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Faculty Perceptions of the Use of Virtual Learning Environments in Introductory Biology Courses

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Walden University
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Abstract

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MS, Green Mountain University, 2016

BS, University of North Alabama, 2014

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Learning, Instruction and Innovation

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Abstract

Blended learning (BL) and virtual learning environments (VLEs) are innovative approaches that many higher education instructors are using to promote student success and learning in introductory biology courses. However, research does not provide insight into whether specific VLEs such as Mastering Biology (MB), are useful or effective in increasing student success. The purpose of this basic qualitative research study was to explore the experiences and perceptions of higher education introductory biology instructors regarding the use of BL and MB to promote student success and learning. The theoretical framework for this study was connectivism, based on the work of Siemens. Research questions were designed to explore higher education introductory biology instructors' perceptions and experiences when using BL and MB to promote student learning. Participants included 10 higher education introductory biology instructors who either currently used or have used MB in their courses. Data were collected using semistructured interviews and then coded using emergent coding to identify themes and patterns. Results indicated that BL and VLEs are useful or effective tools that help to promote student success and learning. Instructors indicated that MB offers access to interactive activities to help supplement lecture materials. This study may foster positive social change by informing biology educators about the potential value of using MB and other VLEs in introductory biology courses to promote student learning.

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Chapter 1: Introduction to the Study

While there has always been a need to develop employable biologists in the United States, job opportunities for biologists are currently increasing and will continue this trend up to 2030 (American Institute of Biological Sciences [AIBS], 2018). According to the Bureau of Labor Statistics [BLS] (2018), the job outlook for life, physical, and social science occupations such as technicians, wildlife biologists, psychologists, and medical professionals will increase by 10% in the next 10 years. While these statistics show a forecasted need for more biologists, higher education institutions are not producing enough biologists to meet demands due to lack of student success in introductory courses. A need therefore arises to explore ways for educators to promote student learning in these introductory courses to enable a greater number of employable biologists. Many higher education instructors are using blended learning (BL) and virtual learning environments (VLE) to help promote student learning (Wienhold & Branchaw, 2018). One VLE that many higher education institutes have started using in introductory biology courses is Mastering Biology (MB; Beard, 2017). In this study, I aim to explore instructor perceptions and experiences of using MB to promote student learning.

Chapter 1 includes the background, problem statement, purpose of the study, research questions, theoretical framework, and nature of the study, including a rationale for selection of the research design. To eliminate any uncertainty regarding key concepts, I present operational definitions of relevant terms. This chapter also includes discussion of assumptions, scope and delimitations, and limitations of the research. I describe how

participant confidentiality was preserved and explain the measures I took to mitigate limitations. At the conclusion of Chapter 1, I summarize the main ideas and significance of the study and its implications for positive social change.

Background

As use of technology in education continues to increase, many higher education institutions continue to explore ways to use technology throughout their courses to offer students a more personal and individualized approach to learning (Bower, Lee, & Dalgarno, 2017; Sorbie, 2015). Advancements in technology have created a rise in the use of BL and VLEs in many higher education institutions. As of 2017, 70.7% of higher education institutions offered some type of distance learning course, which may be blended or undertaken completely online (Halverson, Spring, Huyett, Henrie, & Graham, 2017). There are many reasons for the recent increase in the use of BL and VLEs in higher educations across the globe, including ease of access to resources, more opportunities for collaboration, and flexibility in terms of availability, and these formats enable students to learn materials at their own pace (Halverson et al., 2017; Kurt & Tingöy, 2017).

As a result of rapid changes in technology, there are several differences in terms of teaching methods that are used in today's classrooms compared with methods that have been used in the past. One change in teaching approaches is the use of VLEs to help supplement lecture materials (Fuller, 2017; Wienhold & Branchaw, 2018). BL and VLEs can be used in higher education courses to help increase student success rates by

increasing student motivation and engagement due to additional online activities offered through the VLEs (Ates & Olpak, 2018; Yapici, 2016).

The BLS (2018) indicated that within the next 10 years, employment in life, physical, and social science occupations is expected to grow 10%, which is quicker than average for all occupations in science. With this increase comes the need for higher education institutions to produce employable biologists. However, in the biology discipline, introductory courses have continuously resulted in low student success rates due to lack of student engagement, variety of instructional methods used, and students transitioning to a college setting (Fuller, 2017). Given consistently disappointing student outcomes, educators continue to look for ways to not only increase student success in introductory biology courses but also to promote student learning (Batz, Olsen, Dumont, Dastoor, & Smith, 2015; Fuller, 2017).

An approach that is currently being used in these courses includes using BL and VLEs in the curriculum (Boulton, Kent, & Williams, 2018; Weerasinghe, 2018). Many instructors have begun using MB to help promote student learning in introductory biology courses. Research into educators' perceptions and experiences in using specific VLEs in introductory biology courses such as MB is limited. However, many instructors are questioning if using BL and VLEs help to promote student learning in courses (Boulton et al., 2018; Kurt & Tingöy, 2017). This study provides insight into biology instructors' perceptions and experiences, which has not been addressed in detail in the current literature, in terms of the use of BL and MB in introductory biology courses to promote student learning.

