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The Effect of Animations Within PowerPoint Presentations on Learning Introductory Astronomy

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Abstract

We present results of a two-semester study to determine whether the inclusion of basic animation techniques in PowerPoint presentations provides an additional learning aid, inhibits learning, or has no effect on student learning for students in an introductory astronomy course. We found that (1) students perceive that animated slides are substantially more effective; (2) student understanding as measured via in-class exams is largely unaffected by the use of animated slides, but that end-of-semester diagnostic surveys may indicate that animated presentations aid in long-term retention of the material; and (3) the animation of illustrations may provide a greater impact on learning than simply the animation of text.

1. INTRODUCTION

Since the introduction of slideshow presenters such as Microsoft PowerPoint, more and more instructors have turned to PowerPoint as the preferred method of presenting lecture material. These days it is common practice to use PowerPoint presentations as the primary method of lecturing. PowerPoint offers a number of advantages over previous forms of lecturing (such as the use of overhead projectors) and is considered more favorable by students as well (Bartsch and Cobern 2003).

Mayer's (2001) cognitive theory of multimedia learning makes three assumptions of how students learn. According to the Dual Channel assumption, humans possess two channels of learning: one involves visual/pictorial processing while the other involves auditory/verbal processing. PowerPoint presentations enhance an instructor's lessons by taking advantage of the visual/pictorial aspect of learning (which includes screen text as well as images) along with auditory/verbal learning. Second, as students learn material, each of them has a limited cognitive load. Students can only process a limited amount of information in their working memory at one time. Each channel has its own, separate limit, and so presenting material in more than one format (visual as well as auditory) allows students to process more information at one time without exceeding their cognitive limit. On the other hand, presenting too much information at one time may exceed their cognitive limit, impeding their ability to learn new material. Third, students engage in active learning that involves completing a set of cognitive processes while they learn. This includes paying attention to the presentation, determining the important aspects of the presentation and organizing the information, and integrating new information with pre-existing knowledge. To facilitate student learning, it is important that PowerPoint presentations are well organized, concise, and do not overload the students' cognitive load with too much information at once.

PowerPoint has a number of useful features that can aid in the delivery of lesson material. Basic PowerPoint presentations can make use of bullet points to draw student attention to important aspects of the lesson and include images that illustrate key concepts. More advanced presentations may include animations. This can be as simple as animating a list of bullet points such that they appear one at a time as the instructor discusses each one in turn, to animating figures such that motion or a progression of events can be conveyed through the figure. A study of a series of computer based instruction modules found that animated visuals were more influential in student learning over static visuals when the animations played an integral part in the explanation of the concept in question and were not simply attention grabbing (Rieber 1990).

While some studies suggest that the increased use of PowerPoint presentations and its full capabilities may aid in instruction (Lowry 1999), others suggest that its use is altering the way in which material is being taught. Craig and Amernic (2006) suggest that PowerPoint encourages the simple transfer of knowledge from instructor to student, while neglecting the shaping and nurturing of that knowledge within the student. They also state that PowerPoint presentations reinforce a “televisuality” form of learning, but that today’s generation of students, who are used to interacting with a variety of multimedia sources, are already accustomed to this.

Whether or not PowerPoint presentations can enhance learning is still a question of debate. The strength of PowerPoint is that it allows instructors to present visual images and animations along with text. Slideshows can also become more dynamic with the incorporation of motion through transition effects and custom animations. PowerPoint allows instructors to import movies and sounds, thus presenting students with both auditory as well as visual stimulus. This multifaceted approach to instruction meets the needs of a greater number of learning styles (Levasseur and Sawyer 2006). In addition, more engaging presentations have been shown to grab students’ interest more, helping them to pay more attention in class and recall information better (Grabe 2000). Where studies suggest that students begin to lose attention roughly 10 to 18 min into class (Johnstone and Percival 1976), anything that can keep their attention longer would be beneficial.

While evidence suggests that PowerPoint animations aid in the presentation of lesson material, does it aid in student learning, or is it simply a distraction to the students? A recent study (Mahar, Yaylacicegi, and Janicki 2009) suggests that the latter may be the case. A study of 93 students taking a large introductory section Management of Information Systems class compared the level of learning between students who received instruction via animated PowerPoint slides compared to those who did not. (Here, “animated” refers to material being incrementally presented one line at a time on a slide, as opposed to everything appearing all at once.) According to their results, students who viewed the nonanimated PowerPoint presentations performed statistically better than students who viewed the animated presentations. Their conclusion was that animated slides required greater concentration from students as well as reduced the overall amount of time that material was available to students. The authors, though, do acknowledge that their results may be limited to the learning of new material, as well as subject-dependent.

Lang’s (2000) limited capacity model suggests that too much of a good thing might not be so good. While visual images and animations pertinent to the lesson material may aid in student learning, superfluous animation and imagery may detract from learning, placing an increased processing load on students and distracting them from paying attention to what is really important. Two studies (Bartsch and Cobern 2003; Pippert and Moore 1999) compared “basic” PowerPoint presentations to “expanded” PowerPoint presentations. In both cases, the basic presentations simply contained nonmoving text and graphics. In the first study, the expanded presentations contained pictures, sound, and moving text. In the second study, the expanded presentations contained changing colors, sound, video clips, and other similar enhancements. Barsch and Cobern found that students performed worse on quizzes related to the expanded presentations, while Pippert and Moore found no significant difference between the two.

2. DESCRIPTION OF COURSES

Sam Houston State University offers a two-semester version of introductory astronomy for nonscience majors. The first course, PHY 133 (Introductory Astronomy) covers the motions of celestial objects, the history of astronomy, light and telescopes, as well as the solar system. The second course, PHY 134 (Stars and Galaxies) provides a brief refresher of basic material covered in PHY 133 before moving on to stars, galaxies, and cosmology. Students are not required to take PHY 133 in order to take PHY 134.

