Scientific skateboarding and mathematical music: edutainment that actively engages middle school students

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Abstract: Edutainment has recently been a major growing area of education, showing great promise to motivate students with relevant activities. The authors are among innovators who have developed cutting-edge fusions of popular culture and STEM concepts to engage and to motivate middle school students, using vehicles such as music/song and skateboarding. The importance of using relevant and practical methods of instruction and curriculum delivery that build on student interests and increase enjoyment in the learning process are critical at the middle school level, especially in the STEM fields. The use of edutainment in this manner is meant to inspire broader interest in mathematics and science for middle school students and to develop a culture of education that makes learning more accessible to all students. This paper surveys and illustrates the use of such immersive modalities to involve middle school students actively with concepts and suggests further directions for the use of demonstrations and videos in educational settings.

Keywords: action, science, mathematics, skateboarding, music.

Introduction

Edutainment has recently been a major growing area of education, showing great promise to motivate students with relevant activities. The authors are among innovators who have developed cutting-edge fusions of popular culture and science, mathematics, engineering and mathematics (STEM) concepts to engage and to motivate middle school students, using vehicles such as music/song and skateboarding. The importance of using relevant and practical methods of instruction and curriculum delivery that build on student interests and increase enjoyment in the learning process are critical at the middle school level, especially in the STEM fields.

The use of edutainment in this manner is meant to inspire broader interest in mathematics and science for middle school students and to develop a culture of education that makes learning more accessible to all students. This paper surveys the use of such immersive modalities (including some specific vignettes) to involve middle school students actively with concepts and suggests further directions for the use of demonstrations and videos in educational settings.

Throughout history, there have been abundant examples of entertainment education (also called by its portmanteau, edutainment), especially for health and social issues (e.g., Singhal, Wang, & Rogers, 2012). The purpose of this article is to focus on edutainment in the specific context of STEM education, chronicling large-scale interactions (as opposed to, for example, digital games individuals can play) with students, teachers and community members involving relevant content in student-centered contexts.

Our focus on edutainment is restricted to examples where the entertainment value is significant, but not overshadowing the educational content. We also agree with Resnick (1987: 1) to avoid implying that education is a “bitter medicine that needs the sugar-coating of entertainment to become palatable” or that education and entertainment are “services that someone else provides for you” rather than “things that you do.”

Particular Need for Motivation in STEM Fields in the Middle Grades

The use of strategies of edutainment in science and mathematics 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 immersive and entertaining educational opportunities to positively impact achievement for middle school students in STEM, especially in the areas of science and mathematics knowledge and skills. By immersing students in a learning approach that is based on appealing delivery of content and focuses on the goals and objectives in middle school science and mathematics, the process skills and overall content knowledge of the students have the potential to greatly increase. Studies have shown that students, who are involved in active learning in meaningful contexts, acquire knowledge and become proficient in problem solving (Robertson, 2008). The long-term prospects of this research area will seek to determine how the implementation of curriculum approaches integrating strategies in edutainment and built around student interests such as skateboarding and music can impact student achievement in the area of science and mathematics content and conceptual understandings.

Each learner understands content and concepts differently based on his or her previous experiences, and the materials help to provide a context for understanding both science concepts and real world connections. So much fascinating content is at the fingertips of learners everywhere, and with computer access and technology becoming more affordable, more information is accessible. The main emphasis is to engage students in the exploration of STEM topics in a real world context and to link education to delivery methods that integrate entertainment value and presentation. 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 & Algren, 1990: 198). Learning is the responsibility of the learner, but the teacher guides the student into developing meaning from content material and classroom experience.

In the classroom, constructivist curriculum must be designed so that it reflects real life situations (Bentley, 1995), and the use of relevant contexts helps to contextualize the concepts, as well as help provide connections across subject areas (Hofstein & Yager, 1982). Research scientists and mathematicians cross over the barriers between academic disciplines all the time, and seldom operate solely on isolated areas of content, but integrate the use of language, knowledge and process application. STEM programs that emphasize investigation give students the ability to retain facts through critical thinking by working through problems logically and making connections to the real world.

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, especially in the STEM fields (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.

