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Race to the Future: Integrating 21st Century Skills into Science Instruction

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ABSTRACT Race to the Future is an exciting and dynamic activity modeled after the reality television show *The Amazing Race*. It exemplifies how 21st century skills can be incorporated into core subject instruction and at the same time positively enhance student engagement. In this activity, students work quickly and cooperatively with their teammates and use 21st century skills to successfully decipher five clues related to science content. We have used this activity with excellent results with different groups of students (middle school, high school, and university students), for different purposes (ice-breaker, team-building, course assessment, and evaluation), and in broad curriculum areas (science and math). However, the activity is especially powerful when introduced during the first day or week of class. The meaningful and enjoyable student collaboration, the upbeat class environment, and the enhanced student engagement achieved at the conclusion of this challenging activity set an optimal teaching and learning environment for the entire quarter/semester.

KEYWORDS student engagement, cooperative learning, 21st century skills, science instruction

It is absolutely clear to me that simply tinkering with centuries-old education practices will not prepare Ohio's children for success in college, for success in the workplace, or for success for life.

—Governor Ted Strickland's 2009 State of the State Address, January 28, 2009

In 1996 the *National Science Education Standards* were developed to offer a coherent vision of what abilities students need to achieve scientific literacy by the time they graduate from high school (National Research Council 1996). Scientific literacy is, unquestionably, a necessity for success in the modern world: "Science, energetically pursued, can provide humanity with the knowledge of the biophysical environment and of social behavior needed to develop effective solutions to its global and local problems; without that knowledge, progress toward a safe world will be unnecessarily handicapped" (American Association for the Advancement of Science 1990, xiv).

While it is clear that scientific literacy is essential for individuals to understand scientific issues that affect society, scientific literacy is also intrinsically linked to success in the workplace. The scientifically literate citizens envisioned by the *National Science Education Standards* must possess the knowledge and skills needed to be successful in higher education and the workplace. Those

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21st century knowledge and skills include creativity, innovation, critical thinking, problem-solving, communication, collaboration, personal responsibility, global awareness, social/intercultural skills, team learning, and of course, mastery of rigorous academic content. However, the integration of these skills into instruction of already-packed core subject areas often presents a challenge to many teachers. This challenge is likely to persist until teachers receive adequate training and are provided with good examples on how to integrate these skills into the K–12 curriculum. Here, we describe an exciting and dynamic activity called Race to the Future in which 21st century skills are successfully and seamlessly infused into existing curricula.

Race to the Future is an activity modeled after a "town and gown" event held in Delaware, Ohio, for over 30 years called the Treasure Hunt and resembles the recent reality television show *The Amazing Race*. This activity exemplifies how 21st century skills can be incorporated into core subject instruction and at the same time positively enhance student engagement. In Race to the Future, students work quickly and cooperatively with their teammates and use 21st century skills to successfully decipher five clues related to science content. We have used this activity with excellent results with different groups of students (middle school, high school, and university students), for different purposes (ice-breaker, team-building, course assessment, and evaluation), and with broad curriculum areas (science and math). However, the activity is especially powerful when introduced in the first day or week of class. The meaningful and enjoyable student collaboration, the upbeat class environment, and the enhanced student engagement achieved at the conclusion of this challenging activity, set an optimal teaching and learning environment for the entire quarter/semester.

MATERIALS

- 6″ x 9″ brown Kraft envelopes (four for each group)
- Blank CDs (two for each group)
- Black and white copier transparencies (three for each group)
- 12 oz Dixie paper bowls (two for each group)
- 20 oz bag of M&Ms or similar candy
- Plastic bags (goody bags) containing helpful items including hand lenses, calculators, cheat sheets, and distracting items (miscellaneous items like rulers, numbered flashcards, Sudoku puzzles, dice, Morse code cheat sheets, country flags cheat sheets, microscope slides, eye droppers) (one for each group)
- Miscellaneous: Glue, scissors, pencils, markers, sheets of white paper (8 1/2″ x 11″), and colored card stock
- Prizes for top finishers (e.g., candy, pens, certificates, extra points)
- Laptop/desktop computer capable of playing CDs
- The following documents (in doc and pdf formats) are available on labeled folders on http://cosmos.bgsu.edu/resources/racetothefuture: clues and their answers, answer sheet, rules, and cheat sheets.