We gathered data from a total of seven sections over the course of two semesters. Three of these sections came from our Spring 2010 offering of PHY 133 (hereafter referred to as PHY133S10), taught by an adjunct professor at Sam Houston State University. His course was divided into three units: (1) celestial motions, history, and light; (2) solar system basics and terrestrial planets, and (3) jovian planets, stellar debris, and the formation of the solar system. Each unit ended with an exam. Most of the class period was spent reviewing the PowerPoint presentations, with any leftover time spent discussing questions from the material that are posed to the class to emphasize important facts.

The PowerPoint presentations used in PHY133S10 were those provided by the textbook publishers. Most slides were composed of one astronomical image along with one or two sentences. Some slides were composed of a bulleted list of facts. In the case of the slides with images, the animation usually consisted of having the text appear one sentence at a time, and the image appearing at the same time as the sentence that described it. In the case of the bulleted list, the slide was animated such that one bullet point appeared at a time. From here on, we will refer to this type of animation as text-animation.

Two of the sections (hereafter referred to as PHY134F09) came from our Fall 2009 offering of PHY 134 and was taught by the second author. This course was structured somewhat around student questions (e.g. students were asked on the first day what aspect of a particular Hubble Space Telescope picture they were most interested in exploring; later they would return to the picture and pose new questions). The main topics covered, though, were (1) light; (2) distance determinations; (3) stellar properties; (4) fusion and nucleosynthesis; (5) stellar evolution; (6) stellar death; (7) galaxies; and (8) cosmology and the fate of the universe. There were approximately seven short quizzes based on homework assignments and four in-class multiple choice exams, the lowest grade of which would be dropped. A cumulative final exam was administered at the end of the semester. The typical class began with addressing points of confusion from the previous class as determined from “one-minute papers,” and then a 20–25 min PowerPoint lecture on the topic, interspersed with 3–6 personal response questions. This was followed by a lecture tutorial (Prather *et al*. 2004), ranking task, or other handout that students would collaborate on. Typically, another short round of personal response questions would follow to gauge the overall level of understanding. Classes would end with the assignment of a one-minute paper, wherein students were to state what did or did not make sense in class.

The PowerPoint slides consisted typically of 3–4 bulleted statements that would appear one at a time during the “animated” portions of the class. Approximately half the slides contained a graphic, such as an Hertzsprung-Russell (HR) Diagram, astronomical photo, etc. Only the text was animated. Figures and illustrations were static. Once or twice per class, a slide would contain a link to an outside website that contained an animation, simulation, or video.

The last two sections (hereafter referred to as PHY134S10) came from our Spring 2010 offering of PHY134 and were taught by the first author. His course was divided into six units: (1) Universal laws and light, (2) the Sun and star formation, (3) stellar properties, (4) stellar evolution, (5) galaxies, and (6) cosmology and life in the universe. Each unit culminated with a quiz, while units three and six ended with a midterm or final, respectively. A typical class period began with an image or thought question to focus the students on the lesson of the day, followed by roughly 15 min of PowerPoint presentation with periodic concept-test questions answered using a personal response system (i.e., “clicker”). The next 15–20 min was usually spent working on and discussing an in-class activity, such as a lecture tutorial or some other activity. The remaining time was spent wrapping up the PowerPoint presentation along with a few more concept-test questions to assess student level of understanding.

The PowerPoint presentations used in PHY134S10 consisted mostly of astronomical images and illustrations along with bulleted keywords and phrases. Animating the slides consisted of presenting the bulleted keywords and phrases one line at a time, as in the other courses, but also consisted of animated figures. Animated figures were presented in one of two ways. First, rather than presenting the entire figure at once, animated figures presented one part of the figure at a time, as the instructor was describing each part of the figure. Second, when possible, the figures were animated to indicate motion across the image, such as photons being scattered by a dust cloud, or a star swelling into a red giant while its core shrinks. From here on, we will refer to this type of animation as figure-animation.

3. ASSESSMENT TOOLS

In order to assess the effectiveness of PowerPoint animations, we conducted our experiments in three sets of classes. Classes within each set were identical, with the exception of the animations. In order to determine any differences between sections, each section started off with identical, nonanimated presentations. After the first exam, sections alternated in how lessons are presented. While one (or more) section(s) received animated presentations, the other section(s) did not. After each exam, the presentation style switched. This allowed us to

Table 1. Animation schedules for (a) PHY133S10, (b) PHY134F09, and (c) PHY134S10

(a) PHY133S10	Section 1	Section 2	Section 3
Unit 1	Static	Static	Static
Unit 2	Static	Animated	Animated
Unit 3	Animated	Animated	Static
(b) PHY134F09	**Section 1**	**Section 2**	
Unit 1	Static	Static	
Unit 2	Static	Animated	
Unit 3	Animated	Static	
Unit 4	Animated	Animated	
(c) PHY134S10	**Section 1**	**Section 2**	
Unit 1	Static	Static	
Unit 2	Static	Animated	
Unit 3	Animated	Static	
Unit 4	Static	Animated	
Unit 5	Animated	Static	
Unit 6	Animated	Animated	

remove any possible bias due to differences in enrollment or base student performance. The animation schedule for all three courses is listed in Tables 1(a)–1(c).

To analyze the effect of the animations, we administered identical multiple-choice exams in each section of a course, as well as pre- and postdiagnostic tests. In PHY133S10 we administered the Solar System Concept Inventory (SSCI) (Hornstein *et al*. 2010), a 26-question survey (the last question asking students if they have taken an astronomy course previously) covering planet formation and basic solar system concepts. In the PHY134F09 and PHY134S10 courses, we administered the Star Properties Concept Inventory (SPCI) (Bailey 2007), a 26-question survey (three of which gather statistical information and one requiring a written short answer) covering star formation and stellar properties.

