AC 2009-1789: CONSTRUCTIVIST DESIGN AND BLENDED INSTRUCTION: RETHINKING COURSE DESIGN FOR THE ENGINEERING CLASSROOM

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Constructivist Design and Blended Instruction: 
Rethinking Course Design for the Engineering Classroom

Abstract

The engineering classroom is changing¹: the student body is ethnically, linguistically, and culturally more diverse² than ever before and the infusion of technology is redefining work skills and society’s expectations. Web-based technology has grown to become a critical instrument in education³ and its integration is often seen as a significant force driving change⁴. It is now causing educators to re-think the very nature of teaching and learning. But where do you start? How can instructors design powerful, innovative, and effective web-based environments that can be successfully integrated in a face-to-face class or stand alone to support a distance course?

In this paper, we answer the question from the perspective of a four-year long project that led an instructor from using an institutional, unimaginative, web-based template to designing a fully customized, award-winning course that truly reflected his teaching style and philosophy, supported the institution’s mission statement and the course objectives, and supported the students’ learning styles.

After a general introduction to instructional design, we provide a historical perspective illustrated by the four dramatically different designs that evolved over the years. We then propose a constructivist design approach to designing blended courses and guide the readers though its main stages.

Introduction

In this phenomenological case study we followed the collaboration between an instructor and an instructional designer over a period of four years. During that time, the instructor went from using an institutional, unimaginitive, web-based template to designing a fully customized, award-winning course that truly reflected his teaching style and philosophy, supported the institution’s mission statement and the course objectives, and supported the students’ learning styles. Over the same period of time, the instructional designer went from following a behaviorist approach to a constructivist approach to instructional design.

Instructional Design – A Powerful Tool

Over 100 different instructional design (ID) models try to capture or represent the ID process⁵. Most ID models consist of five critical activities or stages⁶ that are often referred to as ADDIE⁷, an acronym created from the name of each of the five phases: analyze, design, develop, implement, and evaluate⁸. Although there is no such thing as an ADDIE model⁹, the acronym has become an umbrella term often used to refer to the key processes followed by all instructional design models¹⁰. Regardless of which instructional model instructors and instructional designers might choose to design a blended environment, they go through each of the ADDIE phases.

The Analysis phase is the foundation for all other phases of instructional design¹¹. Its main focus is to identify what is needed or what needs to be done differently. The instructional designer
develops a clear understanding of the "gaps" between the desired outcomes and the audience's existing knowledge and skills, identifies the instructional needs, determines the learner characteristics, and develops the program goals and purposes.

In the Design phase, the results from the analysis are used to plan a strategy for developing and delivering the instruction. The instructional designer develops learning objectives, assessment measures, exercises, and content, in addition to specifying instructional content, processes, and resources. The creation of the learning materials is completed in the Development phase. This will include instructional plans and lesson materials, all media used in the instruction, and all supporting documentation.

The Implementation phase refers to the effective and efficient delivery of the instruction and the achievement of the learning objectives. During the Evaluation phase, the effectiveness of the materials is reviewed to determine the adequacy of the instruction. The Evaluation, which may be summative or formative, should occur throughout the entire instructional design process.

**Instructional Design – Behaviorist and Constructivist Lenses**

Through much of the first half of the twentieth century, the dominant school of thought in learning theory in the United States was behaviorism. Behaviorism explains learning as a "system of behavioral responses to physical stimuli" and a permanent change in behavior as a result of experience or practice. Behaviorism assumes that learners are passive participants who respond to environmental stimuli. Their behavior is shaped through positive or negative reinforcement.

In this paradigm, the subject matter or new material is seen as a finite body of predetermined knowledge which must be broken into manageable components and skills and presented to students in a graded sequence of controlled steps. These are in turn sequenced into a hierarchy ranging from simple to more complex. Learners are diagnosed in terms of deficiencies, then taught until "mastery" is achieved at each of the sequence levels.

The instructional design process is largely based on behavioral psychology. Its emphasis is on "specifying behavioral objectives, analyzing learning tasks and activities and teaching to specific levels of learner performance." The roots of instructional design can be traced back to the seminal work of Gagné on the conditions of learning and early attempts to apply general systems theory and systems analysis.

Whereas behaviorism assumes a linear learning process, constructivism assumes a complex, recursive learning process. Instead of behaviors or skills as the goal of instruction, cognitive development, and deep understanding are at the core of the constructivist experience.