Scientific Skateboarding

Dr. Skateboard's Action Science is a curriculum supplement for middle school (6-8) students that is designed to address content and process objectives in physical science for the 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. It is the purpose of this research project to determine what impact Dr. Skateboard's Action Science has on a sample of Middle School students in the area of physical science knowledge and skills.

Dr. Skateboard's Action Science maps to the physical science TEKS in which all middle school students need to be engaged. Dr. Skateboard's Action Science explores scientific concepts in a curriculum that is designed to address both physical science content and process skills. The video instruction focuses on the physical science concepts found in the areas of motion, forces, Newton's Laws of Motion, and simple machines. 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.

Dr. Skateboard's Action Science is an example of transformative education, a student-centered curriculum supplement built around interesting content linked to specific physic knowledge and skills in science. The videos and classroom materials provide the classroom teacher with an instructional series rich in science and including topics such as centrifugal and centripetal forces, inertia, center of gravity, and momentum. The purpose is to contextualize the classroom process of acquiring critical knowledge, developing proficiency in problem solving, engaging in self-directed learning, and participating in collaborative teams.

The activities and materials are designed for students to interact in small teams, and this sharing within cooperative groups is a fundamental constructivist strategy that allows the teacher to facilitate the learning process. As a student-centered approach, it also helps to develop a common base of experiences on which to help students make connections to content. In the classroom, problem-solving strategies depend on the development of conceptual understandings, and hands-on explorations of simple topics combined with collaborative interactions among learners help to build an understanding of processes and concepts (Apple, 1993). It is important for educators to not merely regard the learner's point of view alone as fully complete and significant (Dewey, 1970), but to guide the students in the analysis and synthesis of content information. The learner is always defining meaning within the context of action and reflection (Brooks & Brooks, 1993), and the social situations, including discussion, explanations and hands-on experiences, provide the context for knowledge construction.

The video segments themselves do provide action, but also relevant content for the classroom, and complement the activities that teachers can implement in the classroom, and in tandem, can help reinforce the conceptual emphasis in a lesson. For example, the teacher can utilize the portion of the "Newton's Laws" video that covers the concepts of force, mass and acceleration, which is designed as an effective introduction to the activity "Force Makes a Mass Move". This brief video segment serves as a hook in order to introduce the activity and additionally as a review for the content covered in class. In that sense, the materials serve both pre-activity and post-activity purposes, and allow the teacher the flexibility to have students explain fundamental physics as well as pursue inquiry extensions. Each activity contains both a teacher section and a student section. The teacher section provides standards alignment information, background knowledge, guiding questions with answers and extensions for student enrichment. The student section contains the classroom science activity, connections to real world examples, explanations of concepts and actual photographs of BMX riders and skateboarders in action.

Action Science is designed to teach fundamental science concepts in physics in an approach that utilizes transformative educational strategies, which help students move from memorizing facts and content to constructing knowledge in meaningful and useful manners. The activities associated with Action Science address both the objectives and enduring knowledge of physical science in content and process skills for both the United States of America (USA) National Science Standards and the Texas Essential Knowledge and Skills (TEKS) state standards.

The materials in Dr. Skateboard's Action Science were also designed to emphasize inquiry in classroom explorations. As a foundation for discovery, the teacher can use the video segment in the "Simple Machines" episode that relates to fulcrums and levers, and then have the students perform the classroom activity "Skateboards Have Levers and Fulcrums." After the activity, the teacher may revisit these ideas and then create an extension inquiry exercise for the students to do in teams. The teacher can provide the students with the same materials used in the activity such as rulers, tape, plastic spoons, rubber bands, and modeling clay and challenge the students to design a simple machine made of at least three of the provided that uses a lever and a fulcrum and can propel a small marshmallow the farthest distance.

In making this transition in class, the teacher guides the students towards developing their own ideas and within a given time period, has the students create and test their unique designs. By engaging students in a design competition, there is a spirit of enthusiasm and excitement among the groups. There are also excellent opportunities to develop cooperative group skills and to have students use critical thinking to solve the problem presented. "Students should know what it feels like to be completely absorbed in a problem. They seldom experience this feeling in school" (Bruner, 1962: 50). Finally, the teams of students have to not only launch the marshmallow, but they also have to record the distances, calculate the average distances travelled and identify the lever and fulcrum within their machine. In this manner, the students have to present their ideas, justify their understandings and support their findings with experimental data.