We also administered an attitude survey regarding the use of the PowerPoint presentations at the beginning and end of the semester, as well as before each exam, to determine student attitudes of the animations. Students were asked to periodically complete a survey on the perceived usefulness of animated PowerPoint presentations in introductory astronomy. This survey was adapted from the Technology Acceptance Model (TAM) survey (Davis 1989; Dasgupta, Granger, and McGarry 2002), a 12-question survey used to assess the perceived usefulness and ease of use of technology. Since we were only interested in how useful the students found the presentations, and they themselves were not using the software to create the presentations, we only used the questions that pertained to the aspect of technology usage in which we were interested. This resulted in the 7-question survey listed below in Table 2. The survey was modified slightly depending on whether the students were assessing static presentations (“The instructor’s use of static PowerPoint presentations …”) or animated presentations (see Table 2).

4. DATA AND ANALYSIS

4.1. Comparison of Exam Scores

Our primary source of data used to determine if animated PowerPoint presentations were more effective than static ones came from periodic exams administered to the students throughout the semester. In all three courses, identical, multiple-choice exams were given to the different sections on the same day. Students were not allowed to keep their exams, hopefully removing any chance that later sections had any advantage over earlier sections.

Since every section of each course started the semester with static animations, the first exam in each course is used to determine if any inherent differences exist between the sections. We performed a Student’s t-test for the

Table 2. Technology Acceptance Model

Each statement is rated using a 5-point Likert scale, where a value of 1 corresponds with strongly disagree and a value of 5 corresponds with strongly agree.

1. The instructor's use of PowerPoint animations enabled me to accomplish learning more quickly.
2. The instructor's use of PowerPoint animations improved my educational performance.
3. The instructor's use of PowerPoint animations increased my learning productivity.
4. The instructor's use of PowerPoint animations enhanced my learning effectiveness.
5. The instructor's use of PowerPoint animations made learning easier for me.
6. I would find PowerPoint animations useful in all my higher education learning experiences.
7. The instructor's use of PowerPoint animations kept me totally absorbed in the presentation.

first exam of each course to determine if there were any inherent differences between the sections. For the subsequent exams, we performed a series of ANCOVAs (analysis of covariates) to test the differences between the static and animated sections. In this case, the exams scores are the dependent variables while the method of presentation (static or animated) is the independent variable. The first exam score is used as the covariate. We believe that the assumptions for ANCOVA were met. It is logical to assume that any difference in sections, as indicated by the first exam scores, should apply consistently to all exams regardless of presentation style. Also, the covariate is directly related to the dependent variable. In other words, student performance on the first exam is directly related to student performance on all subsequent exams. By performing this analysis, we can adjust the mean exam scores of the latter exams, removing the influence due to the different class sections and focusing more on the effect of the PowerPoint presentations.

Figure 1 displays the average exam score for the first exam for each course, by section, along with the adjusted exam scores for the remaining exams. For the first exam, the t- and p-values for the comparison between two sections are included. The t-value is an indication of how different the average scores between two sections are; the larger the t-value, the greater the difference. A negative t-value indicates that the first section in the comparison performed worse than the second section in the comparison. The p-value represents the probability that the two sets of exam scores being compared are similar in average and distribution. Typically, if the p-value is less than 0.05 (known as the type-1 error rate), then the two sets of data are considered statistically different. When comparing more than two sets of data (such as in the case of PHY133S10), the effective type-1 error rate is 0.05 divided by the number of data sets (in this case, three). For the remaining exams, the F-ratio and p-value are given. The F-ratio is similar to the t-value in that the greater the value of the F-ratio, the greater the difference between the two sections.

In all three courses, the differences in the average exam scores for the first exam are not statistically significant. While the p-value for the comparison between Sections 2 and 3 in PHY133S10 is only 0.04, because we are comparing three sections of this course, it is not considered significant. Therefore, for our purposes, within each course, we can consider the sections as essentially equivalent to one another. Looking at each remaining set of exam scores for PHY133S10 and PHY134S10, the adjusted average values and distribution of scores are basically similar. In other words, we see no evidence of any difference between sections in these two courses for any of the exams. We find only two cases where there are statistically significant differences in exam scores between two sections, and they occur on exams 2 and 3 in PHY134F09 (the shaded region in Figure 1(b) below). On exam 2, the section with the animated presentations performed better, while on exam 3, the section with the static presentations performed better.

4.2. Comparison of Concept Inventory Results

In addition to exam scores, we also administered pre- and postdiagnostic surveys, the SSCI in our PHY133 course and the SPCI in our PHY134 courses. Each concept inventory tested students on material covered in a number of units from each course, allowing us to divide the questions in both the SSCI and SPCI into groups based on the unit in which they were covered. Unfortunately, we did not realize until after the fact that, for PHY134F09, the questions on the SPCI were only covered on exams 1 and 4, when both sections received the same style of presentations. Because of this we were unable to compare the pre- and postsurvey results to see if one section performed better than another based on the style of presentation they received. Since we were unable to analyze the SPCI data based in this manner, we looked to see if we could find any difference in performance

