**Volume 13, No. 4**
July 2015
ISSN: 1545-679X

# INFORMATION SYSTEMS EDUCATION JOURNAL

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The **Information Systems Education Journal** (ISEDJ) is a double-blind peer-reviewed academic journal published by **EDSIG**, the Education Special Interest Group of AITP, the Association of Information Technology Professionals (Chicago, Illinois). Publishing frequency is six times per year. The first year of publication is 2003.

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# INFORMATION SYSTEMS EDUCATION JOURNAL

# The Flipped Classroom in Systems Analysis & Design: Leveraging Technology to Increase Student Engagement

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## Abstract

Problems associated with the ubiquitous presence of technology on college campuses are discussed and the concept of the flipped classroom is explained. Benefits of using the flipped classroom to offset issues associated with the presence of technology in the classroom are explored. Fink's Integrated Course Design is used to develop a flipped class approach to the author's Systems Analysis & Design course, and a resulting classroom module is provided as an example. Results of the initial use of this approach are discussed. It is concluded that the use of the flipped classroom in systems analysis and design definitely increases in-class student focus and engagement and as a result helped to increased student learning of both program specific and course specific student outcomes. Further longitudinal studies are suggested to determine effects of employing the flipped classroom approach on the continuing attainment of student learning outcomes.

**Keywords:** flipped classroom, systems analysis and design, integrated course design, student learning outcomes, formative assessment, summative assessment.

## 1. INTRODUCTION

The purpose of instruction and all other classroom learning activities is to promote student learning. All decisions relating to a given course, from the selection of reading materials to the design of in class activities to the assessment process itself, should be judged by their contribution to this end.

The speed at which technology is developing has flattened the world and played a major role in fostering changes in the educational process, and it is generally accepted that changes in educational technology have greatly influenced the way in which we learn and teach in higher education. But what is truly important is not the presence of technological tools, but how the tools are used. Technology merely opens the door to new possibilities, but the student learning outcomes are dependent upon decisions we make regarding how best to employ these technologies.

Computers are important in education because they force us to reconsider how people learn, how people are empowered, and the very nature of learning and useful information. We cannot avoid the presence of computers in our colleges and universities; rather, it's almost impossible to enter a twenty-first century college classroom without seeing the overwhelming presence of technology. Even when professors choose to prohibit the use of smartphones, tablets, and laptops in the classroom, students still find a way to maintain a virtually continuous connection to their devices. In fact, it is readily apparent that one of the ways this ubiquitous presence of technology disadvantages students is serving as a distraction from learning process itself.

## 2. PROBLEM STATEMENT

At Quinnipiac University all students are required to have their own laptops and the entire campus has wireless Internet connectivity. Advantages associated with these institutional policies include: (1) everyone has access to online resources such as texts, graphics and videos; (2) information available in most online environments is up-to-the-minute, whereas most information systems texts contain outdated information by the time that they are published; (3) laptops and course management systems can be strategically employed to promote independent learning; (4) course material can be stored and archived on student laptops for future use; (5) blogs, wikis, etc. can be used to interact and work with students; and (6) students learn to use the technology simultaneously with learning the content of the course/discipline. But simultaneous to the presence of advantages are disadvantages that need to be circumvented to create a positive learning environment, including: (1) technical problems can arise which disadvantage the student(s) experiencing the problems; (2) mixed technological ability levels of the students; (3) slow internet connectivity; (4) lack of sufficient technical skills by both students and faculty, although this problem is far less common than it used to be; and (5) classroom management issues can arise because the course instructor may have difficulty keeping students attention due to the presence of distractions caused by the students being online.

Quinnipiac University has made an intentional institutional commitment to be an exemplar of Tagg's (2003) Learning Paradigm College. As such, almost all university decisions are made with respect to how they positively or negatively impact student learning. For us the central question evolving around the use of technology is, "How can we leverage the use of technology both within and outside of the classroom to improve our students' learning?" For us the question is not whether or not our students will have tablets and/or laptops in the classroom. Rather, our approach is to design classroom experiences that will maximize the advantages and minimize the disadvantages associated with the use of technology by our students.

