What makes science relevant?: Student perceptions of multimedia case learning in ecology and health

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Abstract

The perception of science as boring is a major issue for teachers at all instructional levels. Tertiary classes especially suffer from a reputation for being dry, instructor-centered, and irrelevant to the lives of students. However, previous research has shown that science can be interesting to students if it is presented in such a manner as to generate personal curiosity and interest. This study explored the efficacy of two multimedia, case-based approaches to develop interest and perceptions of relevance in an introductory biology class. One of these approaches enabled students to test hypotheses about wolf ecology using radio telemetry data, while the other enabled them to play the role of a geneticist testing for genetic and infectious disease conditions. After completing both projects, 32 students volunteered to participate in one of four video-recorded focus interview groups to determine what non-majors in an introductory biology course think is relevant science to learn and why. Twelve trends in student views on relevance, the most important of which were potential use, curiosity, global relevance, and human relevance emerged from this study. Students preferred both case-based projects to lecture, and liked the project on human health better than the case project on wolf ecology. This research contributes significantly to understanding how personal curiosity and relevance motivate students in science classrooms.

KEY WORDS: Case-based instruction, relevance, science education, student motivation, undergraduate education.

"Why are we studying this?" is a question most science professors have heard. A major failing of the lecture approach to science education is the perceived lack of relevance to the everyday world by students (Aikenhead, 2006, 2007). College students often find science unexciting, disengaging, poorly taught, and difficult to relate to (McManus, 2001; McConnell et al., 2003; Schreiner & Sjøberg, 2004; McConnell et al., 2005). Furthermore, when science is taught by traditional lecture methods, students retain little of the information presented long-term , and there is little comprehension of unifying themes or ideas (Dale, 1969; McDonald & Dominguez, 2005; Lord, 2007; Seymour & Hewitt, 1997; Aikenhead, 2006).

Numerous authors have argued that science must become more socio-culturally relevant and authentic so that students can relate information directly to both their own lives and their cultural perspectives (MacIvor, 1995; Aikenhead, 1996, 2001, 2002; Barton et al., 2005; Stears & Malcolm, 2005; Roth & Barton 2004). However, even the word "relevance" is ambiguous in that educators have not reached consensus on its meaning, and this lack of common definition leads to misunderstandings. Mayoh & Knutton (1997) assert that two dimensions of relevancy must be considered when developing pedagogy and determining content: (a) relevant to whom?, and (b) relevant to what? Aikenhead (2006) identified seven different types of science relevance related to public education. Several of these pertain to this study: 1) need-to-know science, that is resolving real-life problems related to science, 2) functional science, e.g., people in science-based occupations needing info for their jobs, and 3) personal curiosity science, that is wondering how something works. Of the seven kinds, one of the most important for educators to understand is personal curiosity science since this can be a driving motivational factor in science classrooms (Kortland, 2001; Aikenhead, 2006). Even though students may not be innately curious about a topic, instructors can stimulate students' curiosity through instructional methods. Knowing how to stimulate students' curiosity in science allows instructors to chose topics and instructional methods that motivate students' learning.

When students become curious about a topic, they view it as more relevant to their lives and become more motivated to learn. Research from Europe shows that ideas drawn from students' everyday life experiences such as "the rainbow and sunsets" are far more relevant to them than science topics such as "light and optics" (Häussler & Hoffmann, 2000; Sjøberg, 2000; Kortland, 2001; Jenkins, 2006c). Personal curiosity is naturally closely related to students' interests. Topical and current issues such as human health and sexuality, drugs and drug use, population growth , and pollution and environmental hazards have all been identified as generating student interest (Stoker & Thompson, 1969; Aikenhead, 1992; Ratcliffe & Grace, 2003; Irwin, 1995). For students who connect to the environment, natural phenomena such as animal behavior or weather, are also of considerable interest (Malcolm, 2004; Barnhardt & Kawagley, 2005).

How a topic is taught also matters in generating student interest, not just the nature of the topic. A growing body of literature emphasizes the utility of multimedia tools to actively engage students in instruction, especially at the undergraduate level (Lundeberg et al.,2002). These tools may include the combination of video or audio recordings, online forums, interactive simulations, animations, and/or text. By allowing students to interact with the information on multiple cognitive, social, and emotional levels, multimedia learning environments may generate both student curiosity and a sense of relevance. For example, one of the learning environments used in this study has been extensive researched , and shown to develop relevance for students, foster ethical development, and increase student confidence (Bergland et al., 2001; 2006a; 2006b; Foster et al., 2006; Klyczek et al., 2006; Lundeberg et al., 2001; 2003).