At the core of constructivism is the belief that "learning is always a unique product ‘constructed’ as each individual learner combines new information with existing knowledge and experiences." In a constructivist environment, "learning is an active process in which learners are active sense makers who seek to build coherent and organized knowledge." It is built on the precept that knowledge is constructed. Learning is shared and collaborative, with meaning...
negotiated from multiple perspectives. It is situated in realistic settings where testing is an integrated component of the task rather than a separate activity. The development of meaning and understanding rather than the training of behavior becomes the priority, and students’ errors and unanticipated responses are viewed as occasions to learn about their understanding.

Towards the end of the twentieth century the dominance of behaviorism began to fade and constructivism increased in popularity throughout the decade. Instructional design experienced the strong influence of constructivist learning theory and a shift from teacher-controlled to learner-centered instruction. This movement led to the emergence of a number of instructional design models based on constructivist learning principles.

Although constructivist instructional design models and processes are beginning to emerge, they seem to limit the constructivist component only to the instruction designed for the students, not to the process followed to design it. In a constructivist ID model, the only difference seems to be that rather than go through the instructional design process in a systematic and sequential way and complete the ADDIE stages in the prescribed order, the instructional designer completes the stages of the ADDIE framework in any order, at any time, and revisit them as often as the instructional design process requires it.

The behaviorist/constructivist dichotomy in the world of education is also echoed in the world of instructional design when the instructor becomes the student and the instructional designer, the teacher. Just as behaviorist education puts the control of the creation of knowledge in the hands of the teacher, behaviorist instructional design puts the control of the design of effective instruction in the hands of the instructional designer. Constructivist instructional design shifts that control back to the instructor.

**A Historical Perspective**

The first three iterations of the course in 2000, 2002, and 2003 bear the marks of the traditional behaviorist instructional design process. The last version in 2004 captures an instructional design process that not only allowed the instructor to design a constructivist educational experience for his students, but also was itself redefined by constructivist tenets.

**Overview of the Instructional Design Process at Rensselaer Polytechnic Institute**

In 2001, in an effort to provide instructional design support to its faculty teaching at a distance, Rensselaer Polytechnic Institute established an instructional design team whose role was “to promote interactive learning concepts with courses delivered at a distance and to develop the ID function within the distance education program in support of the institution model for interactive distributed learning.” Instructional designers were “responsible for serving as project leaders for course development teams, providing instructional design support to faculty, and developing course development resources for faculty.” The list of additional responsibilities included “assist faculty in converting their courses from face-to-face or video-based teaching modes to web-based delivery helping them reassess course learning objectives and redesign their instructional approaches” and “provide one-on-one consulting to faculty teaching distance courses in course development.”
In 2002, the instructional design process followed by the distance education team at Rensselaer Polytechnic Institute for the courses that had a distance component was very behaviorist. At the heart of its process was the faculty meeting. It was attended by the instructor assigned to teach the class, the director of the distance programs, the assistant director for production, the assistant director for program operations, and the instructional designer assigned to the course. Since most of the decisions, such as delivery mode and format, had been made without input from the instructor, the meeting opened with an overview of the distance program, a reminder of everyone’s roles and responsibilities, followed by a long list of the questions geared at completing the faculty meeting form. The faculty meeting allowed the distance course team to “determine the support needs for each course including the course WebCT site and features to be used, electronic course materials to be developed, animation needed, audio/video production schedule and issues, course schedule, distribution of hardcopy course materials, course computing requirements, assignments/exams, grading, faculty site visits, and technology/network requirements.”

At this time, all blended courses with a distance audience followed the same model. A face-to-face class would take place in one of the three multimedia classrooms and be captured on video tapes, which would then be duplicated and sent to the distance students. A few of the classes were “live.” They had a synchronous component that allowed the lectures to be delivered by satellite, videoconferencing, or video stream and the students participated by videoconferencing, phone bridge, or a chat tool. Each blended course was assigned a course support team (CST): an instructional designer, a producer, and a program operations representative.

There were benefits in creating a “one size fits all” template and process. Using the same designer access, anyone on the team could support any of the courses at any time, quickly and efficiently. It supported the institutional view that a common user interface not only made it easier for the distance students to become accustomed to using a course management system but also helped to establish branding for the institute.

In 2003, there was no instructional design process established for blended courses without a distance audience. As the number of blended courses grew on campus, so did the interest among faculty who increasingly sought to integrate web-based technology in their face-to-face classroom. As a result, the process followed for the blended courses was transferred to the all instructional design opportunities with one major difference: for courses that did not have a distance audience, the technology did not suffer from the same restrictions. This opened a realm of possibilities that neither the instructional designer nor the faculty realized existed.

