Session 1615

Transportation Course Transformation through the Use of Instructional Technology

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Abstract

This paper documents the transformation of the Transportation Systems Engineering Course through the use of instructional technology. The course described is a junior/senior level Civil Engineering course that is required for all undergraduate Civil Engineering students at the University of Missouri-Columbia. The goal in the use of instructional technology is to enhance both the teaching infrastructure and instructional techniques. A course management tool named Blackboard 5 (BB5) was utilized to manage course logistics such as acting as the project data server, providing solutions, updating and personalizing grade reports, and posting announcements. A wireless Personal Address (PA) system worn by the instructor was utilized in laboratory sections to enhance the instruction in a team setting where discussions among group members were encouraged during class. Teaching techniques using computer laboratories completely transformed the course. Four projects, each requiring significant computer modeling and engineering, were implemented to replace and augment homework sets. The four projects were (1) geometric design with AutoCAD, (2) traffic flow analysis with CORSIM, (3) traffic signalization and control with Synchro, and (4) transportation planning with Simcity3k. The results from the mid-course and final student surveys from the Fall semester and the mid-course survey from the Winter semester indicated that BB5 has been useful in the course while not all of the students accessed all of the functions of BB5. Most students were ambivalent about the use of the PA system during the Fall semester even though the instructor felt it was helpful. The students overwhelmingly affirmed the usefulness of the computer laboratory and projects. However, the class was divided over the issue of preferring homework only over a combination of homework and computer projects.

I. Introduction

The Introduction to Transportation Systems Engineering course is offered both Fall and Winter semesters in the Department of Civil and Environmental Engineering at the University of Missouri-Columbia. This course is required for all civil engineering majors and is the first course in transportation engineering. Usually, a mixture of both junior and senior students enroll in the course. Transportation engineering is an extremely diverse field that includes elements of economics, urban planning, statistics, sociology, electrical engineering, logistics, and other fields. Therefore, it is difficult to achieve any level of depth in an introductory course that will enable students to appreciate the intricacies of the transportation engineering process.

The goal in the use of instructional technology is to enhance both the teaching infrastructure and instructional techniques and to help achieve greater depth. More specifically, one goal is to help students consider complete pictures of transportation areas instead of isolated snapshots. Traditionally, the introductory transportation engineering course utilizes only homework problems and not projects. The hypothesis is that students will gain greater depth and appreciation for transportation areas if they work on projects instead of isolated problems. Because of the difficulty of testing such hypothesis without control groups, a more straight-forward way of questioning student preferences was solicited from student surveys. The use of instructional technology makes projects in the course possible because of several reasons. First, the use of computer tools allows the examination of geographical areas involving significant amounts of transportation data. Second, such tools of graphical nature simplify the data management and analysis process for students. Third, modeling and simulation tools can reduce the time frame required for a project to fit within a few weeks of the semester. Another specific goal is to enhance the classroom logistics in addition to the course content. The use of Blackboard 5 (BB5) and personal address system (PA) were intended to improve the student class experience both in and out of the classroom.

II. Instructional Technology Components

The three instructional technology components implemented within the course were Blackboard 5, wireless PA, and computer projects. They are described in the following subsections.

A. Blackboard 5

Blackboard 5 is a web-based learning management system that provides course, course content, and user services. The user's privacy is protected using authenticating password. After selecting a course, users are provided with a navigation menu to different BB5 course services. Instructors have access to the Control Panel through which they can create course content, and alter system, or student user settings. Blackboard is mainly concentrated on an asynchronous teaching environment. Any document can be either uploaded into a shared file area, or submitted through a form with text areas to be posted inside the course content.

As utilized in the course, BB5 was a data server for projects, an information repository for announcements and other class postings, and a grade management tool. Project data such as a coded traffic simulation file or a topographic map were accessed via BB5. All the required assignments such as homework and projects were available for viewing through BB5. Solutions were posted for homework and examinations. Additional materials that supplemented the textbook such as pavement design tables or signal timing examples were also made available on BB5. Student grades for every single assignment were available on BB5.