Most research on relevance in science uses surveys to ask questions about what students are *potentially* interested in, rather than assessing interest after they have *experienced* a science topic. In this study, students experienced two multimedia case-based approaches. Both approaches access topics that previous research has shown should be theoretically relevant to students: one engaged students in an ecology project, and the second engaged students in a health project. After students completed both projects, we interviewed them to understand what non-major students in an introductory biology course think is relevant science to learn and why.

Method

Participants

Approximately two-thirds of the 46 students enrolled in an introductory biology course for non-majors at a Midwestern university ($n = 32$) agreed to participate in one of four video-recorded focus group interviews. The sample population was comprised primarily of freshmen and sophomore students with one junior. The class was divided into two lab sections, and two groups of participants were drawn from each lab section for a total of four interview groups ranging from 5 to 10 participants each. Twenty (20) women and 12 men volunteered to participate. All participants experienced both learning environments.

Non-majors were selected as the sample population in this study because they represent a major student subset that science struggles to reach via conventional instructional methods such as lecture (Seymour & Hewitt, 1997). Similarly, we chose to study a biology class because it tends to be the easiest of the sciences for non-majors to access, understand, and pass, and yet large numbers still fail such introductory courses (Astin & Astin, 1993; Seymour & Hewitt, 1997).

The Two Learning Environments

The introductory biology course investigated was taught using a variety of pedagogical methods throughout the semester, including both lecture and case-based inquiry. The two learning environments highlighted in the following text were the two primary case investigations undertaken in the course and represent the diversity of instructional possibilities in using case-based instruction. Cases may be relatively simple or very complex; however, the point is to actively engage the students in the material on multiple levels to create novel connections. To better understand this relationship, we intentionally chose dissimilar cases in order to parse out what makes for successful cases.

Wolf telemetry exercise. Students participated in a lab project to track gray wolves in the Superior National Forest. The main objectives of the lab were to introduce students to observational data collection in biological settings, and cause students to use the scientific method to critically analyze data. The wolf telemetry project was envisioned by the instructor both as an interesting way of understanding scientific methods of inquiry in biology, and as current environmental content.

Individual students used a large, pre-existing dataset maintained by the International Wolf Center (IWC) to obtain wolf-tracking data such as wolf identification number, date, and range. This data set was available either on a local server, or directly from the IWC (http://www.wolf.org). Students chose an individual wolf with known "associates" (animals detected at the same time and location) to work with. They searched the observational data for approximately 20-25 data points in an effort to establish parameters such as a pack's range and territory. By choosing a single animal to follow and using the data to track and predict interactions, students stopped seeing this as a data exercise and began to identify with their wolf, potentially better understanding the complex ecological reality present on the ground.

At this point in the case study, students formed groups to aggregate data and developed hypotheses about why their wolves' demonstrated particular movement patterns and the potential ecological interactions they might be encountering. Once students identified a potential pack via data analysis, they tested their hypotheses about wolf dynamics by virtually mapping movements using Google Earth with an external plug-in map for the Superior National Forest. Students actively engaged in the scientific process, especially observation, analysis and review, during the interactive mapping process using computers and their data sets to track the wolves. At the end of the project, student groups orally described their results and simulations in multimedia presentations to the class. Students spent four weeks working on this exercise, including one week for in-class team presentations.

Case It! Case It! is a National Science Foundation-sponsored project to enhance case-based learning in high school and university biology courses worldwide, and to stimulate motivation by engaging students in research (http://caseit.uwrf.edu/). The project consists of four separate, but interlinked tasks: (a) viewing video-based or reading text-based cases on an infectious disease or genetic disorder that affects individuals in the United States and worldwide, (b) engaging in virtual simulations to replicate molecular and DNA lab techniques to answer specific questions related to the case, (c) organizing data and findings into a virtual poster, which is shared online with other teams in the class and globally, and (d) actively role-playing as a patient, family member or health care professional involved with the case being presented (Foster et al., 2006).