Away from the imposed limitations of a mandated template, they were able to experiment with the course management software and realize that what “could not be done” was a human rather than a technical limitation. Where blended courses had to adhere to the tightly prescribed rules of the template, the on-campus courses had all the flexibility afforded by the technology. This
newly found “freedom” allowed them to “play” with WebCT, push the limit of the technology, and grow in their understanding of what the tools could and could not do.

**From Behaviorism to Constructivism**

To help follow the evolution from behaviorist to constructivist instructional design, we looked at each of the iterations of the course which included: the archived WebCT sites, email communications, as well as archived interview transcripts from 2002 and 2006, instructional design artifacts such as design briefs, design documents and classroom observation notes. Figure 1 summarizes this evolution.

<table>
<thead>
<tr>
<th>Year</th>
<th>ID Process</th>
<th>ADDIE Framework</th>
<th>Technology</th>
<th>Collaboration between Instructor and ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>- behaviorist - inflexible - instructor focuses on teaching. Everything else is controlled by the DE team -Blended course with DE component</td>
<td>A – None D – Template D – Template I – Limited to traditional lecturing E – Institutional end-of-term evaluations</td>
<td>- Instructor refuses to use WebCT</td>
<td>None</td>
</tr>
<tr>
<td>2002</td>
<td>- behaviorist - inflexible - similar to 2000 - involvement of ID - blended course with DE component</td>
<td>A – None D – Template D – Template I – Addition of new materials, beginning of integration of technology E – Institutional mid-semester, and end-of-term evaluations</td>
<td>- Instructor begins to use some of the WebCT tools and features</td>
<td>- Instructor and ID start educational dialogue</td>
</tr>
<tr>
<td>2003</td>
<td>- behaviorist - beginnings of flexibility - similar to 2002 - emerging signs of constructivism - blended course, no DE component</td>
<td>A – None D – Customized template D – Customized template I – Similar to 2002, increased use of technology E – Institutional mid-semester and end-of-term evaluations</td>
<td>- Instructor begins to master some of the WebCT tools and features</td>
<td>- Instructor and ID begin to collaborate on design</td>
</tr>
<tr>
<td>2004</td>
<td>- constructivist - flexible - consideration of teaching styles, teaching methods, teaching presence, and learning styles</td>
<td>A – Use of design brief D – Full customization D – Full customization I – Explosion of new materials and new techniques E – Formative and summative, institutional and instructional</td>
<td>- Instructor has full understanding of capabilities and limitations of WebCT tools and features - instructor’s ownership</td>
<td>- Constructivist collaboration between instructor and ID</td>
</tr>
</tbody>
</table>

Figure 1: Evolution of instructional design process
In 2000, the instructional design process followed was extremely behaviorist and basic. As a result, the stages of the ADDIE framework were not fully implemented. Everyone supporting the course, including the instructor, seemed to have done so at a very superficial level. In 2000, the instructor was completely separated from the technology and did not realize it could be of use to him or have applications to his teaching. In many respects he was “disconnected” from the instructional design process.

The iteration of 2002 followed the ADDIE framework of 2000. However, its application was beginning to take an unexpected route. The distance education department continued to control the analysis, design, and evaluation stages. They did so through the faculty meeting, the template, and the mid semester and course evaluations. However, the instructor and the course developer had begun to take some ownership of the development and implementation phases. The instructional designer had become the connector between the instructor and WebCT. In facilitating his early use of the technology, the instructional designer’s role was still very “directive” while the instructor’s remained more that of an “observer.”

Although they could have moved away from the instructional design process established for the distance courses, the instructor and the instructional designer followed it in 2003, carrying on the traditional instructional design process: their pre-semester meeting led to shared WebCT support and was marked by formative and summative evaluations: the midterm evaluations and the IDEA forms.

There were, however, emerging differences in the manner in which they followed the ADDIE framework. The instructional designer was “responsible” for the design and development phases, creating the new look and feel and navigational patterns, doing so with the instructor’s input. Whereas he did not really mind what the site looked like, he had provided very specific requests about the access and organization of the various pages and materials. Both shared the implementation phase, with the instructor slowly taking over as he became more comfortable with the WebCT tools and their applications in the face-to-face classroom. He turned into a more active participant, beginning to test the limits of the technology while the instructional designer moved from the directive stance of 2002, to that of a guiding one. Although the instructional designer remained the “more able other” with the technology, their roles started to overlap.

