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# Multimedia Science Education on Drugs of Abuse:
# A Preliminary Evaluation of Effectiveness for Adolescents

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Abstract

This paper reports on the development and evaluation of a science education-based multimedia prevention curriculum on drugs of abuse. The evaluation used a pretest/post-test quasi-experimental design in which sixth, seventh and eighth-grade students in the treatment group (N=611) were exposed to the curriculum and those in the control group (N=731) were not. Eight charter schools in four states participated. Descriptive and multivariate approaches were used to analyze data from knowledge and attitude measures. The findings suggest that the multimedia approach significantly improved knowledge about drugs of abuse in the treatment group, providing preliminary support for the approach of using multimedia science education as a health education and prevention tool in schools.

## Introduction

Adolescent substance abuse is a significant public health problem. According to the National Survey on Drug Use and Health (NSDUH, 2006), 2.7 million youth used alcohol for the first time and 1.5 million used an illicit drug in the past year. Similarly, the 2005 *Monitoring the Future* survey found that 41 percent of eighth graders have used alcohol, and 21 percent have used an illicit drug (Johnston et al 2006). These usage rates are alarming because drug use in adolescence can have serious physical, emotional, and social consequences. Physical consequences of adolescent drug use include short and long-term negative effects on the brain and body, including disease, impaired judgment, addiction, and even death (Girasek, Gielen & Smith, 2003; Naimi et al 2003). Emotional risks for youth that drink or use drugs include high rates of depression and suicidal thoughts (Hallfors, et al 2004) and a higher risk of later substance abuse and dependence (Anthony & Petronis, 1995; Hawkins et al 1997; Gil, Wagner & Tubman, 2004). Other negative consequences include poor academic performance and school drop-out (Ellickson, Bui & Bell, 1998; Windle & Wiesner, 2004), early sexual initiation (Mott et al 1996; NCASA 1999) and perpetration of violence (SAMHSA 2001).

What is more, longitudinal studies suggest that many of the negative outcomes associated with youth drug use can persist into adulthood. Adolescents who were regular users of alcohol or had experimented with it in seventh grade are more likely to have academic, legal, and social problems throughout high school and young adulthood than their non-drinking peers (Ellickson, Tucker & Klein, 2003).

A large body of literature indicates that school-based substance abuse prevention programs can reduce drug use (Hansen 1992; Tobler & Stratton 1997; McBrider, 2003). In particular, increasing knowledge about the negative effects of drugs may effectively delay the onset of use and prevent negative consequences of use among youth (Perry et al 1996; Wynn, Schuenburg, Kloska & Laetz, 1997; Komro et al 2001; Botvin & Griffin, 2003). Evidence supports implementation of prevention curricula before high school, as by that time the majority of youth are already experimenting with alcohol and drugs (Foster, Vaughan, Foster & Califano, 2003). According to the 2005 Youth Risk Behavior Survey, conducted every year by the Centers for Disease Control, 26 percent of the high school students in the U.S. started drinking alcohol before age 13, and each successive cohort of high school freshmen is initiating drinking at an earlier age (CDC 2005). Early prevention is crucial, because delaying the onset of drug use during adolescence may delay or prevent future addiction and negative consequences (Grant et al, 2005).

Despite the benefits of school-based prevention, the amount of this instruction that children receive declined significantly from 2000 to 2004 (Orwin 2006). Indeed, with the implementation of the No Child Left Behind law, the emphasis on core academic subjects such as math, science, reading, and writing often means less instructional time for health and prevention (NEA 2004; Morse, Wilbur & Ballard 2004).

In this new educational climate, science education offers an opportunity to inject persuasive health information into the core curriculum. Because science education curricula are matched to state and national standards of learning, they can be integrated into the standard science curriculum, a core area less prone to cutbacks than prevention or health in a time-pressed, standards-driven educational climate (NEA 2004; Morse, Wilbur & Ballard 2004).

Because there is a negative correlation between the perceived risks of using a drug and actual drug use, a critical component of prevention is information about drugs and their consequences (Johnston et al 2006). But science education differs from prevention as this information is presented without admonitions against use, and drugs are not described as bad or dangerous. Despite the differences between science education and prevention, the presentation of information in a science education curriculum about drugs may be persuasive and may therefore change attitudes and intentions. In this manner, science education can be a type of “stealth” prevention in which students are presented with facts that are likely change their attitudes and behaviors regarding drug use, but not direction to do so.

The scientific concepts related to drug use, including information on brain function and neurotransmission and how drugs change them, are complex. Nonetheless, research has shown that children of all ages can master complex concepts when information is presented in an engaging and age-appropriate format (Liu, 1996). Multimedia applications such as CD-ROM-based games, where difficult concepts are illustrated and interactive and competitive elements are included to engage the learners, hold promise as education and prevention tools.

