for science education;
- determine if endorsement of science education is associated with specific teaching modalities (e.g., hands-on science);
- determine if those students who subscribe to the values of the new science education criteria are distributed evenly throughout the catchment area for this project or if there are demographic factors that cluster them disproportionately.

Data Needs

The members of the Harvard BASE project Science Advisory Panel and their respective constituencies had the opportunity to contribute to the identification of data needs, hypotheses, operational definitions, determination of appropriate respondents, and the instrument implemented to survey the student population so that the assessment would address their concerns. The material that follows evolved from numerous meetings and discussions held to complete the aforementioned task and, ultimately, prioritize the educational activities of the Harvard BASE Project.

Student Data Needs Guiding Curriculum Development. Certain assumptions were made to determine which students would yield the data that guides the development of new curricula. For this project, with its primary purpose of increasing children's interest in science and its secondary purpose of increasing their interest in and knowledge about addictive behaviors as an object of scientific inquiry, we made the following assumptions:

the curriculum will remove science education obstacles encountered by middle school children;
the curriculum will increase the scientific performance of children at every intellectual level; each level will use "hands-on" science skills based on students' inherent skills - more advanced students will do more sophisticated experimentation; less advanced students will do more basic experimentation;
the curriculum will have the least impact on the most advanced students who exhibit competency, maximum interest and curiosity toward science regardless of their environment;
the curriculum will increase the interest of students from backgrounds that do not include scientists;
the curriculum will increase the scientific experience of students who have little "hands-on" exposure to scientific thinking and experimenting;
the curriculum will increase the relevance of science for students who see minimal value for scientific activity in their daily lives.

Guiding Hypotheses. Like any scientific study, a needs assessment is guided by working hypotheses. In this project, the primary hypotheses were:

students subscribe to science education when family experience encourages discovery;
students more curious about their world will be more interested in science when compared with those who are less curious;
females are less likely than males to experience science or endorse the new science education standard;
students with hands-on science experience will have more interest in continuing science education than those absent such experience;
students will have very little or no experience with addictive behaviors as an object of scientific inquiry;
given the opportunity, students will express interest in studying addictive behavior as an object of scientific activity; furthermore, this area of study will have broad appeal, attracting interest from students who are advocates of science as well as those who are impartial to science.

Methods

Survey Instrument

Developing Needs Assessment Survey Items. The survey items were designed to meet the data requirements identified by the Science Advisory Panel for this project. These items grew from a review of the extant literature and a series of meetings and focus groups with teachers, students, administrators and parents. These meetings were held with the specific

purpose of determining the data needs for this project. When the specific data needs corresponded to items from existing sources, these items were borrowed or modified. However, a careful review of the science education and substance abuse literature revealed that there have been few attempts to conduct needs assessments for the development of science education programs in general, (e.g., Baker and Leary, 1995; Ebenezer and Zoller, 1993; National Assessment of Educational Progress, 1979; Shepardson and Pizzini, 1993) and none specifically in the combined areas of science and substance abuse education. Furthermore, few studies examined teacher needs[4] associated with science teaching (e.g., Monroe and Mikovch, 1994). Therefore, the majority of the items for this survey were created specifically for this project.

Items for the science curriculum standards were derived from the American Association for the Advancement of Science (AAAS) *Benchmarks for Scientific Literacy*, the National Science Teachers Association *Scope Sequence and Coordination Content Core* (SS&C), and the National Science Education Standards. A review of the literature, including the draft of the National Science Education Standards, reveal that these proposed criteria represent the core knowledge and skill elements of a comprehensive science education curriculum. The *Benchmarks* initiative provides a detailed list of the knowledge and skills required of science students in grades K-12, but fails to document the process by which students should acquire these skills. Similarly, the *Science/Technology/Society Movement* (STS) stresses learning science in the context of contemporary society. Since each of these reform movements embrace slightly different science education criteria, we selected the needs assessment items from a variety of sources to ensure that a range of knowledge and skills was covered.

Time Frame. As Derogatis (1992) notes, a very important aspect of any assessment procedure is the time set reference given to the respondent during data collection. This instrument used one primary time set reference and one secondary but directly related time frame. Each of the needs assessment modules was designed to provide an index of science and substance abuse education need by determining what experiences respondents had <u>during the present school year</u>. Using this indicator, we can most accurately estimate what patterns of need will relate to science education during the next year. In addition, by comparing different middle school grades, we can examine the trends associated with the current "layered"[5] approach to science education. Therefore, in the various modules of this instrument, respondents were expected to answer each item with the information they had available during the present school

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[4]Examples of teacher needs are the training required to execute a curriculum, administrative support, and the availability of resources necessary to implement a new curriculum.

[5]Layering is the strategy of introducing one subject each academic year within a particular discipline. For example, within science, 10th graders traditionally study biology, 11th graders study chemistry, and 12th graders study physics.

year unless otherwise specified. The secondary time set reference involved items that asked about "current" feelings and attitudes. These questions were phrased in the present tense and, similar to the items that referred to the present school year, provided a predictor trait or state for understanding attitudes during the next school year.

Procedure

Specific instructions included on each survey form provided the background necessary to administer the needs assessment survey and answer any questions that might arise. Students were informed that it was an anonymous survey about science and alcohol & drug education. They were asked to answer each question carefully, and were reminded that it was important that they attempt to complete every item. To facilitate survey administration, interviewers instructed respondents to mark down the first response that came to mind and not dwell on any single item, since it was possible that there were items of which students had little or no knowledge. Interviewers emphasized that respondents were not expected to be familiar with every subject covered in the survey.

The attitude and disposition of the survey administrator were essential to gathering the most accurate and complete information from each respondent. To minimize administration bias, survey administrators were very careful when answering student questions. Survey administrators responded to questions by asking students to reconsider their interpretations of the questions and then answer as best they could with their information. The survey administrator addressed questions related to ethnic identification by inquiring whom the child most identified with and then instructing the child to complete the item accordingly.

Sampling Design

This needs assessment survey was designed for use with middle school students who study science and speak English as their primary language. The communities of Billerica and Lowell Massachusetts were selected as representative of the Merrimack Valley Educational Collaborative. Therefore, all of the middle school students in these communities comprised the target population for this study. Table 1 below summarizes the Harvard BASE Project student sampling methodology.

