RESEARCH ON LEARNING

Teaching High School Physiology Using a Popular TV Medical Drama

MARISA ALVARADO, APRIL CORDERO MASKIEWICZ

Abstract

Teachers know that educational experiences extend far beyond the classroom. With a wide variety of science-related programs on television, there is a need for more research into how these programs can be utilized in a classroom setting. In this mixed-methods study, we asked the question: Can student understanding of human physiology be improved through the use of multimedia resources, specifically through the use of popular television? Episodes of Fox's popular medical drama "House, M.D." were incorporated into high school biology curricula during instructional units on two body systems: the nervous system and the immune system. Through the use of integrated media and classroom discussions, students were exposed to the social aspect of learning as they worked together to analyze what they viewed on TV. This study was conducted over a traditional school year in a general biology class at a lower-socioeconomic urban high school.

Key Words: *Physiology; integrated media; popular television; high school.*

According to the U.S. Department of Health and Human Services (1991), 96% of Americans watch television an average of 3 hours a day. With programming ranging from newscasts to reality shows to documentaries to dramas, students are exposed to an assortment of science in their living rooms. The Centers for Disease Control and Prevention (CDC) claim that 88% of people in America learn about health issues from television. These national surveys have shown that daytime and prime-time viewers pay attention to the health information in TV shows, learn from it, act on it, and share the information with others (CDC, 2009). These programs introduce medical jargon, procedures, human diseases, and potential therapies, and they often lead to naive conceptions regarding human physiology.

Educators have long used popular film in classes in order to demonstrate realistic and real-world connections to concepts.

In order to improve the accuracy of the science content reaching the public, AARP (Kaiser Daily Health Policy Report, 2008) announced its "Divided We Fail" campaign, which encouraged Hollywood writers to include health-care issues in popular TV shows and movies in the hopes of educating and reaching more people. The CDC has also created the Entertainment Education Program that works in partnership with Hollywood, Health & Society at the University of Southern California to provide expert consultation, education, and resources for writers and producers who develop scripts with health storylines and information. As science-education researcher Dhingra (2003) points out, educational experiences extend far beyond the classroom. With such a wide variety of science-related programs on television, there is a need for more research into how these programs can be utilized in a classroom setting.

Educators have long used popular film in classes in order to demonstrate realistic and real-world connections to concepts. "Used effectively, film can take students to the higher levels of application, analysis, synthesis, and evaluation as they apply theories to life on the screen, analyze characters, create new scenarios or endings to films, and evaluate the quality of a film's presentation of relevant concepts" (Roberts et al., 2003: p. 2). A search for "films, science classroom" on Google elicited thousands of websites listing movies and lesson plans that can be used at different grade levels to cover a spectrum of scientific concepts. Successful studies have been conducted addressing the use of integrated media in academia, yet few have addressed how integrated media can support content learning in a *science* classroom. As a result, we were interested in finding out whether students' understanding of human physiology could be improved through the use of multimedia resources, specifically through the use of popular television.

Both California's state science standards (California Department of Education, 1998) and the *National Science Education Standards* (National Research Council, 1996) include physiology concepts that high school students should master in order to gain the essential skills and knowledge necessary to become scientifically literate citizens in the 21st century (Table 1). Therefore, the premise of this research study is to capitalize on student interest in multimedia so that it becomes a vehicle for helping science learners develop an understanding of the nervous system and the immune system. On the basis of previous studies on the use of multimedia in the classroom, we felt that the collaborative

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Table 1. California State Science Standards (California Department of Education, 1998) and *National Science Education Standards* (National Research Council, 1996) that cover the nervous system and immune system.

	California State Standards	National Science Standards
Nervous System	9b. nervous system mediates communication…. 9d. functions of the nervous system and role of neurons…. 9e. roles of sensory neurons, interneuron's, and motor neurons….	H.C.6a. Multicellular animals have nervous systems that generate behavior. Nervous systems are formed from specialized cells….The nerve cells communicate with each other….
Immune System	10b. role of antibodies in the body's response to infection 10c. how vaccination protects an individual…. 10d. important difference between bacteria and viruses…. 10e. individuals with a compromised immune system….	M.C.1e. The human organism has systems … and for protection from disease. M.C.1f. Disease is a breakdown in structures or functions… H.F.1b. The severity of disease symptoms is dependent on many factors…Many disease can be prevented, controlled, or cured. Some diseases…result from specific body dysfunctions…

nature of "integrated media" would be the best approach for the science classroom because the discussions about the science content can help facilitate learning.