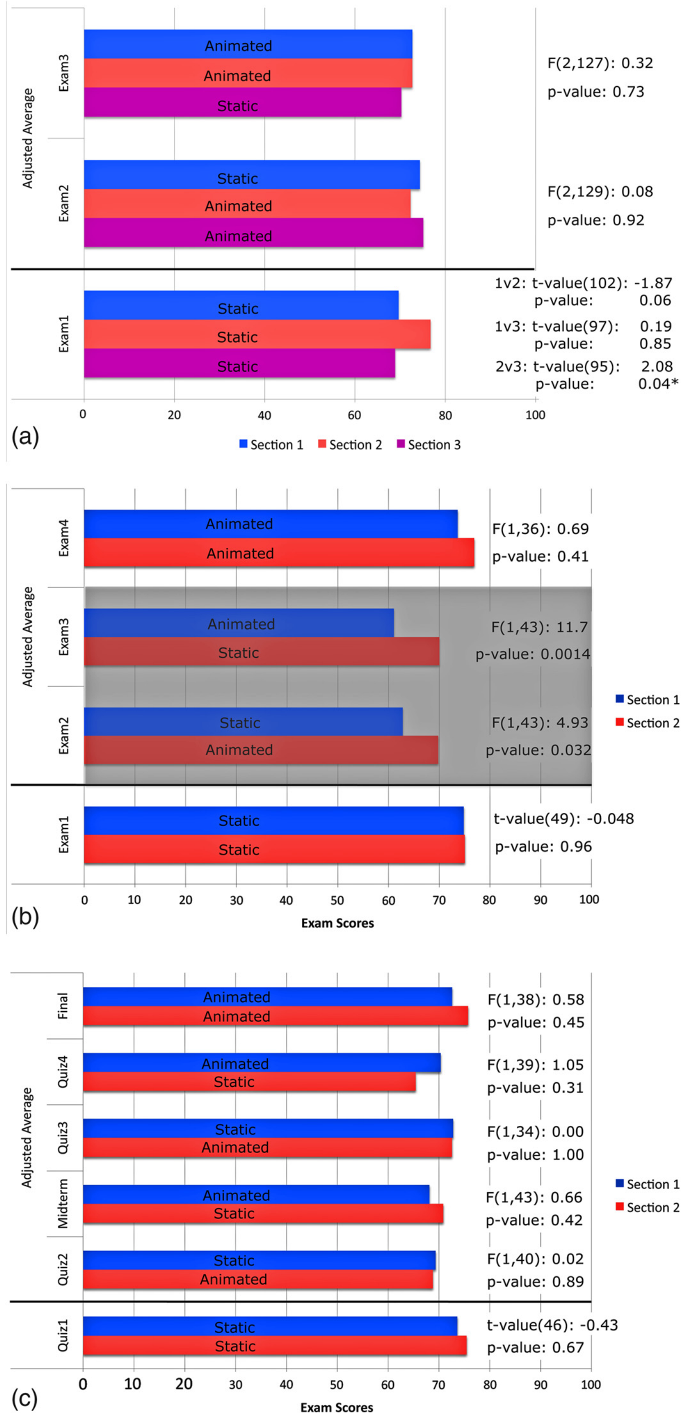


Figure 1. (a) Adjusted average exam scores for the three sections of PHY133S10, along with the method of presentation. For the first set of comparisons, the t- and p-values are listed. For all subsequent sets of comparisons, the F-ratio and p-values are listed. The degrees of freedom for each analysis are listed in parentheses. (*While the p-value in this case falls below the 0.05 level, when comparing more than two sets of data, the effective α level is equal to 0.05 divided by the number of data sets, or in this case, 0.017). (b) Adjusted average exam scores for the two sections of PHY134F09, along with the method of presentation. For the first pair of comparisons, the t-values and p-values are listed. For all subsequent pairs of comparisons, the F-ratio and p-values are listed. The degrees of freedom for each analysis are listed in parentheses. Both exams 2 and 3 show statistically significant differences in exam scores. In each case, Section 2 performed significantly better than Section 1. (c) Adjusted average exam scores for the two sections of PHY134S10, along with the method of presentation. For the first pair of comparisons, the t-values and p-values are listed. For all subsequent pairs of comparisons, the F-ratio and p-values are listed. The degrees of freedom for each analysis are listed in parentheses. In the cases of the midterm and the final, only questions from units 3 and 6, respectively, were used in calculating the values depicted above.

Table 3. **Average normalized gains on the SPCI for PHY134F09**

	Static questions (unit 1)	Animated questions (unit 4)
Average student gain	0.12	0.34

on questions relating to topics from static presentations compared to questions relating to topics from text-animated presentations. In looking at the SPCI data, we found that there was no significant difference in terms of performance on individual questions between sections, average survey scores (either pretest or post-test) between sections, or average normalized gains between sections. The only comparison where we see any appreciable difference in terms of performance is in the comparison of average normalized gains between static vs. text-animated questions. Table 3 lists the average normalized gains on the SPCI, separated by the type of presentation used to introduce the related concept.

The average normalized gains were calculated using the formula

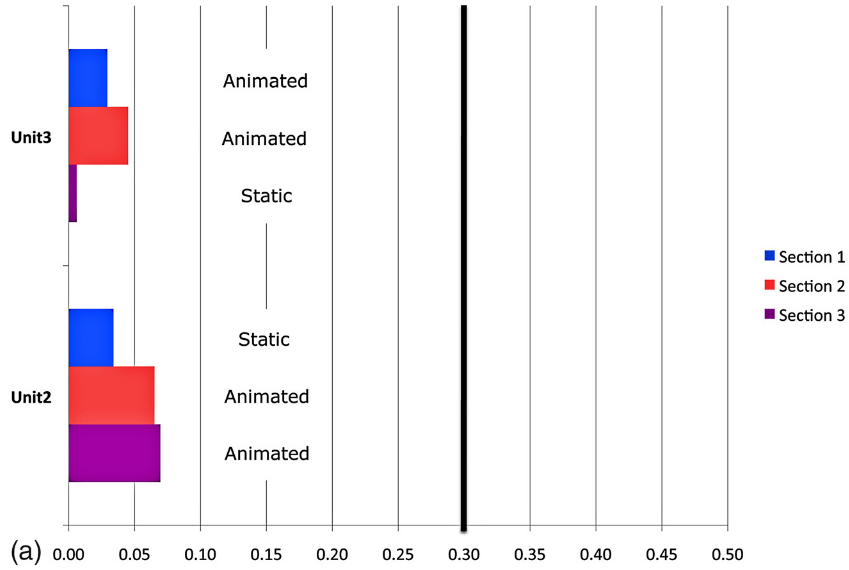
$$\frac{\sum \frac{\text{Post} - \text{Pre}}{1 - \text{Pre}}}{n},$$

where "Pre" and "Post" are the percentage of static or animated questions answered correctly on the pretest and post-test survey, respectively, and n is the number of students.