Table 1

BASE Project Sampling Methodology

	Total # of students in town	Total selected	Total obtained	Absentees (number)	Absentee percentage	Percentage of town selected
Billerica	1,426	1,426	1,327	99.00000	6.90000	100.00000

Billerica random sample		434.00000	406.00000	28.00000	6.50000	30.40000
Lowell	4,433	1,348	1,133	215.00000	15.90000	30.40000

Lowell Sample. Resources did not permit us to survey every Lowell student. Therefore, Lowell classrooms were randomly selected. We obtained master lists of all of the middle school science classrooms in the Lowell school system. There are seven middle schools in Lowell ranging in size from 566 to 766 students. Each of these schools contain students in grades five through eight, and students are divided fairly equally among the four grades.

School classrooms were selected randomly. Across the seven schools, there were 163 classrooms from which to choose. Seven classrooms were selected randomly from each middle school (i.e., 30.4% of the middle school students). This procedure yielded 13 fifth grade classrooms, 11 sixth grade classrooms, 11 seventh grade classrooms, and 15 eighth grade classrooms. Of the 1,348 students selected for survey, 1,133 participated, yielding a community completion rate of 84.1%.

Billerica Sample. This project targeted all of the Billerica middle school students for survey. Of the 1,426 eligible students, we obtained surveys from all but 99 students. A separate data file for all of the Billerica respondents was created, and 99 blank cases were entered to represent the absent students. We then randomly sampled 30.4% of the cases in the Billerica database. This proportion matches the proportion of respondents randomly selected from the Lowell school system (1348/4433 = .304). This procedure allows us, in effect, to randomly sample from a pool including every student in Billerica; absent students have the same chance of being selected as students in attendance do. This procedure resulted in a random sample of 434 Billerica students. Of these 434 selected students, 28 represented absent cases. Thus, the Billerica completion rate was 93.5%.

Merrimack Valley Sample. To derive the total sample of 1,539 students, we merged the randomly selected Billerica and Lowell data sets. The ratio of Billerica to Lowell students in this new sample was approximately equivalent to the ratio of Billerica to Lowell students in the two town populations: Billerica students accounted for 26.38% of the merged sample, whereas in the actual combined town student population Billerica students accounted for 24.34%. The relatively high absentee rate in Lowell (15.9%) explains this small proportional difference.

Results

The results described below summarize a variety of analyses that are organized around six broadly defined areas of interest: (1) respondent demographics; (2) respondents' attitudes towards science and drug & alcohol education; (3) favorite and least favorite school subjects; (4)

how often respondents have thought about becoming scientists and the attitudes of students who we identified as science advocates; (5) where and how respondents learn science best, their experience doing science-related activities, and the obstacles associated with science education; and finally; (6) student patterns of gambling and substance use prevalence. Readers should recall that, as we noted above, unlike traditional needs assessment, where deficiencies are identified, these results are intended to inform and guide curriculum development. Therefore, the data was examined repeatedly to determine if there were significant differences among grade, gender, and science advocacy.[6] The data reported below represents analyses that yielded statistically meaningful results.

Respondent Demographics

The respondents were 1539 middle school students, enrolled in fifth through eighth grade. Of the total respondents, 19.8% were in fifth grade, 23.8% were in sixth grade, 26.0% were in seventh grade, and 30.4% were in eighth grade. Sixth, seventh, and eighth graders attended schools in both Lowell and Billerica, while fifth graders attended schools in only Lowell. In Billerica, middle schools include sixth through eighth grade; in Lowell, middle schools include fifth through eighth grade. When examining the data, it is important to note that fifth grade respondents are different from other grades in that they represent only one town, which has different demographic characteristics than when the two towns are combined.

Females comprised 50.7% of the respondents; 49.3% were male. A majority of respondents (54.7%) were White, while 23.3% were Asian, 10.7% were Hispanic, 4.1% were Portuguese, 2.1% were Black, 1.2% were Indian, 0.8% were Native American, and 3.1% represented other racial or ethnic groups.

Representing the proportional size of each school district, 73.6% of the respondents were from Lowell and 26.4% were from Billerica. Within Lowell, respondents attended seven different schools. Of the total data set, 12.0% of the respondents attended Daley School, 11.7% attended Wang School, 10.7% attended Sullivan School, 10.6% attended Butler School, 10.4% attended Bartlett School, 9.1% attended Rodgers School, and 9.1% attended Robinson School. The Billerica respondents represented two middle schools. Twelve percent (12.0%) of the total data set attended Locke School and 14.4% attended Marshall School. Figure 1 summarizes the demographic characteristics of this data set.

Insert Figure 1 about here
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[6]The criteria used to determine science advocacy will be described later.

Attitudes Toward Science Education

Grade Differences. Respondents rated nine items that indicated their attitudes toward science education. For each of the items, respondents used a Likert-type response scale ranging from "not at all" (0) to "extremely" (4). When these mean ratings were analyzed by grade using one-way analysis of variance, significant differences across grades occurred for six of the nine items ($p < .001$ for each univariate analysis). Post-hoc Scheffe tests revealed that for each of these six items, fifth graders had significantly higher ratings of their science education than sixth, seventh, and eighth graders. These six items were (1) interest in current science teacher ($F = 13.70$, range = 3.96, df = 3,1502, $p < .0001$), (2) interest in learning science ($F = 6.72$, range = 3.96, df = 3,1531, $p < .0001$), (3) interest in current science class ($F = 5.93$, range = 3.96, df = 3,1520, $p < .001$), (4) teacher interest in them ($F = 8.92$, range = 3.96, df = 3,1475, $p < .0001$), (5) friends' interest in science ($F = 13.50$, range = 3.96, df = 3,1512, $p < .0001$), and (6) family interest in science ($F = 16.39$, range = 3.96, df = 3,1496, $p < .0001$). Figure 2 illustrates these findings.

Insert Figure 2 About Here

Gender Differences. When comparing respondents' attitudes toward science education by gender, the only significant difference between the mean ratings of males and females was on measures of "teacher interest in science". Females rated their teachers' interest in science significantly higher ($t = 3.41$, df = 1512, $p < .005$) than males. These mean ratings are illustrated in figure 3.