Interactive multimedia tools combine text, graphics, and sound in formats that can be manipulated by the user (Suomala, Korhonen & Ketamo, 2000). The use of educational multimedia has grown in tandem with increased access to computers in school settings. In 1993, only 3 percent of all classrooms had Internet access, but this grew to 93 percent in 2003 (Parsad & Jones 2007). Moreover, in 2003, 77 percent of students in Kindergarten through twelfth grade lived in a household with a computer (NSF 2006). At the same time, there is a growing body of evidence on the ability of multimedia to actively engage students in the learning process (Coley, Cradler & Engel, 1999; Rideout & Hamel, 2006).

Multimedia techniques tend to support children with different learning styles (Liu, 1996; Zimmer, 2003; Shady, 2007). The interactive nature of multimedia products encourages active learning and participation (Moreno & Mayer, 1999; Suomala, Korhonen & Ketamo, 2000) and may hold particular promise for inquiry-based instruction, where students gather, analyze and synthesize information to solve multifaceted problems (Sandholtz, Ringstaff & Dwyer, 1997; Ringstaff & Kelley, 2002). What is more, interactive multimedia provides students with opportunities to practice skills and may enhance their motivation and self-efficacy to make healthy decisions and manage their health (Lieberman 2001; Duncan et al 2000).

Multimedia educational approaches successfully taught children and adolescents complex science concepts, such as neuroscience and astronomy (Miller, Moreno, Smither & Mayers, 2006; Taasoobshirazi, Zuiker, Anderson & Hickey, 2006), and health skills, including pedestrian safety, asthma management, and drug prevention (Lieberman, 2001; Glang, Noell, Ary & Swartz, 2005; Williams, et al 2005; McPherson et al 2006). Recently, a multimedia drug prevention program for adolescents was designed to reduce drug use by increasing knowledge and self-efficacy. The CD-ROM included 10 sessions that taught students general social skills and drug resistance skills through interactive audio and video. Exposure to the intervention related to increased knowledge and protective attitudes towards drugs and alcohol, and the intervention was highly engaging to students (Williams et al 2005).

Based on research on the scope and consequences of youth drug use, recent changes in the educational climate that necessitate innovative methods to provide prevention information to students, and the potential power of multimedia tools to engage and educate, this article explores the development and preliminary evaluation of a science education-based multimedia curriculum on drugs of abuse. More specifically, we use a pretest/post-test quasi-experimental design in which sixth, seventh and eighth-grade students in the treatment group were exposed to the curriculum and those in the control group were not to address the following empirical questions:

- How did knowledge of science and drugs change from pretest to post-test?

- To what extent does group assignment (treatment or control) relate to change in knowledge about science and drugs? In other words, what is the effect of the multimedia curriculum on knowledge change?
- How do factors, such as protective attitudes toward drugs, relate to change in knowledge?
- What is the statistical effect of the curriculum on knowledge change, when controlling for other key factors, such as grade, gender, and race of the students?

The remainder of this paper discusses the development and theoretical foundation of the curriculum, provides the methodology used its evaluation, describes the key findings of the evaluation, and concludes with the theoretical and practical implications of implementing a science education-based, multimedia curriculum on substance abuse in middle schools.

**Development of and Theoretical Basis for a Multimedia Science Education Curriculum**

The multimedia science education curriculum, entitled *Keys to Brain Power!* and developed with funding from the National Institute on Drug Abuse, provides students in grades 6–8 with interactive lessons on the normal functions of the brain, nervous system, and the body, and how drugs change these processes. The overarching goal of the curriculum is to increase knowledge about these topics and promote protective attitudes about drugs. The curriculum was developed through an iterative process, incorporating input from the target audiences of youth and teachers, as well as experts in the field of substance abuse and neuroscience. Because of the policy push in primary and secondary education to increase the proficiency of students in math, reading, and science, the content of the curriculum was aligned with National Science Education Standards (NSES) and key state standards of learning.

There are six lessons in the multimedia curriculum. Each lesson focuses on a discrete topic and contains several interrelated activities, including quizzes, animated tutorials, and games. Lessons build on one another cumulatively, where early lessons on the typical functioning of the brain serve as a foundation for later modules on how drugs change that functioning. The curriculum provides scientific information on many specific drugs, including alcohol, nicotine, inhalants, prescription and over-the-counter drugs, marijuana, cocaine, heroin, steroids, methamphetamine, and club drugs such as GHB, MDMA, Ketamine, and Rohypnol. All lessons were field tested with the target audiences prior to initiating the formal evaluation of the curriculum. Figure 1 provides the learning objectives of the curriculum by lesson.

