Chapter 27
Instructors as End-User Developers:
Technology Usage Opportunities in the Inverted Classroom

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ABSTRACT

This chapter seeks to elaborate on two points. First, the authors would like to focus on the inverted (flipped) classroom, by providing a detailed understanding of it, as well as, current practices. Second, the authors want to propose that instructors become end-user developers, in other words, becoming content creators and designers of their technology usage in the inverted classroom. For instance, several issues arise when using this teaching approach, such as resources, costs, time constraints, and the process of learning new technology. The authors believe that allowing instructors to harness technical ability is beneficial and critical to their success in implementing the inverted classroom.

INTRODUCTION

The ever-evolving realm of technology and education continues to move at a rapid pace. Presently, technology plays a tremendous role in our classrooms. Alternative approaches to teaching and learning are being prescribed to meet the needs of students and new technologies. Instructors are beginning to understand that perhaps traditional approaches are not as successful as they once were. Instructors want to create engaging and interactive learning environments that will succeed in catering to students' needs while being accessible and intuitive to arrange.

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The inverted (flipped) classroom is a pedagogical approach that transforms the structure of a classroom (Lage & Platt, 2000). In the past decade, this approach has become extremely popular in classrooms, and is part of a shift in our educational model. From k-12 through higher education, instructors are using this approach to enhance students' classroom experiences and harness their own creative abilities (Bishop & Verleger, 2013). There are different variations of the approach being used depending on the instructor's course content and needs.

It is common knowledge that when an instructor teaches a course for the first time, they tend to struggle, either with students, teaching the content, acquiring the materials they need, or simply adjusting to their environment. This is ultimately heightened when one also tries to implement a new teaching approach, like the inverted classroom because technology is such an integral part of it. Other factors may arise that can hinder the success of the inverted classroom, like the availability of resources, costs of tools, time constraints and the learning curve associated with using new technology (Pena & Rosson, 2014). Some instructors have interest in incorporating the inverted classroom into their courses but refuse to learn new tools to do so.

The aforementioned problems make using the inverted classroom, at times, difficult to deploy. As instructors spend more time creating, organizing, displaying content, and finding the appropriate technologies to help them achieve this, they detract from student time (Bishop & Verlger, 2013). Currently, instructors are using as many as eight different pieces of technology to support their inverted classroom, which may partly involve learning a new tool (Pena & Rosson, 2014). The authors believe that preparing for an inverted structured course should be efficient and effective. In spite of these issues, the authors propose a solution to this problem, by encouraging instructors to become end-user developers. For example, instructors do not have to be professional software developers to build or contribute to software artifacts (Burnett & Scaffidi, 2013). Instructors do not *only* have to be responsible for instructional design, they should also have a heavier hand in the technologies they choose to create or repurpose for their classroom. They should exercise creativity in combining existing tools together to support their course tasks. Even if they must learn a new tool, they should have, if not internal, external resources to help them accomplish this.

In this chapter the authors aim to

1. Elaborate on the inverted classroom as a phenomenon by discussing its foundations, origins and definitions,
2. Discuss current technological practices in the inverted classroom and issues associated with it,
3. Explain end-user development and how these activities can provide a solution to the problem of technological efficiency in the inverted classroom.

The authors want to improve *effective teaching* in the inverted classroom through refining technology usage and preparation practices. Thus, the authors view this chapter as an important contribution to education and technology, as this idea may provide alternative methods for other hybrid learning environments.

BACKGROUND

The Inverted Classroom

There are several definitions of the inverted classroom; the simplest definition describes the approach as a reversal of traditional lecture activities (Lage & Platt, 2000). For instance, where homework usually occurs outside of the classroom, this activity is performed within the classroom, while lectures usually occur in the