Insert Figure 3 About Here

Student Attitudes Toward Drug & Alcohol Education

Grade Differences. To examine the layering effects of drug & alcohol education, we had respondents rate ten items that reflected their current attitudes toward drug & alcohol education. These items were similar to the survey questions about science education and were rated on the same five-point Likert-type response scale as the science items described above: that is, ranging from "not at all" (0) to "extremely" (4). Chi-square tests[7] identified significant differences across middle school grades. For each of the ten items, earlier grades evidenced more interest than later

[7]This data failed to satisfy multivariate normality and homogeneity of variance assumptions necessary for multivariate and parametric analyses. Consequently, we applied the chi-square statistic to this data. Throughout these results, we employed a consistent strategy of testing data for its capacity to satisfy the assumptions of a specific test. When data violated these assumptions, we deferred to the next available analysis. We report results only for statistical tests when the data satisfy the basic underlying assumptions associated with that test..

grades. These items, graphically represented in figure 4, are (1) how interested is their teacher in teaching drug & alcohol (chi-square = 348.81, n = 1487, df = 12, p < .00001), (2) how much they like their drug & alcohol teacher (chi-square = 601.12, n = 1480, df = 12, p < .00001), (3) how interesting their drug & alcohol teacher is (chi-square = 487.73, n = 1498, df = 12, p < .00001), (4) how well educated they are in drug & alcohol issues (chi-square = 313.49, n = 1491, df = 12, p < .00001), (5) their interest in their current drug & alcohol education (chi-square = 450.37, n = 1505, df = 12, p < .00001), (6) their interest in learning about drugs & alcohol (chi-square = 297.28, n = 1495, df = 12, p < .00001), (7) how well they are doing in drug & alcohol education (chi-square = 262.76, n = 1495, df = 12, p < .00001), (8) their drug & alcohol teacher's interest in them (chi-square = 320.25, n = 1500, df = 12, p < .00001), (9) their friends' interest in learning about drugs & alcohol (chi-square = 254.19, n = 1499, df = 12, p < .00001), and (10) their family interest in learning about drugs & alcohol (chi-square = 167.38, n = 1518, df = 12, p < .00001).

Insert Figure 4 About Here

Gender Differences. When respondents' attitudes toward drug and alcohol education were analyzed by gender, significant differences occurred between males and females on eight items. Female middle school students displayed significantly higher mean ratings than their male counterparts on the following items: (1) their teachers' interest in drug & alcohol education (t = 2.90, df = 1477, p < .005), (2) how well they were doing in drug & alcohol education (t = 2.70 , df = 1485, p < .005), (3) how well educated they were in drug & alcohol issues (t = 2.37, df = 1428, p < .05), (4) interest in learning about drugs & alcohol (F = 4.73, df = 1,1330, p < .05), (5) how well they liked their drug & alcohol teacher (F = 5.64, df = 1,1330, p < .05), (6) interest in their current drug & alcohol class (F = 10.75, df = 1,1330, p < .005), (7) their teachers' interest in them (t = 3.06, df = 1490, p < .005), and (8) their friends' interest in drug & alcohol education (F = 7.36, df = 1,1330, p < .005). Figure 5 summarizes these results.

Insert Figure 5 About Here

Predicting Interest in Learning about Drugs & Alcohol. A stepwise linear regression was employed to identify significant predictors of student interest in learning about drugs & alcohol. The following eight factors (F = 22.46, p < .0001) successfully predict higher student interest in drug & alcohol education: (1) lower grade level, (2) not having a computer at home, (3) being female, (4) living with an aunt or uncle, (5) living with a foster parent, (6) thinking of someone at home as a scientist, (7) learning science best at school and/or at a computer, and (8) getting help with science assignments from family.

Comparing Student Attitudes Toward Science and Drug & Alcohol Education

Student respondents rated science and drug & alcohol education meaningfully different on six out of eight items. Middle school students indicated that they, their friends, and their families have more interest in drug and alcohol education than in science education. However, drug & alcohol teachers and these teachers' interest in their subject were rated less favorably than their science teacher counterparts. To illustrate, the students' mean ratings for drug & alcohol education items were significantly higher than for parallel science education items in the areas of "interest in learning subject" ($t = -3.81$, $df = 1497$, $p < .001$), "friends' interest in subject" ($t = -6.31$, $df = 1483$, $p < .001$) and "family interest in subject" ($t = 7.41$, $df = 1491$, $p < .001$). Conversely, students rated science education items higher than drug & alcohol education items in the areas of "interest in current teacher" ($t = 6.05$, $df = 1471$, $p < .001$), "how interested their teacher is in the subject" ($t = 9.57$, $df = 1475$, $p < .001$), and "how well they are doing" ($t = -2.04$, $df = 1494$, $p < .05$). Figure 6 summarizes these important results.

Insert Figure 6 About Here

Science and Drug & Alcohol Education Teachers: Grade Differences. As indicated above, students rated both science and drug & alcohol education teachers on their "interest in subject" and "interest in the student". Ratings on the following variables were significantly different across the four grades: (1) science teacher interest in students (chi-square = 52.63, $n = 1479$, $df = 12$, $p < .00001$), (2) teacher interest in drug & alcohol (chi-square = 348.81, $n = 1487$, $df = 12$, $p < .00001$), and (3) drug & alcohol teacher interest in students (chi-square = 320.25, $n = 1500$, $df = 12$, $p < .00001$). Fifth graders rated all three variables more favorably than sixth, seventh, and eighth graders. Furthermore, the ratings for "teacher interest in drug & alcohol education" and "drug & alcohol teacher interest in students" both decreased as grade level increased. Figure 7 illustrates these findings.

Insert Figure 7 About Here

Composite Science Interest Ratings by Gender. A composite Science Interest index was computed by summing the interest scores for nine survey questions that evaluated students' ratings of their science class, their science teacher, their friends' and families' interest in science, and their standing in science class. This sum was divided by nine to obtain an average score for each individual. Similarly, the ratings for the ten drug & alcohol questions were added and divided by ten to obtain a composite Drug & Alcohol Interest index for each individual. These ten questions addressed the students' interest in drug & alcohol class, their drug & alcohol teacher, how well they were doing in their drug & alcohol education class, and their friends' and families' interest in drug & alcohol education.

A t-test demonstrated no gender differences on the composite Science Interest score; however, females had significantly higher composite Drug & Alcohol Interest scores than males ($t = 3.29$, $df = 1330$, $p < .01$). This relationship is illustrated in figure 8.

Insert Figure 8 About Here

Favorite and Least Favorite Classes

Respondents were asked to identify their favorite and least favorite school classes. The most popular class among students was physical education: 31.1% of respondents indicated that it was their favorite class. Science was the favorite class of 14.7% of the respondents, and math was the favorite class of 13.7% of the respondents. The two least popular classes were mathematics and social studies: 20.3% and 21.9% of the students indicated these were their least favorite classes, respectively. Figure 9 summarizes these results.

