STUDENTS' EPISTEMIC MODES WHILE MAKING SENSE OF ACTION MOVIE CLIPS

Physics is an integrated part of our lives. Yet students in introductory physics courses can seldom apply their physics knowledge to explain their everyday experiences. We used action clips from popular movies to examine the extent to which students can construct their knowledge and what source of knowledge they use to explain situations shown in movie clips. In the initial phase of our study a total of eight movie clips were shown to students in a semi-structured interview format. Based on results of our initial phase, in the second phase we used four of these clips to further probe student thinking and investigate what prompts may be needed for enhanced scientific thinking. In this paper we focus on students' epistemic modes and sources of knowledge as they reason through the physical underpinnings of the action movie clips.

Carina M. Poltera, Ball State University
Peter R. Fletcher, Kansas State University
N. Sanjay Rebello, Kansas State University

Introduction

Movies are an integral part of students' everyday experience. This familiarity with movies provides an opportunity to explore the possibilities for which they can be effectively integrated into a students learning and demonstrate the connection between science and other everyday experiences. Our overarching goal is to investigate whether and how movies can be used to help introductory students learn physics. Here we focus on epistemologies of students as they make sense of action movie clips. We ask:

- What epistemologies mediate students' sense making processes regarding the physics underlying action movie clips?
- How do students' epistemic modes vary with their prior background and with the action movie clip?

By adapting a grounded theory, (Holloway, 1997; Strauss & Corbin, 1998) phenomenological approach (Holloway, 1997; Marton, 1986)and using think aloud semi-structured interviews, we gained insight into how students conceptualize the physical underpinnings of the action sequences shown in the movie segments, and their underlying epistemologies.

Theoretical Underpinnings

Students' epistemologies are often defined as their beliefs about knowledge and learning. According to Hammer (1995) the recognition of student epistemologies is vital and important for designing instructional strategies that promote student learning. Unlike previous researchers, however Hammer and Elby (2002) have proposed that the "unitary ontology" of "epistemological beliefs" or "theories" used by some previous researchers is insufficient to accurately describe student epistemologies. (Hofer & Pintrich, 1997) Hammer and Elby cite experimental evidence from other researchers (Stodolksy, Salk, & Glaessner, 1991) which supports their contention that student epistemologies are contextualized. Thus, they propose that a more productive way of describing these epistemologies is in terms of small grain size elements analogous to ‘p-prims’ (diSessa, 1988) or ‘resources’ (Hammer, 2000) that are used to describe “knowledge in pieces.” In this framework, a student activates different epistemic modes or “resources” based on the context of the situation at hand. Hammer’s and Elby’s (2002) epistemic resources describe the nature and sources of knowledge in terms of: 1) “Knowledge as propagated stuff” which includes knowledge that is conveyed from some other individual e.g. teacher or peer. 2) “Knowledge as free creation” which describes knowledge that is created spontaneously by the individual. We believe that this may also include internalized intuitive knowledge gained from everyday experiences whose source the student is unable to articulate. 3) “Knowledge as fabricated stuff” which includes knowledge that is constructed by the learner through inference from other knowledge, such as knowledge constructed through logical deductive or inductive reasoning. Learners are often able to articulate the process by which they constructed this knowledge. We believe the “manifold ontology” of epistemic resources or modes, rather than the “unitary ontology” of epistemological beliefs, provides a flexible theoretical framework within which to analyze the epistemologies of the participants in our study.

Background

Instructors (Chandler, 2002; Daley, 2004; Everitt, Capt, & Patterson, 1999) have used video clips as learning or teaching tools and to assess what students can relate from classroom or personal experiences. Daley in (2004) has developed an “exhibition” to analyze underlying physics in his classroom. Students are asked to find a short movie clip, look for correct or incorrect physics, make measurements and use equations to argue the plausibility of a scene. Others have implemented videos in the form of classroom exercises, “visual word problems,” and concept review or introduction. Although blockbuster movies have been used in classrooms, there is very little research on their impact or role for learning. In our research we investigated the epistemic modes activated as students reason through these movie clips.