One benefit of BB5 was the timely dissemination of information to all students. For example, students had access to homework and midterm solutions immediately after they turned in the assignments. This allowed students to check their understanding while the problems were still fresh on their minds. The timeliness also allowed students to keep track of their grades for each assignment and to dispute incorrect grades right away. The students appreciated the fact that their standing in the course was always evident because of the updated grades. A second benefit of BB5 was its 24 hour availability on and off campus. Students were able to access data files and course documents in the evenings and on the weekends via remote connections. A third benefit was the posting of vital class announcement such as due date changes. Students who missed a class were made aware of the class progress and any class changes. A fourth benefit was the privacy of the system for students to access their personalized grades with their own accounts. As a comparison, the use of a student identification number or social security number for public posting of grades seems less desirable since those numbers are sometimes numbered in alphabetical order. Another benefit was the centralized data server function. Once the students became familiar with the BB5 interface, they were able to retrieve data files easily and operate with less help on projects.

B. Nady Wireless Personal Address System

In a computer laboratory setting, the instructor was required to lecture in front of the class, demonstrate software packages, and work with individual teams. Many times, these tasks occur continuously throughout the laboratory period. The ability to hear the instructor would change depending on the location of the instructor and whether he was behind of in front of a particular team. Due to the nature of team environments, the instructor had to project his voice above the several team discussions that occur as teammates work together. Also, the sum total of all the noise emitted by the electronics equipment (computers, monitors, printers, routers, etc…) created a significant background noise level. A reason for the use of the PA was to make sure that all teams were able to hear the instructor clearly throughout the laboratory session.

C. CAD Geometric Design Project

The CAD geometric design project involved the following challenge:
You have undoubtedly heard the following saying: "The proof of the pudding is in the eating!" Well, we have been discussing geometric design in class. We are covering horizontal curves, cross sections, superelevation, vertical curves, sight distances, and other miscellaneous topics related to geometric design. As a class, are we able to design a roadway alignment that is safe and efficient?

This project involved a brand new Turtle Creek development needing the construction of significant infrastructure in Dubuque Iowa. Within the scope of this development was the construction of three highways. The students were asked to design a portion of Route 169 connecting two highways which are not yet constructed. Route 169 was north of a subdivision that involved mostly residential housing. Route 169 was a two-lane rural road. The topographic map of the site was provided via the BB5 website.

The deliverable of this project consisted of a set of plans capturing the design of Route 169. The deliverables included the following subsections:

1. Cover sheet
2. Plan view (horizontal alignment)
3. Profile sheet (vertical alignment)
4. Typical cross section
5. ALL calculations pertaining to sight distances and geometric design.

D. Traffic Simulation Project

The traffic simulation project involved the following challenge:
Congratulations on being hired as consultants on the I-70 evaluation project. You and your partner (maximum of two per team) will utilize the TSIS/CORSIM micro-simulation software developed by the Federal Highway Administration (FHWA) for this analysis.

The I-70 network consisted of a mainline freeway stretch of just under 2 miles and two parallel arterials with the corresponding intersections. The students were asked to analyze the effects of the following changes on a section of the I-70 network:

1. An increase in the free-flow speed from 65 to 70 mph on two major links on I-70 (82-84 and 89-87). This change can show the effects of a possible change in the speed limit such as what happened when the national speed limit law was repealed in the mid 1990's.

2. A change in the grade from 0% to 8% on the same links on I-70. This change examines the effects of geometric design on overall efficiency.

3. Increase the entry flows into the network by a factor of 2. This change relates to an increase in demand that can occur over time with population growth, or can reflect a short-time influx of vehicles because of special events

E. Traffic Signalization and Control Project

The traffic simulation project involved the following challenge:
Your buddy who lives in the city found out that you are taking this course. This person asks you to investigate the signals near his/her house. You think to yourself, I might as well try out some of the things that I have been studying in class.

The students were asked to study two consecutive intersections in the City of Columbia. The example of two signals, albeit simple, helped to explore the issues related to isolated intersections as well as coordination between multiple intersections. The project was performed with a team of two engineers. Traffic volumes for all movements at the two intersections were collected and saturation flow rates were measured for similar movements. The existing signal timings were noted.

Synchro is a software package that is used by transportation agencies for optimizing traffic signal timings. Synchro performs capacity analysis, signal timing optimization, and signal coordination. The students utilized Synchro for completing the following set of deliverables:

1. Evaluation of existing timing.
Code the existing timing into Synchro. Comment on the delays and L-O-S. Are intersections currently coordinated? If so, how did you determine that they are coordinated?

