

AC 2008-741: LESSON STUDY FOR A DISTANCE EDUCATION STATICS COURSE

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Abstract

A lesson study by definition is a process where faculty develop, teach, observe, analyze, and revise a single lesson for a single class period. The objectives are to understand student learning, create useable lessons, improve teaching, and build knowledge of pedagogy using a manageable unit of analysis. A lesson study begins by first determining the student learning goals. A lesson is then developed by a group of instructors to achieve these established outcomes. During the planning, the instructors anticipate student reactions, interpretations, and difficulties with the lesson and alter the instructional experiences accordingly. Once developed, one instructor delivers the lesson while the other instructors observe student learning. The group then analyzes these observations and the lesson is revised. This paper considers a lesson study conducted for a Statics course delivered via distance education. This course is delivered synchronously using an audiographics setup. The instructor and the students connect to a web conference and a telephone conference simultaneously allowing real-time discussion and data sharing. The lesson was also designed to create a hands-on learning activity for the students who are engaged in a passive learning environment. The lesson study gave insight into how engineering students learn via this distance education delivery mode, methods of creating an interactive classroom in a distance education environment, and improved teaching all engineering courses delivered by this method.

Introduction

A lesson study is where a small group of teachers develop, teach, observe, analyze, and revise a single lesson to meet certain student learning objectives¹⁻³. A lesson study is usually focused on a lesson requiring a single class period. Focusing on a single class period gives the teachers a more manageable component in which to concentrate their teaching. In planning the lesson, teachers start by determining the learning goals they want students to achieve. From these goals, learning objectives are formed and then the student exercises or activities are developed to attain the objectives. The lesson plan consists of the instructor methodology and techniques for instruction as well as the expected reaction of the students. The lesson is developed with student learning as the focal point, including how students will interpret the information and the difficulties they may have in reaching the learning goals.

The overarching goal of a lesson study is to improve teaching. This goal is achieved by three specific objectives. The first objective of a lesson study is to understand how students learn. This understanding comes from observing student behavior during the lesson and then analyzing the behavior and modifying the lesson to allow for better student understanding. The second objective of a lesson study is to create a database of usable lessons for use by other teachers. As lessons are created, and modified to enhance student learning they are then deposited into a repository for use by other teachers, thus allowing for more effective teaching and learning in the engineering classroom. The third objective of a lesson study is improved teaching through collaboration. As with most problems, better solutions can be devised by a team rather than an individual. The teachers meet to develop the lesson's goals, objectives and delivery methods.

The collaboration and brainstorming of various delivery methods and pedagogies for the lesson result in a revised lesson to be used by the entire team.

The particular lesson study considered by this paper is unique in that the students receiving the instruction are Non-Online Distance Education (NODE) students of the University of _____ engineering program in the Statics class offered by the _____. The first section of the paper will describe the process by which the lesson study was created and executed. The next section will detail the manner in which the course was delivered via distance education. Then the specifics of the lesson study will be outlined including the initial development, the observation and analysis, and the revision. That will be followed by a discussion of what was learned from the study generally and the specific to the distance education delivery mode. The final section will consist of some concluding remarks about the work.

Non-Online Distance Education (NODE) Course Delivery

The lesson study discussed in this paper was carried out by three engineering faculty members from the University of _____. The _____ is part of the _____ and are comprised of 13 campuses throughout the state. The University of _____ mission is to prepare students for success at the baccalaureate level of education, and provide the first two years of a liberal arts general education. At an institutional level, the _____ has 17 academic departments. These departments are institution-wide, meaning each departmental member is located on a different campus. It is rare that there is more than one member in a discipline at any given campus.

The engineering department of the _____ consists of five faculty members at five different campuses. Distance education is utilized to reach engineering students at all 13 campuses. The course for which this lesson study was done is delivered synchronously via an audiographics setup utilizing Microsoft Live Meeting. The University of _____ Instructional Communication Systems (ICS), manages the course delivery. The delivery method is typically called _____. _____ is real-time data conferencing with audio capabilities. _____ allows students to see the instructor's computer screen via an internet connection and hear the instructor's voice using a telephone connection. The computer screen is used as a blackboard or overhead projector. Software can also be demonstrated by sharing the instructor's computer screen. Students are able to ask questions directly of the instructor as well as other students.

This mode of educational delivery can be problematic for several reasons. The largest obstacle an instructor using _____ faces is that the instructor cannot see the students. Therefore, he or she is unable to know if the pace of the course is too fast or too slow, if the students understand the concepts being presented, taking notes, or paying attention during class. These challenges as well as the fact that all of the _____ engineering courses are offered via _____ are the reason this mode was considered for this lesson study.