The multimedia curriculum was delivered through a self-contained CD-ROM. For the evaluation, the teacher provided a brief introductory discussion on the topic of the lesson and instructed students, working together in small groups, to explore the CD-ROM lesson at a self-directed pace. Students completed one lesson per 45 minute class period, over the course of two weeks, at a rate of three lessons per week.

The curriculum was predicated on the Theory of Reasoned Action (TRA), which posits that exposure to new persuasive information causes progressive changes in knowledge, attitudes, and ultimately behavior (Ajzen, 1991). People generally have negative attitudes toward behaviors that they believe will result in negative outcomes (Mykytyn & Harrison, 1993). This curriculum builds knowledge about the physical risks of drugs use, which theory suggest will then translate into attitude, intention, and eventually behavior change. A seminal work applied the TRA to drug abuse prevention (Fishbein & Middlestadt, 1987). Since that study, the TRA has been used extensively to explain motivations for drug consumption (Petraitis, Flay & Miller, 1995; Norman, Bennet & Lewis 1998; Morrison et al 2002) and to design interventions to prevent drug use (Amaro, Black, Schwartz & Flinchbaugh 2001; McNeal, Hansen, Harrington & Giles, 2004; Worden & Slater 2004).

**Figure 1: Learning objectives for a multimedia science education curriculum, by lesson**

**MODULE 1: AN INTRODUCTION TO THE BRAIN AND NERVOUS SYSTEM**
After completing this lesson, students will be able to:
- Name the major parts of the brain: cerebral cortex, hypothalamus, cerebellum, brain stem, and limbic system
- Identify the lobes of the cerebral cortex: frontal, parietal, occipital, and temporal
- Explain the functions of the major brain parts
- Identify the components of a neuron: cell body, dendrites, and axon
- Explain the process of neurotransmission

**MODULE 2: LEGAL DOESN'T MEAN HARMLESS**
After completing this lesson, students will be able to:
- Explain how nicotine disrupts neurotransmission
- Explain how alcohol use may harm the brain and body
- Understand how alcohol can intensify the effects of other drugs
- Define addiction and understand its basis in the brain
- Draw conclusions about why our society regulates the use of nicotine and alcohol for youth

**MODULE 3: DRUGS IN THE CUPBOARD**
After completing this lesson, students will be able to:
- Explain the effects of prescription drugs
- Explain how prescription drugs affect the brain and body when used improperly Understand how inhalants can change the brain
- Understand why it is important to use medication as instructed

**MODULE 4: WEEDING OUT THE GRASS**
After completing this lesson, students will be able to:
- Explain the short- and long-term effects of marijuana use and the seriousness of these effects
- Understand how THC, the active ingredient in marijuana, disrupts neurotransmission
- Explain how marijuana can adversely affect the hippocampus and other parts of the brain

**MODULE 5: DRUGS ON THE STREET**
After completing this lesson, students will be able to:
- Explain how heroin and cocaine use affect the brain and body
- Explain how heroin and cocaine use affect normal neurotransmission
- Understand how heroin and cocaine can change the brain and cause addiction

**MODULE 6: DRUGS IN THE NEWS**
After completing this lesson, students will be able to:
- Explain the effects that methamphetamine, steroids, and many common "club drugs" can have on the brain and body
- Understand the dangers of these drugs and become aware of their presence in our society
- Identify and critically analyze the media information about drugs in the news

Although the TRA is common to the field of public health and prevention, it has not been applied to science education, which instead focuses on knowledge acquisition and application of the scientific process (Bower 2007). The integration of behavior change theory and science education creates opportunities for schools to integrate prevention into the core curriculum as opportunities for traditional prevention become increasingly limited. Using multimedia to present science education material may decrease barriers to adoption faced by traditional prevention curricula.

## Method

The evaluation used a quasi-experimental, pretest/post-text design. Eight charter schools located in North Carolina, Tennessee and Texas participated. Students in four of the schools were assigned to an experimental group and received the multimedia curriculum. Students in the other schools were assigned to the control group and therefore received no exposure to the curriculum. Multiple sixth, seventh and eighth grade classrooms in each school participated. A federally registered Institutional Review Board approved all human subjects protections for the research.

We created several instruments to assess students' knowledge and attitudes. These measures were based on existing measures in the literature, and none exceed a fifth-grade reading level, as tested by the Flesch-Kinkaid Readability Index.