2. Optimize timings using Synchro.
Determine and document the optimal timings for the corridor. Compare with existing timing and comment. Also comment on coordination or progression between the two intersections. Will it make sense to maximize the bandwidth in a certain direction, or both directions? How about the movements that are perpendicular? How are the objectives of minimizing delay and maximizing bandwidth similar or different?

3. Analyze the situation further. Is there anything else that you can do to make the intersections more efficient? e.g. geometrics, phasing changes, striping, etc…

F. Simcity Transportation Planning Exercise

SimCity 3000 is a city simulator, i.e. a dynamic model of urban life, complete with simulated citizens, traffic, commerce, industry, utilities, taxes, and other important aspects of city life. Even though the academic rigor of its core simulation models are unknown, this graphical software introduces students to the complexities of city planning and the interactions between land use and transportation.

For this project, students were asked to add additional roads and/or other forms of transportation such as trains or subways to a city. The students tried to place the transportation in such as way that promotes building in all of the zones. The design was tested by running the simulation for two years. The students had to answer the question, "How might proximity to transportation influence the development of a real city?"

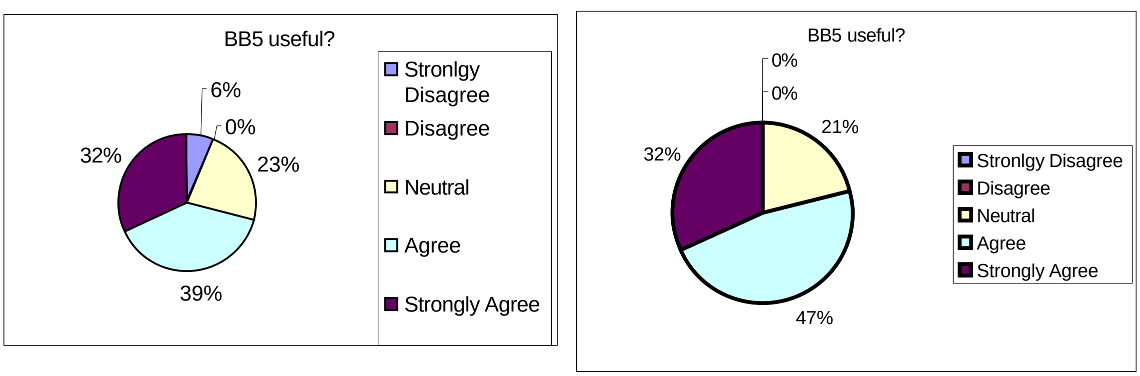
III. Survey Results

Figures 1 through 9 show some of the results from the mid-course and end-of-the-semester survey results. The results are from a mixture of surveys from two semesters. Table 1 documents which course surveys are presented in Figures 1 through 9. The results from the final course evaluations from the Winter evaluations were not yet available when this paper was completed.

Table 1. Originating Surveys for Figures 1-9

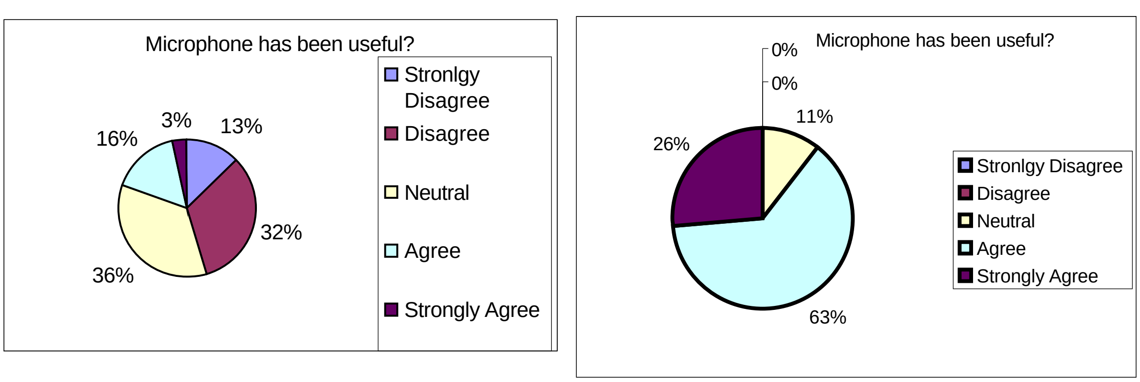
Survey Result	**Course Survey/Semester**
Figure 1a	Final/Fall
Figure 1b	Mid/Winter
Figure 2a	Final/Fall
Figure 2b	Mid/Winter
Figure 3	Mid/Fall
Figure 4a	Final/Fall
Figure 4b	Mid/Winter
Figure 5a	Final/Fall
Figure 5b	Mid/Winter
Figure 6-8	Final/Fall
Figure 9a	Final/Fall
Figure 9b	Mid/Winter