The version of Case It! used during the study period (v5.03) consisted of two semi-autonomous programs. *Case It! Simulation* software is designed to allow students to perform virtual lab tests such as gel electrophoreses, western blot, and ELISA. While allowing students the experience of running these tests, the simulation software also reduces costs associated with running these lab tests since expensive equipment and reagents do not need to be purchased. *Case It! Launch Pad* is a tool that allows students to create virtual posters and chat on message boards in cyberspace. These posters incorporate the information produced in the previous module, and permit student teams to share and discuss their research with others.

Students used the Case It! learning environment to investigate one of eight cases involving a genetic or infectious disease. Each case included 2-3 (total 23) narratives about individuals with the selected disorder. These examples were from both the United States and global communities. Students used lab techniques such as ELISA, Southern and Western-Blot simulations, and PCR reactions to generate data on their particular case. They used results of this data in creating and presenting their web posters, and role-playing.

Students divided into 27 teams of two or three and chose either a genetic disorder (e.g., Breast Cancer, Fragile X syndrome) or an infectious disease (e.g., HIV/AIDS, SARS) to research. After viewing/reading cases about individual persons being tested for a particular disease, students played the role of laboratory technicians to test the individuals' blood or DNA samples using the simulation, and created virtual 'posters' based on their interpretations of the lab results and internet research on the disease. During synchronous Internet conferences, students were required to review other groups' posters and pose as individuals (patients or family members) seeking information or advice. In turn, they were also required to pose as an expert (e.g., physician, lab technician or genetics counselor) answering questions posted by other role-playing student on their topic disease. After students completed conferencing, they were interviewed about both their experience with Case It! and the relevance of their chosen research topic to their own lives. Overall, students spent six weeks working on their Case It! projects, including two weeks of synchronous, in-class online conferencing.

Measures

We asked students to participate in 1 of 4 focus group interviews about their experiences using Case It! and the Wolf Telemetry project, and their opinions on relevance in science education. Participants voluntarily answered 23 questions regarding their perspectives on relevancy in science education, such as, "Why you chose the disease to study" [for the Case It! project]. We used Aikenhead's (2006) theoretical framework as our motivation to investigate student perceptions of relevance and personal curiosity. We asked questions based on this framework, such as "Do you think science is relevant if it helps you resolve real-life problems, or decisions related to science and technology in the future?" We also asked students to reflect on their experiences in both the Wolf project and Case It!, asking, "Do you think doing a project like this was relevant or not? Please explain." The full text of questions used are available in Appendices A and B.

Data analysis

Student responses to video focus group questions were transcribed, and first-level qualitative document analysis was conducted on all written materials (Creswell 2007). First, two researchers who conducted the interviews read both transcripts several times and generated codes based on students' responses. Next, each response was given one code, although some responses were divided if two codes were evident, such as if the participant spoke specifically about being curious because they could perceive a use for the information in the future. After generating codes, these researchers coded all transcripts independently. Finally, the researchers identified common themes emerging from these codes. Percentages were calculated by dividing the number of comments per category by the total number of comments made.

Participants consented to be video-recorded as part of the interview, and Michigan State University's Institutional Review Board on the Use of Human Subjects approved all research procedures prior to their implementation (IRB #X07-511). All students were provided a pseudonym to protect their identity.

Results

What did students find relevant?

Seven categories of relevance emerged from the data (Tables 1 and 2). Table 1 provides percentages showing the frequency of each category in interview responses, while Table 2 includes a description and quotes from each category.

Potential use. Twenty-three percent of student comments related to potential use (Table 2). Most students commented on relevant experiences that were *personal,* linked to concerns about current or potential needs, as illustrated by Felicity, who stated that Case It!, "…may be our only exposure to these diseases until one of us has to face it later." Few of our 32 participants indicated that they were either science majors or considering a career in the sciences, limiting the number of individuals who could potentially have a future vocational use for what they learned. Several students appreciated the ability to choose their own learning path, and found topic material more engaging

Category	*n*	*Percent (%)*
Potential use	32	23.0
Curiosity	30	21.6
Global vs. local relevancy	24	17.3
Becoming the expert	16	11.5
Active learning	14	10.1
Human relevance (Wolves aren't people)	13	9.4
Effective communication skills	10	7.2

Note: Percentage calculated by [n(category) / total n]

Table 1. Categories of relevance and their positive instances (n =139) based on student responses to interview questions. (*Note: not every student chose to answer every question.*)