○ Using Integrated Media for Learning Physiology

By definition, the terms "integrated video enhancement" and "integrated media" refer to the incorporated use of media and discussions within curricular units (Harwood & McMahon, 1997). The idea is to preplan scheduled interruptions during the media presentation that allow for teacher–student question–answer interaction time. Using integrated media in high school biology classes, we were able to show significant achievement gains in physiological content knowledge over the course of the entire academic year. Episodes of Fox's popular medical drama "House, M.D." (http://www.fox.com/house/index.htm) were incorporated into the curricula during instructional units on two body systems: the nervous system and the immune system (Figure 1).

We chose "House, M.D." because of three factors: first, its ability to provide relatively accurate scientific scenarios in an interesting and entertaining format with limited side stories; second, the frequent animations of what is occurring inside the patient's body, which set the program above its competition; and third, the show's familiarity among previously surveyed students. Of the 44 students surveyed, 59% claimed to be regular viewers of science- or medical-related TV programs, and "House, M.D." was one of the top three most popular programs (Figure 2). Although the show was familiar to the students, few admitted being regular viewers, thus diminishing the chances that students had previously seen the episodes used in this study.

Episode Information provided by House M.D. Guide to the TV show (http://www.housemd-guide.com/episodes.php)	
Nervous System	
"*Insensitive*" season 3, episode #314, first broadcast February 13, 2007	
The patient of the week:	Hannah Morganthal, a teenager has CIPA (Congenital Insensitivity to Pain and Anhidrosis) so she cannot feel pain. But House thinks something is wrong and indeed she develops fever.
The mis-diagnoses:	While undergoing tests, she gets a second-degree burn and develops paranoia and then her legs become numb and she falls to break bones. House later decides she has a B-12 deficiency but she just got a B-12 injection. While stealing one of Wilson's sandwiches, House decides that something else ate the B-12.
The final diagnosis:	A 25-foot tapeworm

Immune System	
"*Role Model* " season 1, episode #117, first broadcast April 12, 2005	
The patient of the week:	Senator Wright collapses after a campaign speech in his run for President.
The mis-diagnoses:	Without even seeing the patient, House declares to Vogler it is "bad sushi". But then during the evaluation, he says it is the Senator's brain. This leads to having his brain biopsied. That reveals toxoplasmosis. This leads to a diagnosis of AIDS. But when the Senator denies risky behavior, House takes the AIDS test again. When this time it comes back negative, they start guessing and decide to look for hairy-cell.
The final diagnosis:	The Senator had had "childhood epilepsy. He took phenytoin. That drug, with the Epstein-Barr virus, is associated with common variable immunodeficiency disease. T-cells down, B-cells down, it keeps you from forming enough antibodies." "That's a type of immunoglobulin deficiency."

Figure 1. Episode information provided by the online guide "House M.D." Guide for the TV show "House, M.D." (http://www.housemd-guide.com/episodes.php)

Bones*	Health Channel*
Court TV*	House**
CSI**	Law and Order*
CSI: Las Vegas*	Law and Order: SVU*
CSI: Miami	Man vs. Wild
Delivery Babies	Medical Diagnosis
Discovery Channel Science	Medical Incredible
Discovery Health	Mythbusters
Emergency Crimial Justice	Naked Science*
ER*	NCIS*
Forensic Files	Trauma: Life in the ER
Grey's Anatomy**	Untold Stories of the ER

** represents programs that were identified more than once*
*** represents top 3 most popular programs*

Figure 2. List of science/medical-related TV programs.

○ Research Design

This mixed-methods study was conducted over a traditional school year in a general biology class at a lower-socioeconomic urban public high school in southern California. Participants ranged in age from 15 to 19 years old. See Figure 3 for an overview of the research design. The first author was the instructor for all three classes in this study. Through the use of integrated media and classroom discussions, students were exposed to the social aspect of learning as they worked together to analyze what they viewed in the show.