Methodology

A multi-methodological framework was developed by adapting grounded theory (Holloway, 1997; Strauss & Corbin, 1998)and phenomenological approaches. (Holloway, 1997; Marton, 1986) This framework was designed to progress in time first by casting a wide research net utilizing high intervention semi-structured interview techniques and building toward a non-directional interview protocol. (Cohen & Manion, 1994) The framework provides a responsive platform in which to gain insight into how students think about the physical underpinnings of the movie clips. Our research evolved over two phases.

Phase I

Phase I of the study explored the possible use of movie clips using an open grounded approach. We used individual think-aloud interviews to provide a relaxed environment. Eight video clips were shown to each student. These videos consisted of projectile motion, Newton's laws, gravity, and circular motion. To encourage the use of critical thinking skills, we utilized a mix of movies in which action scenarios were both plausible and questionable according to the laws of physics. Questions were designed to generally explore particular instances that the students found interesting in a clip and then develop into a discussion to contrast the clip in relation to other clips.

Phase II

Phase II focused on the development of prompting questions and included stimuli to encourage students to express their knowledge through a variety ways – toy cars, ramps, drawing, and demonstrations were introduced. To investigate deeper, the previous eight videos from Phase I were culled down to four. These four videos were *Speed* (a bus jumping over a gap in a bridge), *Matilda* (forward and back sliding of a baby in a car seat as the car starts and stops and the car seat spinning as the car turns), *Mission to Mars* (a spaceship traveling to Mars contains a rotating section with people walking and sitting along on the circumference of a spinning hull but floating in the center) and *Speed 2* (a cruise ship traveling at a constant speed crashes into an island dock gradually coming to rest and colliding with several objects in its path). The four videos all had a common theme related to Newton's laws. Our selection was based on videos in which students seemed more engaged with, and expressed difficulty in reasoning. The aim was to identify sets of videos and stimuli appropriate for further refinement. It was not our intent to use the videos to assess student understanding or correctness, but rather to gauge the epistemic modes in which students operate as they reason through these clips, and thereby gauge the usability of these videos for instructional purposes.

Data and Analysis

Phase I

Phase I data was colleted from 13 students five of whom were from first semester algebra-based physics and eight students from second semester algebra-based physics. The interviews were videotaped using two video cameras and were later analyzed using DIVER™ -- a video analysis program. Student responses to interview questions were analyzed for overall patterns for each video.

Phase II

In Phase II we had 12 participating students, six non-science majors enrolled in conceptual physics and six engineering majors enrolled in calculus-based physics. We transcribed each videotaped interview and coded the transcripts for each video, including the follow-up questions that might have prompted certain student responses. We used a phenomenographic approach (Marton, 1986) which led us to code responses into categories. In keeping with an "actor-oriented" perspective, (Lobato, 2003) we did not code for transfer of particular scientific knowledge, but rather coded for anything that the student transferred in their sense making process. Two researchers independently coded each of the 12 transcripts. The inter-rater reliability was about 75% before discussion and nearly 95% after discussion. The categories arising from the coding were collapsed into the three epistemic modes or resources described by Hammer and Elby (2002). These include 1) “Knowledge as propagated stuff,” 2) “Knowledge as free creation,” and 3) “Knowledge as fabricated stuff”

Results and Discussion

Phase I

In Phase I students seemed to be more comfortable with using their own personal experiences rather than concepts covered in class to explain a given scenario. Comments from students were based on descriptions using basic physics terms – mass, velocity, gravity, and falling objects. These terms often appeared to be no more than just a list of labels that students may have learned in their physics class. Students were often usable to explain exactly how these terms were applicable to their description. In general, students appeared to rely more in intuition gained through everyday experiences rather than a deeper understanding of physical underpinnings.

Phase II

In Phase II, we compared epistemic modes exhibited by students in two ways; one was by comparing the epistemic modes of engineering and non-science students for all the movies clips. The other was by comparing various movies in terms of each of the three epistemic modes.

