Understanding by Design, Moodle, and Blended Learning: A Secondary School Case Study

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Abstract

In a 2013 report, the Organization for Economic Co-operation and Development (OECD) discussed the need to develop skills for the knowledge society. Education institutions must develop opportunities for students to gain the skills needed to participate in an increasingly global economy. The OECD uses knowledge intensity to identify economically successful countries. All countries that have high knowledge intensity are innovative, have good education systems, economic incentives, and current information and communication technology available for their citizens. This increase in knowledge intensity has precipitated the need for a more skilled workforce. Starting learners on the path to knowledge intensity cannot wait for postsecondary education institutions. Secondary schools need to start the process of integrating the skills necessary to succeed in a knowledge society. Skills that enable students to succeed globally promote critical thinking, communication, collaboration, and the ability to connect one learning situation to another. The researched institution was guided by the development of the aforementioned skills in an effort to give teachers a focus for their courses. The use of the understanding by design (UbD), Moodle, and blended learning (BL) models has provided opportunities for students to develop the skills in knowledge intensity that they will need to compete globally.

Keywords: Backward design, blended learning, Moodle, PISA, OECD, secondary school, understanding by design, virtual learning

Introduction

The global delivery of education is in flux. Institutions are searching for viable options to cope with the supply of and demand for skills required by a global workforce. Students need options to maximize their ability to gain the skills necessary to compete for future jobs in the global economy. Educators also need tools that will increase student engagement in the learning process and ensure that students are obtaining the skills that will be in demand in the global economy. Skills that enhance students' abilities, according to the Organization for Economic Co-operation and Development (OECD, 2013), are the four Cs of communication, collaboration, creativity, and ability to connect one learning opportunity to another.

A public secondary school in a suburb of Denver, Colorado, chose to focus on preparing students for the knowledge economy. The study school identified three concepts required to meet these needs: understanding by design (UbD), Moodle, and blended learning (BL). UbD is a model of planning that puts engagement and achievement in the forefront of efforts by school planners and educators. UbD, BL, and

Moodle are useful tools when designing learning. The study school put these tools to use with the intention of preparing students to enter the global workforce. How the school used UbD, Moodle, and BL could be generalized to a variety of learning institutions concerned with preparing learners to join the knowledge society. This case study followed the school's journey to address the ways in which education was being delivered to meet the needs of students as they prepared to compete in the global workforce.

Understanding by Design

UbD is a model of planning championed by Wiggins and McTighe (1998) as a method of intentional planning in education. At its core, UbD has three main stages: (a) Identify the desired results, (b) determine the desired evidence, and (c) plan instruction and experiences to meet the results. The first stage examines the goals of a course and reviews the applicable standards and outcomes. This stage might be the most important of the three. As the standards movement becomes predominant in education, it is up to institutions to determine what is essential for students to know and be able to do in each subject. These outcomes, termed *essential learnings*, come from a governing body such as a school district, an institution, or a teacher with expertise in a particular field. The goal of the study school was to define essential learnings that have depth. Once the essential learnings had been clearly identified, the appropriate assessment evidence was determined to be a mix of formative and summative assessments as well as performance assessments to demonstrate understanding. The third step was to develop a plan for the unit or course that would expose the students to the goals and assess the success in meeting a given standard. The UbD design format was chosen so that each course that was developed had an intentional design. Part of the UbD framework included the many tools available for planning units. These tools helped the planners to identify results, consider appropriate evidence, and plan the steps to meet the standard. The UbD template informed the designer of the necessary components and helped in the UbD planning process (McTighe, Emberger, & Carber, 2008). Using UbD helped to ensure that the focus was on the 4 Cs.