## 3. INTRODUCTION TO THE FLIPPED CLASSROOM

"Flipping the classroom" has been an education buzzword for the last few years, driven in part by high profile publications in the *New York Times* (Fitzpatrick, 2012), *The Chronicle of Higher Education* (Berrett, 2012), and *Science* (Mazur, 2009). Substantively, "flipping the classroom" means that students gain first exposure to new material outside of the classroom, usually by either reading provided or online material and/or viewing lecture videos, and they use class time to do the more difficult conceptual work of assimilating that knowledge through problem-solving, discussion, debates or other active learning strategies. In terms of Bloom's revised taxonomy (Anderson & Krathwohl, 2001), this means that students are doing the lower levels of cognitive work (gaining knowledge and comprehension) outside of class, and focusing on the higher forms of cognitive work (application, analysis, synthesis, and/or evaluation) in class, where they have the support of both their peers and the course instructor. This model contrasts from the traditional model in which "first exposure" occurs via lecture in class, with students assimilating knowledge through homework; thus the term "flipped classroom."

The flipped classroom approach has been used for years in some disciplines, most notably within the humanities and the sciences. Walvoord & Anderson (1998) promoted the use of this approach by proposing a model in which students gain what they called "first-exposure learning" prior to class and focus on the "processing" part of learning (synthesizing, analyzing, problem-solving, etc.) in class. To ensure that students do the preparation necessary for productive class time, they propose an assignment-based model in which students produce work (writing, problems, etc.) prior to class. The students then receive productive feedback through the processing activities that occur during class, reducing the need for the instructor to provide extensive written feedback on students' homework. They provide numerous examples of how this approach has been implemented in various disciplines such as history, physics, and biology classes, thus suggesting its broad applicability.
A similar approach was referred to as the "inverted classroom" in the field of economics (Lage, Platt, & Treglia, 2000). Additionally, Mazur & Crouch (2001) describe a modified form of the flipped classroom that they term "peer instruction." Like the approach described by

Walvoord & Anderson, and that of Lage, et al., the peer instruction (PI) model requires that students gain first exposure prior to class, and uses assignments (in this case, quizzes) to help ensure that students come to class prepared. Class time is structured around alternating mini-lectures and conceptual questions.

## 4. THEORETICAL BASIS OF THE FLIPPED CLASSROOM

*How People Learn,* the seminal work from Bransford, Brown & Cocking (2000), reports three key findings about the science of learning, two of which help explain the success of the flipped classroom. They assert that, "To develop competence in an area of inquiry, students must: a) have a deep foundation of factual knowledge, b) understand facts and ideas in the context of a conceptual framework, and c) organize knowledge in ways that facilitate retrieval and application." (p. 16)

By providing an opportunity for students to *use* their new factual knowledge while they have access to immediate feedback from peers and the instructor, the flipped classroom helps students learn to correct misconceptions and organize their new knowledge such that it is more accessible for future use. Furthermore, the immediate feedback that occurs in the flipped classroom also helps students recognize and think about their own growing understanding, thereby supporting their third major conclusion that, "A "metacognitive" approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them." (p. 18). Although students' thinking about their own learning is not an inherent part of the flipped classroom, the higher cognitive functions associated with class activities, accompanied by the ongoing peer/instructor interaction that typically accompanies them, can readily lead to the metacognition associated with deep learning.

## 5. KEY ELEMENTS OF THE FLIPPED CLASSROOM

The flipped classroom can be successful only if sufficient attention is paid to its key components. While different authors appear to espouse different key components, essential components common to all interpretations of the flipped classroom include the following:

**Provide an opportunity for students to gain first exposure prior to class.**

The mechanism used for first exposure can vary, from simple textbook or online readings to lecture videos to podcasts or screencasts. Videos can be created by the course instructor, or found online from sources such as YouTube, the Kahn Academy, MIT's OpenCourseWare, Coursera, or other similar sources. The pre-class exposure does not need to be high-tech; students can be asked to simply complete pre-class reading assignments and/or engage in writing-to-learn exercises.

**Provide an incentive for students to prepare for class.**

In all cases, students should be required to complete a task associated with their preparation, and that task should associated with some points or percentage toward their final course grade. The assignment itself can vary, ranging from online quizzes to worksheets to short writing-to-learn assignments. In each case the task should provide an incentive for students to come to class prepared by speaking the common language of undergraduates: points. In many cases grading for completion rather than effort may be sufficient, particularly if in-class activities will provide students with the kind of feedback that grading for accuracy usually provides.