Comparison of Epistemic Modes across All Videos: The comparison of the prevalence of various epistemic modes is shown in Figure 1. The graph shows the cumulative percentage of instances of each epistemic mode across all four videos. In general, both the non-science and the engineering students tended to operate in the “knowledge is fabricated” mode while making sense of the movie clips. While there was no significant difference between the percentages of instances in which both non-science and engineering students appeared to be operating in this mode. However, a significantly larger percentage of instances were observed for non-science students in the “knowledge is propagated” compared to the engineering students. Conversely, a larger percentage of instances of the “knowledge is freely created” mode were observed for the engineering students compared to the non-science students. The fact that virtually no engineering students appeared to operate in the “knowledge is propagated” mode of reasoning indicates that these students feel comfortable either relying on their intuition or their own self-constructed knowledge as they make sense of the movie clips. They do not appear to feel the need to refer to knowledge propagated from a source of authority such as the teacher or textbook.

Compared to the engineering students, the non-science students, tend to rely more on knowledge propagated from authority such as knowledge learned in class, while making sense of the movie clips. We speculate that the difference is because the non-science students are less confident of their abilities in physics than the engineering students, and hence the non-science students tend to recall what they had learned in class more often than the engineering students do. The fact that both groups were virtually identical in their use of "knowledge is fabricated" mode of reasoning indicates that in spite of their differences in physics knowledge, both groups can construct their own knowledge while making sense of movies, although the non-science students tend also to rely on knowledge propagated to them from authority.

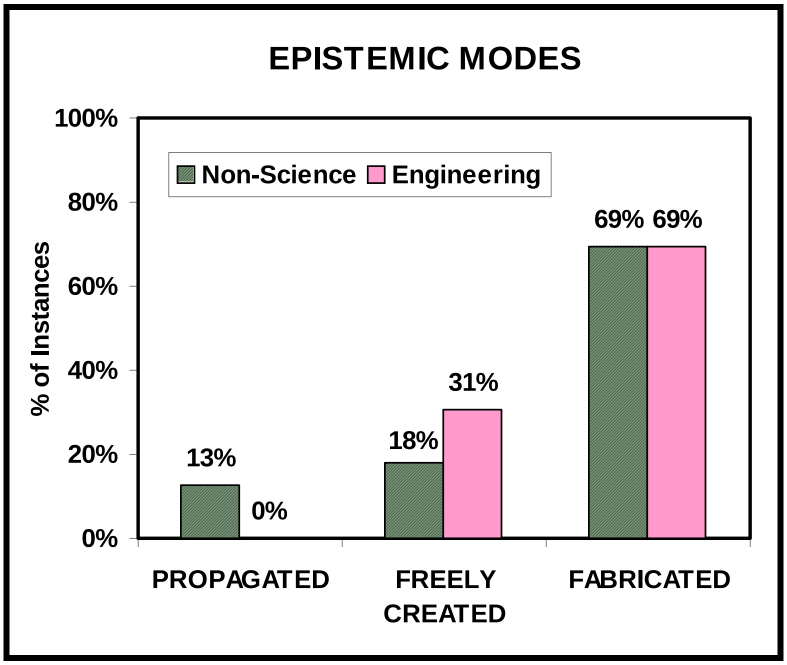

Figure 1: Comparison of epistemic modes between non-science and engineering students.

Comparison of Videos Across Each Epistemic Mode: Figure 2 through Figure 4 show comparisons of videos across each epistemic mode. Below, we focus on the salient features in each figure. Further details will be discussed in the main paper.

In Figure 2, we find that the "knowledge is propagated" epistemic mode is activated more often in the first two video clips than the last two for the non-science students. This may indicate that these students are becoming less reliant on using knowledge propagated from the teacher as they make sense of the video clips. However, we would need to reverse the ordering of the videos to test this hypothesis.