classroom are shifted outside of the classroom (Lage & Platt, 2000). Bishop and Verleger (2013) define the inverted classroom as the combination of, "interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom." Their purpose was to narrow the audience associated with the inverted model and provide a detailed definition, as they claimed the broader one seems to undermine its relationship to historical models and theories. Nonetheless, the authors reject this refined definition and acknowledge the first one offered. The inverted classroom is meant to be flexible and its formation has taken on in variability. In moving forward with the first definition, this general structure has several advantages for example, students can absorb content at their own pace whenever they please. Instructors use an existing system, usually their content management systems (CMS), to house video lectures, PowerPoints, documents, and other necessary materials. This allows students to repetitively review materials in case they do not understand, as opposed to an in-class lecture where time constraints dictate how much time an instructor has to explain concepts. Moreover, homework within the classroom means that instructors are immediately available to students for questions and help. Many will argue that students need time in the classroom to attack homework problems with the presence of an instructor, instead of having them listen to lectures without hands-on activities (Gannod, Burge, & Helmick, 2008). The instructor becomes less authoritative and becomes more approachable as a facilitator while students are held responsible for their learning. For first time instructors, this concept may be hard to grapple with, as they must learn to coach and become a guide.

The inverted classroom is also extremely flexible, in that it molds to fit the needs of instructors and students (Findlay-Thompson & Mombourquette, 2014). Instructors can pick and choose even within a semester which lessons lend themselves better to a more rigid or loose variation of the structure. Past research has indicated that science, technology, engineering, and mathematics (STEM) courses are typically ones that apply this approach in their classrooms (Gannod, Burge, Helmick, 2008). This most likely is because STEM content is practical, of a problem-solving nature; there is usually a systematic way of arriving at a solution. STEM courses also feature heavy technical content and long-term projects that lend itself well to this format (Gannod, Burge, Helmick, 2008). Whereas, humanities and liberal arts courses contain at times abstract content which are subjective.

Although, some may argue that the concept of the inverted classroom has existed for decades, one of the first 'coined' implementations of the inverted classroom was by Lage and Platt (2000) around the beginning of the new millennium. It is critical to remember the status of the internet and technology at the time of their usage. In their economics undergraduate business class, they built a simulated website that mimicked a student's real world, though it was meant to mirror traditional classroom activities (Lage & Platt, 2000). Their purpose was to create this virtual environment to boost classroom activity and participation, but more importantly, improve critical thinking skills and cater to different learning styles. For example, students may be visual or auditory learners, so they believed the freedom provided by the inverted classroom was part of the solution to this problem.

Despite the fact that instructors are directly associated as stakeholders in the application and success, it is important to recognize that there are other interested parties like instructional designers, curriculum developers, system developers, education administrators and even policy makers. Implementations of the inverted classroom have been mixed, though in favor for mostly positive results. Previous research has compared traditional-lecture style classrooms with inverted style classrooms quantitatively and qualitatively by collecting student feedback through observations, interviews, surveys, and log data Instructional

designers have reported ways of modifying content for discipline-specific courses (Warter-(Perez & Dong, 2012). Lastly, Mason (2013) compared the student performance between an introductory level and upper level course of inverted classrooms of similar content courses. Research indicates that most students are open to alternative teaching methods, and although they are used to the traditional-lecture routine, they will take some time to adjust (Pena & Rosson, 2014). Many students like the autonomous nature of the inverted classroom but others find it hard to remain motivated when tackling content outside of the classroom (Zappe, Leicht, Messner, Litzinger, & Lee, 2009). The authors believe that variations of the inverted classroom will continue to rise, and because of this, it is important to investigate this from a research perspective.

In order to understand the inverted model, we must visit its underlying constructs. Primarily, the inverted classroom is grounded in active learning practices that shift the student and teacher relationship. As stated before, the staple of traditional lecture classrooms is the teacher-centered approach. Active learning posits that the student moves away from passive behaviors in the classroom and that instructors should create opportunities for hands-on activities, engaging and collaborative environments (Bishop & Verleger, 2013). In addition, the inverted classroom is closely associated with problem-based learning which at its core is concerned with developing problem-solving skills, self-directed learning, effective and flexible knowledge. Both ideas stem from constructivism. It is important to note that there are several viewpoints of constructivism; we are relying upon Vygotsky and Piaget's perspectives (Grabinger & Dunlap, 1995).