In 2004, the instructor informed the distance education team that he would not be using their template, but his own, a highly customized one. Although it caused some concerns that were duly expressed, he brushed them aside. The course was his, to be delivered on his terms. This stance caused a shift in control that remained the instructor’s throughout the semester. Rather than limit themselves to the one-time faculty meeting to discuss the course, the instructor and the instructional designer established a two-hour weekly meeting that allowed them to address and revisit issues.

They both shared aspects of each of the ADDIE framework stages, weaving in and out of each. For example, at the Analysis stage, the instructor focused on the content, and the instructional designer, on the audience. At the Design phase, they jointly worked on identifying which WebCT tools to use, how to navigate the site, what the layout might be. At the Development
phase, while the instructor concentrated on identifying content and materials, the instructional
designer worked on the HTML codes and the various graphics. At the Implementation stage,
they both focused on the integration of the technology in the face-to-face classroom, one from
the classroom’s, the other from the technology’s perspectives. Finally, at the Evaluation stage,
although the instructional designer was the one conducting the various summative and formative
evaluations, they both worked together to establish the questions to be used.

As they shared the technology, they each kept the lead in their respective field: one as the
instructor, and the other as the instructional designer. The Develop and Implement phases
seemed to remain more with the instructor, and the Design phase with the instructional designer.
By the end of 2004, the instructor had gone from being “disconnected” to “owning,” and the
instructional designer had gone from “directive” to “fully collaborative.”

Student feedback and learning experience

Although the focus of this paper is on the transition from behaviorist to constructivist
instructional design from the instructor’s and instructional designer’s perspectives, it is important
to share some of the student feedback and responses. To the formative and summative
evaluations afforded by the institutional midterm evaluations and the IDEA forms, we added
quantitative and qualitative data collection of student feedback. We used the tracking tool in
WebCT to monitor their access to course materials and use of the tools as well as conducted
face-to-face interviews at the end of the semester, and content analysis on the discussion board
posts.

As had been the case for the instructor, the students went from “resentful” and “disconnected”
with their learning experience to “fully engaged” and “owning.” Their use of the various tools,
the depth of their posts, the quality of their assignment submission, all reflected the impact the
2004 design had on their learning experience.

Constructivist Instructional Design Approach to Designing Courses

This research allowed us to identify critical issues that led us to rethink our approach to
designing courses and make the following recommendations. When designing or re-designing a
course, instructors and instructional designers should:
1. Follow a constructivist instructional design approach, apply the W3h throughout
2. Create a design brief
3. Identify the level of blend for the course
4. Identify the instructor’s level of comfort with technology
5. Select the technology based on overt and covert objectives

Follow a constructivist instructional design approach

Most instructional design (ID) models consist of five critical activities or stages\(^7\) that are often
referred to as ADDIE\(^8\), an acronym created from the name of each of the five phases: analyze,
design, develop, implement, and evaluate\(^9\). Regardless of which instructional model the
instructors and instructional designers might choose to design their learning environment, they should go through each of the ADDIE stages.

The constructivist component of instructional design is captured by the $W_5h$ formula we developed as a result of our research:

- **Who** are the students? (freshmen, juniors, working professionals, returning adults, second language speakers, …)
- **What** is being taught? (introductory course, core subject, elective, …)
- **When** is the course being taught? (first period of the day, seminar, 3-hour class, …)
- **Where** is the class taking place (online, in a classroom, in a lab, …)
- **How** is the course being taught? (level of blend, delivery mode, teaching style, …)
- And most importantly, **Why**? Why use the technology or the tool? Why teach the course? Why select this specific objective? … Trying to answer the “why?” of everything is often the most effective, albeit challenging, tool in course design.

At the heart of the constructivist instructional design is the instructor, the “i” in our formula. Our research showed us that s/he is the most critical, integral part of effective instruction, just as the student is the most critical, integral part of constructivist instruction. The instructors must consider their teaching style and teaching methods, and as they do, map them against their students’ learning styles.

Create a design brief

One of the most powerful tool used to design the 2004 version of the course considered in our research, was the design brief. It is a high level design document that maintains consistency with other courses, and adherence to sound instructional design principles as well as to specific instructional rules. It provides an instructional blueprint for the development and implantation of activities pertaining to the course. It is both a record of planned activities and a guide for the development and implementation of a course.

It is composed of six main areas: General information about the course, an overview, a section dedicated to the tools and technologies selected, another to the design of the user interface for the Web-based component, a third dedicated to the content and organized by unit(s) of instruction and finally a flowchart that capture visually the relationships between the various components.