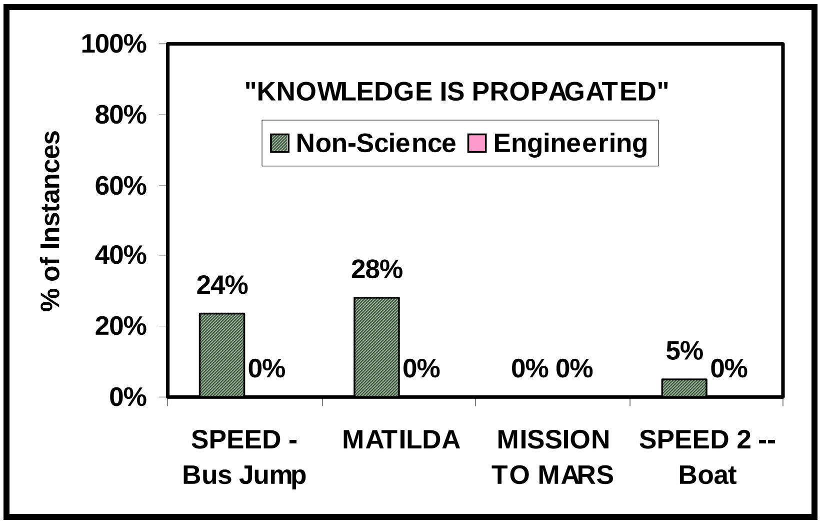

Figure 2: Comparison of the four videos for the "knowledge is propagated" epistemic mode.

In Figure 3, we see that students were least likely to operate in the "knowledge is freely created" mode in the *Matilda* video. The lack of reliance on intuitive, freely created knowledge was perhaps because students felt they could reason through this video based on what they had learned in class. The concepts underlying this video were most recently covered in class by the students. The non-science students tended to operate in the "knowledge is freely created" mode most often when they were reasoning through the *Mission to Mars* video. Again, use of this epistemic mode was probably because these students had not covered this topic in class. Thus these students were most likely to rely on their physical intuition rather than their classroom-based knowledge.

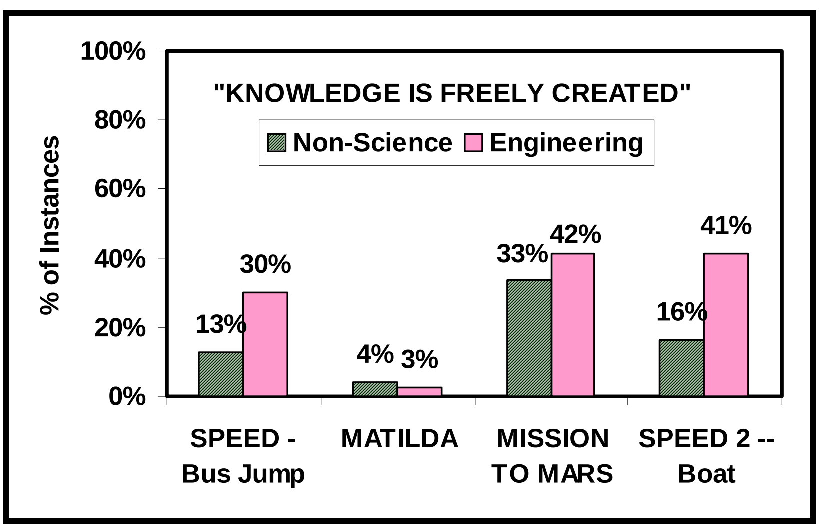

Figure 3: Comparison of the four videos for the "knowledge is freely created" epistemic mode.