Constructivism is a paradigm that defines learning as an active process (Cunningham & Duffy, 1996). The learner constructs information which is transformed into knowledge and that associations exist between prior knowledge and newly constructed knowledge (Phillips, 1995). It is believed that knowledge construction is a continuous process impacted by the human experience, and that instruction may or may not have an effect on their mental representation of that knowledge. The way one acquires knowledge dictates how they might use it later on. As a result, knowledge is context-dependent, in other words, one knows when to apply the knowledge in a given environment. What is most intriguing about the inverted classroom is the assimilation of advanced technology practices together with active learning approaches.

Technology is an important part of the inverted classroom because it helps in organizing materials, generating new materials, their delivery, and the construction of activities and lessons. Generally, instructors have a CMS at their disposal or a tool that provides administrative and instructional support to produce and host materials online, in the least, a default system provided by their university. Some examples of these are Blackboard and Moodle. However, if resources are lacking in their education communities, they may look elsewhere by purchasing new software. Developing course content usually consists of audio and video editing, file management, system management, file creation, and the how they want the students to interact with it. Past research has reported several findings from technology-oriented research on the inverted classroom. For instance, Lockwood and Esselstein (2013) discussed the types of technologies instructors have used to design and implement an inverted environment. In specific, they focused on the learning curves associated with video production, because video lectures are pivotal in the inverted classroom (Lockwood & Esselstein 2013). For instance, they created online videos by enlisting outside software support from Camtasia Relay and Jing through tablets (Lockwood & Esselstein, 2013). Zappe et al (2009) listed tools that have lessened preparation time for instructors like Adobe Captivate and CamStudio. Other instructors like Gannod et al (2008) have played around with audio techniques and outputs for their

lectures. Instead of using PowerPoints or video lectures, some have turned to podcasting—which another versatile tool readily available to students using music libraries like iTunes. Bates and Galloway (2012) attempted the use of clickers in the classroom to facilitate peer instruction. Campbell et al (2014) reported spending six-hundred hours preparing video lectures for their course; recording seventy-five videos lasting up to ten minutes and then presented them on Coursera which is a massive open online course (MOOC) platform. This is a prime example of instructors exploring technologies they are unfamiliar with to achieve a course task, in this case, content creation. Let us not forget Lage and Platt (2000), whom constructed a website that acted as a simulation of a real world environment by including places students would most like need for academic purposes; a desk, library, classroom, and coffee shop. McLaughlin et al., (2014) incorporated Echo360 screen capture software to record lectures and cater to their erratic schedules. Strayer (2012) used an intelligent tutoring system to ensure that students were interacting with content outside of the classroom and exhibiting comprehension skills. Walter-Perez and Dong (2012) elected to use tablets with DyKnow classroom management software along with Yahoo groups to implant materials for their course. Haden et al., (2009) created weekly modules by using Camtasia Studio and tablets which were edited into Flash videos; afterwards, they were hosted on a website. Houston and Lin (2012) sought to learn HTML in order to design their custom website that supported video content. All in all, past research has managed to list the types of technologies instructors use as well as their purpose. More importantly, we see how instructors have independently accommodated external technologies to support their courses, and their willingness to learn. The authors applaud these instructors for their creative efforts and view this as essential descriptions of current practices of technology usage in the inverted literature.

The duality behind the inverted classroom calls for a combination of hands-on activities and some form of technology to aid outside of the classroom. Technology appears in support of preparation and content creation, content delivery, assessment, engagement, and student experiences (Pena & Rosson, 2014). The author will focus on content creation and content delivery. The authors see these tasks significant in time consumption and a better likelihood that instructors may explore other viable options to achieve these tasks, they are central to *effective teaching* when using the inverted classroom. The next section, the authors will briefly discuss background on end-user development. After that, the authors shift to our perspectives on issues pertaining to technology and the inverted classroom, and the end-user development approach as a potential solution.

End-User Development

Lieberman, Paterno, Klann, and Wulf (2006) described end-user development as a paradigm—a set of practices that have the potential to evolve the development and use of interactive systems. End-user development is a set of methods and tools that encompass the whole software development lifecycle, not just one aspect of it (Lieberman et al, 2006). This term may also be confused with, but overlaps with, end-user programming and end-user software engineering (Burnett & Scaffidi, 2013). End-user software engineering is concerned with the quality of software that users produce and deploy, while, end-user programming is solely focused on the building of an artifact (Burnett & Scaffidi, 2013).