An example of the UbD process and the ways in which Moodle and BL can work in concert to support an intentional learning environment was demonstrated in mathematics at the study school. The state had identified four standards in mathematics: (a) Number Sense, Properties, and Operations; (b) Patterns, Functions, and Algebraic Structures; (c) Data Analysis, Statistics, and Probability; and (d) Shape, Dimensions, and Geometric Relationships. These broad standards needed to be narrowed to essential learnings. To determine what was essential, the teachers of mathematics met and progressed through the UbD process. One of the identified results for the Shapes, Dimensions, and Geometric Relationship standard was that objects in the real world can be modeled using geometric concepts. The team then developed two essential questions for the concept: (a) How do you find a side and length of a triangle? and (b) How do trigonometric functions relate to similar triangles? The desired evidence was that students would be able to measure the height of a building using geometric concepts.

The instructional plan started with practice problems using Moodle quizzes with the Geogebra block installed, teacher instruction, and teacher-generated videos. Students were assigned to groups to work through problems using any resources available to them. This work was completed in a BL learning environment. In this case, the Moodle quiz served more as a learning tool than an assessment. Once the students completed a series of practice questions, they continued on to the assessment. For this standard, the performance assessment was being able to measure the height of a building using two angles from two measurements taken 50 feet apart. Once they completed this section of the unit, they could answer Question 1 of this essential learning. This unit was designed to feed into higher levels of mathematics and engineering. For example, the principle of measuring angles from two distances is essential for the aerospace industry to determine what orbital distance from Earth a satellite needs to be in for optimal performance.

Moodle and Blended Learning

The history of BL models in the United States can be traced to the Chautauqua Movement for rural Sunday School education circa 1890s, with teachers giving instruction followed by lesson completion via the U.S. Postal Service. The technology in BL has evolved from the mainframe computer-based training of the 1960s and 1970s to the video courses, correspondence material, and computer-based training of the 1980s and 1990s. From the 1990s to the present, there has been a movement toward web-based

instruction. The impetus for change has mostly been from the business community; however, there also has been a vibrant movement, mostly in higher education, toward the concept of BL (Scott, 1999).

As technology and delivery systems for BL have advanced, Moodle has become the virtual platform of choice for education. Florian (2010) discussed a variety of virtual options for schools with respect to virtual learning environments and concluded that Moodle is optimal for institutions because of its constructivist learning design; cost effectiveness; ability to expand with the student population; data analysis capabilities; and ability to meet the diverse needs of institutions, instructors, and learners. Examples of why Moodle is the optimal tool for institutions are many and varied. The mathematics example discussed previously gave the students multiple opportunities to complete work successfully.

Mathematics and science teachers can use the calculated question type in the quiz module as a learning tool more than an assessment tool. Teachers using calculated questions can set the parameters for an equation and give a one-question assignment that students can take several times, with each iteration using the same formula but inserting different number values. This process gives students multiple opportunities to learn how the formula works and saves teachers time because they do not need to create multiple assignments. In addition, the learning can be personalized for individual students. Once students understand the formula, they can proceed to new assignments. If they do not understand the formula, they can work through multiple iterations. The calculated question type is unique to Moodle and was a valuable resource for the study school's teachers. When the study school adopted Moodle, other learning management systems (LMS) were charging extra for upgraded mathematics functions, if they had them at all.

Another example of Moodle meeting varied needs was evident in the school's foreign language department. The school has a robust Mandarin language program, and as it prepares students to meet the demands of the global economy, interacting with China, which has one of the fastest growing and largest economies in the world, will play an important role. Moodle is one of the few LMS providing an option for imbedding Mandarin. The study school has five levels of Mandarin courses, and from Level 3 on, the entire Moodle course page is in simplified Mandarin. Students in Mandarin courses at Level 3 or higher are immersed in the language and are learning more as a result of using Moodle.

As the design of courses at the school progressed using Moodle, it was decided that UbD should be evident in each Moodle page (see Appendix). With its cost structure (open source), scalability, increased functionality, and ease of use, Moodle was considered an optimal tool as the school continued to develop BL courses. Using UbD in combination with Moodle, teachers were able to create efficient, well-designed courses that intentionally incorporated the four Cs as part of the learning curricula.