The sample size of the mid-course evaluation for the Fall semester was 34 out of 35 while the sample size of the end-of-the-semester evaluation was 31 out of 35. The sample size for the Winter semester mid-course evaluation was 19 out of 24.



a. Fall semester b. Winter semester

Figure 1. Usefulness of Blackboard 5



a. Fall semester b. Winter semester

Figure 2. Usefulness of wireless PA

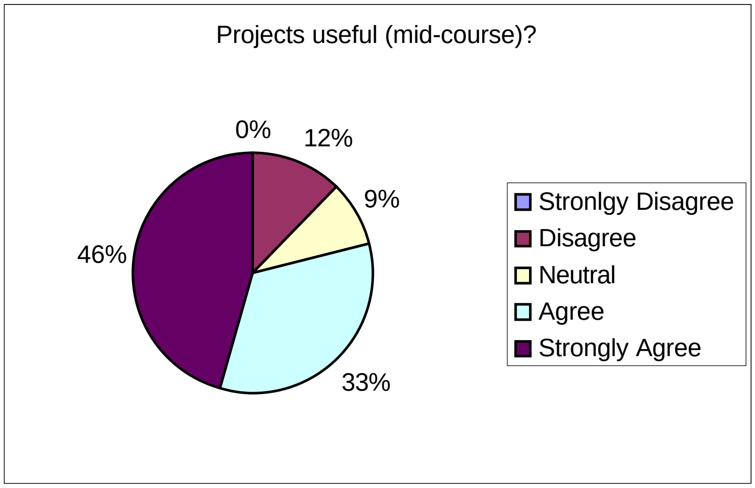
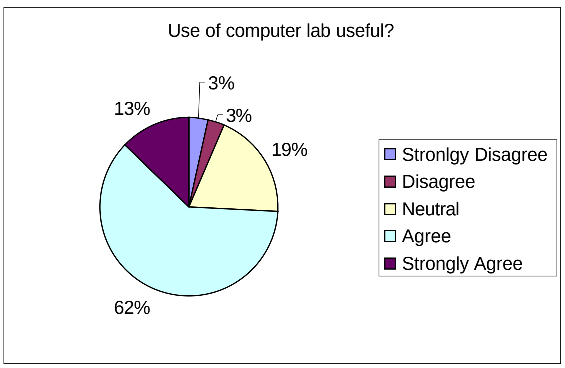
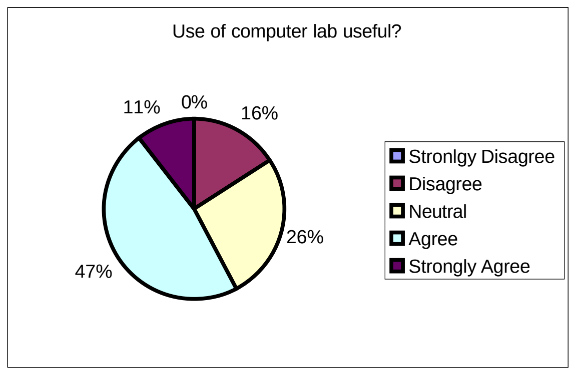


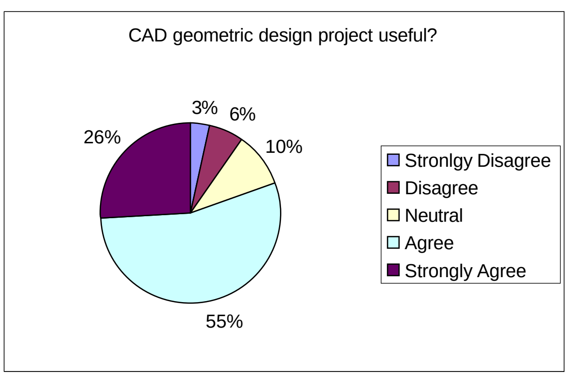
Figure 3. Usefulness of projects from mid-course evaluation