Insert Figure 9 About Here

Interest in Science as a Career

Grade Differences. Respondents were asked to rate how often they thought about becoming a scientist. Using a Likert-type scale where 0 = none of the time, 1 = very little of the time, 2 = some of the time, 3 = most of the time, and 4 = all of the time, the mean rating was 1.61 for fifth graders, 1.15 for sixth graders, 1.26 for seventh graders, and 1.30 for eighth graders. These findings are summarized in figure 10.

Insert Figure 10 About Here

Figure 11, which summarizes the proportion of respondents who have thought about becoming scientists, reveals that there was little change across grades, particularly across the sixth, seventh, and eighth grades. For these three grades, between 40.8% (6th grade) and 34% (8th grade) of the respondents had never thought about becoming scientists. Although there is a slight decline in interest in becoming a scientist between sixth and eighth grade, a majority of students still think about becoming scientists.

Insert Figure 11 About Here

Predicting Which Students Will Think about Becoming Scientists. A discriminant function analysis was conducted to identify the factors that influence students to think about becoming scientists. The following five factors significantly (chi-square = 145.75, n = 1111, df

= 6, $p < .0001$) discriminated students who think about becoming scientists from those who do not: (1) being a member of a minority group, (2) more frequently going to a library to find answers to science-related questions, (3) learning science at home and at the library, (4) living with a father who is interested in science, and (5) living with someone who is interested in science. This five-factor model correctly classified 64.72% of the respondents as to whether they had thought previously about becoming scientists. Furthermore, although this variable was not a discriminating factor, a comparison of means revealed that students who have thought about becoming scientists expressed significantly more curiosity about learning new things ($\underline{M} = 3.08$) than students who had not thought about becoming scientists ($\underline{M} = 2.50$, df = 894.51, t = -9.04, $p < .001$).

Science Advocates

Determination of Advocacy. Although thinking of becoming a scientist for even a brief time can be a meaningful experience for students, we were interested in identifying students who expressed a stronger dedication to science. Therefore, we classified respondents as either science advocates or impartials. The purpose of this distinction was to determine the defining characteristics of each group, and then target impartials (i.e., using the new addiction science curriculum) in an effort to increase their interest in science. Respondents were identified as science advocates if they satisfied the following six inclusion criteria: (1) had thought about becoming a scientist, (2) their favorite class was science, (3) they liked learning about science "very" much or "extremely", (4) they were interested in science "very" much or "extremely", (5) their science potential was rated "very" or "extremely", and (6) even if they made mistakes, they liked science "all of the time." These criteria identified 31% of the student sample as science advocates.

There were several similarities between the criteria for science advocacy and the variables that predicted whether students thought about becoming scientists. To illustrate, <u>family interest</u> in science appears to be a significant influence on students. In addition, students express a strong personal interest in science by <u>going to the library</u> to find answers to science-related questions. Interestingly, while over 60% of students have thought about becoming scientists, only 31% are science advocates. Therefore, a new addiction science curriculum must address the factors that influence students who have thought about science as a career but currently are not classified as science advocates. There may be important distinctions between science advocates and impartials.

Items that Discriminate Science Advocates from Impartials. A discriminant function analysis identified five significant predictors of science advocacy. The following variables (chi-square = 104.03, n = 1394, df = 5, $p < .0001$) successfully discriminated science advocates from

impartials: (1) lower grade level, (2) more frequently thinking about becoming a scientist, (3) more frequently going to the library to find answers to science-related questions, (4) receiving help with mathematics assignments from family, and (5) living with a father who is interested in science. These five factors correctly classified 68.69% of the respondents as science advocates or impartials. In addition, although the discriminant function failed to identify curiosity as an item that differentiates advocates from impartials, advocates were significantly more curious than impartials about learning "new things" about their world ($t = -11.91$, $df = 667.34$, $p < .001$).

Science Advocates' versus Impartials' Interest in the New AAAS Standards. Science advocates revealed significantly more interest than impartials in each of the new American Association for the Advancement of Science (AAAS) benchmarks for science education. The following are the new AAAS education standards: universe, planets, & forces of nature ($F = 206.39$, $df = 1,718$, $p < .001$), human body ($F = 162.86$, $df = 1,719$, $p < .001$), theories of the universe ($F = 245.68$, $df = 1,718$, $p < .001$), gravity, measurement, communication, & computers ($F = 160.67$, $df = 1,717$, $p < .001$), plants, genes, and the food chain ($F = 255.70$, $df = 1,718$, $p < .001$), reasons why we study science ($F = 232.84$, $df = 1,719$, $p < .001$), history of scientific discoveries ($F = 207.18$, $df = 1,716$, $p < .001$), doing or using mathematics ($F = 132.51$, $df = 1, 716$, $p < .001$), reasons why we study math ($F = 103.56$, $df = 1,719$, $p < .001$), robots, farming, & energy sources ($F = 216.90$, $df = 1,717$, $p < .001$), and how people think and feel ($F = 97.5$, $df = 1,716$, $p < .001$). Although the addictive behaviors is not an AAAS standard, we included it in this analysis with the AAAS items; the results revealed that, like the other areas, science advocates expressed significantly more interest in studying addiction than did their impartial counterparts ($F = 10.91$, $df = 1,708$, $p < .01$). However, as figure 12 demonstrates, science advocates and impartials rated their interest in the addictive behaviors more similarly than any other area of science study.

Insert Figure 12 About Here

Gender Interest in the New AAAS Standards. Males and females expressed significantly different levels of interest in the new AAAS standards on four of the twelve items. Males were significantly more interested than females in robots, farming, & energy sources ($F = 40.28$, $df = 1,1134$, $p < .001$) and theories of the universe ($F = 4.86$, $df = 1,1134$, $p < .05$). Females were significantly more interested than males in doing or using mathematics ($F = 7.61$, $df = 1,1134$, $p < .01$) and how people think and feel (chi-square = 54.61, $n = 1425$, $df = 6$, $p < .00001$). Figure 13 illustrates these results.

Insert Figure 13 About Here

Perceived Dangerousness of Gambling and Substance Use. This section compares the responses of science advocates and impartials regarding the perceived dangerousness of gambling and substance use. These findings reveal that science advocates consistently rated substance use and gambling activities as significantly more dangerous than did impartials: taking stimulants ($F = 6.09$, $df = 1,689$, $p < .05$), taking narcotics ($F = 7.82$, $df = 1,689$, $p < .01$), using marijuana ($F = 11.66$, $df = 1,689$, $p < .005$), smoking or chewing tobacco ($F = 14.91$, $df = 1,689$, $p < .001$), drinking alcohol ($F = 20.29$, $df = 1,689$, $p < .001$), sniffing inhalants ($F = 8.72$, $df = 1,689$, $p < .005$), gambling on sports, card games, sports cards or other activities ($F = 23.83$, $df = 1,689$, $p < .001$), and gambling by buying lottery tickets (chi-square = 21.31, $n = 720$, $df = 4$, $p < .0005$). Figure 14 illustrates these results.