Well-developed BL courses provided students with multiple opportunities to engage using skills represented by the four Cs. Current understanding of BL is that it is a combination of face-to-face and online instruction that varies based upon the needs of the learners. Research has suggested that BL is a more effective method of instruction if it is learner centered and well designed. Research also has identified an increase in student satisfaction in BL when courses are designed in advance to have interactivity and engagement in the online portion of the courses. In a well-constructed BL course, the time in class either can lead the online requirements or it can follow, but the two parts need to be connected and dependent upon each other to ensure a successful BL environment (Graham & Allen, 2009).

BL courses that have not been successful shared common traits, and courses that students have had the most difficulty with were created separate from the instructors. Other difficulties have been described as finding the right "blend" for the classroom, increased demand on the instructors' time, and overcoming institutional and cultural barriers. In addition, the negative traits of online-only education need to be addressed when developing courses. Isolation, the use of digital-only text, digital and computer skills, and pedagogical design of courses are reasons that students have expressed for their dislike of online-only education (Rose & Ray, 2012). At the school, these issues have been addressed using the UbD framework, Moodle, and BL, where the four Cs are intentional components of the courses.

The Study School

The study school was developed to meet the growing needs of a suburban school district. Administrators were selected from a pool of candidates, and the person chosen to lead the school had a dynamic vision

for a school to prepare students to compete on a global scale. To fulfill this vision, the administrator hired individuals who were innovators and leaders who were open to new ways of delivering instruction. The authors of this study were faculty hired to open the school and be part of the administrator's vision. For strategies to be implemented effectively, faculty members need to be part of the innovative process (Graham & Allen, 2009).

The ability to offer students content knowledge, assessments, and tools needed to be successful in the changing world of education was a skill that the study school's administrator was seeking in faculty when opening the school. As new personnel were hired, faculty, such as the authors, continued to use Moodle in new ways as well as train new faculty. To meet the growing need for administration-supported training, the authors developed and taught courses at the study school site as well as at the school district level, and they were available to consult with new and already established faculty to continue to use Moodle and develop BL strategies. Training and staff development are the hallmarks of effective and efficient school environments (Sawchuk, 2009). A full discussion of how training and staff development were implemented at the study school is essential, but such a discussion is beyond the scope of this paper.

The study school has been using UbD and BL with Moodle since its opening in 2008. The school opened with the directive that all courses incorporate the four Cs skills, be designed using UbD, and use an LMS as a way to blend traditional and online learning. After extensive research and input from faculty, Moodle was selected as the LMS. Staff members started creating courses in Moodle in 2008 and have been modifying and changing them every year since. Moodle's versatility and open source nature are important because of its scalability, diverse set of tools for education, and low operating cost. Key tenets of the school's drive to use an LMS are to have learning objects and opportunities available as students need them.

Initially, Moodle was mainly a resource repository accessible to students outside of the school day. The use of Moodle quickly expanded options for student learning, and teachers began developing assessments (i.e., individual and collaborative); lessons; and interactive activities, where students could communicate and connect their learning in constructivist ways and have opportunities to collaborate within the LMS on projects. Thus began the process of changing the design of the blend from an instructor-led process to a student-driven process (Kolowich, 2010). As familiarity with Moodle increased, pedagogy began to shift from traditional teacher-centered learning to the student-centered delivery of education.

In 2010, teachers at the study school began to research BL to better define the "blend" for its BL classes. A theory that incorporates many of the aspects of the BL courses that were developed and provides a path to further refine what the school currently offers is online collaborative learning (OCL). OCL theory states that online components need to be developed so that students must collaborate, all the while focusing on the four Cs, to achieve a goal. Forcing students to collaborate addresses the dual issues of disengagement and instrumentalism. Disengagement happens in classes when the instruction does not meet students' needs at particular times. Instrumentalism occurs when students are asked to work on an instrument such as a worksheet in class that might not be the best learning practice for particular students (Precel, Eshet-alkalai, & Alberton, 2009). A learner-centered model gives students choices in the learning process. Combined with the constructivist model of Moodle, where students learn through their shared experiences, the addition of OCL is refining the path for the school.