Another classroom example in the design of the series is the use of the video segment in the "Forces" video that focuses on the concept of center of gravity, which additionally bridges the concepts of gravity and lift. Prior to showing the video segment, the teacher can use open-ended questions with students in order to activate their previous knowledge concerning this content. Sample questions could include, "What do you do when you ride a skateboard or a bicycle?", "How do you balance on a skateboard or bike?" and "What forces are acting on you as you are trying to ride a bike or skateboard?" Additionally, previously marginalized students who have experience in these activities, but may struggle in science, can become experts in this discussion and contribute greatly to the classroom investigations.

Finally, the teacher should conclude the series of questions by asking, "What is the center of gravity and why is it important?", and then facilitate the conversation in order to introduce the segment in the "Forces" video that covers gravity, lift and the center of gravity. This approximately 4-minute segment of the video then serves as the engagement to the activity "Flatland BMX and the Center of gravity" in which students create irregular cardboard shapes and determine the object's center of gravity through a series of step by step procedures. Students exploring a concept should be given opportunities to work with hands-on materials 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 explorations and experiments.

Next, students modify their shapes either by adding paper clips (which increases the mass) or by cutting off part of some of cardboard (which decreases the mass). In turn, they come to see that there is a fundamental relationship between the center of gravity and the mass of an object, and that the center of gravity will move in relation to an increase or a decrease in mass. After the classroom lesson, the teacher can revisit the activity by asking the students to explain their findings and the relationships they discovered. 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). Finally, there is a list of open-ended questions for students to answer, as well as extensions that they can engage in if there is additional time and motivation to explore these concepts. This entire activity can be done in the timeframe of a normal class period with minimal setup and cleanup, and can provide both teachers and students an interesting alternative to exploring these fundamental physics ideas.

Mathematical Music

Music is a great motivating vehicle because middle school students are captivated if not consumed by it whether or not they play an instrument and almost no other medium has a faster capacity to capture attention and build community in a classroom or a larger-scale event. Research shows that integrating music composition into mathematics lessons has helped elementary students attitudes and beliefs toward mathematics learning (An, Kulm, & Ma, 2008), and improved elementary students' math achievements and attitudes (An, 2012). In light of these studies, it is promising to explore how integrating mathematics and music for middle school students might produce similar results. Such curriculum integration is consistent with the NCTM (2000) standard on connections ("recognize and apply mathematics in contexts outside of mathematics," p. 65) and the mathematical practice standard #7 ("look for and make use of structure") from the Common Core State Standards (National Governors Association, 2000).

The second author has delivered interactive workshops, conference keynotes, school assemblies, etc. for teachers or students at all grade bands, ranging from a 20-person classroom to an 800-person auditorium. The presentations are designed so that teachers can do follow-up explorations with their students, without needing undue talent or materials. The presentations connect mathematics and music through two main ways: (1) unpacking the mathematics underlying common demonstrations and manifestations of playing and writing music, and (2) making mathematics connections with the lyrics of commercially-released popular songs – sometimes as is, sometimes after rewriting them. This paper focuses on the former method, but an example of the latter is how the Taylor Swift 2012 Grammy-winning song "Mean" was rewritten to explore when the median is more appropriate than the mean to be the measure of center for a dataset (Lesser, 2011), a topic that is of critical importance given that even most high school students did not correctly choose (with satisfactory explanation) the median to summarize a dataset for which the mean was inappropriate (Groth & Bergner, 2006). The effectiveness of songs in increasing student motivation and learning in educational science contexts has recently been increasingly researched (Crowther, 2006; Leck, 2006; McCurdy et al., 2008) and has also been discussed in mathematics and statistics (Lesser, 2000, 2001; VanVoorhis, 2002).

Just as the musical staff is a type of graph (of pitch over time), there are graphical elements of guitar tablature as well as chord diagrams that can be discussed. With all of these representations, there are geometric transformations (e.g., Cooper & Barger, 2009) such as translations that can be modeled in real time as students see the effect of moving a group of notes higher up the staff or shifting a chord shape further down the guitar neck or using a capo.