Insert Figure 14 About Here

Obstacles to Science Education

Respondents rated how often specific issues have been a problem in their science education. They rated these issues on a 5-point scale ranging from none of the time (0) to all of the time (4). These ratings, which are summarized in figure 15, ranged from 0.86 ("fear of learning science") to 1.71 ("class period length"). Within the context of a needs assessment for curriculum development, we assume that if these obstacles to science education were decreased, interest in, and perhaps access to, science education would increase.

Insert Figure 15 About Here

Grade Differences. The mean ratings for "fear of learning science" as a problem in science education diminished consistently from fifth grade to eighth grade. The respondents' average ratings were .9493 for fifth grade, .9302 for sixth grade, .8785 for seventh grade, and .7162 for eighth grade. These differences were significantly different across grades ($F = 6.39$, range = 3.96, $df = 3,1503$, $p < .001$). The mean rating for "science is too hard" was 1.3322 for fifth grade, 1.3503 for sixth grade, 1.2148 for seventh grade, and .9847 for eighth grade. Fifth and sixth graders considered "science is too hard" as more of an obstacle than eighth graders ($F = 6.72$, range = 3.96, $df = 3,1495$, $p < .0005$). Figure 16 illustrates the grade differences described above.

Insert Figure 16 About Here

Gender Differences. Females rated "fear as a problem" less (M = .8102) than their male counterparts (M = .9023). However, females reported that "science is too hard" more (M = 1.2671) than males (M = 1.1362). Nevertheless, these differences were not found to be statistically significant.

Experience Doing Science-Related Activities

Respondents indicated how often during the school year they had experience doing various science-related activities. On balance, middle school students spent little time doing hands-on science-related activities. Table 2 summarizes these response patterns.

Table 2

Experience Doing Science Related Activities

	all of the time	**most of the time**	**some of the time**	**very little of the time**	**none of the time**
Research	15.60000	22.70000	29.00000	18.10000	14.60000
Experiments	15.00000	20.30000	28.60000	18.60000	17.40000
Observing	10.60000	16.80000	28.90000	22.70000	21.00000
Data collection	8.90000	10.90000	23.80000	23.20000	33.20000
Hypothesis testing	8.50000	12.20000	27.20000	20.30000	31.80000
Creating a theory	7.60000	12.00000	24.20000	23.50000	32.60000

Figure 17 illustrates the data presented in Table 2.

Insert Figure 17 About Here

Students with hands-on science experience rated science more favorably than students who were lacking this experience: there was a significant positive correlation between hands-on science experience and how well students like science ($r = .2517$, $p < .001$); similarly, there was a significant positive correlation between hand-on science experience and science advocacy ($r = .2061$, $p < .001$).

Where and How Respondents Learn Science Best

As part of the needs assessment survey, students were asked to indicate where they learn science best. The majority of the students (81.7%) indicated that they learn best in school. The

next most popular learning place was television (23.3%). In addition, students were asked how they learn science best. The largest percentage of respondents (29.7%) indicated that they learn best by listening to someone, 23.9% indicated that they learn best by watching someone demonstrate, and 22% indicated that they learn best by reading. Figures 18 and 19 summarize these and other response patterns.

Insert Figures 18 & 19 About Here

Patterns of Gambling and Substance Use

Students' Use, Friends' Estimated Use, and Perceived Dangerousness. Respondents were asked to report the most recent time they had participated in gambling or substance use activities. In addition, respondents estimated how many of their close friends participated in gambling or substance use activities. Finally, the students rated the danger of gambling and substance use activities. Figure 20 summarizes these responses. "Students' Use" and "Friends' Estimated Use" represent lifetime prevalence rates (i.e. the proportion of students who have ever used). "Perceived as Dangerous," illustrates the proportion of students who identified drug and gambling activities as "very" or "extremely" dangerous.

Insert Figure 20 About Here

A substantial proportion of students identified the various gambling and substance use activities as "not at all dangerous." As figure 21 reveals, approximately 20% of the respondents did not perceive stimulants, narcotics, inhalants, marijuana, alcohol, and tobacco as dangerous. Similarly, about a third of the respondent sample did not perceive the lottery or gambling as dangerous.

Insert Figure 21 About Here

Lifetime Prevalence Rates by Grade. When the lifetime prevalence rates of substance use and gambling were analyzed across grades -- with the exception of inhalants, narcotics, and non-lottery gambling -- substance use and lottery gambling increased with grade, as illustrated by figure 22. For example, figure 22 reveals that the lifetime prevalence rate for smoking or chewing tobacco was 12.9% for 5th grade, 21.9% for 6th grade, 25.3% for 7th grade, and 41.1% for 8th grade.

Insert Figure 22 About Here

Past Year Prevalence Rates by Grade. Past year prevalence rates of gambling and substance use also were analyzed across grades. During the past year, rates of gambling and substance use increased with grade, with the exception of inhalants and narcotics. Figure 23 summarizes these findings below.

Insert Figure 23 About Here

Past 30 Day Prevalence Rates by Grade. Past 30 day prevalence rates more likely represent patterns of substance and gambling abuse than do past year rates. Prevalence rates for the past 30 days reveal that student use increases consistently by grade for gambling, tobacco, marijuana, and stimulants. For example, figure 24 illustrates that the past 30 day prevalence rates for tobacco use were 4.6% for 5th grade, 9.3% for 6th grade, 12.3% for 7th grade, and 21.9% for 8th grade.

Insert Figure 24 About Here

Eighth Grade Students' Substance Use Compared with National Averages. We compared the substance-using patterns of 467 eighth grade Merrimack Valley students with the 1993 national averages (n = 18,300; Johnston, O'Malley, & Bachman, 1994).[8] As figure 25 illustrates, eighth grade respondents from the Merrimack Valley had rates lower than or similar to national averages for all activities except marijuana use, which was considerably higher. The lifetime prevalence rate for eighth grade respondents' marijuana use was 26.1%, compared to 12.6% nationally. Similarly, the prevalence rate for Merrimack Valley eighth grade respondents' marijuana use during the past year was 17.0%, compared to 9.2% nationally. This finding was expected, because we compared 1995 local data with 1993 national data. During the past two years, marijuana use has been increasing among young people.