The design change in the study school's BL started with four core classes: Honors Chemistry, U.S. Government, American Tapestries, and Honors Trig. /Pre-Calc. These courses and teachers had well-developed UbD plans. Teachers examined their course UbD units and modified them to fit the new blend. It was decided that at first, all four courses would use the same blend and meet in class on Tuesdays and Fridays, with students using the remainder of the time to collaborate with their groups online and in person. Teachers held office hours to meet students on an as-needed basis during the other days of the week. With Moodle as the foundation of each course, the blend was modified to include a collaborative component as a mandatory part of the outside learning, as suggested by OLC theory. Students were not told how to collaborate; instead, they were told only that they needed to collaborate as a requirement for each course. This intentional lack of guidance was an effort not to limit the type of collaboration and to discover what ways students would choose to work.

Mathematics was a flipped class offering lectures online and practice work in class. Students created self-guided study groups and met several times during the week to review lectures and work in independent practice. The U.S. government modified the course to include group projects, issue-based research, creation of a political advertisement for the candidate of choice, and a final project for the class addressing a local government issue. In Honors Chemistry, differentiation was the key focus. Students self-selected groups to complete Titan Team activities and projects away from class at their desired pacing. In addition, the groups came to class to complete lab work and collaboratively solve challenge problems on an as-needed basis. Individual work was differentiated through notes and homework quizzes completed on Moodle. The blend used in the English course gave students choices to complete projects or use the forums and journal modules in Moodle. The change resulted in students in the BL course writing more than students in the non-BL courses. A difficulty reported in the English course was assessing students' novel reading because they were doing the reading at home. Currently, strategies are being developed to address this issue.

Collaboration, as reported by teachers in the modified BL courses, was slow at first, but when the groups began working together, the bonds in the groups became evident. This could have been one reason for increased student engagement. To complete assignments, students had to use the Moodle LMS for information and communication. This might not have been the sole form of technology or collaboration used in the BL courses; indeed, subsequent inquiry showed that it was not. Students reported using a variety of resources in addition to Moodle to collaborate. These other resources included Facebook, Twitter, Microsoft Xbox Live, as well as in-person meetings at school or a local coffee shop. However, all material, learning modules, videos, and most assessment evidence required the use of Moodle.