Before end-users became stakeholders in the software development process, they were held at bay decades ago. They had little control or influence over the design and development of systems. As a result of new technologies and programming languages in the 80s, users began to alter applications and manipulate settings to meet their needs (Burnett & Scaffidi, 2013). For example, when

spreadsheets became available in organizations, it created opportunities for end-users to modify functions for work-related tasks, even though, they may not necessarily realize or acknowledge that they were expanding a software artifact (Burnett & Scaffidi, 2013). Furthermore, relationships between users and developers began to shift in working relationships (Galletta & Helmick, 2008). In organizations, users were unhappy with their treatment at the hands of developers; their novice skill level was unhelpful in aiding other users or filling in for developers' busy attending to other problems (Galletta & Helmick, 2008). To avoid conflicts, end-users started to adopt EUD efforts.

Fundamentally, this idea allows end-users to create their own programs (Burnett, 2009). Though, this approach sounds similar to traditional software development practices, it is actually far from it. These activities do not simply mimic traditional practices; they are based on the ability of the individual and their goals (Burnett & Scaffidi, 2013). End-users have the promise of creating software like spreadsheets, graphical interfaces, web applications, and mockups of educational systems. As a society, not everyone is as highly motivated to learn new technical skills nor do they have the time, software skills are not to be assumed by any means. While software developers have the skills to build, test, evaluate, and deploy technology, they do require the feedback from end-users. Collaborative practices are becoming more prevalent, and the challenge is to create environments where end-users can make significant contributions. The goal is to generate adaptable environments that match the needs of end-users' backgrounds and can easily be implemented to address certain skill levels and empower them to impact information systems (Lieberman et al., 2006). The requirements for end-users to build technologies through these environments means having expert support for help, easy to learn and instinctive functionality, and simple to understand interface (Lieberman et al., 2006).

Past research has looked into several aspects of end-user development activities in different settings with most occurring in organizations. Research into the development of technologies for instructors has been growing, especially with the advent of novel teaching approaches. For instance, Wiedenbeck (2005) partook in the intimate process of interviewing instructors whom have taken on the role of end-user developers. Wiedenbeck's (2005) goal was to uncover the reasons instructors started their end-user development efforts, discover the factors that assist or hamper their efforts, and their distinct backgrounds. Wiedenbeck (2005) uncovered that instructors encounter a variety of situational factors that stem from knowledge and content that affect their involvement in end-user development practices. Moreover, she found that instructors become severely frustrated with their progress and move at a very slow pace. Even though, end-user practices boast the idea of 'learning while doing', instead, instructors reported stopping to learn (Wiedenbeck, 2005). Another result found that while instructors are enthusiastic they do not always know what technologies are suitable for their goals, so choices may be based on irrelevant factors. The authors would like to use this work as a stepping stone towards outlining issues with technology support and tasks in the inverted classroom.

Overall, the intriguing question in end-user development is who and why? (Rosson, 2014) For instance, what drives people to create new software or change existing ones? Our next sections focus on combining the issues that drive instructors to gravitate towards building and modifying technologies for the inverted classroom and the factors that influence their decision. And ultimately, acknowledging that we must move forward with end-user development practices.

ISSUES WITH INVERTED CLASSROOM TASKS

As mentioned earlier in this chapter, the authors are concerned with content creation and content delivery tasks in the inverted classroom, particularly, with how technology intervention can improve these tasks by making them more efficient. The problem at hand is to alleviate the stresses of an instructor's environment and provide more support to access, learn and troubleshoot these technologies while enabling the expansion and creation of usable artifacts. The authors believe that instructors, whom may not possess software development skills, can still have the power to repurpose and create tools suitable for their needs. Before the authors propose on how to incorporate end-user development practices, let us describe the scene—by listing factors that affect technology usage or lack thereof. In a previous section, past literature provides an in-depth look into current practices, here; the authors will imagine causes of what leads to the technical choices of instructors.