This naturally leads into a demonstration of string length in which students make and then test a conjecture about what happens to the note's pitch(frequency) when a string's length is shortened (either because of a capo or because of a fingering). Having seen instruments such as pianos and harps, students usually readily conjecture the correct answer. We conclude this part by bringing in the language of Algebra I, saying that string length is *inversely proportional* to frequency. Next, we ask students if that means all six open (i.e., unfretted) strings should have the same note, which leads students to generate two other aspects of the strings that also matter -- the tension (or force) and the thickness (or weight). In particular, students (perhaps drawing upon their experience with rubber bands!) conclude that pitch is increased with higher tension and decreased with thicker, heavier strings, and these relationships are consistent with what are known as Mersenne's laws:

$$\text{frequency} = \frac{\sqrt{\frac{force}{mass\ per\ unit\ length}}}{2*length}.$$

Mersenne's laws are now applied to rock music as students watch a live (or videotaped) demonstration of an electric guitarist "bending" notes (increasing the pitch of a fretted note by a half or whole step) during a solo. Students discuss that the guitarist increases the pitch of the note by using his finger to increase the force on the string. After being told that guitar strings come in various gauges (thicknesses), students can conclude that a lead guitarist would find bending notes easier with strings that have a smaller gauge or diameter.

To get more specific about how string length affects pitch, we demonstrate particular ratios, for example, contrasting the "nice" ratio 2:1 to the "not-so-nice" ratio $\sqrt{2}$:1. Students measuring the lengths verify that 2:1 compares the open string with the string pressed against the 12th fret, while $\sqrt{2}$:1 compares the open string to the note at the 6th fret. Students hear and declare for themselves that the ratio with small whole numbers sounds more pleasing to the ear, consistent with the explanation of Osserman (1993: 58). (In particular, 2:1 makes an octave, while $\sqrt{2}$:1 makes a diminished fifth.) A 2:1 ratio can also be demonstrated using a monochord, in which you play on both sides of a movable bridge that can divide the string into lengths in any ratio (whereas the guitar is limited to the fixed positions frets are in and one can play only on one side of a fret). A monochord can be built (COMAP, 2002; Haak, 1982) or bought.

Students notice that the distance between successive guitar frets decreases as you move from the nut towards the bridge. Matson and Grigoriadou (2013) have a wonderful activity for finding the ratio of the distance between the guitar's bridge and a particular fret and the bridge and the next fret. By doing this for all pairs of successive frets, students recognize that there is a common ratio, approximately 0.94. (By applying algebraic representation of a geometric progression to the observation that the 12th fret is at the halfway point of the string, we see that $ar^{12} = 0.5a$ yields the ratio's value of $2^{-1/12}$. This relationship can be compared to the luthier's rule of thumb of placing the next fret at a distance of 1/18 of the remaining string length.) What is even more fascinating to students is that (in equal temperament) this ratio applies to *all* sizes of stringed fretted instruments, whatever the length of the strings.

Another demo involves playing natural harmonic notes, and this can be demonstrated without ability to play guitar, merely access to a guitar (and if you don't own one, odds are someone in your classroom or department does). And so the payoff will be something students can recreate and share later without needing any one person's presence or talents.

First, I grab students' attention by sharing examples of popular songs that involve harmonic notes. (These examples can be found on the Internet -- as studio recording, concert footage, or instructional video clip -- if no one in the class feels up to playing them live.) For example, consider the signature song (and 1971 #13 hit) "Roundabout" by the British progressive rock band Yes (Yes, 1971). This song continues to get airplay (on stations that play classic rock) and has also appeared on more recent live albums, movies and the music video game Rock Band 3. The opening harmonics of this song can be played by placing a finger lightly on top of the strings at the 12th fret (the halfway point of a string's length), playing the thickest bass string, and then playing simultaneously the three treble strings. Unlike playing a fretted note against the fingerboard (which takes a certain amount of coordination and strength and perhaps a bit of a callus on one's fingertip to push down and play clearly and comfortably on a steel-string guitar), these harmonic notes can be readily played without prior experience.

Students are now motivated to discuss what harmonic notes are and where those ghostly sustaining tones are located along a string. They occur at each nodal point (i.e., a point that is one of the points that divide the total open string length into n equal parts) as explained by Hughes (2000, p. 301):

> "To produce a harmonic, a string instrumentalist gently touches the string at a point known to be a fixed zero ('node') for some (but not all) of the partials. Damping in this way removes all nodes of vibration except those that have a node at the point touched. The resulting tone sounds softer because it is made up of fewer audible partials, and higher-pitched because the fundamental is among the partials removed."

