Using a Blended Learning Approach in the Secondary Mathematics Classroom

Anne Aronson

Abstract: Blended learning combines aspects from the traditional face-to-face setting and an online learning environment. This type of learning environment provides a variety of benefits to students that are not otherwise available in purely face-to-face classrooms or online learning environments. Secondary mathematics teachers can utilize a blended learning set-up that incorporates the characteristics that make up an effective classroom specifically by looking at the National Council of Teachers of Mathematics (NCTM) Mathematical Teaching Practices. There are many aspects of the blended learning environment that allow for these teaching practices to be incorporated into the classroom and even enhanced when compared to what the traditional classroom can offer.

Introduction

With the increasing use of technology for the delivery of educational content, there is a need to take a deeper look into how we can best structure classrooms that incorporate technology, yet still not lose the important features that face-to-face instruction provides. Blended learning, like other applications in education, has a variety of definitions. However, Alebaikan and Troudi (2010) provide a useful general summary of blended learning as referring to "an integration of online activities and traditional face-to-face class activities" (p. 50).

Due to the variety of definitions and models of blended learning, this article will use the term "blended learning" to refer to the general concept of a combination of both online and face-to-face learning experiences. It will begin by describing the benefits that any general form of a blended learning environment can provide to secondary mathematics students when compared to learning in either the traditional face-to-face or completely online classroom setting. Next, it will explore how a blended learning environment can still allow teachers to utilize what research has shown to be the most effective teaching practices by specifically looking at the National Council of Teachers of Mathematics (NCTM) Mathematical Teaching Practices (2014).

Along with the variety of definitions offered to describe blended learning, there also are a wide variety of learning models that can be described as blended learning environments. For example, Harding, Kaczynski, and Wood (2012) studied a blended calculus course where students accessed the course website at least 2-3 times per week, completed assessments both online and in a classroom, and communicated both online and in course sessions. In contrast, Staker and Horn (2012) described a blended learning setting where "students rotate on a fixed schedule or at the teacher's discretion between learning modalities at least one of which is online learning" (p. 8) These are just a couple of the various ways a blended learning classroom can be created. Research has not shown there to be any one best way to organize a blended learning environment. Instead, it is more effective to look at the

specific students and resources available when deciding how to specifically structure the blended learning environment.

Historically, secondary mathematics education has utilized a traditional structured setting where the students and teacher met at a scheduled time and location. Such a system meant that the teacher was constantly present during the class to monitor student progress and answer questions that arose while students are working on their material. This setting allowed for collaborative group work and discussions during which the teacher was always nearby to monitor and assess progress. Despite its strengths, this setting can produce challenges both for students who need extra remediation on a topic and for those students who are working at a faster pace than the majority of the class.

One response to this challenge has been the implementation of online learning, which is asynchronous, and thus offers students much more flexibility to work at their own pace and not be confined by time and location meeting constraints. Not only can this be a good solution for students who both need extra time with a skill or those who want to learn at a faster pace, it also is beneficial to students who are dealing with other situations that prevent them from being able to attend school on a regular basis, such as having a physical or mental illness, raising children, or holding down a job. Yet online learning has several drawbacks as well. For example, one concern with students working in an online environment is the inability of instructors to track whether students are doing the work themselves, or if any cheating is taking place. Solutions are being developed for this problem; for example, one school in China is piloting a facial recognition program to make sure students are paying attention during class, and a similar program could potentially be used in the future to also track students working outside of school in an online program (Fussell, 2018). However since this technology is still in the early stages, the current best solution to this problem is for teachers to provide students with open-ended questions and assess their learning when they are in the physical classroom to ensure the student is able to accurately demonstrate knowledge of the material.

Learning in an online environment also means that one needs to have the self-drive or motivation to continue working on their school work even if not in an actual classroom. Also, there may not necessarily be immediate communication or interaction with the teacher when assistance is needed, which can stymie students' progress and lead to frustration. The concept of blended learning takes the benefits of both face-to-face instruction and online learning and combines them to achieve the best of both.

For example, Horn and Staker (2011) described one of the benefits of blended learning as the ability to "allow students to progress at their own pace and work on their individual learning needs" (p. 10). Since blended learning also includes a face-to-face component, they argue that the face-to-face time can be used most effectively for the teacher to "pull together small groups of students struggling with the same content" (p. 11). Horn and Staker examined a program at Carpe Diem Collegiate High School in Yuma AZ which used software in a blended learning course that would alert an assistant coach or teacher if the program found a student struggling for more than three minutes on a given concept. Utilizing this form of technology learning allowed the teacher to become aware of struggling students

much faster than waiting for assessment results in a classroom. With this information the teachers could more easily group students depending on specific needs.