Identify the level of blend for the course

"Blended learning is a combination of face-to-face and online instruction." They redesign their engineering class, the first critical decision will be to choose the level of “blend” to be used in the course. At Rensselaer Polytechnic Institute we use an adaptation of Harmon and M. G. Jones levels of Web use to define our blended courses. With Level 0 being the traditional face-to-face class, Level 1 is the Administrative/Web-enhanced first option. At this level, there is no
course content posted and the online component is mainly used for administrative information such as the syllabus, schedule, or contact information. It is often created by the instructor and require little or no daily maintenance. One of the main advantages is that it only requires minimal space and bandwidth.

At Level 2, Supplemental/Web-enhanced, some course content such as course notes, handouts, and homework is posted. It may include additional materials such as pre-instructional activities, study guides, or assigned readings. At level 2, bandwidth becomes a consideration. At Level 3, Essential/Web-centered, the bandwidth becomes critical. The majority of the course content and materials are available online, and asynchronous tools are used on a regular basis. At this level, student must be Web and computer savvy and have regular Web access.

Level 4, Communal/ Web-centered, is often considered the “real” blended course. The course proposes a true blend of face-to-face and the Web-based instruction with 30 to 79% of the content delivered online. The use of asynchronous and synchronous tools becomes an integral component of the instruction. Finally Level 5, Immersive/Completely online refers to “distance education” or "distributed" courses with most or all of content delivered online, and an extensive use of asynchronous and synchronous tools.

Instructors and instructional designers need to identify the level of blend carefully and select the one that work best for the instructor and his/her course. Select your web-based tool as carefully. If you want to do more than post your materials electronically, consider the use of a learning system. If you would like to have everyone collaborate and create content, then look into using a wiki.

Identify the instructor’s level of comfort with technology

This process of utilizing technology in academe has significantly changed both the way faculty think and the role that faculty play in the learning process. Despite the fact that 80% of public 4-year colleges make course management tools such as Blackboard, Desire2Learn, and Moodle available to their faculties, professors actually use them in only 20% of their courses. Online education has moved to the mainstream of higher education as 81% of all institutions of higher education offer at least one fully online or blended course.

Faculty motivation for designing and using blended courses varies and ranges from the desire to learn to utilize technology to enhance teaching, to expand student learning opportunities, to create more engaging learning opportunities, and to experiment with technology to discover its potential in teaching effectiveness in general. As a blended course incorporates characteristics of both the face-to-face and the online classrooms, it offers faculty the best of both worlds as learning can occur in synchronous and asynchronous modes. In a blended setting, students receive the benefit of face-to-face interaction with faculty and students while at the same time they are being exposed to Web-based learning paradigms. Using technology in the classroom offers a wide variety of benefits: it increases student interest in the course materials, introduces the "real-world" into the curriculum, provides timely information, enables communication with content experts, fosters independent learning and exploration, expands information technology competency skills, and increases critical thinking skills.
As we learned in our research, effective integration of technology does not happen overnight, and the design of a blended class can spread over several semesters. To start, the instructors/instructional designers should select one week of instruction, or one module, or one typical unit, and redesign it to include the online component(s). This prototype will enable them to get the basic exposure needed to familiarize themselves with the integration of online technology in their face-to-face classroom. It will give them an opportunity to utilize and test the technology in a controlled environment. It also allowed for the development and testing of a customized design that captures the instructor’s teaching style.

*Select the technology based on overt and covert objectives*

There are three key questions the instructors should ask themselves as they look at the various tools and technologies: Why would I use it? How would I use it? And most importantly … Am I sure I really want to do this?

One of the most common pitfalls in selecting technology is identifying the technology first and then trying to make the pedagogy fit. That is what happened in the 2000, 2002, and to some extent, 2003. The technology was there, and was not used to support the learning objectives, but to facilitate the dissemination of course materials and content.

In 2004, the roles were switched, and pedagogy drove the selection of the tools, the design of the learning environment, and the use of WebCT. The instructor did not use the discussion board just because it was the available artifact available for asynchronous communication, but because it fostered reflective thinking and allowed for creation a community of learners.

**Conclusion**

Instructors can design powerful, innovative, and effective web-based environment that can be successfully integrated in a face-to-face class or stand alone to support a distance course. They can do so by following a constructivist instructional design approach, guided by reflective thinking on their teaching styles, and collaborative work with others. They can do so by allowing change to take place and by becoming aware of their own knowledge and limitations, and by taking the time to redesign their courses, one lesson at a time, one module at a time.

**Bibliography**