Measurement of Effectiveness

PISA Internationally

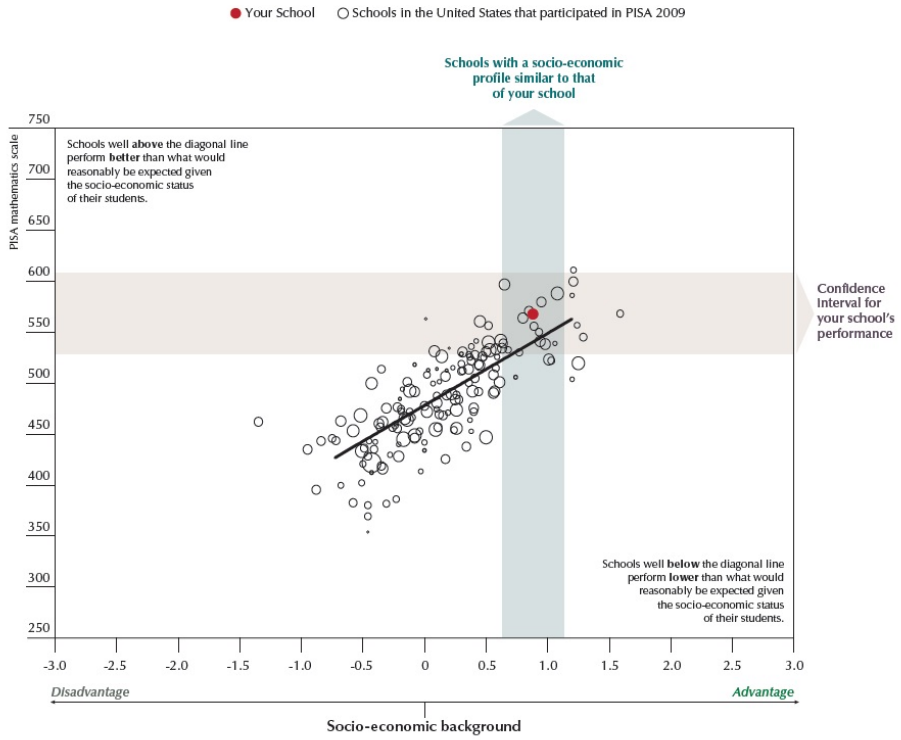
The Programme for International Student Assessment (PISA), which is administered through OECD, "evaluates the quality, equity, efficiency of school systems in over 70 countries that, together make up nine-tenths of the world economy" (OEDC, 2013, p. 3). PISA provides a level of consistency across borders and is generally accepted as the international standard for measuring academic achievement. Rather than produce test scores that measure current trends in education, PISA attempts to measure skills needed for the future (Harlen, 2011). PISA collects quantitative data from test scores in mathematics, science, and reading, as well as qualitative data from questionnaires. Questions asked range from socioeconomics to attitudes toward learning. Countries modify education policies based upon the PISA results of their students. In 2009, South Korea's performance showed high levels of achievement, but the qualitative data suggested that only a small percentage of elite students were achieving at very high levels. South Korea modified its policies, and when the test was administered a few years later, the number of students who were achieving at an excellent level doubled.

PISA measures more than just mathematics, reading, and science. It also measures the skills that are in demand in the global marketplace. The data from PISA have been shown to influence international education policies (Bulle, 2011). One country that has shown gains based upon PISA data is China, Shanghai specifically. Shanghai, China, a perennial leader in the PISA scores, showed that with a minimum of resources, more than a quarter of its "15-year-olds can conceptualize, generalize, and creatively use information based on their own investigations and modeling of complex problems" (OECD, 2013, p. 3) in the Mathematics section. Variability among schools also has been a concern of the OECD (2013). In many countries, socioeconomic factors determine the quality of education received, and the skills needed to be competitive in the future remain elusive for many. Eastern Europe has shown a high level of variability, and one country, Poland, used data from PISA to make changes in policy across the country. PISA scores were used as a guide to change the education system and reduce the variability of achievement in schools. Understanding how PISA has been used to impact global education gives the test a significant level of confidence among OEDC members. Indeed, results from PISA have shown a wide variety of achievement in the 70 countries that have taken the test. The OECD has ben concerned about the quality of education in member countries and has suggested that to improve the long-term economic outlook of a country, improvements in education must become a priority.

PISA and the Study School

In 2012, the school was selected to administer the sample PISA to a random sampling of students. The study school had been using its model incorporating Moodle, UbD, and BL for 4 years, making minor changes in the ways in which education is being delivered. PISA would give the school a unique measurement of its effectiveness as a model for developing students' skills to enter the global economy.