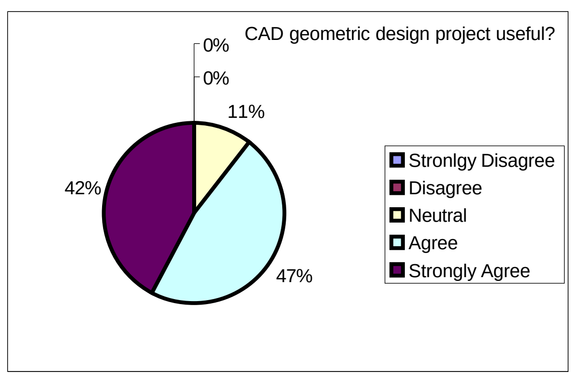




a. Fall semester b. Winter semester

Figure 4. Usefulness of computer lab/project from end-of-semester evaluation





a. Fall semester b. Winter semester

Figure 5. Usefulness of CAD geometric design project.

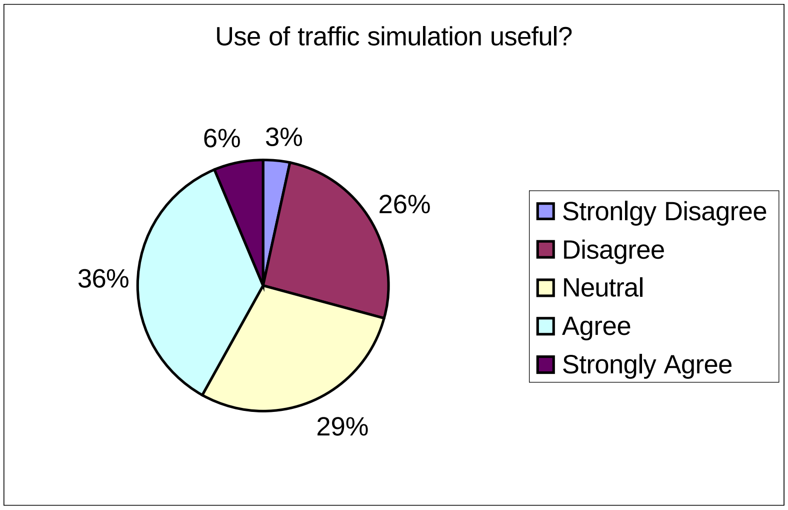


Figure 6. Usefulness of CORSIM traffic simulation project

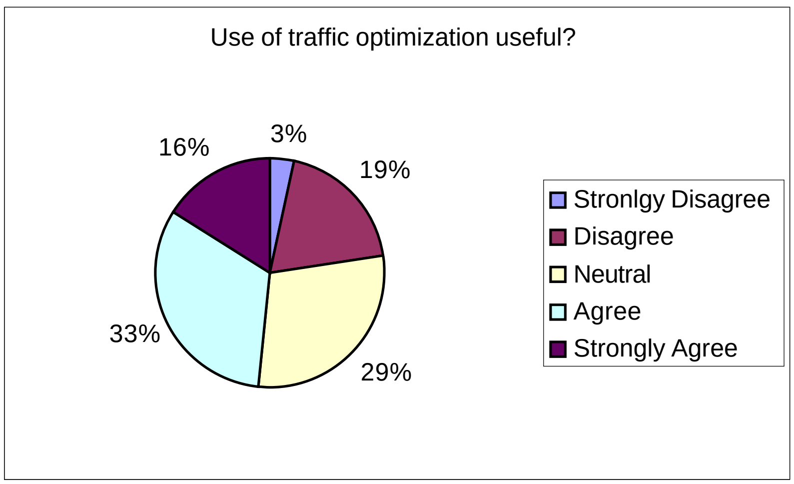


Figure 7. Usefulness of traffic optimization project using Synchro.