PROCEDURE

The activity, as described, can be completed in approximately 90 min depending on the group ages. We prefer to devote 100 to 120 min with high school students. However, you can always scale down the activity by eliminating one or more of the clues and complete the entire Race to the Future in less than 60 min.

We first divide the class into small groups of three to five students and give each group an identical set of directions that carefully explains the rules and procedures of the activity (Figure 1). Also, we give each group an answer sheet (half-page printed on card stock) with a separate line for each clue on which to write an answer (Figure 2). Lastly, we give each group a goody bag containing items that will help them decipher the clues as well as distracting items (see materials above) of no use to the participants. We prefer to direct each group to separate rooms, although a big room (e.g., gym) could also work. The groups have their own laptop that is needed to play the CDs containing two of the clues. Internet access is not necessary to solve any of the clues, but students may utilize the Internet to solve clues faster. The facilitator should be in a separate room roughly equidistant from all of the groups. All participants meet at this central room where the facilitator gives each group an envelope with clue #1, and the activity begins. Each group is directed to its own room or assigned space. As soon as a group thinks that it has the answer to clue #1, one or more group members bring their answer sheet (with the answer written on it) to the facilitator, making sure that the other groups do not see or hear the answer. If the answer is wrong, the students go back to their room and try again. There are no limits to how many times a group can guess an

1. You must observe all (name of school/institution) regulations & laws.

2. All clues can be solved inside the building. Do not leave the building looking for solutions to the clues. Please leave the area in which you choose to solve the clues in the same condition as when you arrived.

3. All teams must check in after solving each clue, by bringing their filled-in answer sheet to the judges.

4. All clues will be given to you by the judges.

5. The winning group is the group that completes the entire *Race to the Future* answer sheet in order in the least amount of time.

6. In case of a tie, a coin will be tossed to determine the top 3 places.

7. All groups should complete the race in less than 2 hours.

8. The top 3 groups will be awarded prizes.

FIGURE 1 **Example of the rules given to students at the beginning of Race to the Future.**

answer. When the students come up with the right answer, the facilitator gives them an envelope containing the next clue. We then follow the same procedure for the rest of the clues. All groups should work until they have successfully deciphered all of the clues, but the teacher decides how many teams receive prizes.

Following are more detailed accounts of the preparation and procedures that go along with each of the five clues. Refer to the materials list above to determine what should be placed in the envelope for each clue.

Answer Sheet	
Number	**Answer**
1	
2	
3	
4	
5	

FIGURE 2 **Answer sheet given to each group.**

CLUE #1
Description

We give the students the first envelope with clue #1 and direct them to their assigned room/space. Students find a CD inside the envelope and should intuitively insert it in the computer or laptop. A QuickTime movie automatically plays and loops, showing a series of slides featuring international code flags. One of the items in the goody bag of materials that the group received at the beginning of the activity is a sheet of paper with images of all the flags that can be used to decipher the clue. Basically, each flag corresponds to a letter of the alphabet. Once the students identify the correct code (sheets depicting other codes are also in the bag serving as distracters), they should substitute the letters for the flags in the movie to spell out the correct answer. We typically keep this first answer rather simple (e.g.,