Lesson Study Procedure

The first step in a lesson study is to form a team. Teams generally consist of at least three teachers to ensure varied perspectives in teaching. Teams consisting of more than six people can

lead to difficulties in reaching a consensus during development and analysis. Team members should have similar teaching interests and usually come from the same academic department. However, teachers need not teach the course for which the lesson study is being done as their outside perspective may be valuable in developing or analyzing the lesson. The team for this study consisted of two tenured faculty members and one tenure-track faculty member.

After the team has formed, student-learning goals are developed. The goal is then used to create objectives for the lesson and the objectives serve as the backbone for the lesson. The objectives drive the development and analysis of the lesson. The first step is to choose a topic for the lesson. Typically the topic is one that tends to be difficult for students to learn or for instructors to teach. The objectives are active learning objectives in that the student will be able to understand or demonstrate a specific concept. Goals should not only be both specific to the topic addressed by the lesson, they should be more global. Goals for lesson may be focused on achieving goals for the entire course or altering the long-term general mindset of the student.

Using the learning objectives, the team should plan the lesson. This is a very time consuming process as instructors typically begin by sharing the method of delivery for the specific topic and how students have responded to their delivery method. This usually leads to a debate as to the methods or activities that will work best to achieve the learning objectives. The team creates a lesson based on their experiences and perceptions of how they believe students understand the topic and how a student will best learn the topic. Predictions should be made as to what difficulties students will have and how they will react to the designed activities. By developing the lesson from the students' point of view, student learning is put at the forefront, which is the motivation of the lesson study.

After the lesson is developed one team member teaches the lesson while the other members observe student learning. The focus of the observation is not to observe the teaching, but to observe the learning and students reactions to the lesson. Therefore, observers should focus on students rather than the teacher. Observers should look for evidence of student learning and achievement of the learning objectives.

After the lesson is taught, the lesson study team convenes to discuss and analyze the lesson observations. Both the teacher and the observers should analyze the lesson based on perceived student learning and reaction to the lesson. Three questions should be address during the analysis. The first is "Did the students accomplish the learning objective?" The second is "How can the lesson be improved?" The final question is "What did the teachers learn?" This analysis of the lesson delivery and student reactions is where teachers truly discover how students learn and what instructors can do to foster learning.

The entire process is then repeated for a second cycle. From the analysis of the initial lesson, teachers revise the lesson to facilitate better delivery, which may result in a greater understanding of the material by the students. A different instructor teaches the lesson to a different class a second time. This lesson is again observed and a final analysis is conducted to determine if students successfully accomplished the learning objectives, thus achieving the learning goal. The second iteration promotes a deeper understanding of the delivery methods that effectively promote student learning.

_____ Lesson Study for Statics

Lesson Development

The team approached the creation of the lesson, by trying to throw away any preconceived notions, and approached the lesson from the point of view of the student. This was very difficult as each of the faculty members were traditional students in a traditional classroom setting, therefore, it was expected students would behave and react as they would in a traditional setting.

The team for this lesson study consisted of three engineering professors that teach via _____. Statics was chosen as the course for the lesson study for two reasons. First, it is a course each instructor on the team teaches using _____. The second is that statics is the first mathematically intensive course students take and the hope was to understand how these early engineering students learn using the delivery method of _____. The topic chosen to cover was mass moments of inertia, specifically the parallel axis theorem and composite bodies. This was also chosen for two reasons. The first is that the topic is presented toward the end of the semester, which gave the team ample time to plan the lesson. The second is the concept of moments of inertia is quite abstract and difficult for students to comprehend, and the team thought the delivery mechanism made this topic even more abstract as demonstrations are not a viable option in this delivery mode. Choosing a difficult topic would give some insight on how students learn using _____.

The team met and developed a learning goal and three learning objectives for the lesson. The learning goal was to improve the student understanding of mass moments of inertia, specifically the parallel axis theorem and composite bodies. Three objectives were created to accomplish the learning goal. The first objective was for students to understand the parallel-axis theorem and apply the theorem to determine the moment of inertia of a composite body. The second objective was for students to define the mass moment of inertia of an object and understand how the properties of the object affect the rotation of an object. The final learning objective was for students to be an active participant in the learning process using _____. As a side note, the team set a goal for the instructors, which was to gain a better understanding of how students behave in a _____ class and how the instructors performed in a _____ class with regards to delivery methods and the pace of the class. .

