Winter 2009

Dr. Skateboard's action science: Transforming science education for middle school students

William H. Robertson, *The University of Texas at El Paso*

Dr. Skateboard's Action Science: Transforming Science Education for Middle School Students

William H. Robertson, Ph.D.

Abstract: Dr. Skateboard's Action Science is a curriculum supplement for middle school students that is designed to address content and process objectives in physical science for both the National Science Standards and Texas Essential Knowledge and Skills (TEKS). The video instruction and twenty classroom activities provide the teacher with a series of instructional tools and content information that can be used to explore and explain the concepts found in the areas of forces, motion, Newton's Laws of Motion, and simple machines. Action science can be defined as the use of familiar objects, circumstances and situations within the lives of students in order to explain specific concepts in science built around student interests, such as skateboarding and bicycle motocross (BMX).

About Author: Dr. William H. Robertson is an Assistant Professor of Science and Technology Education in the Teacher Education Department at the University of Texas at El Paso.

Introduction

Dr. Skateboard's Action Science is a curriculum supplement that integrates both skateboarding and BMX. As an example of transformative education, it is built around student interests with a direct link to specific science knowledge and skills that need to be learned. It incorporates a four part video series and twenty classroom activities for students and teachers to use in the classroom. The video and classroom materials focus on the physical science concepts found in the areas of motion, forces, Newton's Laws of Motion, and simple machines. These materials also provide the classroom teacher with an instructional series rich with science content information. The Activities include topics such as momentum, center of gravity, inertia, centrifugal and centripetal forces. The purpose of the activities is to engage students in meaningful science topics set in the context of something they enjoy doing, namely skateboarding and BMX. The main emphasis is to link the concepts of science to action sports and to engage students in the exploration of science in a real world context.

In this manner, Dr. Skateboard's Action Science explores scientific concepts in a curriculum that is designed to address both physical science content and process skills. The main purpose is to provide an interesting method of engaging students in the exploration of science in a real world context. The overarching theme for Dr. Skateboard's Action Science is the appeal of action sports as teaching and learning vehicles for students, teachers, and the community. In partnership with the El Paso Independent School District (EPISD) and the University of Texas at El Paso (UTEP), Dr. Skateboard's Action Science is being produced to provide classroom instruction in the Middle Grades classrooms across the EPISD. With more than 63,000 students in 92 campuses, EPISD also is the seventh largest district in Texas and the 57th largest district in the United States. Beginning in the fall of 2007, Action Science has been added as part of the scope and sequence for instruction within the science curriculum for all 16 Middle Schools and is being used in approximately 84 classrooms by teachers and students in EPISD.

The Foundations Of Action Science

Dr. Skateboard's Action Science is an example of the use of transformative educational strategies to enhance the study of science for middle school students. The term "action science" can be defined as the use of familiar objects, circumstances and situations within the lives of students in order to explain specific concepts in science built around student interests, including action sports like skateboarding and bicycle motocross (BMX). Transformative education (or learning) is a process in which the student moves from beyond acquiring factual knowledge and becomes changed in some meaningful way by what he or she learns. Students learn to consider multiple points of view, to question assumptions and values and beliefs, while always seeking to verify reasoning. The goal of this approach is to make middle school science transformative through action science.

Although transformative education has largely been associated with adult learning theory, there are reasons for considering transformative learning theory as a possible medium for working with middle school students. First, helping young adolescents transition into adulthood requires that they develop a deeper understanding of concepts and issues which will lead them to question their fundamental beliefs and assumptions, thus resulting in a transformation of perspective or worldview. Second, preparing middle school students to develop critical and reflective thinking skills encourages them to care about the world around them and to recognize that some degree of personal or social transformation is required. Currently, the idea of implementing transformative education in middle school classrooms is gaining momentum because of its link with constructivist pedagogy, a popular and successful learning theory that suggests that students actively construct and reconstruct knowledge, thereby transforming meanings to arrive at new understandings and multiple ways of thinking (Brooks & Brooks, 1993). The work of John Dewey, Maria Montessori, Jean Piaget, Jerome Bruner, and Lev Vygotsky is presented in the constructivist view of teaching and learning.