**Provide a mechanism to assess student understanding**

The pre-class assignments that students complete as evidence of their preparation can also help both the instructor and the student assess understanding. Pre-class quizzes can also allow the instructor to practice Just-in-Time Teaching (Novak, G., Patterson, E., Gavrin, A. & Christian, W., 1999), which means that the instructor can tailor class activities to focus on the elements with which students are struggling. If automatically graded, the quizzes can also help students pinpoint areas where they need help. Pre-class worksheets also can help focus student attention on areas with which they are struggling, and can serve as a departure point for in-class activities, while pre-class writing assignments can help students clarify their thinking about a subject, thereby providing for richer in-class discussions. Most importantly, the use of pre-class activities provides for the time needed to supply students with much needed feedback in class, reducing the need for instructors to provide extensive commentary outside of class (Woolvard & Anderson, 1998). Additionally, many of the activities used during class time (e.g., clicker questions, debates, etc.) can serve as informal checks of student learning.

**Provide in-class activities that focus on higher level cognitive activities**
Given that the students have gained basic knowledge outside of class, class time can now be spent promoting deeper learning. The in-class activity selected will be dependent upon both the learning goals of the course and the culture of the discipline. For example, Lage, Platt & Treglia (2000) describe experiments students did in class to illustrate economic principles, while Mazur et al. (2001) focused on student discussion of conceptual "clicker" questions and quantitative problems which focused on physical science principles. Other in class activities may consist of debates, data analysis, or synthesis activities. What is important, regardless of the activity chosen, is that students are using class time to deepen their understanding and increase their skills at using their newly acquired knowledge.

## 6. DESIGN OF THE FLIPPED SYSTEMS ANALYSIS AND DESIGN CLASSROOM

The "flipped" version of the author's Systems Analysis & Design (SAD) course was designed using Fink's (2003, 2005) principles for integrated course design. Particular attention was placed on developing an active-learning environment for the course consistent with the recommendations of both Bonwell & Eison (1991) and Meyers & Jones (1993). In addition to these two seminal works, Richlin's (2006) *Blueprint for Learning* is one of many excellent sources for effective active learning strategies, and Michaelson, Knight & Fink (2002) provide a primer for the effective use of active learning in small (3-5 person) groups in both large and small classes.

**Step 1: Course Situational Factors**
The initial step in designing the course was to carefully size up the course situation factors. Situational factors provide the backdrop against which important course design decisions will be made. There are a number of potentially important factors that might affect the design of the course, including:
*Specific Context of the Teaching/Learning Situation*

- This is the first course beyond the introductory course and a prerequisite to all other courses in the major
- The course meets two mornings per week for 75 minute class periods
- Class size is between 25 and 30 students which implies 8-10 3-person teams per class

*General Context of the Learning Situation*

- Must cover 4 ABET program-level student learning outcomes
- Additionally the course has been assigned several course-specific student learning outcomes
- Need to develop and deploy performance indicators and rubrics for all course student learning outcomes
- Employ both formative assessment designed to increase student learning and individual student summative assessment as a basis for grading
- Employ a flipped classroom approach with active learning in class strategies

*Characteristics of the Learners/Students*

- CIS majors & CIS Minors (might be 1-2 additional students exploring the major or minor)
- Range from 1st semester sophomores to 1st semester seniors, but mostly sophomores and juniors
- Almost all students enrolled are full-time students, though many hold part-time jobs during the academic year which makes for difficult logistics to arrange for team meetings out of class

*Physical Factors*

- Classroom on top (2nd) floor of building; windows facing west (cool in morning, very warm by mid-afternoon)
- Wireless internet access present and very reliable
- Classroom seats 50 maximum; provides room for students to spread out in groups given the class size

*Characteristics of the Teacher*

- Taught course for many years and well-versed in traditional SAD techniques
- Well versed in the Scholarship of Teaching and Learning
- Teaching strengths are in interacting with students; weakness in leading class discussions

**Step 2: Course Learning Outcomes**
Student learning outcomes are assigned to the SAD course at both the program level and at the course level.
*Program Level Learning Outcomes per ABET Accreditation*

- (b) an ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- (f) an ability to communicate effectively with a wide range of audiences
- (g) an ability to analyze the local and global impact of computing on individuals, organizations, and society