The m^{th} harmonic has m-1 equally-spaced nodes lying strictly between the nut and bridge. Node n of harmonic m divides the open string into a ratio of m-n:n (where n = 1, 2, 3, …, m-1), so that node has a distance from the nut that is n/m times the full string length. Using the preceding facts and the measured length of a full open string, students can fill in column 4 of the table below and then measure off those distances using a tape measure to estimate the corresponding fret position. As the table below shows, the first few (and most commonly-used) harmonics in guitar-playing each fall exactly or nearly exactly on a fixed integer fret position. This is good because a guitarist playing a song needs to aim for a particular fret location rather than pull out a tape measure! As an aside, we note that when students study logarithms, they can verify that the formula for fret position of the n^{th} node of the m^{th} harmonic is given by $12*\log(m/(m-n))/\log(2)$, by equating the expression for the distance of a fret from the bridge to the expression for the distance from the bridge to a harmonic's node that is closest to the nut.

The fact that there are many harmonics along a string can be easily demonstrated by a nonmusician student who lightly runs a finger continuously along the length of the third string from the 3rd to 12^{th} fret, while repeatedly plucking it with the other hand, producing a series of harmonics that occur in, for example, the second verse of the 1983 #53 hit "New Year's Day" (U2, 1983). The table below, however, shows only the first few harmonics not just for space reasons, but also because the higher harmonics become trickier to isolate on the guitar. Also, the table omits node 2 of harmonic 4 because that location is already dominated by node 1 of harmonic 2. A connection to fraction arithmetic is to say that the third column of the table omits fractions (e.g., 2/4) that are not in simplest form. Also, we note that locating a harmonic note by fret position will be limited by the number of frets a guitar has, and so a fret position as high as 24 may not work on many guitars (forcing students to rely on the tape measure distance).

Table 1. Location of harmonic notes on a guitar

harmonic, m	node, n	(Distance from nut) / (full string length) = n/m	string length times previous column	Fret position	Pitch of note relative to fundamental
1	0	NA		NA	fundamental
2	1	½		12	octave
3	1	1/3		7.02	fifth above octave
3	2	2/3		19.02	Fifth above octave
4	1	¼		4.98	Two octaves
4	3	3/4		24	Two octaves

Since the 12th fret is at the halfway point on the string, the 12th fret harmonic note (m=2, n=1) is a very clear note that divides the string into two equal vibrating parts and 2:1 ratio results in an interval called the octave (so students can hear that the pitch is the "same" yet higher than the original note). Because the 5th fret is located approximately halfway between the nut of the guitar (where the string starts) and the 12th fret, it is no surprise that the harmonic at the 5th fret (m=4, n=1) is an octave higher than the one at the 12th fret. We have already discussed that frequency is inversely proportional to the length of a string free to vibrate. Since the mth natural harmonic note divides the string into m equal lengths that are vibrating, each vibrating length is $1/m$ the length of the full open string and therefore it is not surprising that the frequency of the m^{th} natural harmonic note would be m times the frequency of the open string. While we have focus on guitar-based demos for maximum edutainment value and efficiency, ideas for other math-and-music connections and demos are plentiful (e.g., Assayag, Feichtinger, and Rodrigues, 2002; Beall, 2000; Benson, 2006; Fauvel, Flood, and Wilson, 2006; Garland and Kahn, 1995; Hall, 2008; Harkleroad, 2006; Johnson, 2003; Loy, 2007; Wright, 2009).