The integrated media units were administered one at a time, each following the same research design. The unit began with a pretest in the experimental and control classrooms in order to determine prior knowledge of the body system. The unit was then taught following the instructor's standard lesson plans: textbook assignments, PowerPoint notes, demonstrations, and a laboratory activity. Toward the end of the unit, the experiment utilizing multimedia was implemented in two classes, with the third class as a control group participating in more traditional instruction:

- Control Group: spent approximately a day and a half (70 minutes) on an assignment, using their textbook and corresponding worksheet.
- First Experimental Group (Exp1): watched the "House, M.D." episode without interruption by the instructor. The following day, the students wrote a paragraph explaining how the episode was related to the current unit of study. The viewing and writing assignment took approximately a day and a half (70 minutes).
- Second Experimental Group (Exp2): watched the "House, M.D." episode, with the instructor incorporating the method of integrated media. Because of the combination of viewing and discussions, a day and a half (70 minutes) was spent on this activity.

At the end of the unit, all classes were administered a posttest in order to assess the amount of content material learned.

In the Exp2 group, the stopping points for discussion were preselected ahead of time on the basis of Harwood and McMahon's (1997) recommendation of 5–7 minutes as well as the natural flow of content in the program. Two to three open-ended discussion questions were developed by the first author for each stopping point; however, students were encouraged to pose additional questions for discussion. The length of each stopping-point discussion varied from 5 to 15 minutes depending on the amount of participation. Figure 4 provides an example set of questions for one stopping point for each unit.

Two separate data collections took place, one for the nervous system and the other for the immune system. The unit on the nervous system was administered first, with the immune-system unit immediately following. Test groups were reassigned for the second unit in order to factor in and cancel out the variables of time, students, and familiarity with the intervention.

Approximately 5 months after the implementation of the experiment, near the end of the school year, a delayed-test, identical to the first posttest, was administered in order to determine the amount of content retained. The nervous-system delayed-test was administered first, followed by the immune-system delayed-test one week later.

After the delayed-test, six students were interviewed in order to further determine whether the use of integrated media had an effect on students' content-learning of human physiology. Each volunteer represented one of the individual test groups. An end-of-the-year survey was also administered to the participants that elicited their ideas about the overall school year, memorable units of study, and class requirements.

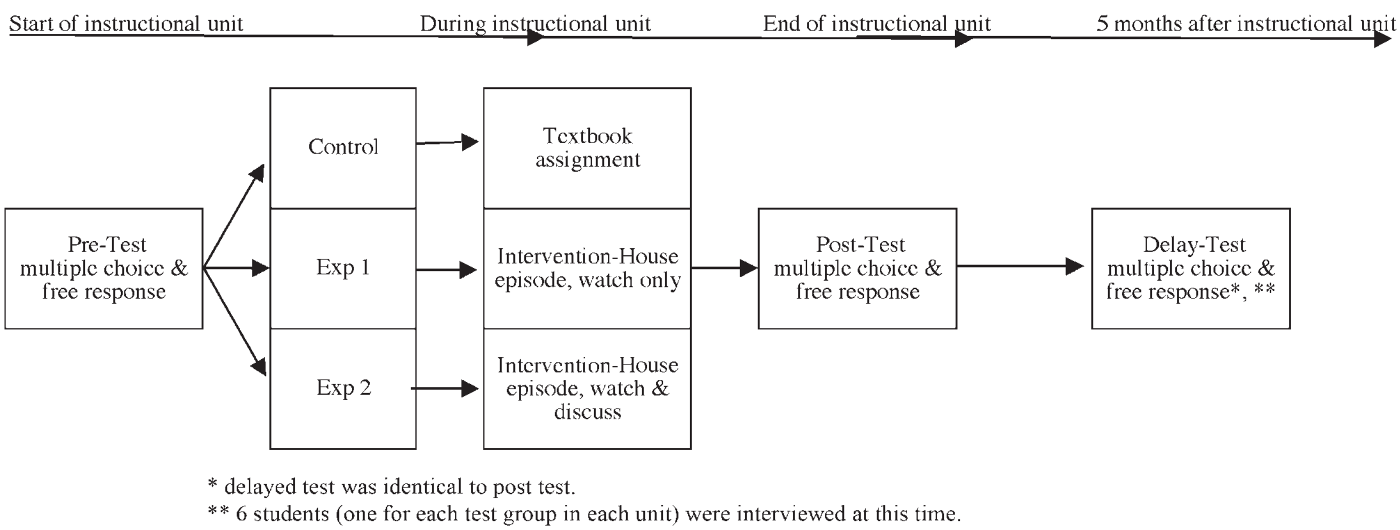

Figure 3. Mixed-methods research design over a timeline.