In Figure 4 we find that engineering students operate almost exclusively in the "knowledge is fabricated" mode in the *Matilda* video. Also, in the last two videos, the non-science students surpass the engineering students in the percentage of instance s in which they operated in the "knowledge is fabricated" mode, although these differences are barely significant. We speculate that the 'peaking' by engineering students operating in the "knowledge is fabricated" mode of reasoning in the *Matilda* video followed by a gradual drop off in the later two videos may be because the engineering students have, for some reason, lost interest in these last two videos, while the non-science students, appear to be gradually growing in their operation of this mode of reasoning, probably due to increasing degree of comfort with the videos as speculated earlier. However, as pointed out earlier, we would need to test these hypotheses, by reversing the order of the videos. It is important to point out, that the order of the videos was not randomly chosen. Rather, the videos were sequenced so that they addressed topics in the same order in which the topics were covered in class.

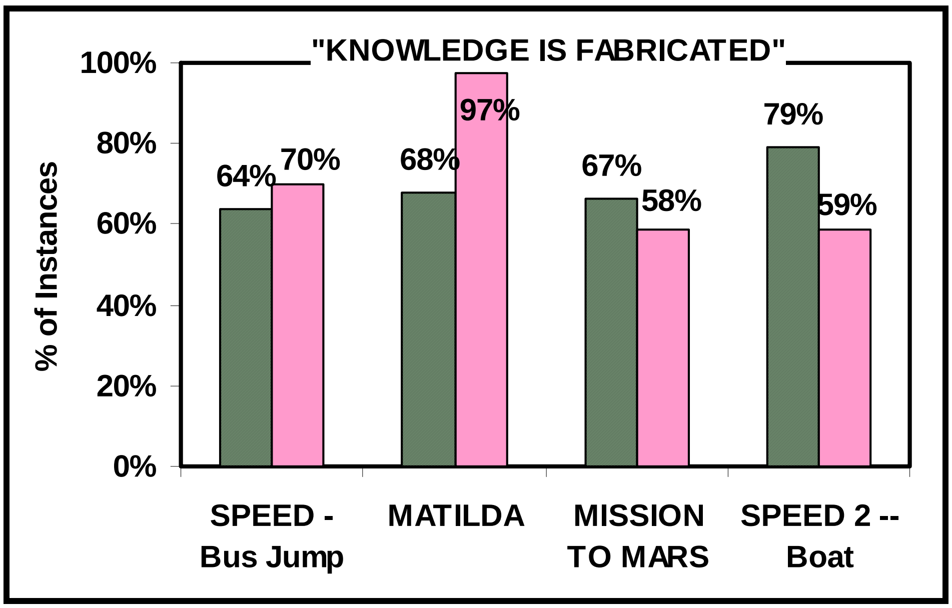

Figure 4: Comparison of the four videos for the "knowledge is fabricated" epistemic mode.

Conclusions

In this study we explored the epistemic modes in which students operated as they made sense of the physical principles underpinning action movie clips. We used action movie clips because they are a familiar and interesting context that most students can easily relate to. In analyzing student reasoning through these clips, we did not focus on the scientific correctness of students' explanation, but rather on the epistemic mode that students operated in and the sources of knowledge that they utilized in their reasoning.

Our results indicate that both non-science and engineering students appear to be quite comfortable to operate in the "knowledge is fabricated" epistemic mode as they reason through these clips. However, differences do exist in the two groups of students pertaining to the epistemic mode in which they operated. In virtually no instance, did engineering students appear to operate in the "knowledge is propagated" mode, while they appeared to operate in the "knowledge is freely created" significantly more often than the non-science students. We also find that the non-science students tended to increase in confidence and operate less in the "knowledge is propagated" mode as the session progressed. However, we would need to reverse the order of videos to further verify this latter hypothesis.

Implications for Instruction

Overall, we find that action movie clips are a useful context in which to help students develop reasoning skills and fabricate their own knowledge. Therefore, our results seem to indicate that it is possible to use video clips with students, regardless of their prior physics background, to promote a constructivist view toward knowledge and learning among these students who may otherwise not be comfortable constructing their own knowledge. Thus video clips are conducive for use in constructivist classroom with range of students. We are continuing this study and are currently in the process (Phase III) of utilizing some the aforementioned video clips, based on the insights gained through our research, to create curricular materials that can be used in an introductory physics classroom.

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