To achieve the learning objectives, it was decided to use a combination of explanation of theory, hands-on experiments, and interactive problem solving. The lesson began with a brief presentation of the theory of the parallel-axis theorem and its application in determining the mass moment of inertia of composite bodies. This presentation was given using PowerPoint slides, as this is the preferred delivery method in the _____ learning environment. After the theory was explained, the students performed two experiments using Tinker Toys. The students used a set of Tinker Toys that were previously mailed to each campus as well as the PowerPoint slides showing the students how to build the models. In the first experiment, students made two pendulums of similar mass and different lengths. They then swung the two pendulums to feel that the longer pendulum was harder to swing and therefore had a larger moment of inertia. Students were then asked to perform calculations to compare the moments of inertia numerically.

The goal was that the students would learn that the further away a pendulum is from the center of rotation (i.e. increase in parallel-axis distance) the harder it is to rotate (i.e. the larger the moment of inertia). In the second experiment, students created a composite body using the Tinker Toys and then rotated it about different axes to feel which axis had the greatest moment of inertia. The students then completed a series of calculations to compare numerically the moment of inertia of the composite body about each axis. For each Tinker Toy piece the length, diameter, and mass were given to the students. The faculty believed in designing this lesson that the students would be active during class and get a physical feeling for the mass moment of inertia was and how it changes based on the axis of rotation. Specific information regarding this lesson, including the PowerPoint presentation, will be available from the authors by request.

Initial Lesson Presentation & Review

In theory, one instructor gave the lesson while the other two were to observe the student learning. Since the students were on different campuses as the instructors or the observers, video cameras were set up at all sites in order allow for asynchronous observation of the students. After the initial delivery, prior to any observation, it was determined the lesson was too lengthy and only the first half of the lesson was completed in a 50 minute class period. The second half of the lesson was delivered in the next 50-minute class. The material presented showed observers that what was covered seemed successful in that students seemed to gain a better understanding of mass moment of inertia. This was demonstrated by the students answering questions posed by the instructor as well as the students nodding in agreement to statements made by the instructor as well as statements made by other students. The observers also stated that the students understood the parallel-axis theorem and how the mass's distance away from rotation affected the mass moment of inertia. After viewing the various lectures three main observations regarding problems with the lesson were made by the reviewers of the class. First, it was observed that students had trouble following instructions and building the desired Tinker Toy models to be used in the experiments. Second, it was observed that the students were unable to relate the actual tinker toy elements to elements in the tables in the book. Finally, the observations gave insight as to the student's behavior in a _____ class. The team members assumed that the students would come to class prepared, ready to learn, and be active participants. This was not the case in some instances. One observation was that some students did not come prepared to class. It was observed that most students did not come to class with their textbook, making references made to he tables in the book by the instructor impossible for the student to follow. The instructor has no ability to see if the students have their book or is following along; therefore the instructor continually references the book and calculations that are to be made and is unaware that the students are not performing as would be expected.

Another observation was that students were easily distracted by the Tinker Toys, playing with them while the instructor was discussing theory or working on calculations. The inability to see the students and the muting of the phone connection make it difficult to keep students on task. In general, students were not taking notes, doing the calculations, or actively following along. A few students were responding which kept the instructor thinking all students understood. The overarching observation was that even though the instructors felt they created a very interactive lesson, students were easily distracted and not participating to the extent the instructors were hoping. The nature of the delivery method created a disconnect between the instructor and the

students that would be difficult to overcome in truly creating an interactive learning environment. All team members felt had the lesson been done in a face-to-face environment, these observations would not be made and the students would be following along and participating in an active learning environment.

Lesson Revision

Based on the observation by the faculty member presenting the material, the first step in revising the lesson was to shorten the lesson. The team members agreed to present the theory in the previous class period and devote the entire class period to the experiments and calculations in order complete the lesson and attain the learning objectives. In response to the first observation, pictures were added and detail within the pictures was included in order to help students better build the Tinker Toy models. It was desired that the students would be able to easily build the models that were required for the experiments. Video was created in order to aid in building the models, but the _____ environment did not support the use of video.

The second observation detailed the students could not make the connection from the Tinker Toy elements to the material in the book. The students struggled with the terminology used in the book with regards to the parallel axis theorem. Specifically, students could not correlate the axes of the body they built to the axes in the moment of inertia table of simple shapes. In the book the axes are labeled x , y , and z , however, these axes typically do not correspond to the x , y , and z in the problem being considered. Therefore, axes for calculating the Tinker Toy bodies were changed to the colors of the rods used in the body. This allowed the students to convert a green axis on the Tinker Toys to the y -axis in the moment of inertia table.