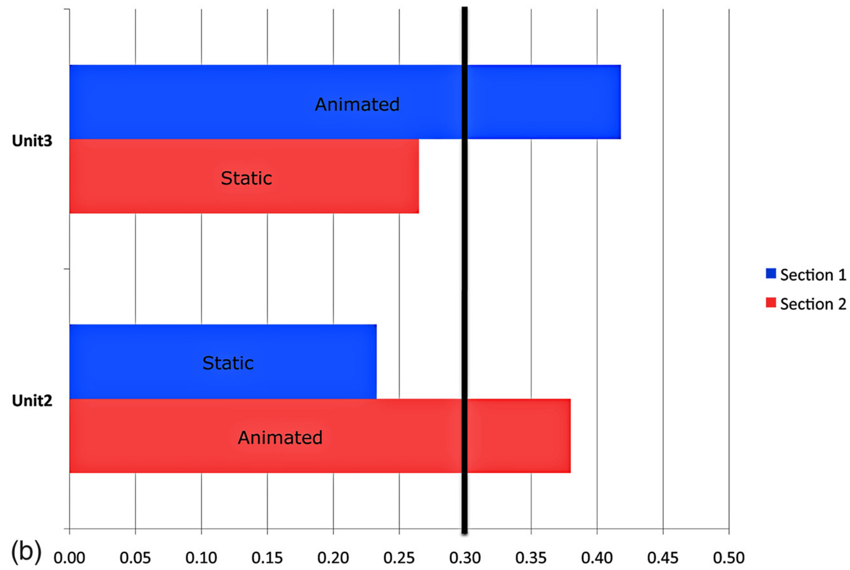
Fortunately, in the other two courses, the concept inventories divided almost evenly between two units of alternating presentations, such that we could use them to determine if there was any difference in performance between the various sections of the courses that received different presentation styles. Tables 4(a) and 4(b) display the average scores for each section for PHY133S10 and PHY134S10, respectively. The t- and p-values for the comparisons between sections are also included (with the degrees of freedom listed in parentheses). Looking at the p-values for each comparison, we see no statistical difference in performance between sections in either unit.

Table 4. (a) SSCI averages by section for PHY133S10 and (b) SPCI averages by section for PHY134S10

		Pretest		Post-test	
(a)		**Unit2**	**Unit3**	**Unit2**	**Unit3**
Sec. 1 avg.		23.40	17.90	26.00	20.30
Sec. 2 avg.		21.60	15.60	26.70	19.40
Sec. 3 avg.		25.20	17.60	30.40	18.10
	t-value	0.63(90)	1.15(90)	−0.21(60)	0.29(60)
1v2	**p-value**	0.53	0.25	0.84	0.78
	t-value	−0.66(90)	0.17(90)	−1.17(53)	0.73(53)
1v3	**p-value**	0.51	0.87	0.25	0.47
	t-value	−1.28(90)	−0.90(90)	−1.02(51)	0.45(51)
2v3	**p-value**	0.21	0.37	0.31	0.65
		Pretest		**Post-test**	
(b)		**Unit2**	**Unit3**	**Unit2**	**Unit3**
Sec. 1 avg.		34.80	20.00	50.50	55.00
Sec. 2 avg.		34.20	23.60	55.90	44.20
t-value		0.14(49)	−0.82(49)	−0.83(40)	1.31(40)
p-value		0.89	0.42	0.41	0.20



(a)



(b)

Figure 2. Average normalized gains (a) on the SSCI for PHY133S10 and (b) on the SPCI for PHY134S10.

Figures 2(a) and 2(b) show the average normalized gains for PHY133S10 and PHY134S10, separated by section as well as the unit during which the material was covered. In both courses, and in both units, the animated sections saw a larger gain in average score than the static sections. While the average normalized gains in PHY133S10 were minimal, in PHY134S10, the average normalized gain for both static sections fell within the "low" region (below 0.3; Hake 1998) while both animated sections saw "medium" average normalized gains (between 0.3 and 0.7).

4.3. Results of TAM

The TAM was administered in all three classes at the beginning of the semester, before every exam, and at the end of the semester. In order to determine if there was any difference in perceived usefulness between the static and animated presentations, we aggregated the survey results into two groups: those pertaining to the static presentations and those pertaining to the animated presentations. The complete results of the aggregate data for all three courses are presented in the appendix. To determine if there is an appreciable shift in student perception between the static and animated presentations, we use the Wilcoxon Two Sample Test (Mann and Whitney 1947). The Wilcoxon Two Sample Test compares two sets of ordinal data and calculates the probability that the

Table 5. Probability values comparing static and animated survey data

	PHY133S10	PHY134F09	PHY134S10
Learn more quickly	0.23	**0.018***	**0.0060***
Increased performance	0.64	0.14	**0.060**
Increased productivity	0.27	**0.079**	**0.022***
Learning effectiveness	0.16	**0.021***	**0.058**
Made learning easier	0.85	**0.052**	0.15
Useful	0.42	0.13	**0.0085***
Engaging	0.22	**0.024***	**7.2E-06***

two are statistically similar. Typically, p-values less than 0.05 are considered statistically significant. In other words, if the p-value is small enough, then the two sets of data can be considered significantly different. Table 5 lists the p-values for all three courses. Values less than 0.05 are indicated (*).

Out of the three courses, both PHY134F09 and PHY134S10 have p-values less than 0.05 for at least half of the statements, indicating that for at least these statements, student responses were statistically different between the static survey and the animated survey. In every case, the students rated the animated presentations more favorably than the static ones. If we relax our criterion to a probably value less than 0.10 (indicated in bold in the table above), then we see that for these two courses there was a shift in perception for most of the statements, again in favor of the animated presentations. In other words, in these two courses, students' acceptance of the PowerPoint presentations was substantially greater for the animated presentations than it was for the static presentations. We see little to no statistical difference between surveys in the PHY133S10 course.