Insert Figure 25 About Here

Eighth Grade Friends' Estimated Use Compared with National Averages. Eighth graders' perception of their friends' drug use also was compared to national averages (n = 16,535). The proportion of students reporting that none of their friends use substances was higher than or similar to national averages on all substances except marijuana, which was considerably lower. Of eighth grade respondents, 52.7% reported that none of their friends use marijuana, compared to 69.2% in the national survey. The percentage of students reporting that all or most of their friends use also was compared to national averages: among the Merrimack

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[8]National data was not available for grades below eighth.

valley sample, friends' use of marijuana, inhalants, alcohol, and tobacco was higher than national averages. These findings are illustrated in figure 26.

Insert Figure 26 About Here

Discussion

This needs assessment research study identified middle school students' attitudes toward both science and drug & alcohol education. Unlike traditional epidemiologic needs assessment projects that measure the level of a target phenomenon, this needs assessment yields findings that can encourage and guide the development of an innovative addiction science curriculum for middle school students. The new addiction science curriculum will address students' educational needs by increasing their interests and hands-on experiences in science; simultaneously, this educational program will prevent or delay the use of psychoactive substances. By increasing students' interest in science and their ability to apply the scientific method, we are hopeful that the addiction science program will improve the state of American science education.

The results reported above support the majority of our original hypotheses. However, there were some surprising results: for example, with few exceptions, female middle school students expressed as much interest in science as their male counterparts. In the following discussion, we will revisit the original hypotheses that guided the development of our survey instrument and examine other important issues. The following discussion will be organized around four major themes: (1) students' attitudes toward science and drug & alcohol education; (2) students' educational interests and experiences and how these relate to their science and drug & alcohol education; (3) whether the results support our original hypotheses; (4) the implications of the gambling and substance use prevalence rates. However, before we begin to discuss these results, a brief but important digression is necessary.

Middle School Demographics: Caveats About the Fifth Grade

The Merrimack Valley respondent sample examined in this study was obtained randomly and proportionally; Lowell encompasses a larger population than does Billerica. Consequently, Lowell students represent a majority of the total data set. In addition, Lowell includes greater ethnic diversity than Billerica. While most middles schools include only grades 6-8, Lowell is one of the rare communities that also include the fifth grade in middle school. Therefore, since fifth grade respondents came exclusively from Lowell, they differed demographically from the aggregate sixth, seventh, and eighth graders. These demographic differences likely influence the significant differences observed across grades. Nevertheless, we have included the fifth grade results in this report so that other communities with fifth graders in

middle school can consider the relevance of these findings. We focus primarily on the 6-8 grade findings in the discussion that follows.

Student Attitudes

Gender and Grade Differences. Student attitudes towards both science and drug & alcohol education differ significantly across grades; however, significant differences between males and females were observed only for drug and alcohol education. Using the layering concept, the significant differences across grades should be reflected in differing curricula throughout the middle school years. In general, (1) lower grades tend to be more positive about their science and drug & alcohol education, and (2) females tend to be more positive than males only about their drug & alcohol education. Existing studies suggest that females have less interest in science than their male counterparts (Catsambis, 1995; American Association of University Women, 1992); however, this finding was not obtained in this study. This study's findings suggest the possibility that there is more gender equity in the Merrimack Valley than in other communities that have been studied.

Teacher and Student Interest. Ratings of "teacher interest in students" declined with increasing grade for both science and drug & alcohol education; however, ratings of "teacher interest in subject" declined with increasing grade only for drug & alcohol education. A predictor of student interest in drug & alcohol education is a lower grade level. Most likely, students' ratings of teachers' interest decline as a consequence of their diminishing idealization of adults in general and teachers in particular. Another predictor of interest in drug & alcohol education is living with someone who is interested in science and helps with science assignments. This finding would suggest that an interest in drug & alcohol education is related to interest in science. Perhaps family members who are interested in science stimulate students' interest not only in science, but also in drug & alcohol education. Most likely, family members recognize the relationship between these two subjects and will be supportive of a new science addiction curriculum. Furthermore, if families become more involved in science education, they may enhance their children's interest in drug & alcohol education as well.

Science versus Drug & Alcohol Education. When comparing science and drug & alcohol education, respondents rated drug & alcohol education significantly higher than science education on "personal interest," "friends' interest," and "families' interest." Conversely, respondents rated science education significantly higher on "current teacher," "teacher's interest in the subject," and "how well they are doing in class." These findings -- and those discussed in the next section -- suggest that although there is high interest in drug & alcohol education, the class itself may need improvement to match the levels of teacher interest and self-efficacy derived from science classes. Also, to improve America's relationship with science, students',

friends', and families' interest in science must be increased. Given that there already is more interest in drug & alcohol education than in science education, introducing addictions into the science curriculum can serve to increase a community's overall interest in science. Similarly, since the composite interest ratings demonstrated that females rated their interest in learning about drug & alcohol education significantly higher than did males, introducing the study of addictions into the science curriculum can serve to enhance female students' interest in science. This strategy will be beneficial in school systems where gender equity exists, where it will further promote females' interest in science, and in school systems where females have been observed to be less interested in science that males, where it will stimulate their interest to appropriate levels.

Students' Educational Interests and Experience

Students' Interests. More respondents selected physical education as their favorite class than any other class; the second and third most frequently selected favorite classes were science and math. Interestingly, drug & alcohol education class was not popular, even though respondents expressed a strong interest in the subject. In fact, respondents expressed more interest in drug & alcohol education than in science education, even though science was one of the most popular classes. In other words, interest in drug & alcohol education as a topic is high, but the popularity of the class experience is low. Conversely, interest in science education is lower than interest in drug & alcohol education, but the popularity of the actual science class is higher. The science addiction curriculum can improve both science and drug & alcohol education by combining the two positive factors from each of these educational domains. Addictions, a topic area in which students indicate high interest, can be introduced into science class, which is one of students' favorite class experiences. This integration should be designed to enhance students' overall interest in both drug & alcohol education classes and science as a topic area.