Category	*Description*	*Example quotations*
Potential use	Response to specific decisions or problems in a student's life.	"[We are] able to see the actual tools used by professionals to find defects in DNA."
Curiosity	Learning driven by curiosity.	"It is eye opening to see what diseases are out there…"
Global relevancy	Information learned predicated on the idea of global connections.	"Global issues are important because of the economy and ease of travel"
Becoming the expert	A drive to acquire knowledge to be able to better understand experts, or to double-check expert opinion.	"I think it is important to know how to talk to a doctor. I asked more knowledge questions…[and] thought that it was helpful to learn some of the scientific lingo…"
Active learning	Learning motivated by interaction with others.	"…they were asking us the questions and obviously we're not gonna know the answers. So, we had to do a lot of research in helping explain to them what their question was about and what we knew, even if we didn't know it, we had to research it."
Human relevance ("wolves aren't people")	Knowledge acquisitions predicated on what affects one personally.	"Focus on things more related to you personally. When it comes to crops, I don't care."
Effective communication skills	Knowledge acquisition based on understanding experts and/or conversing successfully with them.	"If you're presented with the problem, well you can ask questions that if you didn't have any knowledge about the disease or anything you wouldn't be able to ask."

Table 2. Definitions and examples of codes

and relevant when they could do so. Students reported that taking part in Case It! had demonstrated to them their own ability to find answers and do research independently. Andi exemplified this attitude when she said, "I'd rather have a brief overview [about a disease] and then do my own research if it affects me more." A few students implied that relevancy can grow from a perception of society's responsibility to educate its members about issues, or to improve one's own life through education. One student, Jane, was vehement about the moral implications of knowledge acquisition, stating that, "I don't think a lot of diseases are portrayed in the media. Once again, we're one of those societies that likes to sweep it under the carpet, and we don't like to talk about it."

Fatalistic or cynical statements were identified five times during the focus group interviews. In these cases, students expressed the feeling that some issues were beyond their ability to impact or scope of possible use, and were therefore less worthy of study. This was illustrated by Helen who told us that she, ". . . didn't feel like there was much I could do about the wolves. . ." and by Keith who said, ". . . with genetic disorders, you can't do anything, so why bother?" His peers corrected Keith when he made this comment, some of whom pointed out the interaction between lifestyle and disease.

Curiosity. We began our research expecting that current world problems mentioned in the media would be relevant to students because they would have some basis of familiarity to build on; however, we were disabused of this notion during the focus group interviews. Less than one third of participants ($n = 11$) indicated to us that they watched or read the news, and only two said the media piqued their curiosity. However, approximately 22 percent of student comments were coded as curiosity (Table 1), which includes opinions about altruism and self-motivated learning. A number of students ($n = 7$) reported wanting to know more once they had gotten involved, like Derek who said, "It is eye opening to see what diseases are out there," while Mark said he now had, ". . . more of an incentive to learn." Several women ($n = 6$), thought concern for issues made sense from both altruistic and personal perspectives, reasoning that such issues may impact both themselves and ideals that they value. Jane said,

> "I didn't learn about [the disorders] at all in school—any of these diseases—so I think by doing this, I think its bringing up our awareness at an age group where we can do something about it still. And if it does bother us we can go out and act together or something."

Associated with these opinions are those coded into the potential use category as moral/ethical dilemmas; however, the delineating difference for us was the clear expression of relevancy based in a desire to *help others* or influence society in some way. Jessica provided a good example when she told us that, ". . . if we learn about stuff happening around us, we can do something [about it]."

Global vs. local relevancy. As a group, students disagreed as to the importance of local versus global relevancy in their learning. However, an apparent majority expressed that issues were more relevant to them if they could see how it had direct effect on their lives. Thus, they liked learning about common diseases, such as breast cancer, that they knew affected people like them, but thought that SARS was not as relevant because even though it was a topical global issue, they did not feel it could possibly affect them personally. More students thought global issues ($n = 19$) were more relevant than local ones ($n = 5$). However, the composite of these comments is complex because several students favored both, like Emily, who stated that it was ". . . important to study both, but for this project it was more important to study local things."

Kristin's statement demonstrated that many students ($n = 19$) felt global issues were important to study when she said, ". . . it is good to learn about other things because the world is getting smaller every year." Most students who commented on global versus local relevancy felt they needed to have information on both local and world issues to be informed citizens, but they still wanted to study things that had some form of personal connection. It is important to note that several students expressed doubt as to how effective discussion of worldwide problems would be, like Jim who said, "people tune out more with global issues, but still think it's important," which gathered nods of agreement from his entire focus group. Still other students thought the line between local and global issues was blurry, as illustrated by Jason, who said, "What is local? Global issues affect me locally."