For education to be transformative, the traditional teacher/student relationship, namely, that of the teacher conveying content while students listen passively is discarded. Instead, teachers serve as facilitators, mentors, role models, co-inquirers and friends. Teachers view themselves as respectful guides and compassionate helpers who grant students the opportunities to become actively involved in their own learning and in classroom operations (Hasslen, 2008). More importantly, however, teachers become change agents as well. They work to establish links within their communities, and try to engage their students in active learning projects that require them to interact with individuals outside the school (Donovan, 2002). For the transformative education teacher, learning can take place in different venues and not solely in the classroom (Palmer, 1998).

In the classroom, constructivist curriculum must be designed so that it reflects real life situations (Bentley, 1995). The use of the social context of learners as curriculum developers, who define this approach of content organization as contextualizing the concepts, have promoted an organizer for content taught in distinct and unique disciplines of study (Hofstein and Yager, 1982). Research scientists cross over the barriers between disciplines all the time, and seldom operate solely on isolated areas of content, but integrate the use of language, knowledge and process application.

Research based programs give students the ability to retain facts through critical thinking by working through problems logically and making connections to the real world. Jerome Bruner further emphasizes this point by writing, "Students should know what it feels like to be completely absorbed in a problem. They seldom experience this feeling in school" (Bruner, 1962, page 50). Studies have shown that students, who are involved in active learning in meaningful contexts, acquire knowledge and become proficient in problem solving. (Robertson, 2000)

Students exploring a concept should be given opportunities to work with materials and manipulatives so that they can have experiences that are real and fundamental. Hands-on learning plays a valuable role in the constructivist paradigm, as it is the process of learning by doing (Dewey, 1970) that is utilized in the exploration phase. So much fascinating content is at the fingertips of learners everywhere, and with technology becoming more affordable, more and more is present in their homes. It is important to engage learners in learning situations that effectively integrate their own experiences and familiar materials that students can use to better understand specific concepts. (Eisenkraft 2003) For example, students who enjoy skateboarding can be given opportunities to explore the concepts of velocity, acceleration, center of gravity, and moment of inertia. They may also use the skateboard and a local skatepark to investigate topics such as inclined planes, levers, fulcrums and screws. The purpose of this approach is to allow the students to explore meaningful science topics set in the context of something they enjoy doing.

Meaning is a human construction within a social situation. The learner is always defining meaning within the context of action and reflection (Brooks and Brooks, 1993). Yet, educators must beware of regarding the learner's point of view as fully complete and significant in and of itself (Dewey, 1970). Each learner understands content and concepts differently based on his or her previous experiences. The students need opportunities to address misconceptions and to develop concepts in real world situations. "Students come to school with their own ideas, some correct and some not, about almost every topic they are likely to encounter" (Rutherford and Algren, 1990, page 198). Learning is the responsibility of the learner, but the teacher guides the student into developing meaning from content material and classroom experience.

As students explore concepts, they develop a broader understanding of those concepts. When they relate what they are learning, seeing or doing to others, they can begin to see similarities in their understandings, as well as self identify misconceptions they may have about content material (Bybee, 2006). This sharing within cooperative groups is a fundamental strategy in constructivism as it allows the teacher to facilitate the learning process, and also helps to develop a common base of experiences on which to help make connections to content. Problem-solving strategies depend on conceptual understandings, and hands-on exploration of simple topics combined with collaborative interaction among students helps to build an understanding of processes and concepts (Apple, 1993).

The Development Of Dr. Skateboard's Action Science

I currently work at the University of Texas at El Paso (UTEP), where I am an Assistant Professor in the Teacher Education Department. As an educator and a skateboarder, I knew that there would unique opportunities to teach and provide new methods to instruct students and aid teachers. With a Ph.D. in science and technology education, I am able to apply solid instructional principles to the courses I teach at UTEP and, on a broader scale, to the community in outreach activities through skateboarding.

Through skateboarding, I personally have learned patience, discipline, creativity, and the art and science of practice. My audiences for onsite demonstrations have included elementary, middle-school, and high-school students in El Paso and around the country. Much of my experience has been done in schools, and now with the Dr. Skateboard's Action Science curriculum, there are new options that schools can pursue to have relevant educational materials for middle grade students. Utilizing this platform to teach the physics of skateboarding has given me the unique identity of Dr. Skateboard. Dr. Skateboard's Web site (http://www.drskateboard.com) provides details on performances as well as curriculum materials for students and families. My audiences of children and parents typically do not see the connections between skateboarding and physics. They wonder, if you have a Ph.D., why do you skateboard? The answer is simply that it is fun and part of who I am.