*Knowledge*: We developed a 24-item multiple-choice instrument to assess children's knowledge about drugs and drug abuse before and after the curriculum intervention. Items directly test knowledge, application, and synthesis of content material in the curriculum. For these knowledge questions, we recorded pretest and post-test answers and determined their correctness. Each student could receive a maximum of 24 correct answers on the survey. We summed the correct answers to create composite scores for the experimental and control groups at pretest and post-test.

*Attitudes*: Drawing from the literature on drug and alcohol expectancies (Christiansen, Goldman & Inn, 1982) we created a 5-item attitude survey that asked students to rate, on a 5-point likert scale, how likely negative social, academic, legal and health outcomes were from drug use. These questions allowed us to create several independent variables that theoretically predict a change in knowledge about drugs. For example, we used pretest scores to calculate the degree to which the two groups held protective attitudes about drugs before the curriculum was implemented. These "preexisting" factors, one may theoretically reason, may explain some of the variation in knowledge change across the study groups.

Additional independent variables include group assignment (experimental or control) and student-level demographic controls, such as gender, race, and grade. Experimental group assignment (yes/no) and gender (male/female) are measured dichotomously. Race is measured as white, African-American, and other. Grade is measured as $6^{th}$, $7^{th}$ or $8^{th}$.

We use both descriptive and multivariate statistical methods to analyze the data. But the manner in which the data were collected creates some methodological challenges and limitations to this study. Because we were not provided with unique identifiers for students in the study, we analyzed the data as separate populations by group assignment (experimental and control) and time (pre-test and post-test). Also, how schools were assigned to experimental and control groups created some participant bias. Indeed, Table 1 shows that there were significant differences in the population characteristics by age, grade, race and location at pre-test. These variations were also evident at post-test, suggesting that random assignment was not effective in creating equivalent groups. While we attempt to control for these differences, the generalizability of these findings to other school populations should be viewed cautiously. Still, the data consist of 1,342 observations from two points in time (pretest and post-test), providing a well-sized data set to examine the extent of knowledge and attitudinal change in the two populations.

**Results**

The data reveal several key findings about the impact of the multimedia curriculum on knowledge and attitudes in the target population. First, the experimental group gained considerable knowledge between the pre-test and the post-test. Indeed, differences in knowledge in the experimental group were positive and statistically significant in 14 of the 24 survey questions (Table 2). Most impressive was the knowledge increase on the question of which part of the brain is likely to be damaged by teen alcohol use. At pre-test, 19.9 percent of students in the experimental group correctly answered that the hippocampus had the greatest probability of being damaged. At post-test, 50.5 percent of survey participants identified the correct answer. Similarly, only 16.1 percent of participants knew at pre-test that which rat should be given a placebo in an experiment that tests drug effects. At post-test, the percentage of correct responses had significantly increased to 49.2 percent.

The composite score for the experimental group also demonstrates a significant difference in knowledge across the span of survey questions. As noted above, the composite knowledge score equals average number of questions answered correctly. On average, students correctly answered roughly 40 percent of the knowledge questions at pre-test (Table 2). But at post-test the average correct response rate was 52.1 percent. This positive change in knowledge is significant at the 99 percent confidence level.

The experimental group did lose ground on two knowledge questions, although only one showed a statistically significant difference. From pre-test to post-test, students exhibited a slight loss in knowledge (0.7 percentage points) in which drug is used by athletes to build muscle but can cause stunted growth (steroids). Still, even with the knowledge loss, 4 of every five participants in the experimental group correctly answered the question. More problematic is the considerable decrease in correct responses on the question of whether nonmedical use of prescription drugs over a long time can lead to addiction. From pre-test to post-test, the percentage of experimental students correctly answering “sometimes” declined from 30.4 to 14.6. The explanation for this decrease is unclear and may reflect some ambiguity in the curriculum. Nevertheless, the students who answered the question correctly on the pre-test but wrong on the post-test were more likely to switch their answers to “yes” than “no,” potentially suggesting that they were developing more protective attitudes about drugs.

Another key finding is that participants in the control group saw very little change in knowledge from pre-test to post-test. As shown in Table 3, students in this group exhibited statistically significant knowledge increases on only 4 of the 24 questions. Conversely, they exhibited significant knowledge losses on 2 of the 24 survey questions. And on average, students in the control group correctly answered 37.3 percent of the questions during the pre-test and 37.1 on post-test, reflecting a small and expected change. This finding suggests that not only did the students in the experimental group gain more knowledge across the two points in time, but participants in the experiment group finished the study with significantly more knowledge about the effects of alcohol and other drugs of abuse than students in the control group.