- (j) an understanding of the processes that support the delivery and management of information systems within a specific application environment

*Course Level Learning Outcomes – students will understand and be able to use*

- Structured systems development methodologies
- Feasibility analysis, including Excel as a tool for cost/benefit analysis
- Data gathering techniques (interviewing, observation, documentation, and questionnaires)
- Process Model and Data Modeling

**Step 3: Feedback and Assessment**

In the typical content-centered course, multiple-choice questions from publisher-supplied course supplements are frequently used to construct exams to determine whether or not students have mastered the content. These exams are examples of summative assessment and are used to assign course grades. But in a learner-centered course, where the focus is on enhancing the quality of student learning, a more sophisticated assessment approach is needed. In such courses the goal of assessment is not to assign grades, but rather to determine if students are ready for the next activity after the current activity is completed. In particular, course assessments for the SAD course were designed to:

- *Be Forward-Looking*. One or two major course ideas were formulated by identifying situations in which students are likely to use what they have learned. Then students were required to replicate those situations with questions, problems, or issues.
- *Use Performance Indicators:* For the major learning goals, three to five criteria that would distinguish exceptional achievement from poor performance were identified. Then the instructor and students together wrote two or three levels of standards for each of the performance indicators. In effect, the course instructor involved students in creating rubrics that were used to evaluate their own performance based on their jointly defined performance indicators
- *Include Self-Assessment:* In-class activities provided ample opportunities for students to actively engage in both self-assessment of their own performance and assessment of their teammates' performance, relative to the performance indicators that students own because they helped to create.
- *Provide Feedback:* Procedures were developed that allowed the course instructor to provide feedback that was frequent, immediate, and discriminating (based on clear performance standards and expectations).

**The Resulting SAD Course**

The flipped classroom for the SAD course was first implemented in the fall of 2013, and is currently in its second iteration. The class consists of an opening unit which concludes with students being assigned to project teams, after which the teams are assigned to improve a particular system/ application either on campus or off campus.

The typical classroom unit consists of the following pattern:

- Students receive a research question at the close of the prior class;
- Students post their individual answers to the research question to the course management system no later than midnight of the evening prior to the class session in which the topic will be covered in class;
- The actual class session opens with a 10-15 minute comparison of the student answers and the class searches for commonalities in the answers, following which the students collectively decide which information to archive for summative assessment at a later date;
- Students then apply their understanding of the answers to their particular system or application.

For example, applying the pattern to the SAD class session covering System Requirements:

- Student Research Question: What are system requirements? What is the difference between functional system requirements and non-functional system requirements?
- In class, after the opening discussion, student project teams work together to define the functional and non-functional system requirements for their system or application.
- Project teams quickly come to realize that they cannot accurately define their requirements without input from the system stakeholders (a topic that was covered 2 weeks earlier in the course).
- Students are then provided with their research question and/or assignment

that is due prior to the next class session. In particular, students are asked to find commonly employed techniques to gather data and to determine which data gathering technique(s) would be most appropriate to collect data from each class of stakeholder, which provides input for the following class session which covers Data Gathering Techniques.

Student postings to the course management system are usually graded on a 2-point scale with 0 = answer not submitted by the deadline; 1 = standard Wikipedia answer; 2 = additional source(s) used to provide their answer. No late postings are accepted because all research assignments are posted to the course management system well in advance of the required due dates.

At the close of each class session, students and faculty together decide which information would be best archived for those students who missed class due to illness or other higher priority interventions. This archived material becomes the basis for summative assessments that provide for individual accountability in what is predominantly a team-based course producing team-based project deliverables.

It is important to note that the flipped classroom approach employed herein is not merely a synonym for either viewing online videos or searching for information on the internet. In fact, it is the in-class interactions and carefully designed meaningful learning activities that occur during the classroom face-to-face time that are the most important part of the flipped classroom. Students do not work without structure in class, nor do they work in isolation, nor do they spend the entire class time staring at a computer screen. Rather, the flipped classroom is an opportunity to increase intentionally designed and meaningful interactions between students and faculty.

## 7. RESULTS

The flipped classroom approach to teaching the SAD course was first deployed during the fall 2013 semester with surprisingly good results.