The development of Dr. Skateboard's Action Science was done with a collaborative team that includes faculty from UTEP's College of Education, personnel from the EPISD Central office, and the faculty and students at selected EPISD Middle Schools. Four scripts were written and then used as a guide for capturing live footage at a series of onsite demonstrations at EPISD schools as well as for developing a context for delivering science content in settings including skateparks, classrooms and local community sites. The development team included pivotal personnel from the EPISD video studio, who were vital in the shooting and editing of the footage, as well as the placement of graphics throughout the videos.

In addition, the Pro Impact Stunt Team, a team of professional athletes specializing in the areas of skateboarding and BMX were utilized to demonstrate the action scenes that appear throughout the videos. This group, with their extensive experience delivering performances in educational settings, forms the backbone of the video, as well as serves as a link to the science content that is taught. These athletes perform highflying maneuvers that demonstrate physical science concepts, such as the relationships between velocity and acceleration. Without the athletes, the action would not be as complete, and this also is another pathway that invites learners to learn, in that they may not be ultimately attracted to science, but recognize and respect the difficulty of the maneuvers performed in the video. The videos provide participating teachers and students with a series of instructional opportunities and relevant content information that can be used to explore and explain the given content information as well as engage the students in classroom activities.

The classroom activities were developed in part to allow teachers the opportunity to use readily available common household materials in the context of experiments that help the learner explore and explain the concepts found in the video instruction. As the activities were being developed, they were field tested in classrooms and there

were currently 15 teachers who have been involved in the design of the project, and the researcher has met regularly with them in order to design, develop and implement the activities and video instruction. The curricular focus of Dr. Skateboard's Action Science is centered on the TEKS, which is required of all learners and educators by the state of Texas. It is the premise of this approach that as students are engaged in a curriculum that encompasses their real world, their own content knowledge in science will increase.

The Action Is In The Classroom

Dr. Skateboard's Action Science engages the learner in the process of acquiring critical knowledge, developing proficiency in problem solving, engaging in self-directed learning, and participating in collaborative teams. For the educator, the video segments and activities are designed to be used in tandem, as the videos provide action, but also relevant content for the classroom. The video segments may be shown in their entirety within a given episode, or the instructor may choose to use a portion of the video to highlight a given topic that will be explored in a classroom activity. For example, the teacher may want to show the portion of the "Forces" video that covers the concepts of centripetal and centrifugal forces prior to doing the activity "Finding or Fleeing the Center of a Loop". For each of the activities, the associated section of the video segments can be used as hooks to introduce the activity and as a review for the content covered within the classroom. The activities are provided on the DVD as single activities from which to print copies for classroom instruction. The entire activity manual is also available complete with a glossary of terms and definitions.

As teachers implement the classroom activities and video materials, the fundamental research issue will be to determine how the use of such materials impact student success in physical science. The goal of the project is that middle school teachers in EPISD will use the materials in order to improve student's scores on the standardized tests (the TAKS) in the areas of physical science in grades 6, 7 and 8. The activities themselves map directly to the TEKS objectives found in the classroom activities and video instruction. Although there is not claim that a single intervention can truly impact student achievement, the hope is that as the students and teachers are engaged in this curriculum supplement, there will be gains in teaching and learning as both groups are engaged a new style of curriculum. The videos and classroom activities are also important in order to provide evidence of the conceptual understandings of science topics by the students and to gauge the changes the teachers and students take in developing and explaining their understandings in the given content area of physical science.

Classroom Impacts

As a new educational approach that is both built on student interests and a solid pedagogical foundation, Dr. Skateboard's Action Science provides for the possibility of evaluating student achievement in the focus area of physical science. By building a curriculum supplement that begins with teachers and continues with students in a district wide effort, the opportunity to follow student progress over time is viable. As the initial results of the impact of the curriculum supplement are evaluated and disseminated across neighboring districts, there exist increased opportunities for teacher and

student development in science content knowledge. The hope is that this effort will leverage the partnership with EPISD to promote science education as a functional component of Middle School teacher preparation and classroom interactions, not only in El Paso, but throughout the entire city, state and nation. As one sixth grade teacher at remarked, "The innovative pedagogical process and skateboarding skills revealed an easy way for a young audience to comprehend the scientific concepts of real-word physics."