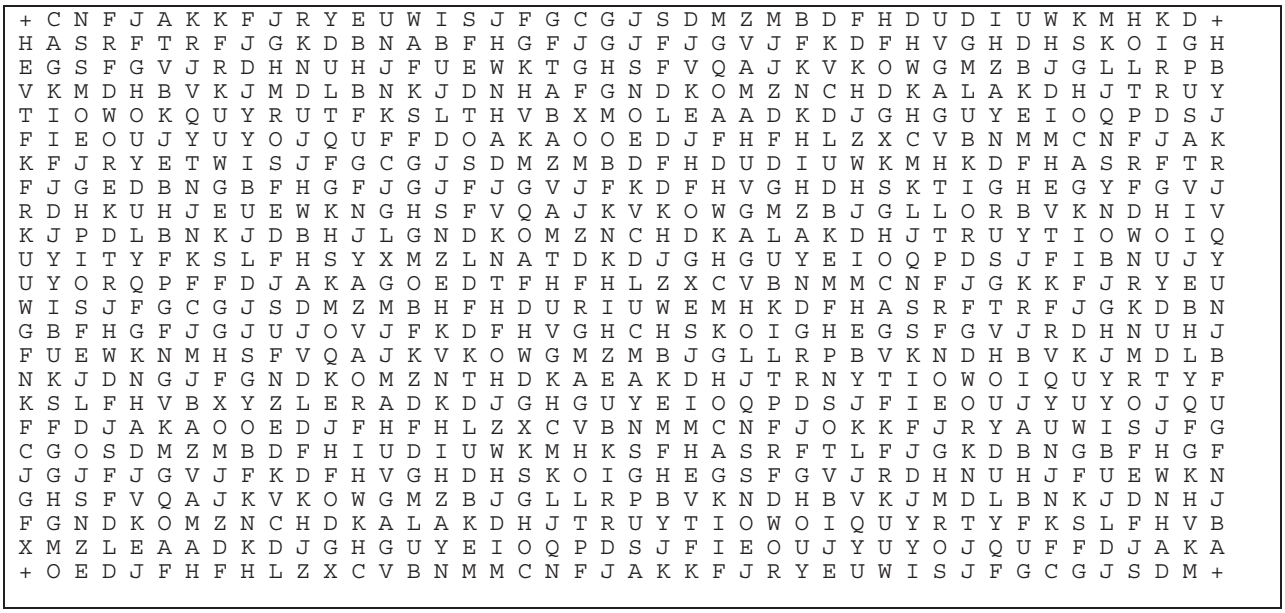

FIGURE 3 **Letter grid used in clue #2.**

"Welcome to Biology Class"). Students should spend no more than 10 min on this clue.

Preparation

The answer for this clue can easily be changed to reflect your desired message. One way to do this is to create your own version of the QuickTime movie. First, you construct a PowerPoint presentation that features one flag per slide. The flags should correspond to the letters or numbers in whichever phrase you choose to use as answer #1. To find out which letters correspond with which flags, refer to the word document "Code Flags.doc" in the clue #1 file on the Web site. You can simply copy the images from the word document and paste them onto the PowerPoint slides. Then, go to "File" and, then, "Save as Movie." The PowerPoint presentation is then converted into a QuickTime movie. Then, copy and burn this movie onto blank CD-ROMs, and place into envelopes labeled clue #1. The file should be the only file on each CD-ROM. Lastly, print some of the other distracting code sheets available on the clue #1 file on the Web site (e.g., Morse code, state flags), and put them in the goody bag.

CLUE #2

Description

The envelope for clue #2 contains a letter grid printed on a half-sheet of cardstock (Figure 3) and six half-sheet transparencies with circles printed on them. The circles represent actual constellations: Ursa Major, Pegasus, Sagittarius, Cygnus, Cassiopeia, and Pisces. The students need to line up each transparency with the grid cardstock to uncover words or phrases. It is important for students to realize that each transparency can be placed in four different ways since they can be flipped upside down or flipped over completely. In one of these four possible options, the transparency spells a message. However, five of the six transparencies display a message (e.g., try again, no luck, mistake, error, keep on trying), indicating to the students that they have yet to find the correct answer to the clue. The correct answer is on the transparency that reveals the word *stellar*. If students are able to realize or guess that the formation of the circles is actually representative of various constellations, they should better understand why *stellar* is the correct answer. Students typically spend 20 to 30 min on this clue.

Preparation

The letter grid is available on the Web site http://cosmos.bgsu.edu/resources/racetothefuture under clue #2, "Letter Grid.doc," and can be printed out on cardstock paper. Cut the blank half of the sheet off so the final grid is only a half-sheet. To create the transparencies, print off the six constellations on transparency paper. The constellations are also found on the Web site on the word document titled "Stars

Transparencies.doc" as part of clue #2. Cut the pages in half so that each constellation is on its own separate half-sheet of transparency. Make sure not to leave the answers above the constellations. Place all six half-page transparencies and the letter grid in the envelope.

CLUE #3

Description

Within the envelope for clue #3 is one sheet of paper featuring the images of 14 different scientists. Next to each image is a short phrase that gives a clue as to the identity of each scientist. Examples of these phrases include: "Gorilla Princess" for Dian Fossey, "A pox on you" for Edward Jenner, and "Look closely!" for Anthony Leeuwenhoek. Additionally, there are blank lines corresponding to the spelling of each scientist's last name. Under each of these blank lines is a number (Figure 4). The numbers are arranged in order from 1 to 95 from the letters of the first scientist's name to the letters of the last scientist's name. Students need to figure out the last name of each scientist and fill in the blanks. The answer for this clue is on the top right-hand corner of the sheet where there is a box with two sets of blank numbered lines with numbers underneath the lines. Those numbers are taken from the correct spelling of several of the scientists and reveal the answer: "Science Reality."