Some students ($n = 5$) said that local issues were easier to relate to and comprehend, such as Kelly, who said it is ". . . better to learn locally, or at least I am better able to relate to it if it is local." Trisha told us that, ". . . stuff that affects us locally [is more relevant]—like a polluted lake," indicating that issues which are both local and have a personal application were seen as being relevant to students' lives. Another student was more blunt about local versus global issues, saying, "For me a lot of the diseases seem like 'fiction' because they don't happen here much."

Becoming the expert. Comments about content expertise accounted for about 11.5 percent of total (Table 1). During role-playing, students preferred playing the part of a doctor, rather than a patient, so they could give answers. In doing so, some of these students ($n = 9$) said they learned more about their own topics, and that they liked being the "experts." Tanya told us that, ". . . it's useful to have the experience and diagnostic information to help make decisions." Kris said he thought increasing self-efficacy was, "pretty critical [because] . . . you need to be able to analyze data for yourself." The ability to give definitive answers on a question was attractive to many students, as demonstrated by comments we received, like Andrea who stated that, "You do know the most about your own project, but I'd say I now know a little bit about everything now." Paul told us that, "I'm not an expert, but compared to the other members of the class, I am."

We were surprised by a minority of students ($n = 7$) who expressed a complete trust in others to interpret tests for them. Even though students had just been through an experience that provided them with the skills and knowledge necessary to understand and decode basic medical tests, they saw little potential use for these skills. For example, Hillary said, "that's why I have a doctor to do this for me." Other students echoed this sentiment saying, "I'm sure that if I need to know what [a test] says, someone will tell me," and "I'll leave [interpretation of test results] up to doctors."

Active learning. About 10 percent of students ($n = 14$; Table 1) said that the role-playing and hands-on elements of Case It! both engaged them, and encouraged them to find information independently. This element of personal discovery was linked by some students, like Britt, to a deeper connection with the material when she told us that, "I think you're going to remember a lot from your own project because you're doing so much research to answer the questions." Other students identified the need to answer very specific and directed questions during role-playing as a reason for conducting deeper research, like Jason, who told us,

> "Conferencing is where I personally learned the most just because I was being asked these questions, and if I didn't know it, or it wasn't on my poster, I was essentially forced to go look for it. . . [and] once I got into it. . . I actually forgot what I was doing."

A few students ($n = 3$) felt that the active participation required in Case It! proved to be both interesting and stimulating, and that the hand-on learning experience created more relevancy for them than lectures. Annette told use that she, ". . . got more into [Case It!] as we went on." Other students said that Case It! was, ". . . a good way to learn more hands-on," and that, ". . . just being exposed to it was good."

Human relevance ('Wolves aren't people'). Several students said that relevancy was derived from connections to humanity as a whole, like Alicia who said, ". . . just something human," would be relevant to her. Others said they felt ideas were easier to relate to once placed in the context of how they affected humans, and many expressed sentiments that bridged to moral/ethical issues, like Laura who said, "…I think, a lot of the diseases that affect people our age weren't really in the Case It project because they are really touchy." Statements about human relevance in science accounted for about 9.4 percent of all student comments in focus group interviews (Table 1). Comments coded here were primarily related to student interest instead of future use, as exemplified by Bridget, who said, "[Case It! is] a lot more relevant than other things that we've done so far. All of us are non-majors so for us to take a biology course, unless it addresses something we might encounter, it's pointless."

The degree of human relevance of the study topic was of primary importance to most students. In general, they would rather study diseases instead of ecology, presumably because diseases have the potential to be more immediately relevant to their own lives than ecology. Although most students stated that they liked nature and ecology overall, Alice summed up the class sentiment when she said she, "…didn't feel as close to [the wolf project] as I would have if it were a child or parent or family member." Jane felt that, "…stuff like reproduction, and how birth control works…are more relevant."

Effective communication skills. A number of comments ($n = 10$; Table 1) indicated that students thought their experience with Case It! was relevant because it required them to develop the skills to communicate ideas effectively with both experts and laymen. The duality students found in communication is illustrated by Jordan who said,

"If you were in a situation where you were presented the results for a friend or family member it'd be easier to compare and interpret it. You know, if you're presented with the problem, well you can ask questions that if you didn't have any knowledge about the disease or anything you wouldn't be able to ask."