The curriculum has already gained recognition in the local community. As one school principal who implemented the program in her middle school states, "The message regarding the importance of education, the fact that skaters can be smart students and the need to set life goals took on a different meaning after seeing the materials. The encouragement and presentation will be something that our students will never forget." With its initial implementation into classrooms in the fall of 2007, Dr. Skateboard's Action Science has been well received by students and educators alike. Initial attitudinal data indicated that a majority (70%) of the 64 students from 3 focus classrooms showed increases in their attitudes towards physical science. Additionally, teachers reported an increased interest and focus in the classroom among previously marginalized students.

It is important for university faculty, public school personnel, school district staff and community members to work together in the design, implement, and evaluate educator preparation programs that serve the needs of the diverse student population of the region. The work with EPISD personnel in the area of Middle School science represents such a partnership. Finally, student interns from UTEP have opportunities to make site visits to classrooms in order to view the use of the Dr. Skateboard's Action Science in local Middle Schools, as well as receive training in the implementation of the classroom activities. They will also gain insight into the professional development process within a school.

Conclusions

By immersing students in a science learning approach that is based on action sports and focuses on the goals and objectives in physical science, the process skills and overall content knowledge of the students will increase. The use of action science as a mechanism for integrating transformative education is an approach that appears to be enhancing the interest and motivation of middle school students in science. It is the purpose of Dr. Skateboard's Action Science to positively impact achievement for Middle School students in the area of physical science knowledge and skills. The long-term prospects of this research will seek to determine how the implementation of curriculum approaches built around student interests such as skateboarding and bicycle motocross (BMX) can impact student achievement in the area of science content and conceptual understandings. Additionally, teachers reported an increased interest and focus in the classroom among previously marginalized students. In order to better measure the impact of this program within a wider context, the author has designed an evaluation plan using both qualitative and quantitative instruments within a larger number of classrooms and students in the fall of 2008.

In addition, this study contributes to the field of educational research in that it aims to determine how transformative education can

be used to motivate marginalized middle school students to learn science. If alternative education students who are often reluctant to become engaged in school work can come to enjoy learning concepts in physics, such as, forces and motion, imagine the possibilities that await students enrolled in regular education programs. As with all middle school students, but even more so with marginalized students, science education needs to be transformed, and action science is a transformational example of an effective manner towards accomplishing this goal.

References

Apple, M.W. (1993). *Official knowledge*, New York: Routledge.

Bentley, M.L. (1995). Carpe diem, *Science activities*, Vol. 32, No. 3, pp. 23-30.

Brooks, J. G. & Brooks, M.G. (1993). *The case for the constructivist classroom*, Alexandria, Virginia, ASCD Press.

Bruner, J. (1962). *The process of education*, Cambridge: Harvard University Press.

Bybee, R. W. et al (2006). The BSCS 5e instructional model: Origins, effectiveness, and applications (Executive Summary). [On-Line} Accessed September 9, 2007 at http://www.bscs.org/pdf/bscs5eexecsummary.pdf

Dewey, J. (1970). *The child and the curriculum*, Chicago: Chicago University Press.

Donovan, B. (2002). An illustration of practice in search of theory. *Theory and Practice, 41,* 17-26.

Eisenkraft, A. (2003). Expanding the 5E Model. *The Science Teacher*. Vol. 70, No. 6 pp. 57-59. National Science Teacher Association (NSTA), Arlington, VA.

Hasslen, Robin. (2008). From a tarpaper shack to a transformed classroom: A teacher's journey. *Kappa Delta Pi Record, 44,* 52-54.

Hofstein, A and Yager, R. (1982). Societal issues as organizers for science education in the 80s, *School science and mathematics*, Volume 82, pp.539-547.

Palmer, P.J. (1998). *The courage to teach: Exploring the inner landscape of a teacher's life*. San Francisco: Jossey-Bass.

Robertson, W.H. (2000). *The critical thinking curriculum model*, Dissertation from the University of New Mexico.

Rutherford, F. James and Algrehn, Andrew (1990). *Science for all Americans*, New York: Oxford University Press.