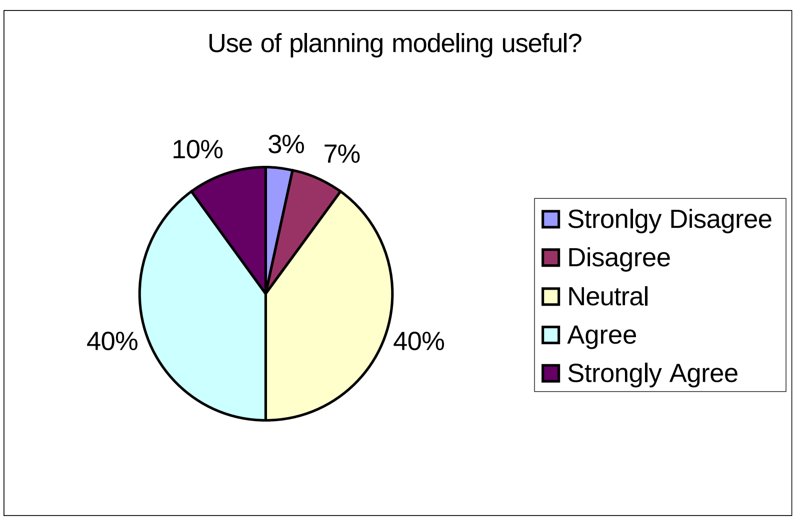
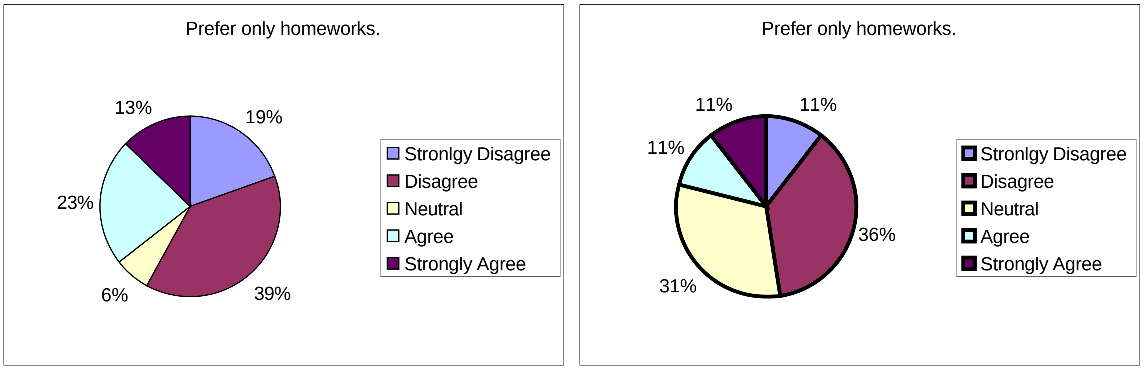


Figure 8. Usefulness of transportation planning modeling using Simcity3k



a. Fall semester b. Winter semester

Figure 9. Prefer having homework only instead of homework and projects.

Figure 1 shows that over 70% of the students in the Fall semester and 79% in the Winter semester agreed or strongly agreed that BB5 was useful in the course. All of the students reported some form of usage of the system over the length of the semester. The two types of documents that were accessed the most on BB5 were homework/examination solutions and course documents such as project files. They were accessed by 87% of the students. Class announcements (68%) and grades (55%) were accessed less frequently although it is not known how many students used BB5 to access their final grades after the semester has ended. The level of usage among different students varied. 51% of the students accessed all the functionality of BB5 (all four components) while the rest varied in their level of access from one component to three.

Figure 2a shows that many students were neutral concerning the instructor's use of the wireless PA in the Fall semester, while other students stood on both sides of the fence. There were some technical difficulties in the initial use of the PA system which caused the instructor's voice to fade in and out. This initial problem might have caused some negative perceptions of the system. The Winter semester response was overwhelmingly positive with 89% of the students strongly agreeing or agreeing that the PA (microphone) system has been useful. The difference in response between the Fall and Winter semesters may be due to the elimination of technical problems in the Winter semester.