Another student, Laura, said she thought the communication aspect of Case It! was, "…corny at first…but then we started doing it and I totally got into it."

Case-Based Projects were Better Received than Lectures

Students strongly preferred the Case It! learning experience to either the Wolf Telemetry project or lecture. However, they also reported that the wolf project was far more interesting to them than lecture was. Eighty-nine (89) percent of students interviewed ($n = 32$) reported learning more from the Case It! experience than they did from lecture, whereas only 4.6 percent of students reported learning less, and 3.1 percent said they learned about the same. One student said she learned both more and less from the Case It! Project. She learned more about her specific disease from doing research and communicating, but thought she learned less than she might have about other diseases from reading her peers' posters about other diseases.

Students preferred interactive learning to passive. Many students expressed more than one opinion on the experience. The majority student attitude (79 percent) cited the specific benefits related to pedagogical techniques incorporated into the Case It! project ($n = 34$), such as active engagement and peer interaction, rather than negative aspects of lecture (14 percent; $n = 6$). The advantages of autonomous inquiry in the Case It! project were illustrated by Adrian, who said,

"We had to look at the poster and ask questions about it, but we weren't going to ask a question that was already there because it was already answered for us. We had to go in depth. We also needed to get information on others [diseases]."

Student Preference of Case It! over the Wolf Telemetry Project

Students expressed a strong preference for the Case It! project over the wolf telemetry project, with 82 percent of responding students indicating that Case It! was a more effective teaching pedagogy, and 18 percent preferred the wolf project. Although many students expressed empathy towards the wolves they studied, several expressed the opinion that wolves were less relevant to their lives because they were not human (see *Human Relevance* section). Others expressed a degree of social cynicism or hopelessness about the plight of the wolves they studied, saying there was little they could do personally to influence the situation. Helen illustrated this when she said she, "…didn't feel like there was much I could do about the wolves, even if I did find it relevant." The wolf telemetry project was taught early in the course before, and this may have affected student opinions of its relevance. More than half of all interviewees thought that both projects were better than traditional lecture instruction.

Discussion

The purpose of this study was to explore what non-majors in an introductory biology course think is relevant science to learn, as well as the reasons students cite for this relevance. Rather than ask what is potentially relevant to students, we asked them about their perceptions of relevance after engaging in two multimedia-learning environments. Students liked both case-based multimedia projects better than lecture, which corroborates previous research showing the benefits of multimedia learning on student engagement in science, especially in undergraduate science courses (Lundeberg et al., 2002). Several studies have also shown a link between students' acculturation and cognitive abilities in the sciences, and between the incorporation of popular technology into classrooms, student engagement in science, and associated interest in STEM related fields (Marshall, 2000; Gilbert & Yerrick, 2001; Hobson, 2001; Aikenhead, 2007; Guthrie & Carlin, 2004; Schreiner & Sjøberg, 2004; Sjøberg & Schreiner, 2005; Jenkins, 2006b; Matthews, 2007; Galvão et al., 2010).

Previous studies of the Case It! learning environment have demonstrated its efficacy in fostering ethical and global awareness and helping students conceptualize complex biological processes (Bergland et al., 2006b; Foster et al., 2006; Lundeberg et al., 2002; 2003). Students who participate in this project have demonstrated increased exam performance and a deeper conceptual understanding of the material taught, perhaps because it immerses students in a virtual environment that allows them to engage with the material in a personal manner (Bergland et al., 2006a; Klyczeek et al., 2006; Lundeberg et al., 2002). The Case It! program appears to serve as a applied conduit for students to apply theoretical knowledge in practical situations that have real and tangible results, making abstract ideas both real and relevant to students (Foster et al., 2006; Lundeberg et al., 2003).

Our research shows that the content involved in multimedia learning environments matters. We think Case It! was considered relevant by students because it engaged them in the content at multiple academic, personal and emotional levels. Using Case It! demonstrated potential personal use for science, stimulated personal curiosity, and connected science with students' global culture. These non-majors sought to make human connections to science, and discussing moral and ethical issues increased the relevance of science. Women in the class especially wanted to learn science for altruistic goals, such as preventing the spread of HIV/AIDS, or being able to assist future family members if they developed a genetic disease. This corroborates previous research showing the importance of altruism associated with women becoming engaged in learning science (Kang & Lundeberg, 2010).