5. DISCUSSION

We found that whether students received static or animated PowerPoint presentations had no appreciable effect on the average exam scores in all three of our courses. In only two cases (PHY134F09—exams 2 and 3) did one section perform statistically better than another. In each case, Section 2 performed better than Section 1. For the second exam, Section 2 received the animated PowerPoint presentations while Section 1 received static presentations; for the third exam the positions were reversed. In PHY134F09, Section 2 consistently performed better on every exam compared to Section 1, but not always significantly so. In the cases of exams 1 and 4, the fact that the p-values are larger than 0.05 does not mean that there is no difference between the two sections, but rather that there is no evidence of any difference. Therefore, while the results of the second and third exams are statistically meaningful, we do not give them too much weight in light of the fact that (1) the results suggest that the mean exam scores are more a factor of student population than presentation style, and (2) no other comparison between sections on any of the other exams in any of the other courses supports the conclusion that one presentation style might actually be more beneficial for students than the other.

Student performance on the concept inventory tests, though, suggests that there could be a long-term effect that does not manifest itself on the exams. Looking at the results of the solar system concept inventory and SPCI, we find that student performance increased more on questions relating to material covered in animated presentations compared to questions relating to material covered in static presentations.

In PHY134F09, while the material covered by the SPCI was discussed in class during units when both classes received the same type of presentation (static during unit 1 and text-animated during unit 4), if we assume that the level of difficulty is similar among the various questions covered by the SPCI, then we observed that students performed better on questions from the text-animated unit than they did on questions from the static unit. Comparing the average normalized gains from pretest to post-test, students improved more on the text-animated questions (a gain of 0.34, or medium-gain) than they did on the static questions (a gain of 0.12, or low-gain). We could explain this result one of two ways. First, it could be that the questions covered in unit 4 were inherently easier than those in unit 1, and therefore a greater gain would be expected. In PHY134F09, the questions covered in unit I mostly pertain to blackbody radiation, luminosity, and the relationship between luminosity, temperature, and radius. While students do have some common misconceptions with these concepts (Bardar *et al*. 2005), these topics are not considered to be any more difficult that others covered in the course. The alternative explanation is more straightforward. The unit 1 material was covered at the beginning of the semester while the unit 4 material was covered at the end of the semester. Students may have performed better on the text-animated questions simply because they covered the material more recently and it was fresher in their minds. This pattern is not repeated, though, in the other two courses, as discussed below.

In PHY133S10, we are able to compare the average normalized gains on the SSCI between units 2 and 3, where in each case two of the sections received text-animated presentations and while the third received static presentations. While the gains were low for questions covered in both units in all three sections, they were higher for unit 2 then they were for unit 3. Within each unit, gains were higher for the sections receiving text-animated presentations than they were for the section receiving static presentations. In fact, the average normalized gains on the questions covered during the text-animated units were anywhere from 2 to more than 7 times greater than the gains on the static units. While we would like to think that this is significant, we need to keep in mind that the largest gain, achieved in a text-animated section on the questions associated with unit 2, was still only 0.07. With such low gains, it is difficult to say with any statistical certainty that the differences are significant.

In PHY134S10, we are able to compare the average normalized gains on the SPCI between units 2 and 3, both of which took place during the first half of the semester. In each case, the static sections achieved “low” gains while the figure-animated sections achieved “medium” gains. While the exam results for each of these units showed no evidence of any difference in performance between the two sections, the SPCI results suggest otherwise. There may be a number of reasons for this. First, it could be that figure-animated PowerPoint slides aid in the long-term retention of concepts covered in the presentations. Exams were administered roughly every two to three weeks, and so when students were presented with exam questions, they only had to recall information from a two-to-three week period just preceding the exam. The postconcept test was administered at the end of the semester, over half of a semester since the associated material was covered. We suggest that the figure-animated presentations may have a longer impact on the retention of material presented in class. Second, students knew the dates of the exams and were allowed to study for them, while the concept tests were administered without the students’ prior knowledge. It may be that when studying for an exam the method of presentation is unimportant, because students will study static notes, not rewatch animated presentations. Students are therefore recalling information they recently reviewed over the past few days, with both sections studying in a similar format, regardless of presentation style. With the concept tests, though, students were not given the opportunity to study beforehand, and so it tests their understanding of the material from throughout the semester without the review of static notes. In this case, they most likely were recalling the information as they learned it in class, based on the presentations they were provided. Third, it could be that the style of questions addressed different types of knowledge. Exam questions were, for the most part, written by the instructor. The concept test questions, on the other hand, were written and field-tested to ensure that the questions properly assessed student understanding of stellar properties and that the results were valid and reliable (Bailey 2007). It may be that presentation style had little effect with the instructor-written questions, but that when it came to the more robust concept inventory questions, students performed better on questions related to material that was presented to them via figure-animated slides.

Based on these results, we suggest that slide animations have a greater positive effect on the long-term retention of material over that of static presentations. In addition, it appears that the inclusion of animated figures, which present information incrementally or indicate motion or progression of images over time, has an even greater impact on retention than that of simple text animation. The reason for this may be that while text animation presents the material incrementally such that it allows the students to comprehend a section of information before processing the next, it mostly involves only the auditory/verbal channel of learning (Mayer 2001). According to Mayer, while students may first process visual text via the visual/pictorial channel, it can shift to the auditory/verbal channel of learning as students mentally articulate what they are learning. By including animated figures along with animated text, students are able to incorporate more material in their working memory at one time through dual-channel learning.