A third key finding is that, in contrast to knowledge, the curriculum appears to be relatively ineffective in changing attitudes about drugs of abuse in the treatment group. Indeed, Table 4 shows no significant differences – either positive or negative – on a series of attitudinal measures about alcohol and drugs. While not statistically significant, the biggest increase in protective attitudes related to students' assessment of whether a person who uses drugs can do poorly in school or at work. At post-test, roughly 66 percent of participants in the experimental group answered "very likely" on this measure, compared to 59 percent at pre-test. Still, the findings reveal that although the attitudes failed to change in any significant way, students exhibited relatively strong protective attitudes about drugs of abuse at both points in time. Of a maximum of 100 percentage points that a student could receive for protective attitudes on the five survey measures, the average student earned a score of 86.5 at both pre-test and post-test. In contrast, children in the control group showed a relatively steep decline in protective attitudes about alcohol and drugs. Indeed, students exhibited a significant decrease in all five attitudinal measures. It is unclear why these drops occurred, but they may relate to testing fatigue (Table 5).

The demographic and locational bias in the survey populations necessitates the need to control for these factors in order to estimate the statistical impact of the curriculum on knowledge differences. These estimations are supplied in two OLS models reported in Tables 6 and 7, respectively. Table 6 provides a series of statistical determinants of the composite knowledge score at the pre-test stage. Table 7 puts forth an identical model at post-test.

In Table 6, participation in the experimental group at pre-test is significantly and positively related to knowledge scores, when controlling for other demographic and fixed effects. In fact, students in the experimental group provided nearly more one correct answer at pretest (Beta=0.78) on the survey than those in the control group, when holding constant other factors. Compared to their reference groups in the model, students aged 11 and 12 and those in grades 7 or 8 are also scored significantly higher on the knowledge test, while students in North Carolina scored lower.

If one compares the results of the two models, however, the potentially important effect of the curriculum on knowledge gains is evident. Indeed, the relationship between experimental group participation and knowledge was much higher at post-test. There, students who received the curriculum intervention produced nearly 4 more correct answers (Beta=3.86) than control group participants (Table 7). And not only did the benefit of being a member of the experimental group gain in strength, but the effects of various demographic factors decreased. While students in grades 7 and 8 were scored higher than those students in sixth grade, the significant relationship between age and knowledge and location and knowledge disappeared from pre-test to post-test in the OLS models. In the end, the post-test model suggests that, holding certain factors equal, participation in the experimental group and receipt of the curriculum serves as the strongest determinant of knowledge about the effects of alcohol and drugs on the body.

## Discussion

Overall, the results suggest that the multimedia curriculum under evaluation is relatively effective at increasing knowledge about alcohol and drugs of abuse. In fact, there was a significant increase from pre- to post-test in overall knowledge about the topics in the curriculum in the experimental group, and the significance of this knowledge change remained high even after effects of grade, geographic location, and ethnicity were controlled for using multivariate statistical techniques. In contrast, the control group showed no significant change in knowledge.

The potential practical benefits of the curriculum are notable. Because school-based prevention is related to decreases in adolescent drug use, a multimedia curriculum that provides relevant information to youth may be an effective method to reach students. Indeed, the research suggests that a multimedia curriculum such as the science-based approach described in this paper is likely to engage students. In addition, the curriculum offers students an opportunity to build computer literacy while being exposed to health promotion and risk reduction content.

Moreover, aligning the curriculum with state and national science standards may increase the willingness of schools and their teachers to implement the curriculum. In fact, the curriculum is likely to be attractive to schools that are exploring ways to integrate health education into the core curriculum. Teachers may also find the curriculum attractive because its preparation demands are low, and their students can move through the lessons in an independent manner.

The evaluation did reveal a potentially important limitation of the curriculum, however: there was no statistically significant evidence that the curriculum positively effected attitudes about drugs of abuse. Although potentially problematic, the finding raises a number of possible explanations. First, the five-point measure on attitudes used for the evaluation was very limited and may have lacked the sensitivity to uncover the full range of attitude change. Second, students in both the experimental and control groups entered the study with relatively strong protective attitudes toward drugs, suggesting a possible ceiling effect. In fact, students in both the experimental and control groups scored in the range of 55 – 76 percent protective attitudes at pretest. Third, an immediate post-test may not have provided enough time for attitudes to change. Educational materials designed to change attitudes in teens must not only provide accurate information about the topic, but they must also encourage youth to apply the knowledge to their own lives (Schulze et al 2003). The multimedia curriculum provides the former, but the design of the evaluation may not have allowed time for students to apply the new information to their own lives. Attitudes are primarily formed and maintained through experiences and the environment, making them difficult to change in a very short time (Gleitman, Fridlund & Reisburg, 1999).