Similarly, Harding, Kaczynski, and Wood (2012) evaluated the outcomes of a calculus course by holding focus sessions with the enrolled students. The students described the flexibility of the online aspect of the course as its major advantage, and saw themselves as more able to participate in cooperative learning, and only needing to use the instructor as a last resort. Harding Kaczynski, and Wood also found that "the blended learning model cultivates self-discipline" (p. 60). In this way blended learning provides benefits to students that derive from aspects of both online learning and a live face-to-face classroom.

An Effective Math Classroom

When looking at how a teacher can create an effective mathematics classroom, one helpful resource is the NCTM Mathematical Teaching Practices. NCTM (2014) offers eight practices that describe what a teacher should be doing in an effective mathematics classroom.

1. Establishing mathematics goals to focus learning
2. Implementing tasks that promote reasoning and problem solving
3. Using and connecting mathematical representations
4. Facilitating meaningful mathematical discourse
5. Posing purposeful questions
6. Building procedural fluency from conceptual understanding
7. Supporting productive struggle in learning mathematics
8. Eliciting and using evidence of student thinking

For a blended learning environment to work in the secondary mathematics classroom setting, instructors need to ensure that all of these teaching practices will still be present. To show how these practices can be incorporated in a blended learning environment, each of these practices will be briefly explained and an example of what the practice could look like in a blended learning classroom will be discussed.

Establishing Mathematics Goals to Focus Learning

This practice is described as establishing goals that fit within learning progressions and are used to guide further instructional decisions (NCTM, 2014). Whether providing instructional content directly to students or through online content, the teacher should be creating goals that are directly related to the learning task, so this is a teaching practice that in no way should be affected by adding an aspect of learning through an online medium into the classroom. Additionally, the use of a blended learning approach allows for students to have more flexibility in how quickly they progress through learning tasks, so as soon as students accomplish a certain learning

goal, they would be able to move immediately on to the next and not need to wait for the rest of the class before moving on.

Implementing Tasks That Promote Reasoning and Problem Solving

This practice centers on the idea of providing students problems that allow for multiple entry points and varied solution strategies (NCTM, 2014). Even when students are learning through an online medium, they can still work on tasks that allow for a variety of ways to approach and solve the problem. Online learning does not mean only taking multiple-choice quizzes on a computer. For example, Illuminations.com provides a wide variety of activities for students to work with concepts and solve complex problems. Discussion boards can also be utilized through the online medium where students can share their ideas and strategies for solving posted problems, so that they can read and respond to other students ideas.

Using and Connecting Mathematical Representations

This practice refers to providing opportunities for students to make connections between various representations of concepts or procedures to deepen the mathematical understanding and use while problem-solving (NCTM, 2014). This can be accomplished for students both when learning online and in face-to-face classroom settings. Students can create and view representations through technology, and even when using technology representations can still be written down on paper. Students could even share how they would mathematically represent a problem with a group or an entire class through an online platform.

Facilitating Meaningful Mathematical Discourse

Students need to be able to discuss their ideas and approaches to solving problems with others, and to be able to argue for or against other students' problem-solving approaches (NCTM, 2014). As previously mentioned, discussion boards offer one way to accomplish this practice that incorporates technology. However, a blended learning environment also is at times a face-to-face classroom, so live classroom discussions can still take place, in which the teacher would be more able to direct and lead the discussion compared to if it was through an online discussion. A specific strategy that has been used in blended learning mathematics classrooms is Khan Academy, which contains "instructional mathematics videos … aligned to practice problem sets and a real-time discussion board" (Cargile, 2015, p. 35). Cargile argues that the features provided by Khan Academy can also be adapted and used by "teachers who strive to improve their craft and who want to blend instruction effectively."

Posing Purposeful Questions

The questions posed by teachers need to be directed towards assessing students' thought processes. These questions should also serve to expand students' abilities to make sense of the mathematical concepts and discover new relationships between concepts (NCTM, 2014). Since an online platform allows for discussion groups or blog postings, the teacher can easily post questions for students to think about or to discuss either individually with the instructor, in pairs, or as groups. One concern

may be that if students are working online, the teacher may not always be able to immediately provide the most appropriate questions for individual students. However, when students are in the classroom the teacher has much more time available to work with students individually since they typically will not be using class time to provide full-class lessons. This setting allows for the teacher to provide appropriate questions to individual students based specifically on where they are at in the learning progression and what types of challenges they are facing.