***"Insensitive"* – Nervous System**
Stoppage point 1: After ER scene – CIPA diagnosed
1. Our patient's name is Hannah – what happened to her and her mom?
2. House diagnoses her with CIPA, what is CIPA?
   a. What does that mean?
   b. Which body system does it affect?
   c. How?
3. What were his pieces of evidence?

***"Role Model"* – Immune System**
Stoppage point 1: After the collapse
1. Our patient's name is Senator Gary Wright. What happened to him?
2. What were his symptoms?
3. Sweating/Vomiting is usually an indication of what?
   a. Why do we sweat/vomit?

Figure 4. Examples of stopping-point questions for each episode.

○ Results

An independent two-tailed t-test, which takes into account a positive or negative gain, was used to compare means for pre-, post-, and delayed-test scores between groups of students. Comparison of pretest results revealed that the three test groups were not statistically equal prior to instruction. As a result of these initial differences in students' knowledge, difference scores (also referred to as "actual gain") and normalized gain scores were utilized in comparing the progress of the three groups. Normalized gain takes into account the difference in pretest scores that commonly exist in a group of students from a variety of cultural and educational backgrounds.

The use of normalized gain as a measure of conceptual gain was introduced in Hake's (1998) study on teaching methods in introductory physics courses. Gain measures the fraction of available improvement that is obtained. The normalized gain can be calculated by dividing the actual gain by the maximum possible gain:

$$g = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum possible score} - \text{pretest score}}$$

Table 2. A summary of t values, degrees of freedom, and P values for within-group test comparisons for the nervous-system (NS) and immune-system (IS) units (two-tailed t-tests; P < 0.05).

Treatment Group	Unit	Assessment	t	df	P
Control n = 13	NS	Pre-post Pre-delay	–5.93 –4.41	17 16	0.0001 0.0004
Exp 1 n = 15	NS	Pre-post Pre-delay	–5.72 –2.21	25 25	0.0001 0.04
Exp 2 n = 28	NS	Pre-post Pre-delay	–7.79 –6.93	50 52	0.0001 0.0001
Control n = 32	IS	Pre-post Pre-delay	–5.14 –2.55	56 57	0.0001 0.014
Exp 1 n = 12	IS	Pre-post Pre-delay	–3.38 –1.86	16 20	0.004 0.07
Exp 2 n = 17	IS	Pre-post Pre-delay	–6.03 –2.70	25 25	0.0001 0.012

For example, using actual gains, a student who scores 5/30 on a pretest and 15/30 on a posttest will have identical gain to a student who scores 10/30 on the pretest and 20/30 on the posttest. Each would have an actual gain of 10, indicating that learning improved the same amount, the result of which may not be statistically significant. Utilizing normalized gain, a closer truth may be seen. The first student would possess g = 10/25 = 0.4, indicating that they improved their content knowledge 40%. The second student would possess g = 10/20 = 0.5, indicating that they improved their content knowledge by 50%. Therefore, despite the same actual gain, the second student demonstrated greater learning of the content.

Tables 2 through 7 provide the statistical analysis of test results for both the nervous-system and the immune-system units. On the basis of normalized gain scores, there were positive gains in learning

Table 3. Descriptive statistics of pre-, post-, and delayed-test scores of the nervous-system (NS) and immune-system (IS) test groups. All tests were graded out of a possible 30 points.

Test Group	Control (n = 13)			Exp 1 (n = 15)			Exp 2 (n = 28)		
NS	Pre	Post	Delay	Pre	Post	Delay	Pre	Post	Delay
Mean	2.77	10.62	8.85	6.8	15.13	10	5.5	14.82	13.46
SD	1.96	4.35	4.56	3.21	4.64	4.60	3.83	5.03	4.72
Range	7	15	16	14	16	16	18	18	17
Minimum	0	3	2	1	5	0	0	7	6
Maximum	7	18	18	15	21	16	18	25	23
Test Group	Control (n = 32)			Exp 1 (n = 12)			Exp 2 (n = 17)		
IS	Pre	Post	Delay	Pre	Post	Delay	Pre	Post	Delay
Mean	8.38	15.22	11.69	4.75	10.83	7.17	7.65	15.88	11.18
SD	4.38	6.14	5.92	2.63	5.65	3.66	2.67	4.96	4.69
Range	20	24	24	9	16	13	10	17	19
Minimum	0	5	3	2	3	2	3	7	3
Maximum	20	29	27	10	19	15	13	24	22

Table 4. Normalized gain scores for the nervous system. Positive values reveal conceptual learning.