Preparation

This clue and its answer are also available on the Web site in the clue #3 folder under "Scientists Clue.doc" and "Scientists Answers.doc." If students do not have access to the Internet, we recommend including a list of all of the scientists featured in this clue (also available on http://cosmos.bgsu.edu/resources/racetothefuture as "List of Scientists.doc") in the goody bag.

CLUE #4

Description

For this clue, we give the students an envelope containing a CD and a sheet of paper with 11 sets of blank lines (Figure 5). This clue is similar to clue #3 in that under each blank line is a number and that the numbers go in order (this time from 1 to 130). At the bottom of the page are two sets of seven blank lines, again implying two seven-letter words. The CD contains 11 short iTunes audio tracks of various sound bites from famous science fiction films or television shows. Students need to listen to each sound bite and attempt to determine from which film or television show it is taken. Within the goody bag of materials is a long list of various science fiction film and television show titles ("List of Movies.doc"). Just like in clue #3, this resource can be used as a word bank. Students can also conduct research on the Internet. Eventually, students should be able to place the letters from the titles on the answer section over their corresponding numbers. Once the answer section is filled out, the students have their solution, which is "Science Fiction."

Preparation

This clue, its answer, and the word bank for the bag are available on the Web site in the clue #4 folder under "Sound Bites.doc," "Sound Bites Answers.doc," and "List of Movies.doc," respectively. Also, the content for the CD is available for downloading from the Web site. The sound bites can be copied and burnt onto a blank CD and placed in the envelope.

CLUE #5

Description

For clue #5, we give each group a paper bowl filled with colored M&Ms and no further instructions. The paper bowl is actually glued on top of another paper bowl. In between the two bowls is a tiny and, for many people, unreadable version of the answer sheet. Next to the number 5 on the tiny answer sheet is the phrase "2 Scientists Create 3 from 4." To solve this clue, students need to disregard the M&M'sand discover that the two paper bowls are glued together. When they come to this surprising conclusion, the students need to tear the two bowls apart and locate the tiny answer sheet. Some students may be able to read the sheet with their naked eye, but most of them will need a magnifying glass that is included in the goody bag. Once the students discover the phrase "2 Scientists Create 3 from 4," they must come to the realization that the numbers refer to the answers from clues #2, 3, and 4. When they substitute the answers in for the number of their corresponding clue, the students should come up with the final answer for the activity, "Stellar Scientists Create Science Reality from Science Fiction," and report to the judges.