Taken together, the results of this evaluation provide preliminary support for the approach of using multimedia science education as a health education and prevention tool, at least with regards to changing knowledge about drugs of abuse. Whether through the use of a more sensitive attitudinal measure or by allowing more time to elapse following the post-test, more information is needed to determine the extent to which knowledge and attitude changes, as they relate to the curriculum, are connected. Finally, the results of the evaluation point to the need for research on other innovative approaches that decrease barriers to delivery of critical health information to students in the current educational climate.

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**Table 1. Mean Differences in Population Characteristics, by Group Assignment**

| | Experimental Group N=611 | | Control Group N=731 | | |
|---|---|---|---|---|---|
| | Mean | Std. | Mean | Std. | Signif. |
| Age | | | | | |
| 11 | 16.8 | 37.4 | 22.2 | 41.6 | * |
| 12 | 39.3 | 48.9 | 33.2 | 47.1 | * |
| 13 | 30.3 | 46.0 | 29.7 | 45.7 | |
| 14 | 9.3 | 29.1 | 12.9 | 33.5 | * |
| 15 | 4.3 | 20.4 | 2.1 | 14.2 | * |
| Grade | | | | | |
| Grade 6 | 26.8 | 44.3 | 40.4 | 49.1 | ** |
| Grade 7 | 52.6 | 50.0 | 39.6 | 48.9 | ** |
| Grade 8 | 20.6 | 40.4 | 20.1 | 40.1 | |
| Gender | | | | | |
| Male | 51.6 | 50.0 | 52.0 | 50.0 | |
| Female | 48.4 | 50.0 | 48.0 | 50.0 | |
| Race/ethnicity | | | | | |
| Caucasian | 51.1 | 50.0 | 63.5 | 48.2 | ** |
| African American | 35.0 | 47.7 | 17.5 | 38.0 | ** |
| Hispanic | 5.1 | 22.0 | 11.1 | 31.4 | ** |
| Other | 8.8 | 28.4 | 8.0 | 27.1 | |
| State | | | | | |
| North Carolina | 58.3 | 49.4 | 18.9 | 39.2 | ** |
| South Carolina | 11.0 | 31.3 | 19.5 | 39.6 | ** |
| Tennessee | 30.8 | 46.2 | 61.6 | 48.7 | ** |

Source: Authors' tabulations of KBP data, 2007

*: p<=0.05

**: p<=0.01

**Table 2. Percentage Correct Answers on Knowledge Questions in Experimental Group, by Test**

| | Experimental | | | |
|---|---|---|---|---|
| | Pre-test N=316 | Post-test N=295 | Change in | |
| Question | % | % | % | Signif. |
| In an experiment that tests drug effects, which rat should be given a placebo? | 16.1 | 49.2 | 33.0 | ** |
| Which part of the brain is most likely damaged by teen alcohol use? | 19.9 | 50.5 | 30.6 | ** |
| Nicotine use affects neurotransmission… | 34.2 | 62.4 | 28.2 | ** |
| What is the chemical in marijuana? | 36.4 | 62.4 | 26.0 | ** |
| Methamphetamines and the production of toxic waste… | 51.9 | 76.6 | 24.7 | ** |
| What part of the brain is strongly affected by drugs of abuse? | 15.5 | 36.9 | 21.4 | ** |
| Using animals in research has helped scientists develop important medicines? | 72.5 | 90.5 | 18.0 | ** |
| Which is NOT the name of an illegal drug? | 12.3 | 29.8 | 17.5 | ** |
| Which neurotransmitter does cocaine most affect? | 24.4 | 40.7 | 16.3 | ** |
| What does the cerebral cortex do? | 22.5 | 38.3 | 15.8 | ** |
| Which set of prescription drug categories increases drowiness? | 46.5 | 61.4 | 14.8 | ** |
| How does nicotine change neurotransmission? | 49.1 | 63.7 | 14.7 | ** |
| Three steps in the cycle of addiction… | 64.6 | 76.6 | 12.1 | ** |
| How does marijuana affect memory? | 64.2 | 73.2 | 9.0 | * |
| Which category of drugs increases alertness? | 53.8 | 60.3 | 6.5 | |
| What is the space between two neurons? | 24.1 | 30.5 | 6.5 | |
| Which is most likely to happen when alcohol reaches the cerebellum? | 40.5 | 46.8 | 6.3 | |
| What is withdrawl? | 53.5 | 59.0 | 5.5 | |
| What happens to neurotransmitters after a message is passed to another neuron? | 30.1 | 34.9 | 4.9 | |
| How does cocaine affect a neurotransmitter? | 20.6 | 22.7 | 2.1 | |
| In general, brain scans show… | 63.6 | 65.1 | 1.5 | |
| Inhalant use damages which part of the neuron? | 23.7 | 24.4 | 0.7 | |
| Which drug is used by athletes to build muscle but can cause stunted growth? | 80.7 | 80.0 | -0.7 | |
| Nonmedical use of prescription drugs over a long time can lead to addiction… | 30.4 | 14.6 | -15.8 | ** |
| | | | | |
| Composite Score | 39.6 | 52.1 | 12.5 | ** |