	Normalized Gain 1 Mean (g1) Pre- to Posttest	Normalized Gain 2 Mean (g2) Pre- to Delayed Posttest
Control	0.29	0.23
Exp 1	0.36	0.13
Exp 2	0.38	0.33

Table 5. Statistical comparisons of g1 and g2 scores for the nervous system (two-tailed t-tests; asterisk indicates statistical significance, P < 0.05).

	g1 scores		g2 scores	
	t(df)	P	t(df)	P
Control vs. Exp 1	−1.0 (25)	0.33	1.4 (25)	0.16
Control vs. Exp 2	−1.81 (27)	0.08	−2.02 (24)	0.05*
Exp 1 vs. Exp 2	−0.48 (26)	0.64	−3.27 (22)	0.004*

Table 6. Normalized gain scores for the immune system. Positive values reveal conceptual learning.

	Normalized Gain 1 Mean (g1) Pre- to posttest	Normalized Gain 2 Mean (g2) Pre- to delayed posttest
Control	0.33	0.15
Exp 1	0.25	0.09
Exp 2	0.37	0.16

Table 7. Statistical comparisons of g1 and g2 scores for the immune system (two-tailed t-tests, P < 0.05).

	g1 scores		g2 scores	
	t(df)	P	t(df)	P
Control vs. Exp 1	1.31 (26)	0.2	0.93 (33)	0.36
Control vs. Exp 2	−0.62 (37)	0.54	−0.24 (45)	0.81
Exp 1 vs. Exp 2	−1.77 (26)	0.09	−1.22 (25)	0.23

for both units from pre- to post- (g1) and pre- to delayed (g2) five months later. A comparison of the test groups' g1 scores, however, showed no statistical difference for either body system. Differences resulted when g2 scores were compared. For the nervous system unit, the Exp2 group's scores were significantly greater than the g2 scores of both the control and Exp1 test groups. This indicates that there was an improvement in learning when integrated media was implemented. For the immune system, the g2 scores were not statistically different, which indicates that when it came to the immune system, although learning occurred in all three groups, integrated media was not necessarily more effective than a textbook assignment or simply viewing the program.

Interviews conducted after the delayed test, five months after the unit was taught, confirmed the quantitative results for both units. The subject from the nervous-system Exp2 group was able to demonstrate a stronger retention of the content material than the subjects from the other test group and the control. For the immune-system interviews, all three subjects demonstrated moderate to strong retention of the content material, once again confirming the results seen when comparing normalized gain scores. Students participating in the interviews were also asked about their engagement and thoughts on integrated media, some of which are transcribed in Figure 5.

○ Discussion

Students live in a media-oriented world, and more and more educators are looking for ways to infuse this culture into the classroom setting. This study attempted to quantify the fact that integrating media – combining viewing with discussion – into the classroom curriculum improves student learning and participation. The results from the assessment instrument utilized in this study clearly showed that regardless of the unit or physiological system, integrated media promotes student content learning. There were mixed results, however, when we compared the effects of integrated media with those of the other teaching techniques. Students in the test group that utilized integrated media performed statistically higher (~15%) than the other test groups during the nervous-system unit, which indicates that integrating popular television can have a positive effect on student understanding. However, during the unit on the immune system, all test groups scored statistically the same, which indicates the need for more research.

When it comes to popular TV programming and its effect on content learning when implemented in a high school science classroom, use of media facilitated learning. However, why was there a difference between the two units? Why did the intervention have a greater effect than traditional teaching methods in the nervous system unit but not in the immune-system unit?

Student interests may explain the discrepancies in the learning results between the two units. Kozma (1991) stated that

> the perceptions students have about a medium and the purposes they have for viewing influenced the amount of effort that

> *"[When I was taking the test] I was thinking I can do this and when I got to the CIPA question, I remembered that. The "House" episode did help. This gave me confidence to go back to the other questions [and answer them]."*
>
> —Sam (Nervous system)
>
> *"I think it's good to do both because people need notes but the video, I don't know its kinda fun and it was kinda educational at the same time. Because it was the same topic it kinda helped you get it more. It's a good thing, it's a good thing…I think it's good to stop em both because then that way if you do it that way it's not, it's not too fun like you're watching a movie or we're just watching a movie and then that way it balances it out."*
>
> —Jessica (Immune System)

Figure 5. Student quotes about the use of integrated media in their classroom.