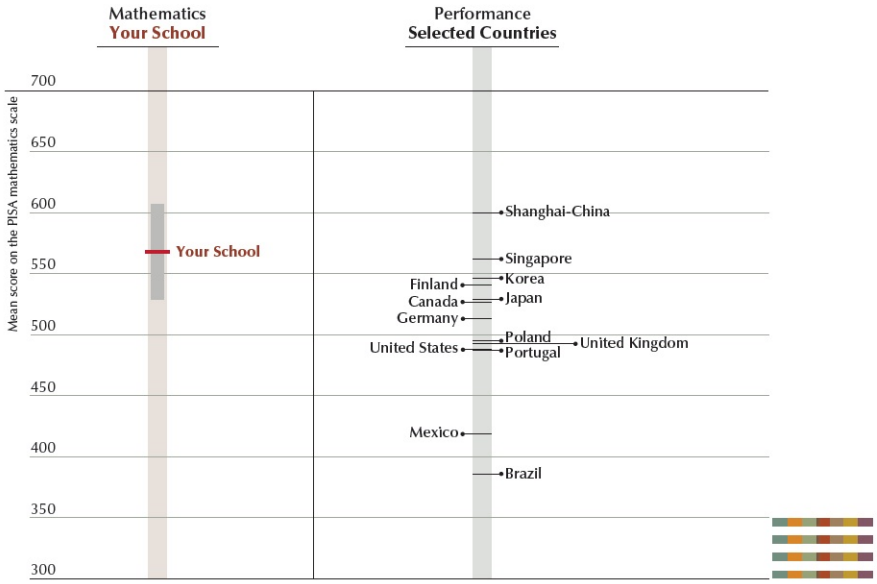
PISA was taken by 41 students at the study school in the content areas of reading, mathematics, and science. All students were age 15 years, as required by the OEDC (2012). The assessment data in Figure 1 show that in mathematics, the study school scored above the average when socioeconomic factors were taken into account. The red dot represents the school.



Note: Size of bubbles is proportional to the number of students enrolled at the school.
Source: OECD.

Figure 1. Study school performance in relation to other schools in the United States.

In comparison to other participants, the study school exceeded most countries in mathematics, second only to Shanghai, China (see Figure 2). In comparison to other schools in the United States, the school also performed well in mathematics. The science and reading results for the study school showed scores that were above other national and international scores. The average reading score for the school was approximately 549, which was second only to Shanghai, which scored an average of approximately 552.



Note: Shaded bars above and below the mean scores represent the 95% confidence interval. In other words, in the case of the results for your school, we are 95% confident that if your school were to administer the test several times, your mean performance scores would fall within this confidence interval.
Source: OECD.

Figure 2. Study school mathematics scores in relation to other OECD countries

When science scores were evaluated, the study school still did well, but not as well as in mathematics. The school's score was approximately 559, which placed it internationally below Shanghai, China, and Finland, and above the approximate score of 510 for the Unites States as a whole. As global competitiveness and the need for effective schools increase, the school's institutional model using Moodle, backward planning using UbD, and BL that incorporates the four Cs seems to be preparing students adequately to enter the global marketplace.

Conclusion

Students in secondary school will compete in a global marketplace that not only provides goods and services but also jobs. The OECD (2013) suggested that learning institutions look at the supply of and demand for skills to meet the needs of the global marketplace. For students to be competitive, educators cannot wait until postsecondary school to expose students to these skills. Students will be better served if they are introduced to portable skills such as collaboration, critical thinking, and effective communication at the secondary level. The school incorporated these skills intentionally into the curriculum when it opened its doors. As the school grew, it made a pedagogical shift in its delivery of instruction to ensure that students received more exposure to the four Cs in an effort to better prepare them to be competitive in the global economy. When looking at the international measurement of PISA, it has become evident that the work being done at the study school is providing a pathway to develop the skills needed by students. As the school continues its march toward global, skills-based education, the metrics of success need to be established and examined to determine the extent to which it continues meeting the needs of students waiting to take their place in the global economy.

The work of the study school shows promise but also raises questions. Schools that introduce new pedagogy such as BL often slip back into traditional methods of teaching (Freeman & Tremblay, 2013). How the study school addresses this issue while continuing to progress is an area that merits closer investigation. A discussion of the experiences of secondary school students in BL classrooms and the use of Moodle also is planned for future research.

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Appendix: Example of a Moodle Page