Thinking About Becoming A Scientist. Grade level did not have a significant effect on the proportion of students who have thought about becoming scientists. Therefore, even though ratings of science education declined by grade, this does not have an effect on whether students' consider becoming scientists. Surprisingly, even though about 65% of respondents have thought about becoming scientists during the current year, only 31% of respondents were identified specifically as science advocates. One of the primary goals of the new addiction science curriculum is to increase the proportion of science advocates. Not only would this increase the number of students who are involved actively in science education, but it also might decrease the proportion of students who engage in gambling or substance use activities. As figure 14 demonstrates, science advocates perceive gambling and substance use as more dangerous than

science impartials do; science advocates also engage in these potentially addictive behaviors less than science impartials.

Obstacles to Science Education. Numerous obstacles to science education were identified by the student respondents. However, no single obstacle appeared to present an overwhelming barrier. Nevertheless, all obstacles to improved science education should be prioritized and reduced to minimize limitations to this aspect of contemporary education.

Interestingly, ratings of "science is too hard" and "fear is a problem" significantly decreased as grade level increased. This finding suggests that middle school students' attitudes toward learning science may improve as students mature and overcome natural obstacles. Alternatively, however, a more ominous interpretation is available: perhaps student motivation to learn science decreases as their grade increases. This situation would yield obstacles that are less important or meaningful to students because they are less stimulated by the area of study.

Considering the Original Guiding Hypotheses

Students have very little or no experience with addictive behaviors as an object of scientific inquiry. The study of addictive behaviors is not part of any existing educational standards or curricula, except in the Israeli research described in the introduction. Therefore, Merrimack Valley students, like most American students, have not studied addictions in science class. They have participated in drug & alcohol education classes, designated specifically for the study of addictions, but these have proven to be relatively unsuccessful. Given that drug & alcohol education has been less than effective in preventing drug and alcohol use problems, perhaps a major change is needed, such as moving addiction education to the science classroom. Hopefully, students would develop increased interest and understanding about addiction and science in this new environment.

Students with hands-on science experience will have more interest in continuing science education than those absent such experience. Students with hands-on science experience expressed significantly more interest in science than those who have not had this experience. Therefore, increasing the amount of hands-on experience in the science curriculum should increase students' science interest and advocacy. Hands-on activities allow students to become more involved in the learning process, as well as to understand the material better and express their own ideas and creativity.

A substantial number of students reported having no experience with many science related activities. However, during our conversations with Merrimack Valley middle school science teachers, the teachers often reported that students indeed have had experience with a wide range of science activities. This paradox suggests that students may not fully understand what they are learning. Perhaps, armed with a better understanding of the scientific method and

more hands-on experience, students will improve their understanding of science and increase their capacity to apply it to problems of daily living.

Students subscribe to science education when family experience encourages discovery. One of the major predictors of both science advocacy and interest in becoming a scientist is having a family member who is interested in science and helps with school work. Given the importance of family involvement, it is essential that the new curriculum has a family component. As families become more involved, students' interest in science should increase.

Most respondents learn about science at school and only a small proportion learn about science at home. Since science experience at home is an important factor in predicting students' advocacy of science, the low prevalence of science education activities at home may explain why such a small proportion of students were identified as science advocates. Students likely would benefit if families became more involved in science education. Furthermore, students reported that they learn science best by listening to someone explain and by watching someone demonstrate. Therefore, receiving personalized attention and assistance from family members with science homework and hands-on projects should benefit students and parents alike.

Students who are more curious about their world will be more interested in science when compared with those who are less curious. Although expressing curiosity about learning new things was not identified as a discriminating factor for science advocacy, science advocates expressed significantly more curiosity about learning new things than did impartials. Furthermore, students who have thought about becoming scientists displayed more curiosity about learning new things than students who did not report this experience. Students who go to the library to find answers to science-related questions are significantly more interested in science than those who do not use the library to solve problems. This finding supports the notion that increased curiosity is associated with increased interest in science. Curiosity about the world and its mysteries and the motivation to find answers to these questions characterizes students interested in science. Since (a) many students who are interested in science also have family members who are interested in science and (b) these family members likely encourage or assist children in finding answers to science-related questions, then a family component of the new addiction science curriculum seems a worthy addition to the project.

Given the opportunity, students will express interest in studying addictive behavior as an object of scientific activity; furthermore, this area of study will have broad appeal, attracting interest from students who are advocates of science as well as those who are impartial to science. Science advocates were significantly more interested than impartials in all of the AAAS standards. However, advocates' interest level was most similar to impartials' in the area of the addictive behaviors: while science advocates were less interested in addictions compared to the other areas of scientific study, science impartials were more interested in

addictive behavior relative to other areas of science. Science impartials also indicated more interest in studying "the human body" and "how people think & feel" than the other areas of science; both of areas are closely related to the study of addictions. "The human body" was one of the highest rated areas among science advocates as well as impartials.

These results reveal that the addictions is an important topic area to integrate into the science curriculum, since it holds the potential to capture the interest of impartials, who represent a majority of the student population. Also, once addiction is integrated into the science curriculum, science advocates may develop increased interest in this area and be stimulated to more advanced study -- perhaps even careers researching or treating addictive disorders.

Females are not less likely to experience science or endorse the new science education standard than males. Contrary to our original hypotheses, for the majority of the AAAS standards, males and females did not express significantly different levels of interest. However, males did express significantly more interest in "robots, farming, & energy sources" and "theories of the universe". Females expressed significantly more interest than males in "doing or using mathematics" and "how people think and feel." While it may surprise some that females expressed more interest in "doing or using mathematics" than their male counterparts, female middle school students generally are more patient than their male counterparts; they may enjoy these contemplative problem-solving activities more than males. Conversely, males are often less interested than females in "how people think and feel." Male and female interest in addiction studies is not significantly different. Given that studying addictions inevitably involves studying how people think and feel, perhaps introducing addiction in science class will increase male students' interest in how people think and feel while concurrently enhancing female students' interest in science and stimulating new scientific interest in areas where they do not have interest.

Substance Use and Gambling Prevalence Rates

The results of this survey reveal that the majority of Merrimack Valley middle school students are involved in substance use or gambling activities. In general, students reported that they use drugs slightly less than their friends. Although this pattern is commonly reported (e.g., Johnston et al., 1994), this data can be misleading. For example, estimates of friends' use will be higher than personal use in a group of friends in which only a few people use drugs. To illustrate, if three members of a group of twelve friends use drugs, all twelve students would report that their friends use, but only three students would report any personal use.