> they put into the processing of the message and consequently, the depth of their understanding of the story.

In other words, if students did not deem the videos interesting or relevant, it could have had an effect on the intervention overall. One student in my study expressed the importance of "activities that grab [your] attention and have fun, [which] helps [you] remember it." The "*Insensitive*" episode used for the nervous system had many more scenes that drifted to the extreme and was more dramatic than the "*Role Model*" episode used for the immune system. The students interviewed for the immune-system unit stressed how much better they remembered the nervous-system episode compared with the immune-system episode:

> "*I remember the nervous system one because that was kinda intense*."
> Karah (immune system)

> *"I remembered the movie for sure. I remember everything that happens."*
> Juan (immune system)

Content material may have also played a role in each episode's effectiveness. In comparing the pretest scores between the nervous system and the immune system, students scored statistically higher on the immune-system pretest ($t_{115} = -3.26$, $P < 0.0015$, two-tailed). It could be possible that the immune system itself is more tangible to the students because of their familiarity with the idea of getting sick and their body fighting the illness. As a result, the students may not have been as intrigued by "*Role Model*" as they were by the nervous-system episode. The actions of the nervous system, however, are more abstract and less familiar to the students. "*Insensitive*," with its' unfamiliarity, may have held more intrigue for the students because of their lack of prior knowledge.

While interest and familiarity may have played a role in the outcome of this study, other factors that could have affected the statistical results include low sample size and test value. Only the first author's classes were utilized in this study in order to guarantee that teacher instructions or comments would not affect the outcome. As a result, each test group had low participant numbers (n = 12 to 32, depending on the unit). A larger sample size might produce different results. Also, despite the fact that normalized gain scores were used when determining significance, with a test value of only 30 points, there was not much room for gain when it came to student test scores.

○ Implications for Teachers

Our results are consistent with those of education researchers Harwood and McMahon (1997), who concluded that integrated media is "an instructional tool that can be used effectively to bring the often abstract, distant worlds of science into close focus and within the personal meaningful realm of each individual student."

From the NSTA to the CDC to college universities, organizations around the country are realizing the importance of combining popular culture with education. Dhingra (2003) stressed that it is important for educators to recognize that television-mediated understandings about the nature of science and scientists influence what students bring with them into the classroom. While there are many media options for educators, TV programs should be considered a viable choice for engaging students with classroom content. Many educators use film or media in their classrooms to enrich the curriculum; however, as this study showed for the nervous system, it is important to include the discussion component of integrated media. The value of teacher-scheduled interruptions into a media presentation allows for processing time and discussion of ideas, which can have important implications for comprehension and learning (Kozma, 1991).

○ Future Research

With 88% of Americans learning about health issues from their television sets, it is reasonable to assume that what Americans are viewing is leading to the alternative conceptions educators see in their classrooms. It is important, therefore, that more research be conducted into how students perceive science as seen on television or in movies. Dhingra (2003) asked, "Would classroom discussion of television-mediated science help students get in the habit of thinking more deeply about and questioning knowledge claims aired on television?" Essentially, more research needs to be conducted on the effects of integrated media and the choice of media being used to promote learning.

The mixed results seen here indicate that our study needs to be replicated in order to determine whether the results are specialized for one human physiological system or if integrated media has an effect on student understanding of multiple human physiological systems. Why did the intervention work best in the case of the nervous system? Could the episode chosen for the immune-system unit have been used differently?

Another direction for future research is to consider the use of integrated media for differentiating instruction for individual students. Both this study and the one by Hardwood and McMahon (1997) were conducted in diverse general-science-class settings; therefore, the question remains: can integrated media be effective at all learning levels, or is it more effective for general science students than for honors or AP students? With technological advancements being made on a daily basis, education researchers need to pay more attention to these developments and how they can be implemented in the classroom in order to best serve the learner.

Nevertheless, bringing popular culture into traditional classroom settings is a new and exciting way to potentially maximize student learning. It is our responsibility as education researchers and teachers to continue this work in the future.

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MARISA ALVARADO is a biology teacher at Monte Vista High School, 3230 Sweetwater Springs Blvd., Spring Valley, CA 91977; e-mail: malvarado@guhsd.net. APRIL CORDERO MASKIEWICZ is Assistant Professor of Biology at Point Loma Nazarene University, 3900 Lomaland Dr., San Diego, CA 92106-2899; e-mail: aprilmaskiewicz@pointloma.edu.