Source: Authors' tabulations of KBP data, 2007

*: $p<=0.05$

**: $p<=0.01$

**Table 3. Percentage Correct Answers on Knowledge Questions in Control Group, by Test**

| | Control | | | |
|---|---|---|---|---|
| | Pre-test N=362 | Post-test N=377 | Change in | |
| Question | % | % | % | Signif. |
| What is the space between two neurons? | 25.4 | 39.0 | 13.6 | ** |
| What does the cerebral cortex do? | 24.0 | 34.7 | 10.7 | ** |
| Three steps in the cycle of addiction… | 48.6 | 56.2 | 7.6 | * |
| What part of the brain is strongly affected by drugs of abuse? | 9.4 | 14.6 | 5.2 | * |
| In an experiment that tests drug effects, which rat should be given a placebo? | 18.8 | 23.6 | 4.8 | |
| Methamphetamines and the production of toxic waste… | 45.3 | 49.9 | 4.6 | |
| How does nicotine change neurotransmission? | 38.7 | 42.2 | 3.5 | |
| Using animals in research has helped scientists develop important medicines? | 75.7 | 79.0 | 3.4 | |
| What is withdrawl? | 42.3 | 43.5 | 1.2 | |
| Which is most likely to happen when alcohol reaches the cerebellum? | 44.8 | 44.3 | -0.5 | |
| Which neurotransmitter does cocaine most affect? | 26.0 | 25.5 | -0.5 | |
| What is the chemical in marijuana? | 27.9 | 27.3 | -0.6 | |
| Inhalant use damages which part of the neuron? | 22.9 | 21.2 | -1.7 | |
| Which part of the brain is most likely damaged by teen alcohol use? | 23.5 | 21.8 | -1.7 | |
| Which set of prescription drug categories increases drowiness? | 43.6 | 41.6 | -2.0 | |
| What happens to neurotransmitters after a message is passed to another neuron? | 27.6 | 25.2 | -2.4 | |
| Which is NOT the name of an illegal drug? | 18.5 | 14.9 | -3.7 | |
| Which category of drugs increases alertness? | 47.0 | 42.7 | -4.3 | |
| How does marijuana affect memory? | 62.2 | 57.6 | -4.6 | |
| How does cocaine affect a neurotransmitter? | 24.6 | 19.1 | -5.5 | |
| In general, brain scans show… | 58.0 | 52.5 | -5.5 | |
| Nicotine use affects neurotransmission… | 38.1 | 31.6 | -6.6 | |
| Which drug is used by athletes to build muscle but can cause stunted growth? | 70.4 | 61.5 | -8.9 | * |
| Nonmedical use of prescription drugs over a long time can lead to addiction… | 32.6 | 21.2 | -11.4 | ** |
| | | | | |
| Composite Score | 37.3 | 37.1 | -0.2 | |

Source: Authors' tabulations of KBP data, 2007

*: p<=0.05

**: p<=0.01

**Table 4. Respondents' Protective Attitudes Toward Drugs of Abuse in the Experimental Group, by Test**

| | Experimental | | | | | |
|---|---|---|---|---|---|---|
| | Pre-test | | Post-test | | Change in | |
| Measure | N | % | N | % | % | Signif. |
| A person who uses drugs can get into trouble with the law | 301 | 71.8 | 271 | 70.1 | -1.7 | |
| I think that drug use is dangerous | 301 | 76.1 | 271 | 78.2 | 2.1 | |
| A person who uses drugs can do poorly in school or at work | 301 | 58.8 | 270 | 65.9 | 7.1 | |
| A person who uses drugs can have more fun at parties… | 301 | 54.5 | 271 | 48.0 | -6.5 | |
| A person who uses drugs can have problems with family and friends | 301 | 59.1 | 270 | 61.9 | 2.7 | |
| | | | | | | |
| Composite Score | 301 | 18.2 | 269 | 18.2 | 0.0 | |
| % Composite Score | 301 | 86.5 | 269 | 86.5 | 0.0 | |

Source: Authors' tabulations of KBP data, 2007

Note: Data from attitude questions reported in percentages. Composite score range from zero to 21, where 21 represents the maximum sum of the five attitude questions and the greatest possible protective attitudes toward drugs of abuse. The percentage composite score equals the composite score divided into 21.