Reverting back to Wiedenbeck's work, instructors provided detailed explanations for reasons that may cause them to use specific technologies and what ultimately contributes to their successes or failures in the classroom. To start, instructors rely heavily on their own knowledge and their ability to apply it, as well as, their pedagogical experience (Wiedenbeck, 2005). This is central to their choice of technology and how they choose to build applications for their students. Although, they mentioned confidence with instructional design activities like lessons and learning outcomes, they found it difficult to translate it into technical requirements. Due to tight windows to create technologies and applications for class, instructors found that developing and expanding an artifact takes a long time. While rummaging through various websites, books, and tutorials, they felt the material was too dry and dull to follow. These are the types of situational factors that dramatically affect how instructors interact and perform end-user development practices, thus affecting pedagogical implementations such as the inverted classroom.

Pena and Rosson (2014) provide a description of other factors that affect the efficiency of content creation and delivery specific to the inverted classroom. For example, cost of resources can be problematic for those without the financial or university-based support. Also, the process of creating technology and programming is not always instinctive, there are domain-specific vocabularies, standards, and certain logic involved with building different types of applications. Time constraints limit the ability to take on new responsibilities outside of class which may be reserved for other personal and professional duties. The type of course content is important because it is used as a blueprint to create applications that cater to students. Furthermore, current technologies at the disposal of instructors may have the potential to provide thorough performance and support but are lacking in upgraded features. Earlier, the authors briefly mentioned content management systems as a university-based resource, almost as a default system provided for instructors to accomplish multiple course tasks. The authors believe that these systems may be hindered by political or financial means of universities, in other words, either they are too stubborn to enforce the changes needed to adapt to innovative teaching, or they have an external party forcing them to remain dormant.

Not only are these tasks important to the inverted classroom, they share similar characteristics with other hybrid and blended learning environments. For instance, the MOOC paradigm is rapidly increasing as online distance education becomes pervasive. Although, the scale is much larger for student enrollment and participation, they still encounter issues with retention, engagement, and technical problems (Zheng, Shih, Rosson, & Carroll, 2015). One of the major differences between MOOCs and the inverted classroom is flexibility because inversion can incorporate a mixture of online and face-to-face interaction.

In regards to technology, MOOCs wholly rely on their platforms like Udacity, edX, and Coursera which are comparable to content management systems. End-user development practices would also be appropriate for MOOC instructors whose interactions with students aren't as structured or routine. They can also expand parts of platforms like Coursera to accommodate their needs. Some instructors have gone as far as using MOOC platforms in their inverted classrooms, finding that the features offered by MOOC platforms best fit with their courses (Martin, 2012). Likewise, there are separated systems like Khan Academy which is an enormous repository of lecture and tutorial videos on STEM topics. Instructors can use this YouTube-like tool to host and create video lectures, but we believe the same problem exists with integration. Why not have one system devoted to addressing a variety of features or have one foundational system that easily integrates with outside tools. The authors' point is want is emphasizing that it is possible to make tasks more efficient by removing extra time spent downloading and learning new technologies. This should be achieved if there are no other alternatives.

IMPROVING INVERTED CLASSROOM TASKS WITH EUD PRACTICES

As more community-based and collaborative approaches are rising in technology and education, end-user development seems more and more appropriate. In the context of the inverted classroom, though technology is an essential piece, we must understand that instructors are exclusively educators first and technical users second. If by chance, they are educators with highly technology-oriented skills, then that is extremely beneficial. Though, sometimes there is pressure associated with the adoption of new technology and educational practices because failure may vary from institution to institution.

The authors believe an important part of establishing end-user development is fostering an engaging community of people who are dedicated to learning new technologies and pushing creative teaching practices forward. Instructors are influenced by their peers, especially those who are open to sharing resources, giving advice, and trading ideas. Furthermore, if high-level administrators are behind movements such as these, it is more likely that they will last. Furthermore, having training and workshops to facilitate end-user development practices is imperative. Instructors can sit down with software developers or IT support to flesh out technical plans for their courses or ask questions about implementing a tool. Also, virtual workshops may be a powerful vehicle with which to attain a wider audience. Since, instructors have extremely hectic and mixed schedules; the option of setting an online session may be appealing that physically attending a workshop. Instructors value appreciation from students and their peers when an activity works, so, having a positive environment with which to create and to pilot technologies is desired. Last, constructing a productive culture of programming and discovery is critical because it allows instructors to feel creative and actually want to produce inventive technologies. In sum, a community of people encouraging each other to create and repurpose technology will increase the use of technology and non-traditional teaching approaches.