Limitations

Our study is a starting point for further investigation into the role of case-based instruction in building relevance. As with any qualitative study that uses a small sample, one must be careful not to extrapolate the results of this study. Confounding factors such as timing of the case, differences in structure of the cases and the voluntary nature of participation may have influenced our results. In addition, we do not know what the participants' level of exposure to science was prior to engaging in the learning environments, or how it may have influenced their responses. Because the sample population was weighted with female students who tend to be more empathetic, this may have influenced the results. Finally, since this was not a controlled experiment in which we counterbalanced the two case studies with where they occurred within the Biology course, it may be that the timing of when the two cases were administered affected the results. Controlled experiments are needed to explore some of these questions raised by this qualitative case study.

Conclusions

In general, higher education sometimes fails to make science relevant to students, particularly those not majoring in science. This has resulted in a decline in enrollment in STEM fields at American universities and colleges (Ashby, 2006; Augustine, 2006). Some population groups are especially isolated when connections and parallels are not made between content and everyday life, such as urban youth, women and minority groups (AAAS, 1989; National Science Foundation, 2003; Augustine, 2006). To effectively engage students in science education, faculty can capitalize on the link between interest and engagement and respond to the issues students experience culturally. Modern global culture requires that students be conversant with basic science principles to be informed citizens (Roth & Barton, 2004; Jenkins, 2006a; Mueller & Bentley, 2006). The confluence of social interaction, such as daily media exposure, and socio-cultural perspectives, like political activism or personal beliefs, also provides fertile ground for engaging students in science content (Vygotsky, 1978; Jiménez-Aleixandre & Erduran, 2008). By utilizing materials students find relevant, educators can stimulate students' curiosity and engagement.

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Appendix A

Wolf telemetry questions

1. Where do individual wolves live in the selected habitat? Does there appear to be a preferred type of habitat (perceivable from the map)?
2. Does the presence of humans (roads, rails, towns) appear to influence the distribution of territories?
3. How many members make up a wolf pack?
4. What is the area (in square miles) of a wolf territory?
5. What is the nature of movement patterns of an individual within its own territory?
6. What is the nature of movement patterns of an individual outside of its own territory? Is it possible to determine that an individual has left its home pack and is venturing into new territory? This would be a disperser.
7. What is the nature of movement of an individual outside of its own territory and clearly inside the territory of a different pack?
8. Can the status of each wolf in the pack be determined from its movement pattern (with help from the Background Information page)?
9. What are the relative movement patterns of wolves of differing status in the pack, e.g., do older individuals (possibly the alpha pair) play a larger role at the fringe of the territory?
10. What are the relationships between a territory of one pack and the territories of other packs?

Appendix B

Case It! focus group interview questions

1. Let's begin by going around the room with introductions. Please say your name, the name of the case you created for your poster, and why you chose that disease to study.
2. Do you feel Case It! taught you more, less, or about the same regarding diseases as you might have learned in a typical lecture? Please explain.
3. Do you think doing a project like this is relevant or not? Please explain.
4. How many of you think science is relevant if it helps you resolve real-life problems and decisions related to science and technology in the future? Did you do this? Explain.
5. How many of you think science is relevant if it teaches you how to access and critically evaluate knowledge, such as interpreting diagnostic tests, or critically evaluating scientific data? Did you do this? Explain.
6. Are science issues that are in the media relevant to you? Are science issues that involve understanding about moral issues, or public risks relevant? Were you involved in this? Explain.
7. Are global science issues relevant to you, such as diseases that affect large numbers of people in the world, e.g., HIV/AIDS? Are local science issues relevant to you, such as issues affecting the state or community? Why?
8. How many of you think it is relevant to study topics in biology because science professors who wrote these textbooks think these topics are important? Why?
9. How interested were you in your topic before starting the project? After?
10. In this class you did a similar multimedia project studying wolves. How did that project compare with this one?
11. What aspects of your biology class did you find most relevant? Why?
12. Let's talk now about the conferencing you did with the other classes. How did you like playing the role of a family member or of a genetics counselor? What did you learn from this?
13. Please tell me a little about the process you used to create the web poster for this class. How did you find info? Did you paraphrase or recombine info? Did you use direct quotes to cite sources or just list them at the end? Is this more writing or less writing that you usually do in a science class?