Other Examples of Edutainment in Science and Mathematics

Songs and skateboards are by no means the only real-world contexts that can be used as vehicles to motivate mathematics or science learning. Another example is magic, and there is a wide range of books and papers available with magic tricks that are accessible to students learning algebra (e.g., Benjamin & Shermer, 2006; Edwards, 1992, 1994; Matthews, 2008; Morgan & Ginther, 1994), statistics (e.g., Lesser and Glickman, 2009) or science (e.g., Featonby, 2010). Former world record-holding juggler and Cornell mathematics professor Allen Knutson does juggling presentations to increase mathematics awareness (http://www.youtube.com/watch?v=38rf9FLhl-8) as does Colin Wright

(http://vimeo.com/27998521), a book (Polster, 2003) includes some mathematics accessible to middle school students, and Beck (2008) connects juggling to science. The mathematics of dance has been also presented and taught in edutainment-style (Rosenfeld, 2011; Schaffer, Stern, & Kim, 2001). STEM edutainment outreach includes the physics/chemistry circus (e.g., Dreiner, 2008; Kerby, Cantor, Weiland, Babiarz, & Kerby, 2010), and the recent opening of the nation's first museum devoted to mathematics (Henebry, 2012).

Another example is the delivery of STEM content in a children's television show. In mid-September 2011, El Paso PBS-affiliate KCOS-TV began airing a weekday locally-produced children's educational show (Blast Beyond) that includes a seasoned television host, a three-piece rock band, and a live on-stage audience of children ages 6-9 from a local school. Past episodes are accessible on the KCOS-TV website (http://www.kcostv.org/blastbeyond.html). Sample video of the educational aspects from the show are available online and can be used to emphasize the types of interactions done within an television show entertainment format designed to actively engage young students in educational content. In addition to television, the authors have also written a number of mathematics/science scripts for an educational radio program on the local NPR station that (as does the PBS-TV station mentioned earlier) has a broadcast audience of 2 million people spanning three states. The radio scripts (often with photos or references added) are archived on the website of a local museum.

As an aside, there are many aspects of such engaging education for middle school students that also enhance the work university professors like us more commonly do, including: identifying a compelling "hook" to generate initial engagement for a lesson (whether the lesson will be 5 or 50 minutes long), identifying the main point or essence of a lesson/concept (which helps greatly when one is interviewed by TV or newspaper reporters), identifying ways to make a lesson interactive (i.e., through building in questions asked to the cadets, or questions asked by Captain Rob, having demos, etc.), developing more confidence in having a "plan" for a lesson but also in being able to make on-the-fly adjustments when all the moving parts or background knowledge of the audience is not quite what you thought it would be.

Another example is the use of large-scale live demonstrations that have been utilized to engage students in multimedia-enhanced stadium settings, whose events produced video content that can also be utilized for in-class instruction and motivation in STEM-related topics. In addition, 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, which were then translated into short STEM related videos on concepts such as creativity and imagination integrated with content such as the center of gravity and simple machines. This various members of this edutainment effort, with their extensive experience delivering performances in educational settings, form the backbone of each video, as well as serve as a link to the science content that is taught. The athletes perform highflying maneuvers that demonstrate 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 produced from the demonstrations 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.

As part of the Gaining Early Awareness and Readiness for Undergraduate Programs (GEARUP), a five-year program funded by the Department of Education, large live demonstrations were done in arena settings for thousands of area Middle School students. The first attempt at this approach produced an effort in which over 3500 Eighth graders from the Ysleta Independent School District (YISD) in attendance learned more about basic scientific theories tested by several professional skateboarders, BMX riders and an inline skater during GEAR UP National Day on September 17, 2009 in the Don Haskins Center at UTEP. The second attempt at this high scale edutainment with action sports was done on May 3, 2012, at which a team of professional action sports athletes in both the disciplines of BMX and skateboarding performed a live demonstration, which will be done in order to engage local students in explorations of mathematics and science in the context of edutainment. This latest large-scale demonstration utilizing professional BMX and skateboarding athletes was done for approximately 8,000 area middle school students and demonstrated the power of motivation in STEM through edutainment.

Conclusions

The use of educational materials contextualized in the form of entertainment has a long history, and has certainly been gaining momentum as delivery methods of content have grown to utilize multimedia and video. The connection of STEM education to real world topics is vital in order to engage students effectively and to provide them with a reason to delve into deeper conceptual understandings. Edutainment, and its synthesis of elements of education and entertainment, has great potential at the middle school level to serve as a primary motivational and engagement strategy for STEM efforts, especially in the STEM areas. Additionally, the potential to reach wider audiences in STEM utilizing edutainment strategies can help to transform STEM education by integrating both informal and formal learning in ways that increase student interest and inspire learners to pursue STEM in school and, ultimately, as professions.

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