### Student Learning Outcomes

Class time was now dedicated to a debriefing of the out-of-class content-based reading/research assignments followed by team-based applications of the content to a specific real system. The flipped classroom approach provided the course instructor with time to interact with individual student project teams as they applied newly learned concepts to their individual "live" applications. These team-based interactions supported student acquisition of specific ABET program level learning outcomes that were assigned to the course. Results on content-based examinations were similar to exam results from prior years, but results on application-based project team solutions to "live" applications have shown significant improvement.

In terms of specific program-level learning outcomes, given the increased interaction of the course instructor with individual project teams students were better able to (1) analyze a problem and define computing requirements appropriate to its solution, (2) communicate more effectively with a wide range of audiences, (3) exhibit a greater understanding of the impact of their solution on system/project stakeholders, and (4) better understand the processes under investigation than in prior academic years. The increased interaction of the course instructor with the project teams also fostered a deeper understanding and ability to execute the course specific learning outcomes.

### Student Reaction to the Flipped Classroom

In general, student reaction to this method was very positive. While the occasional "we have to teach ourselves the material" comment did arise, it was usually quickly countered by other students in their project team. Most students preferred the autonomy of the project team learning on their own and supporting each other both inside and out of class as opposed to using texts that simply cost too much and are virtually outdated by the time that they are written. The flipped classroom in and of itself does not provide for outstanding student learning experiences; rather, it provides the time and space for instructors to design significant student learning experiences both in and out of the classroom and then carry them out. This becomes increasingly possible when the transfer of basic information is relocated to outside of the classroom. But then the responsibility falls upon the course instructor to use that time and space effectively. Indeed, students are not learning on their own; rather they are engaged in carefully designed learning activities both in and out of the classroom under supervision of the instructor and in cooperation with the members of their project team. By using carefully designed learning activities, the flipped classroom has definitely resulted in increased in-class student focus and engagement.

By far the greatest difficulty some students in the course had was not with the course content or even with the idea of flipped instruction; rather, the students' biggest difficulty has been with time and task management. The course is positioned as a first-semester sophomore course, and students are still quite early in developing both the methods and discipline to be engaged as self-directed learners. This "soft" skill is widely recognized as a desirable student learning outcome, but this outcome is seldom taught. In this course "we" routinely practice a "critical thinking" approach to business process improvement by identifying which piece of information the students next need to know to move forward with their project, search for that information using predominantly web-based resources, evaluate the relevance and validity of the information found, compare their results to the results of others, agree to results and conclusions which frequently requires the ability to compromise in team-based environments, and engage in all of these activities in an ongoing basis to complete their projects on time, within budget, and within constraints.

## 8. CONCLUSIONS/RECOMMENDATIONS

Employing Fink's Principles of Effective Course Design to design a flipped SAD course that employs active methods consistent with Weimer's learner-centered teaching and assessments, a course that also provides students with timely formative feedback, has resulted in a course that effectively deploys technology both in and out of the classroom. Students regularly complete their out-of-class preparatory activities because of the point value associated with the assignments. Students are more fully engaged in the classroom because they are actively working on projects which reinforce course core competencies. Further, students enjoy the course more than the traditional text-lecture-test because they are actively engaged in learning that they perceive to be meaningful.

The development and teaching of the course requires an ongoing attention to detail. The integrated course design focuses on developing course learning goals by first considering how the goals would need to be achieved within the context of situational factors, then defining feedback and assessment mechanisms consistent with performance indicators for each of the learning goals, and finally developing and applying teaching and learning activities both within and outside of the classroom to effectively leverage technology to actively engage students in the learning process. The newcomer to either the flipped classroom or the principles of integrated course design is well advised to proceed with caution, perhaps flipping a particular course unit as opposed to the entire course until well versed and comfortable with this technique.

Areas for further longitudinal study include the effect of deploying this flipped approach on student performance on summative assessments. While the use of the flipped classroom effectively blends the principles of direct instruction with constructivist learning theory, and while students are in fact more engaged in the classroom and are therefore assuming more responsibility for their own learning, the actual results of student learning and retention over time has yet to be assessed or evaluated and is a next logical step for further research investigation.

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**Editor's Note:**

*This paper was selected for inclusion in the journal as an ISECON 2014 Meritorious Paper. The acceptance rate is typically 15% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2014.*