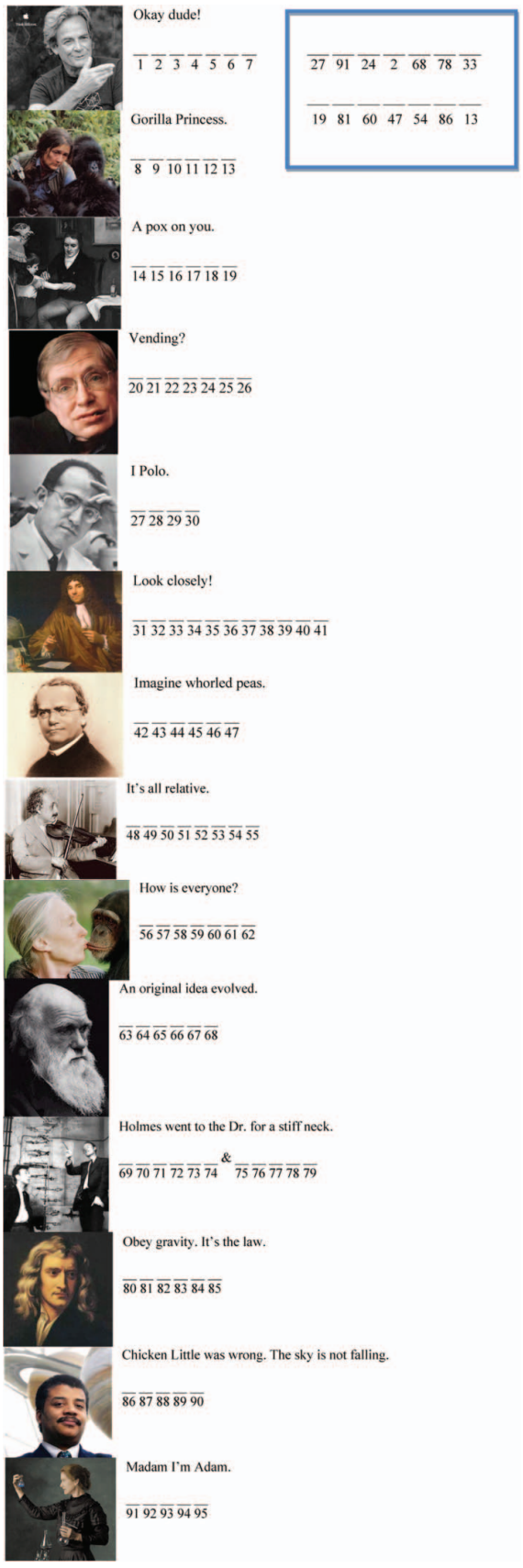

FIGURE 4 **Scientists used in clue #3 (color figure available online).**

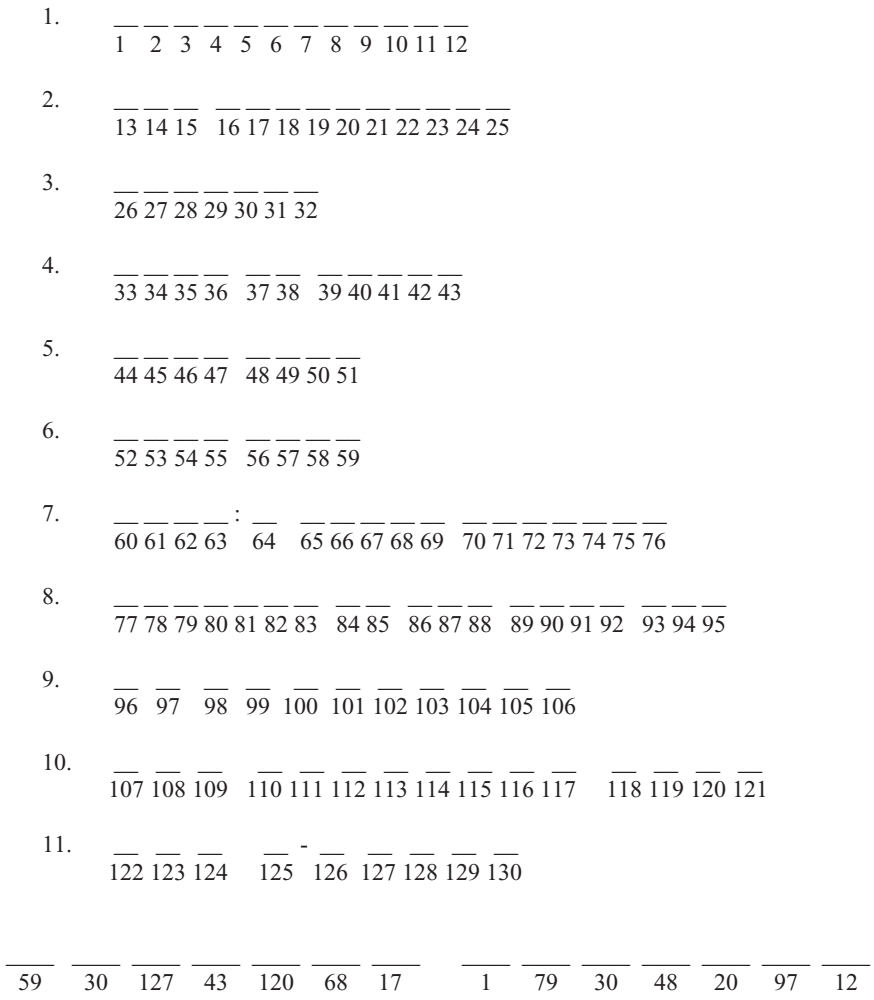

FIGURE 5 **Sound bites.**

Preparation

The clue #5 folder on the Web site contains the answer sheet ("Clue 5 Answer Sheet.xls") that can be downloaded as an Excel document, printed, cut, and glued in-between the paper bowls.