We can compare our results to the findings by other authors. Mahar, Yaylacicegi, and Janicki (2009) concluded that PowerPoint animations actually detracted from student retention rather than enhanced it, contrary to what we suggest. In their study, they presented groups of students with the same presentation, lasting for the same amount of time (under 20 min), but one group was shown a static presentation while another group was shown an animated presentation. Both groups were then asked to answer a series of fact-based, multiple-choice questions immediately after the presentation. While a significant difference in scores between the two groups is evident, no pretest comparison between the two groups is presented. The authors imply that the two groups are inherently similar at the beginning of the course, but no data are presented to support this claim. Bartsch and Cobern (2003) also found that students performed worse on quizzes when exposed to animated presentations, but the format of their presentations differed from ours. In addition to pictures and adding text one line at a time, their text did not simply “appear,” but was added to the presentation slide in a variety of ways. They also included a sound when new text was added, which was not relevant to the concepts being covered by the text. These distractors could easily explain why students’ performance decreased, occupying the students’ attention more so than the material they are expected to learn. Pippert and Moore (1999) found no difference between groups based on presentation styles, but while they varied the presentation style that each student group received throughout the semester, it is only during their fourth and final unit that the two groups being studied received different presentation styles. For the first three units, both groups received the same presentation (either static or animated) and quiz results were consistent among the three units. When comparing the two groups during the last unit, they found that the average tests scores were consistent as well. This is similar to our findings: when looking at test results at the end of a unit little difference exists between the two groups of students. Unfortunately, neither Pippert and Moore, nor any of the other studies, looked at longer-term comparisons between groups of students.

We see a much greater effect of the presentation styles when we look at student perceptions of the PowerPoint slides. In general, students rank the animated presentations higher than the static presentations in every category. What is most interesting is how student perception varied among the different courses.

PHY133S10 saw the smallest, if any, increase in perception from static to text-animated, yet started with higher static ratings than the other two courses. We can attribute this to a number of causes. At Sam Houston State University, introductory astronomy is taught over the course of two semesters. While PHY133 and PHY134 are two separate, distinct courses, students falsely believe that they must first complete PHY133 before taking PHY134. Because of this, the student composition of the two courses is different. PHY133 is composed of a wide range of students, including those who simply take the course for an “easy A,” but are not interested in the subject or participating. PHY134 is usually composed of more dedicated students who already took PHY133 and liked astronomy enough to want to take a second course in the subject. We believe that the uninterested students do not care which presentation they receive, and therefore rate both about the same, causing PHY133S10 to have a lower gain in perception from static to text-animated presentations. PHY134 students better appreciate the added value contained in the animated presentations and the efforts made to improve them, ranking them higher and causing greater gains in both PHY134F09 and PHY134S10.

In addition, the structure of the courses themselves may be reflected in the students’ perceptions. The PHY133 course was taught in the style of a traditional lecture course, relying more on the slideshow presentations than the PHY134 courses. The slides used in the PHY133 course were those provided by the textbook company, while both PHY134 classes used custom presentations designed by the instructors. Both sets of PHY134 slides were more animated, containing on average 4 to 6 animations per slide, while those of PHY133S10 only contained 2 to 3 animations per slide on average. As a result, students in PHY133S10 may not have detected a dramatic difference between the two sets of presentations, while in the two PHY134 classes the difference was more prominent.

Looking at Table 5, the biggest differences (p-values less than 0.01) between presentations styles all occur in PHY134S10. Students in this course rated animated slides significantly higher than static slides on three statements (“The instructor’s use of PowerPoint animations enabled me to accomplish learning more quickly,” “I would find PowerPoint animations useful in all my higher education learning experiences,” and “The instructor’s use of PowerPoint animations kept me totally absorbed in the presentation”). This may be due to the fact that in this course, not only was the text animated, but so too were the figures. Where astronomy is such a visual subject that tries to convey concepts that take place over astronomical distances and time scales, animated figures can go a long way in describing these phenomena. Given the fact that so many students consider themselves visual learners, animated figures not only engage them more than static ones, but also help them visualize the concepts being discussed and help them understand them better.

6. CONCLUSIONS

Contrary to previous studies, we find that the effect of animating PowerPoint slides may have a positive effect on the performance of students. While we found little difference in test scores between groups of students given varying presentation styles, when we looked at the end-of-the-semester postdiagnostic surveys, students appear to perform better on material presented via animated slides compared to static slides. In our study, we limited our animation techniques to having text simply appear one idea or concept at a time (and, in some cases, periodically accompanied with a relevant figure), or in the case of PHY134S10, animating figures to demonstrate a progression of ideas or a step-by-step illustration of a particular concept. We suggest that the use of animation techniques makes the presentations more memorable, such that students recall information more readily and for a much longer period than they would otherwise. In addition, when comparing the effects of text-animation versus figure-animation, it appears that the animation of figures in PowerPoint presentations may have an even greater influence on learning than simple text animation.

Students also ranked the animated slides higher than the static slides, stating that they found them to be more engaging, allowing students to learn the material more quickly and improving their performance and productivity. While the exam results do not support these claims, students believe that they do. Providing students with a more positive outlook on their learning experience is very important, so even if animated slides do not provide substantial benefits to student performance, the fact that they increase the students' perception of their performance and understanding makes them worthwhile. It is interesting to note that the level of increase in perception is dependent upon the general level of interest in the course material and may be dependent on structure of the PowerPoint presentations regardless of presentation style. It may be that "canned" presentations, as typically provided by textbook publishers, do not engage students as highly as personalized presentations created by the instructor.