Figures 3 through 9 are all results concerning the computer projects. The questions from which figures 3 and 4 result are similar in nature since the computer lab was exclusively devoted to the computer projects. Figure 3 is from the mid-course evaluation and shows that 79% of the students agreed or strongly agreed that projects were useful in the course. Only 12% disagreed. Figure 4a is from the end-of-the-semester evaluation and shows that 75% of the students agreed or strongly agreed that projects were useful. Looking at figures 3 and 4 together shows that there are more strongly agreed responses from the mid-course evaluation than the end-of-the-semester. Perhaps, the novelty of the projects wore off after a while, but their value were still recognized since the overall number of students who agreed that projects were useful were still similar. Another possible cause for the decrease of strongly agreed responses can be student burn out from projects. There were some written comments from surveys that expressed that the projects were good but to reduce the number of projects. Figure 4b shows the mid-course student response from the Winter semester. Figure 4b has questionable value since the students have only completed the first computer lab project when the survey was administered.

Figures 5 through 8 show survey results related to particular projects. Even though these results might not seem to be interesting to anyone except to transportation engineers, they do show that students vary in their opinions among different types of computer projects. Some projects maybe were formulated in a more interesting fashion, were better organized, and/or contained clearer instructions and consequently were better accepted by students. The students who disagreed with the usefulness of individual projects varied from 9%/0% (Figure 5a and b) to 29% (Figure 6). However the majority of students did not disagree with the usefulness of all the individual projects. The Simcity3k project elicited some peculiar survey results. Even though only 10% of the students disagreed with its usefulness, 40% of the students were neutral towards the projects. This can perhaps be explained by the fact that even though the exercise was fun, the students questioned the usefulness of the project because of its lack of academic rigor.

The question that pertains to the result shown in Figure 9 is whether or not students prefer to have only homework instead of a combination of homework and projects. In the Fall semester, a majority of 58% disagreed with that statement and once again re-affirmed their belief in the usefulness of projects. However a sizable number of students (36%) also stated that they would prefer to have homework only. One possible interpretation is that students would rather have homework which are clear cut versus projects that are more open-ended. Even though students may believe in the value of projects they would rather tackle tasks that are easier. Another interpretation is that students are used to having more homework and less open-ended projects. This is hinted from several conversations with students where they expressed the fact that other classes had more homework for practice. Perhaps, the class deviated too much from other class experiences and brought students discomfort with so many open-ended projects. In the Winter semester, only 22% indicated that they would prefer to have homework only instead of a combination of homework and projects.

IV. Conclusion

In general, the goal of using instructional technology for improving the Introduction to Transportation Systems Engineering Course has been affirmed by the student surveys. Ideally for evaluation, data should have been collected before the implementation of the new instructional technology in order to do a before and after study. The option of having the same students take the same course being implemented in two different ways is of course not feasible. Previous course surveys were not administered with specific questions geared toward instruction technology therefore an opportunity was lost. It is also undesirable to revert the course to an all homework course again in order to do assessment of the effects of instructional technology, since the instructor sees great value in the current course format. Nonetheless, the student surveys did reveal student opinions on instructional technology, and they were mostly favorable.

Regarding the implementation of BB5, there needs to be more care initially in making sure that all students have become comfortable with the system and that their individual accounts are setup properly. There were a few students during the Fall semester that did not reveal that they had problems accessing BB5 until later in the semester.

Due to the student acceptance of the BB5 system, the BB5 system functionality can be explored further for future semesters. The group pages functionality can be used for the project teams. The discussion board can be utilized for discussions about current events related to transportation engineering.

The instructor believes that some of the Fall semester student opinions on the PA system were due to some initial technical difficulties. Also, the PA system was not utilized until a few weeks into the semester, and was not a part of the computer laboratory from the beginning.

There were many students who expressed verbally that the projects were very useful and allowed them to apply theory in the context of an engineering project. Even though the projects were reduced in scope when compared to real-world projects, they were able to illustrate many of the real-world difficulties and complexities. One possible drawback to the number of projects is that the number of homework assignments is reduced to make the workload manageable. The trade off then is between a reduction in practice problems and an increase in "bigger picture" projects that require more critical thinking.

Biographical Information

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Carlos Sun is an Assistant Professor of Civil and Environmental Engineering at the University of Missouri-Columbia. Dr. Sun received a B.S. in Electrical and Computer Engineering, and M.S. and Ph.D. in Civil Engineering from the University of California at Irvine in 1990, 1993, and 1998, respectively. Previously, he was an assistant professor at Rowan University, a postdoctoral researcher at the University of California at Berkeley, and an instructor at the University of Southern California.