The third observation showed the problems the students had attending to class. In response to this observation various approaches were used. To overcome the lack of preparation of students not bringing their textbook to class, any reference to the book was scanned and made available in the slideshow. This allowed the students to actively follow any reference made to said tables. Nothing specially was done to alleviate students playing with the Tinker Toys, but the hope was the increased activity would keep them on task and to not play when they are supposed to be performing calculations, building models, or participating in a discussion. The team believed the revisions were made to help students in there understanding of the topic as well as to create a more engaging lesson.

Revised Lesson Presentation and Review

A second team member gave the revised lesson. The revised lesson was completed and presented in one 50-minute class period. Even with the shortened lesson, the instructor teaching the revised lesson felt rushed for time and just barely completed the lesson. The reduction in the lesson from the initial presentation to the revised presentation as well as the team member's observation demonstrates that teaching through distance education takes significantly longer than traditional face-to-face instruction. This fact was known in advance of the lesson study, but reinforced by the observations of the students during the lesson. It was observed that students reacted better to the first parallel axis theorem experiment than the composite body experiment. The composite body experiment had too many calculations and the students did not have time to

complete the problem. Even with many of the changes to the lesson it was observed that students in the revised lesson were not prepared for class and had a lack of participation during class. Students still did not bring their books and they still played with the Tinker Toys when other activities in which they were to be participating were occurring. Some students still did not seem actively engaged in class, and they still did not take notes. Notes were supplied in advanced to allow students to focus on the material and supplement the notes with their own findings rather than feverishly take notes for the entire class. It was also observed that campuses that had more than one student tended to follow along and answer the questions, but did not answer the questions using the microphone so that all students could hear.

In response to these observations regarding classroom behavior, the team feels that possible pop quizzes on material from the book would ensure that students bring their book to class. The team agreed that an outline of notes could be given and students can fill in holes in the notes to keep them engaged in lieu of giving the students the entire set of notes. The team members believe that the problem with student engagement and learning came directly from the _____ mode of delivery. The team members are concerned that if students are this disengaged with cameras on them, then they are probably even less engaged when nothing is there to check them. Perhaps a slight change in data conferencing software might allow for web cams to be installed and keep students on task. The _____ is piloting a program using web cams and the _____ software in the spring semester of 2008. Overall, the revised lesson did a better job at meeting the learning objectives and the lesson study goals than the initial lesson, but still fell short in full student understanding and engagement.

Outcomes

The overarching goal of this lesson study was to improve teaching, specifically the mass moment of inertia as it relates to the parallel axis theorem and composite bodies. The team members felt that this goal was mostly achieved. An engaging and active learning lesson was created. There were three specific objectives related to the goal. The first objective of a lesson study is to understand how students learn. This understanding comes from observing student behavior during the lesson and then analyzing the behavior and modifying the lesson to allow for better student understanding. The team members felt that they did not grasp fully how students learn especially in the _____ environment, but do feel they have a better understanding. The team members found that making assumptions about relationships between experiments and the book are not valid. The team members found that the assumption that students are actively following and participating is not always true, but when they do the students seem to understand as demonstrated in the observations.

Another objective of a lesson study is improved teaching through collaboration. This objective was easily reached as the team met for many hours and shared and collaborated in ways that are very typical for faculty members that are on the same campus, but not typical for faculty members on the _____ campuses. Finally the team set a goal for the instructors, which was to gain a better understanding of how students behave in a _____ class and how the instructors performed in a _____ class with regards to delivery methods and the pace of the class. The insights gained from the observations of the _____ class were quite valuable. Both instructors talked too much and did not allow students time to complete computations or allow

students time to answer questions. Lessons and activities delivered via _____ take longer than the same activity in a live classroom. The team members rely heavily on lecture and need to move the delivery mode to hands on and active learning activities. This may include more modeling and experiments, or collaboration on problem solving in class.

Conclusion

A lesson study is a method for instructors to begin to understand how students learn and allows instructors to create engaging and active lessons. The process allowed for instructors to work collaboratively on a single lesson. This collaboration allows for sharing of ideas and improved teaching and understanding of student learning. By focusing on the student, rather than the teacher, the lesson study shifts how instructors think about preparing for class. Specifically, the lesson study detailed here gave instructors a greater understanding of how the _____ delivery mode actually leads to and hinders student learning.

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