In order to aid instructors using innovative technologies in the classroom, there must be IT support available. As end-user developers, we do not expect that instructors can easily solve technical problems when they arise. Sometimes, technical problems arrive at the most inconvenient times, for instance, when teaching or uploading new content. Potentially, there are two ways to deal with this issue, that is having an expert IT team that is readily available to troubleshoot problems as needed or have the instructors themselves become part of the solution. In a perfect world, the first scenario is a great idea, however, minimal

resources may leave smaller institutions with weak IT support. On the other hand, bigger universities may have problems with not enough support, as there may be too many instructors. The second scenario is indeed feasible and is more in line with our belief of end-user development integration.

During content creation and tasks, instructors are creating materials for students to absorb content in a variety of mediums, through audio, video, and text-based documents. If instructors do not have university-based resources to achieve this task, they will find other alternatives. End-user development activities must align the mixed practices of different instructors and disciplines because each instructor has a specific goal for their classroom. The ability to create or expand a software artifact allows instructors to tailor technologies for their specific needs, for instance, combining the use of image editors like Photoshop and collaborative workspaces like those in Google Docs, forums, or even Skype. Instructors must be able to develop, test, and evaluate their applications if they so desire. Collaborative work environments can employ other instructors in their community to participate in testing and artifact refinement. On the other hand, it is not a requirement to develop artifacts from scratch, instructors should repurpose the existing technologies around them to expand their use. This activity is cost effective because instructors can utilize already existing tools provided by the university or any free technologies they happen to come across. Content management systems can become integral to both of these options, as they are a single environment comprising of several different features and widgets that accomplish tasks such as grading, peer assessment, and discussion forums. For the most part, the management of these systems is usually done by an IT department or instructional design staff, sometimes, instructors may perform troubleshooting activities and maintenance if they feel comfortable and have the skills to do so. They have the ability to incorporate collaborative workspaces and output sandboxes that allow instructors to play around with materials and new features. Content management systems should have features that easily are enabled and disabled when instructors are testing or need a specific item to create content, host content, or deliver it. In other words, the authors are encouraging the use of default university systems by upgrading their features to accommodate a myriad of course tasks.

Apparent here, are the endless possibilities associated with combining end-user development practices with teaching approaches such as the inverted classroom. Instructors can either develop entirely new technologies or elect to expand an existing artifact; this choice is dependent on a variety of situational factors, as Lieberman et al (2006) said "EUD is a socio-cultural activity". Regardless of the reason, either choice must provide support from education administrators, staff, other instructors, students, and technical departments. This is not always possible and varies by university, if this is the case, external resources must be available for instructors to collaboratively engage in the process of learning artifact creation and design as end-user developers. *Effective teaching* in the inverted classroom should attempt to ease the abovementioned factors.

CONCLUSION AND FUTURE DIRECTIONS

To conclude, the world of education is ever-changing, this includes teaching approaches and the technologies that support them. It is necessary that instructors understand the changes that surround them and to make the appropriate choices for their course needs. In this chapter, the authors explored the inverted classroom approach by explaining its underpinnings and current practices. Additionally, the authors proposed end-user development as a way of combining technologies and repurposing their use to fit the needs of instructors preparing to implement the inverted classroom. The authors believe that although some instructors

may not be expert computer programmers, they have the ability to comprehend the workings of such to enhance the creativity, collaboration, and effectiveness of an inverted environment, while keeping the tasks associated with content creation and delivery efficient.