Of the eight illicit gambling/substance use activities investigated in this survey, gambling on events other than the lottery was the most common activity, followed by lottery gambling, drinking alcohol, and using tobacco. Sniffing inhalants and using marijuana were the next most

common activities, followed by using stimulants and narcotics; the latter two activities had very low prevalence levels among these middle school students. Stimulants and narcotics were perceived as more dangerous than all of the other activities. Consequently, most students were less inclined to use them. Nevertheless, about 20% of the respondents perceived tobacco, alcohol, marijuana, inhalants, stimulants, and narcotics as not at all dangerous.

Given the emphasis on drug and alcohol education and prevention in these middle schools, finding that 20% of students do not consider potentially addictive behaviors dangerous at all reveals important shortcomings associated with drug prevention education. If students fully appreciated the dangers of gambling and substance use, the prevalence of these activities would be expected to decline. Although some people will engage in dangerous activities specifically because of the dangers, the majority of young people exhibit sufficient self care to avoid dangerous behaviors. In particular, gambling and lottery-related behaviors were not viewed as very dangerous; consequently, absent an awareness of the negative consequences of these activities, more students participated in gambling than any other potentially addictive behavior.

As would be expected, both gambling and substance use increased with grade. The lifetime prevalence of most activities increases as students gain life experience. Tobacco and alcohol use, in particular, substantially increased across grades. Given that middle school is a critical time in which children begin gambling and using substances, education about the risks and hazards associated with these activities is essential. Furthermore, a large proportion of students already are participating in gambling activities by the fifth grade. These findings suggest that education about these issues should begin even earlier than middle school.

National Prevalence Comparisons. When the substance use patterns of eighth grade Merrimack Valley students were compared with 1993 national averages, Merrimack Valley students were shown to have lower or similar prevalence rates for all substances except marijuana. This finding suggests that the Merrimack Valley does not have an uncommon level of drug use. During the past two years, national prevalence rates for marijuana use have increased; the proportion of Merrimack Valley students using marijuana appears to be comparable with this trend. One goal of the new addiction science curriculum will be to reverse this trend. If Merrimack Valley middle schools provide high quality addiction science education, students' gambling and substance use prevalence rates should decline, falling below national averages.

Conclusions

There are potential risks associated with generalizing findings from a regional sample to the rest of the country. Keeping these risks in mind, we will use the findings of the science

education needs assessment to guide the development of the new addiction science curriculum for middle school students. This research revealed that the majority of middle school students have a strong interest in the area of addictions, and science is one of their favorite classes. Having hands-on science experience increased students' interest in science. In addition, students from earlier grades had more favorable views of science education than students in later grades. While students reported that they and their friends and families were more interested in alcohol & drug education than in science education, they thought their science teachers were more interesting and interested in their subject matter. Students classified as science advocates perceived potentially addictive behaviors as more dangerous than those who were impartial toward studying science. Increased perceived danger of substance use and gambling was associated with reduced substance use and gambling. Finally, science advocates and science impartials were more similar in their interest in the study of addiction than they were in any other area of contemporary science education.

Given that the majority of students have a strong interest in the area of addictions, and science already is one of their favorite classes, we can conclude that introducing the area of addictions into science class should prove educationally beneficial. Through hands-on experience, both at school and at home, students' interest in science will increase. In addition, doing science permits students to improve their ability to apply the scientific method to the problems of daily living. Furthermore, since science advocacy is positively correlated with an increased perception of danger associated with addictive behaviors, this curriculum, when implemented by trained personnel, can be expected to prevent or delay students' use of psychoactive substances. By integrating science and addiction studies, drug and alcohol related problems should decrease as students' interest and understanding of science increases.

The New Addiction Science Program: Architecture for New Educational Experiences. Recently, Yager and Lutz (1994) suggested that "Warnings from the past have had little impact on our massive reform efforts of the 35 years following Sputnik and/or our current efforts with 2061, SS&C or STS....We remain enamored of materials that define the goals, the curricula, the form of instruction, and the information we use to assess our successes. Yet the research seems clear: how we teach is more important than what we teach. Why do we continue to focus on the 'what,' while making the assumption that no real attention need be paid to the 'how?'" (p. 342). The Harvard Billerica Addiction Science Education Project (Harvard BASE Project) will focus on how young people are taught science. We believe there must be a balance between <u>what</u> is taught in science education and <u>how</u> it is taught. We do not subscribe to the "fill 'em up" theory of education (i.e., more information is better). Instead, contemporary curricula must provide information that is crucial to an individual's capacity to interact successfully and experience heartily the contemporary social world with all of its potential trappings. Using addictive

behaviors as the object of science education provides an opportunity for young people to experience chemistry, biology, physics, statistics, logic, scientific methods, psychology, geography and other science- related disciplines through a meaningful template of current issues that confront them on a regular basis. As we described earlier, research on science education consistently indicates that students fail to relate learning science to either their daily lives or future careers (e.g., Yager and Lutz, 1994). Therefore, teaching science requires more personally relevant meaning for students to successfully navigate the objects of science (e.g., Matthews, 1994).

The Addiction Science Curriculum. The results of this needs assessment study provide direct support for the Harvard BASE Project mission: to increase students' interest in science by teaching science through the study of addictive behaviors. To accomplish this objective, we will design a new middle school science curriculum that will provide students with the opportunity to learn, for example, about the sources of drugs, classes of abused drugs, medical uses of drugs, the basic structure of nerve cells, drug receptor interactions, how drugs alter normal synaptic transmission, neuroanatomy, addictions, research methods, and hypothesis testing. Teachers will be encouraged to use hands-on, interactive and case study teaching methods. The new addiction science curriculum will be multidisciplinary in focus, emphasizing both the scientific and humanistic issues of drug abuse.

Addiction Science Corps. In addition to the middle school addiction science curriculum, the Harvard BASE Project will introduce students and teachers to a range of science careers in drug abuse and addiction research by providing a limited number of summer internships working with scientists who study addictive behaviors. This group will be known as the Addiction Science Corps (ASC). The ASC, like a student newspaper, will become an extracurricular high school science program capable of providing a community with social psychological research and information about addiction in general and drug use and abuse in particular.

In sum, the Billerica School System and Harvard Medical School partnership have undertaken a special project in contemporary American education by building a curriculum to increase interest in science and, at the same time, help prevent or delay substance abuse. By using science as a means to reduce substance abusing behavior patterns, and addiction studies as a means to increase interest in science, we hope to have a positive effect on two very important contemporary issues.

"Science is an integral part of culture. It's not this foreign thing, done by an arcane priesthood. It's one of the glories of the human intellectual tradition."

Stephen Jay Gould, *Independent* (London, January 24, 1990)

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