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Appendix

RESULTS OF THE TAM

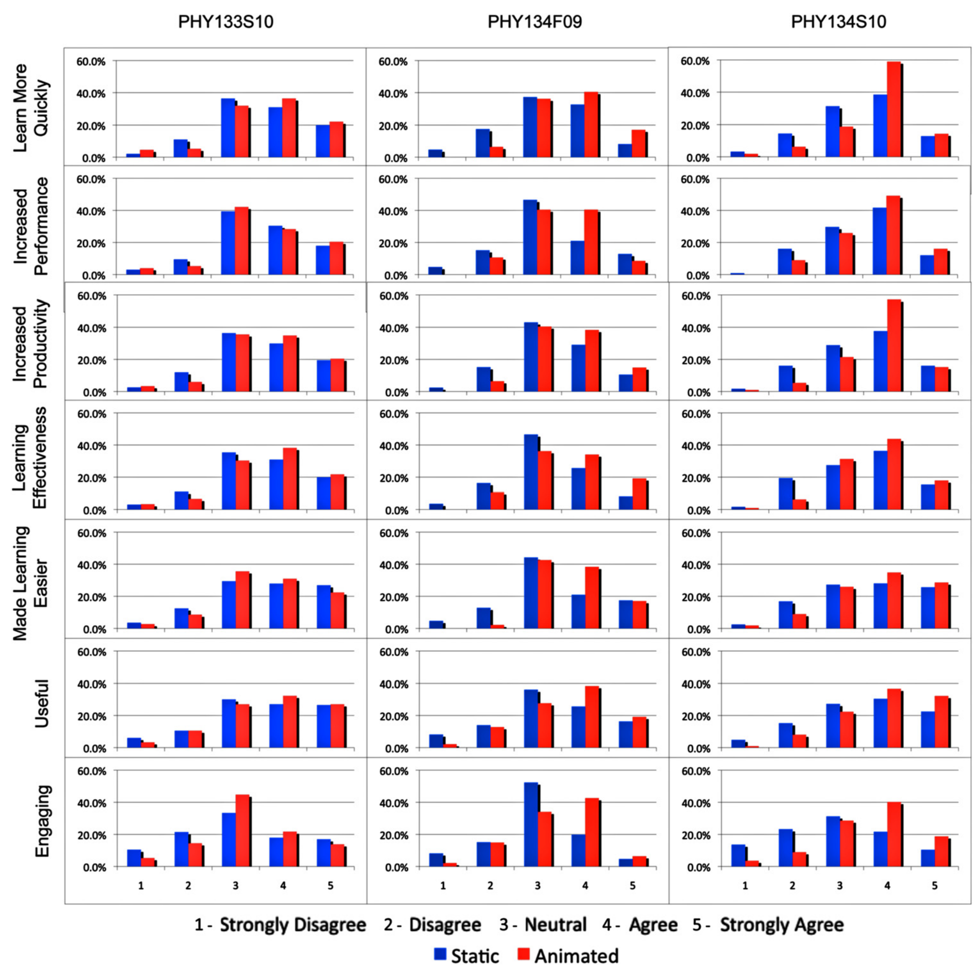

Figure 3. The complete aggregate presentation of the TAM results. Each column presents the combined static and animated results for each of the three courses, while each row presents the results for each of the seven statements.

References

Bailey, J. M. 2007, "Development of a Concept Inventory to Assess Students' Understanding and Reasoning Difficulties about the Properties and Formation of Stars," *Astronomy Education Review*, 6, 133.

Bardar, E. M. (Weeks), Prather, E. E., Brecher, K., and Slater, T. F. 2005, "The Need for a Light and Spectroscopy Concept Inventory for Assessing Innovations in Introductory Astronomy Survey Courses," *Astronomy Education Review*, 4, 20.

Bartsch, R. A., and Cobern, K. M. 2003, "Effectiveness of PowerPoint Presentations in Lectures," *Computers & Education*, 41, 77.

Craig, R. J., and Amernic, J. H. 2006, "PowerPoint Presentation Technology and the Dynamics of Teaching," *Innovative Higher Education*, 31, 147.

Dasgupta, S., Granger, M., and McGarry, N. 2002, "User Acceptance of E-collaboration Technology: An Extension of the Technology Acceptance Model," *Group Decision and Negotiation*, 11, 87.

Davis, F. D. 1989, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly*, 13, 319.

Grabe, M. E. 2000, "Packaging Television News: The Effects of Tabloid on Information Processing and Evaluative Responses," *Journal of Broadcasting and Electronic Media*, 44, 581.

Hake, R. R. 1998, "Interactive-Engagement Versus Traditional Methods: A Six-Thousand-Student Survey of Mechanics Test Data for Introductory Physics Courses," *American Journal of Physics*, 66, 64.

Hornstein, Seth D., Prather, E. E., English, T. R., Desch, S. M., and Keller, J. M. 2010, "Continued Development of the Solar System Concept Inventory," *Bulletin of the American Astronomical Society*, 42, 415; AAS meeting #215, #447.03, American Astronomical Society.

Johnstone, A. H. and Percival, F. 1976, "Attention Breaks in Lectures," *Education in Chemistry*, 13, 49.

Lang, A. 2000, "The Limited Capacity Model of Mediated Message Processing," *Journal of Communication*, 50, 46.

Levasseur, D. G., and Sawyer, J. K. 2006, "Pedagogy Meets PowerPoint: A Research Review of the Effects of Computer-Generated Slides in the Classroom," *The Review of Communication*, 6, 101.

Lowry, R. B. 1999, "Electronic Presentation of Lectures – Effect upon Student Performance," *University Chemistry Education*, 3, 18.

Mahar, S., Yaylacicegi, U., and Janicki T. N. 2009, "Less Is More When Developing PowerPoint Animations," *Information Systems Education Journal*, 7, 82.

Mann, H. B., and Whitney, D. R., 1947, "On a Test of Whether One of Two Random Variables Is Stochastically Larger Than the Other," *Annals of Mathematical Statistics*, 18, 50.

Mayer, R. E. 2001, *Multimedia Learning*, New York: Cambridge University Press.

Pippert, T. D., and Moore, H. A. 1999, "Multiple Perspectives on Multimedia in the Large Lecture," *Teaching Sociology*, 27, 92.

Prather, E. E., Slater, T. F., Adams, J. P., Bailey, J. M., Jones, L. V., and Dostal, J. A., 2004, "Research on a Lecture-Tutorial Approach to Teaching Introductory Astronomy for Non-Science Majors," *Astronomy Education Review* 3, 122.

Rieber, L. P. 1990, "Animation in Computer Based Instruction," *Educational Technology Research and Development*, 38, 79.