*: p<=0.05

**: p<=0.01

**Table 5. Respondents' Protective Attitudes Toward Drugs of Abuse in the Control Group, by Test**

| | Control | | | | | |
|---|---|---|---|---|---|---|
| | Pre-test | | Post-test | | Change in | |
| Measure | N | % | N | % | % | Signif. |
| A person who uses drugs can get into trouble with the law | 345 | 69.0 | 366 | 61.5 | -7.5 | |
| I think that drug use is dangerous | 347 | 75.2 | 364 | 66.5 | -8.7 | |
| A person who uses drugs can do poorly in school or at work | 347 | 67.4 | 364 | 57.7 | -9.7 | |
| A person who uses drugs can have more fun at parties… | 346 | 55.5 | 364 | 42.3 | -13.2 | |
| A person who uses drugs can have problems with family and friends | 347 | 69.2 | 363 | 61.4 | -7.7 | |
| | | | | | | |
| Composite Score | 343 | 18.2 | 357 | 17.3 | -0.9 | |
| % Composite Score | 343 | 86.8 | 357 | 82.4 | -4.4 | |

Source: Authors' tabulations of KBP data, 2007
Note: Data from attitude questions reported in percentages. Composite score equals scale of zero to 21, where 21 represents the maximum sum of the five attitude questions and the greatest possible protective attitudes toward drugs of abuse. The percentage composite score equals the composite score divided into 21.
*: p<=0.05
**: p<=0.01

**Table 6. Determinants of Composite Knowledge Score at Pre-test**

| Variable | Coefficient | S.E. | Significance |
|---|---|---|---|
| Experimental group | 0.78 | 0.24 | ** |
| Protective attitudes - drugs of abuse | 0.05 | 0.04 | |
| Positive attitudes - science | 0.02 | 0.02 | |
| Age | | | |
| 11 | 1.49 | 0.81 | ** |
| 12 | 1.08 | 0.74 | * |
| 13 | 0.67 | 0.69 | |
| 14 | 0.20 | 0.71 | |
| Grade | | | |
| Grade 7 | 1.32 | 0.34 | ** |
| Grade 8 | 0.89 | 0.47 | ** |
| Gender: male | 0.30 | 0.21 | |
| Race/ethnicity | | | |
| Caucasian | 0.52 | 0.41 | |
| African American | -0.11 | 0.45 | |
| Hispanic | -0.16 | 0.55 | |
| State | | | |
| North Carolina | -0.88 | 0.30 | ** |
| South Carolina | -0.08 | 0.38 | |
| Constant | 5.83 | 1.12 | ** |

Source: Authors' tabulations of KBP data, 2007
Notes: N=554; Adjusted R-square =0.127
Reference groups in the general linear model
include age=15, grade 6, race=other, and state=Tennessee
Protective attitudes for drugs of abuse and positive attitudes about
science are reported as composite scores, respectively.
*: p<=0.05
**: p<=0.01

**Table 7. Determinants of Composite Knowledge Score at Post-test**

| Variable | Coefficient | S.E. | Significance |
|---|---|---|---|
| Experimental group | 3.86 | 0.31 | ** |
| Protective attitudes - drugs of abuse | 0.11 | 0.03 | ** |
| Positive attitudes - science | 0.16 | 0.04 | ** |
| Age | | | |
| 11 | 1.61 | 0.97 | |
| 12 | 0.53 | 0.88 | |
| 13 | 0.66 | 0.83 | |
| 14 | 0.03 | 0.86 | |
| Grade | | | |
| Grade 7 | 1.25 | 0.41 | ** |
| Grade 8 | 1.26 | 0.60 | * |
| Gender: male | -0.06 | 0.27 | |
| Race/ethnicity | | | |
| Caucasian | 0.83 | 0.54 | |
| African American | -0.43 | 0.56 | |
| Hispanic | -0.33 | 0.68 | |
| State | | | |
| North Carolina | -0.70 | 0.37 | |
| South Carolina | 0.16 | 0.47 | |
| Constant | 2.24 | 1.32 | ** |

Source: Authors' tabulations of KBP data, 2007
Notes: N=552; Adjusted R-square =0.348
Reference groups in the general linear model
include age=15, grade 6, race=other, and state=Tennessee
Protective attitudes for drugs of abuse and positive attitudes about
science are reported as composite scores, respectively.
*: p<=0.05
**: p<=0.01