Following the topics discussed in our chapter, the authors believe future research can move in several directions. For example, it will be interesting to conduct a longitudinal study investigating how instructors utilize end-user development activities to improve their implementation of the inverted classroom. Next, the authors have considered building their own system that uniquely supports the inverted model, one that encompasses a variety of flexible widgets that caters to different course material. Further investigation into MOOCs may be able to inform a design for the inverted model since parts of online and distance learning share characteristics with this teaching approach. Another direction may look into technical training for instructors and ways of providing resources to learn new technologies. In addition, end-user development activities can be compared on a case by case basis on different disciplines. As its evident here, there are many opportunities to delve deeper into student-centered approaches coupled with innovative technological practices. Modern education is turning towards these emerging trends. The authors envision that the theme of this book will continue to be of importance, as extended theories shape alternative methods of teaching and the design of technologies that support those methods.

REFERENCES

Bates, S., & Galloway, R. (2012). *The inverted classroom in a large enrolment introductory physics course: a case study*. Academic Press.

Bishop, J. L., & Verleger, M. A. (2013). The flipped classroom: A survey of the research. In *Proceedings of the 120th ASEE Annual Conference & Exposition*.

Burnett, M. (2009). What is end-user software engineering and why does it matter? In *End-User Development* (pp. 15–28). Springer Berlin Heidelberg. doi:10.1007/978-3-642-00427-8_2

Burnett, M. M., & Scaffidi, C. (2013). End-user development. The Encyclopedia of Human-Computer Interaction, 2nd Ed.

Butt, A. (2012). Student views on the use of lecture time and their experience with a flipped classroom approach. *Business Education & Accreditation*, *6*(1).

Campbell, J., Horton, D., Craig, M., & Gries, P. (2014, March). Evaluating an inverted CS1. In *Proceedings of the 45th ACM technical symposium on Computer science education* (pp. 307-312). ACM. doi:10.1145/2538862.2538943

Choi, E. M. (2013). Applying inverted classroom to software engineering education. *International Journal of e-Education, e-Business, e-. Management Learning*, *3*(2), 121–125.

Cunningham, D., & Duffy, T. (1996). Constructivism: Implications for the design and delivery of instruction. Handbook of research for educational communications and technology, 170-198.

Findlay-Thompson, S., & Mombourquette, P. (2014). Evaluation of a flipped classroom in an undergraduate business course. *Business Education & Accreditation, 6*(1).

Galletta, D. F., & Heckman, R. L. Jr. (1990). A role theory perspective on end-user development. *Information Systems Research*, *1*(2), 168–187. doi:10.1287/isre.1.2.168

Gannod, G. C., Burge, J. E., & Helmick, M. T. (2008, May). Using the inverted classroom to teach software engineering. In *Proceedings of the 30th international conference on Software engineering* (pp. 777-786). ACM. doi:10.1145/1368088.1368198

Gehringer, E. F., & Peddycord, B. W. III. (2013, March). The inverted-lecture model: a case study in computer architecture. In *Proceeding of the 44th ACM technical symposium on Computer science education* (pp. 489-494). ACM. doi:10.1145/2445196.2445343

Grabinger, R. S., & Dunlap, J. C. (1995). Rich environments for active learning: A definition. *Research in Learning Technology*, *3*(2). doi:10.3402/rlt.v3i2.9606

Haden, C., Flikkema, P., Weller, T., Frolik, J., Verrei-Berenback, W., & Shiroma, W. (2009). Assessment of a hybrid, online/in-class course developed at multiple universities. In *2009 ASEE Annual Conference*. Austin, TX: ASEE.

Houston, M., & Lin, L. (2012, March). Humanizing the Classroom by Flipping the Homework versus Lecture Equation. In *Society for Information Technology & Teacher Education International Conference* (Vol. 2012, No. 1, pp. 1177-1182).

Kellogg, S. (2009, October). Developing online materials to facilitate an inverted classroom approach. In *Frontiers in Education Conference, 2009. FIE'09. 39th IEEE* (pp. 1-6). IEEE. doi:10.1109/FIE.2009.5350621

Lage, M. J., & Platt, G. (2000). The Internet and the Inverted Classroom. *The Journal of Economic Education*, *31*(1), 11. doi:10.1080/00220480009596756

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the Classroom: A Gateway to Creating an Inclusive Learning Environment. *The Journal of Economic Education*, *31*(1), 30–43. doi:10.1080/00220480009596759