DISCUSSION

Although the education system continues to focus on standards and academics, most teachers would agree that to succeed in modern economy and modern life, their students must master what has been termed *21st century skills*. Those 21st century skills and knowledge include: creativity, innovation, critical thinking, problem-solving, communication, collaboration, personal responsibility, global awareness, social/intercultural skills, team learning, as well as mastery of rigorous academic content. However, teachers often struggle with integrating these skills into K–12 curricula. In this article, we describe a safe and constructivist-based activity called Race to the Future in which 21st century skills are successfully and seamlessly infused into existing curricula as a normal course activity. In Race to the Future, students work creatively and cooperatively with their teammates to successfully solve problems presented to them as five clues related to science content. In the first clue, each group of students receives an envelope with a CD that, once inserted into a laptop or computer, plays a QuickTime movie with a message created with international code flags. The first clue is intended to build team camaraderie that will prove essential for the completion of the entire activity (see Figure 6). The message is kept simple, and the students typically solve this clue within 10 min, especially with the aid of the code flag sheet included in the goody bag. Clue #2, the transparency that spells "Stellar," is perhaps the most challenging (and lengthy) clue of the whole activity. Students need to properly align the transparency over the letter grid to get the answer. Some groups, depending on their ages, may

FIGURE 6 **Students work together to decipher science clues (color figure available online).**

also have a problem identifying that the circles on the transparencies represent actual constellations and/or realizing that the word *Stellar* refers to stars. If one or more groups fall behind and cannot solve the clue within 15 to 20 min after the last group reported to the judges with the right answer, we recommend assisting the group in solving the clue but without providing the exact answer. Clue #3, containing the fill-in-the-blank names of the scientists, can be solved easily if students are given access to the Internet and/or the word-bank sheet from the goody bag. Once again, depending on the age of the participants, we determine which option (Internet or word-bank sheet) is given to the students. Clue #4 containing the sound bites from science fiction movies or television shows typically requires assistance in the form of Internet access and/or a list of movies in the goody bag. Otherwise, students may take too long to solve this clue. Clue #5 is usually the "equalizer." We have seen that even the groups that were progressing speedily through the previous clues sometimes get "stuck" solving this one. Perhaps this is due to the fact that this clue represents a much different format and that no instructions are given. Also, we have seen some groups that, even though they were able to locate the mini answer sheet and read the answer, were not capable of substituting the numbers for the correct answers and make a coherent final answer. Interestingly, we often end up with most of the groups working on the same clue at around the same time. This is important because while challenges and competitions are very engaging for many students, we do not want to create unhealthy anxiety or a sense of failure that will impede future learning in the classroom. Therefore, we prefer to provide rewards to all participants, if possible. Sometimes, especially if you have a large or younger group, it helps to have more than one facilitator. The facilitator who is not checking answer sheets can walk around the rooms to observe student behavior and perhaps offer assistance to struggling groups. However, we usually only provide assistance to those groups that really fall behind in their solving of the clues while trying to remain fair to the rest of the groups.

EXTENSION AND CROSS-CURRICULAR APPLICATIONS

This activity can be used as an assessment and/or review tool for any type of content. For example, on some occasions we have included a sixth clue containing a set of 15 multiple-choice math questions from a state achievement test. For this clue, students are still allowed to work together to answer each of the 15 questions. The final answer for this clue is a four-digit number in which each digit corresponds to the exact number of correct A, B, C, and D answers to the entire test. Therefore, if students are to arrive at the final correct answer, they must answer each of the questions correctly.

CONCLUSION

Most of us would agree that the most effective learning that occurs in our classrooms happens when the students learn the content and skills at the same time that they are forced to think critically, solve problems, and work cooperatively. And, perhaps, nobody is playing a bigger role in ensuring that 21st century skills are infused into the classrooms than the Partnership for 21st Century Skills (www.p21.org), a national organization that advocates for 21st century readiness for every student. The partnership has been releasing maps in science and geography that show how to integrate 21st century skills into the classroom. However, teachers need additional training and demand concrete examples in all areas on how to infuse those skills into education. Our activity, Race to the Future, exemplifies how 21st century skills can be incorporated into core subject instruction and at the same time positively enhance student engagement.

ACTIVITY RESOURCES

All of the files and documents mentioned in the activity are available, free of charge, to all users at http://cosmos.bgsu.edu/resources/racetothefuture. The scientist pictures and the sound bites are royalty-free.

ACKNOWLEDGMENT

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