Building Procedural Fluency from Conceptual Understanding

To be successful mathematics learners, students need to have a strong foundational understanding of a concept and then learn how to utilize different procedures based on the type of problem and context (NCTM, 2014). Following this reasoning, learning progressions should be structured so that students do not move on to practicing procedural fluency before deep conceptual understanding is present. For example, Ahmad, Shafie, and Janier (2008) studied the learning of students in an Engineering Math Foundation 2 course using a blended learning method, and the summary of student comments they reported revealed that the various delivery methods of the content allowed them to better visualize the concepts since they had the ability to work at their own pace. These student observations demonstrate that the blended learning environment provided opportunities for students to work with and fully understand the concepts in a more complete way than a traditional classroom may have provided since they could make sure they fully understood the content before moving on.

Supporting Productive Struggle in Learning Mathematics

Teachers need to provide students opportunities to engage in productive struggle both individually and as a group while they work through mathematical concepts (NCTM, 2014). Since the blended learning environment also allows for class time where students can work together on problems, students will also be able to engage in collective productive struggle in groups or as an entire class. Harding, Kaczynski, and Wood (2012) examined calculus students participating in a blended learning course, and the students they interviewed shared that they were more able to participate in cooperative learning, and to support one another as they struggled with concepts and problems. In this setting students were able to both work individually and collaboratively on problems, but the teacher also had the ability to provide immediate feedback and work individually with students.

Conclusion

Even though there is no one standard way to set-up a blended secondary math classroom, by ensuring that the blended setting draws on the strengths of face-to-face learning and online learning, and drawing on best practices in mathematics teaching, instructors can create their own blended model that supports and strengthens student learning By looking at the NCTM Mathematical Teaching Practices, we can see how a teacher can create an effective learning environment for students that

encourages them to grow and develop as mathematical thinkers. If anything, these practices can be enhanced through the addition of the online learning component to the classroom, because it gives students additional flexibility and freedom to work at their own pace on the material. Since the blended learning environment still has a face-to-face component, the students also will not miss out on direct instruction from the teacher or on collaborative, face-to-face group work.

References

Ahmad, W. F. B. W., Shafie, A. B., & Janier, J. B. (2008). Students' perceptions towards blended learning in teaching and learning Mathematics: Application of integration. In *Proceedings 13th Asian Technology Conference in Mathematic* (ATCM08), Suan Sunanda Rajabhat, University Bangkok, Thailand.

Alebaikan, R., & Troudi, S. (2010). Blended learning in Saudi universities: challenges and perspectives. *ALT-J, 18*(1), 49-59.

Cargile, L. A. (2015). Blending instruction with Khan Academy. *Mathematics Teacher, 109*(1), 34-39.

Fussell, S.. (2018). Chinese school piloting face-recognition software to make sure students pay attention in class. *Gizmodo.com.* Retrieved June 22, 2018, from https://gizmodo.com/chinese-school-piloting-face-recognition-software-to-ma-1826142540

Harding, A., Kaczynski, D., & Wood, L. (2012). Evaluation of blended learning: analysis of qualitative data. In *Proceedings of The Australian Conference on Science and Mathematics Education* (formerly UniServe Science Conference), 11, 56-72.

Horn, M. B., & Staker, H. (2011). The rise of K-12 blended learning. *Innosight Institute*, 5.

National Council of Teachers of Mathematics (NCTM). (2014). *Principles to actions: Ensuring mathematical success for all.* Reston, VA: Author.

Staker, H., & Horn, M. B. (2012). Classifying K-12 blended learning. *Innosight Institute*. Retrieved from https://www.christenseninstitute.org/wp-content/uploads/2013/04/The-rise-of-K-12-blended-learning.pdf

Watson, J. (2008). *Blended learning: The convergence of online and face-to-face education. Promising practices in online learning.* North American Council for Online Learning.

About the Author

Anne Aronson received her BAS degree in Teaching Mathematics from the University of Minnesota, Duluth in 2015. She currently teachers math at Findlay High School in Findlay, OH. Previously, she taught math at Life Skills High School in Toledo, OH.