Lieberman, H., Paternò, F., Klann, M., & Wulf, V. (2006). *End-user development: An emerging paradigm*. Springer Netherlands. doi:10.1007/1-4020-5386-X_1

Lockwood, K., & Esselstein, R. (2013, March). The inverted classroom and the CS curriculum. In *Proceeding of the 44th ACM technical symposium on Computer science education* (pp. 113-118). ACM. doi:10.1145/2445196.2445236

Martin, F. G. (2012). Will massive open online courses change how we teach? *Communications of the ACM*, *55*(8), 26–28. doi:10.1145/2240236.2240246

Mason, G. S., Shuman, T. R., & Cook, K. E. (2013). *Comparing the effectiveness of an inverted classroom to a traditional classroom in an upper-division engineering course*. Academic Press.

McLaughlin, J. E., Roth, M. T., Glatt, D. M., Gharkholonarehe, N., Davidson, C. A., Griffin, L. M., & Mumper, R. J. (2014). The flipped classroom: A course redesign to foster learning and engagement in a health professions school. *Academic Medicine*, *89*(2), 236–243. doi:10.1097/ACM.0000000000000086 PMID:24270916

Peña, J., & Rosson, M. B. (2014). An investigation of design features for inverted classroom support technology. *EDULEARN14 Proceedings*, 6271-6280.

Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher*, *24*(7), 5–12. doi:10.3102/0013189X024007005

Rosson, M. B. (2014). Commentary on: Burnett, Margaret M. and Scaffidi, Christopher (2014): *End-User Development*. In M. Soegaard & R. F. Dam (Eds.), *The Encyclopedia of Human-Computer Interaction* (2nd ed.). Aarhus, Denmark: The Interaction Design Foundation. doi:10.1227/NEU.0000000000000357

Schullery, N. M., Reck, R. F., & Schullery, S. E. (2011). Toward Solving the High Enrollment, Low Engagement Dilemma: A Case Study in Introductory Business. *International Journal of Business Human Technology*, *1*(2), 1–9.

Strayer, J. F. (2012). How learning in an inverted classroom influences cooperation, innovation and task orientation. *Learning Environments Research*, 1–23.

Swartz, B., Velegol, S. B., & Laman, J. A. (2013). Three approaches to flipping ce courses: Faculty perspectives and suggestions. In *Proceedings of the 120th ASEE Annual Conference & Exposition*.

Toto, R., & Nguyen, H. (2009, October). Flipping the Work Design in an industrial engineering course. In *Frontiers in Education Conference*, 2009. IEEE. doi:10.1109/FIE.2009.5350529

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Warter-Perez, N., & Dong, J. (2012). Flipping the classroom: How to embed inquiry and design projects into a digital engineering lecture. In *Proceedings of the 2012 ASEE PSW Section Conference*.

Wiedenbeck, S. (2005, September). Facilitators and inhibitors of end-user development by teachers in a school. In *Visual Languages and Human-Centric Computing, 2005 IEEE Symposium on* (pp. 215-222). IEEE. doi:10.1109/VLHCC.2005.36

Zappe, S., Leicht, R., Messner, J., Litzinger, T., & Lee, H. W. (2009). "Flipping" the classroom to explore active learning in a large undergraduate course. In American Society for Engineering Education. American Society for Engineering Education.

Zheng, S., Rosson, M. B., Shih, P. C., & Carroll, J. M. (2014). Understanding Student Motivation, Behaviors, and Perceptions in MOOCs. In *Proceedings of CSCW '15*.

KEY TERMS AND DEFINITIONS

Artifact: Any piece of constructed or expanded software, technology, or application.

Collaborative Environment: An environment that facilitates and incorporates agreed upon participation by multiple individuals to complete a task.

Content Creation: The construction of discipline-specific course materials.

Content Delivery: Hosting and displaying course materials viewable by students through a technical system.

Effective Teaching: Successfully implementing a pedagogical approach coupled with innovative technologies to engage students.

Hybrid or Blended Learning: A combination of digital online media, computer-based activities, and face-to-face interaction.

Traditional-Lecture Classroom: Common structure of classroom activities where lecture occurs within the classroom and homework is assigned outside of class.