Problem Statement

According to the United States Department of Labor (2018), it has been projected that between 2017 and 2027, science, technology, engineering, and mathematics (STEM) jobs would increase by 13%. Many of these STEM jobs, such as those in the physical and life science fields, will go unfilled due to higher education institutions failing to produce enough biologists to meet demands. According to Batz et al. (2015), nationwide, 48% of students who begin a bachelor's program pursuing some type of STEM degree transfer into a non-STEM field or leave college completely. STEM courses, including introductory biology, are often associated with low grades, which play a role in students not completing or transferring out of STEM programs. Due to low grades in these introductory biology courses, they are viewed as barrier courses (Fuller, 2017; Han & Ellis, 2019; Scott, McNair, Lucas, & Land, 2017). The transition into postsecondary biology courses is challenging for many students, due to variety of instructional methods, such as face-to-face (F2F), BL, and online (Fuller, 2017; Wienhold & Branchaw, 2018).

Should the low success rates in the introductory biology-major courses continue, it may be difficult to maintain an adequate number of educated biologists available to fill the ever-increasing number of positions within this profession. A gap in research, therefore, arises to explore ways for educators to help increase student success rates in these introductory biology major courses. While research demonstrates that using BL and VLEs can help support student success in introductory biology courses, teacher perceptions and experiences regarding the gap in research and the use of BL and VLEs in

introductory biology courses have not yet been studied in detail, in particular teachers' experiences using specific VLEs (Ates & Olpak, 2018; Herodotou et al., 2018).

With continued low student success rates, which are as low as 40% in introductory biology courses, many higher education institutions are looking for ways to increase student completion rates and further promote student learning (Beard, 2017; Thompson, Bowling, & Markle, 2017). Approaches to increasing success in the introductory biology courses include integrating BL (Weerasinghe, 2018) and VLEs (Boulton et al., 2018) into these courses. Many educators who teach introductory biology courses have started using MB in their courses. MB, which is created and maintained by Pearson Education, Inc. is considered a VLE that is a repository for resources and a place to complete learning activities, communicate with students, and allows for communication between students (Beard, 2017). This VLE is an online tutorial system designed to help students achieve a better understanding of biology concepts and develop critical reasoning and problem-solving skills (Beard, 2017; Pearson, 2018). However, since educators have started using BL and VLEs, many instructors are questioning whether these approaches are effective in helping promote student learning and boost student success in introductory biology courses (Boulton, et al., 2018; Kurt & Tingöy, 2017). According to Cheok, Wong, Ayub, and Mahmud (2017), it is essential for educators to understand how the use of VLEs promote student success from educator perspectives because educators have the greatest power to impact success for this initiative. To potentially improve biology course readiness, educators need more information about the benefits and challenges of integrating and using BL and VLEs in

their courses. The problem is that there are limited studies available from the perspective of biology instructors on the use of VLEs, specifically MB, in introductory biology courses.

Purpose of the Study

The purpose of this basic qualitative research study was to explore experiences and perceptions of higher education introductory biology instructors regarding the use of BL and MB to promote student learning. By exploring instructors' experiences and perceptions, knowledge gained from this study will help to inform biology instructors about how the use of MB may help to promote student learning in introductory biology courses. The information gained from this study will also contribute to the breadth of knowledge in education regarding best practices in introductory biology course instruction.

Research Questions

This study was designed to address the following questions:

RQ1: How do biology instructors use MB to boost student success in introductory biology courses?

RQ2: What are the perceptions of biology instructors regarding the efficiency and usefulness of BL and MB to promote student learning?

RQ3: What are biology instructors' recommendations on how MB and other VLEs can be used more effectively in introductory biology courses?

Framework

The framework that informed this study was connectivism, which was originated by Siemens (2005) and Downes (2005a, 2008). A central tenet of many traditional learning theories, including behaviorism, cognitivism, and constructivism, is that learning occurs inside individuals. However, at times, learning can occur outside of the individual, for example within an organization or a database (Siemens, 2005). Connectivism is known as an alternative learning theory, with roots that can be traced back to theories of humanistic adult education (Elias & Merriam, 1980). A concept within the connectivist theory is the idea of melding technology with learning. Developed through the integration of chaos, network, complexity, and self-organization theories, the connectivist framework can assist educators in examining the use of technology in courses to connect knowledge and learning (Siemens, 2005).

Connectivism is rooted in the idea that learning can be enhanced using technology. For example, when Siemens (2005) discussed connectivism as a theory that bridges learning between humans and technology, such as computers and tablets, he stressed that once the link between humans and technology is formed, learning ceases to be an individual activity. Learning then becomes a collaborated process, with students using technology to access digital resources located in databases. In connectivism, educators examine the networks of knowledge between learners and technology-facilitated sources. Connections form between learners and external information in databases or other repositories that enable new learning to occur (Siemens, 2005).

A main concept of the connectivism learning theory is that knowledge can be stored in nonhuman appliances, which are devices such as computers and tablets (Siemens, 2005). These devices allow students to locate, store, and retrieve knowledge content, thereby advancing their learning with the support of technology. When using technology, it is necessary to stress to learners the need to connect and understand various sources of information so that all new information can be processed correctly. Siemens suggested that educators using traditional pedagogies that do not incorporate new learning tools, such as computers, in courses may limit the learner's ability to use technology to augment how they learn and connect important concepts. In this study, connectivism is a model of learning that can be used to help educators recognize the importance of using new learning tools such as MB to help learners succeed in a digital era. This study used connectivism to investigate the link between how learning can reside outside the individual, for example in VLEs, and the use of modern pedagogies in college-level introductory biology courses to promote student learning. Connectivism will continue to be discussed in more detail in Chapter 2.

Nature of the Study

This study was a basic qualitative study based on semistructured interviews with biology instructors who teach introductory biology courses in a higher educational setting. The interviews focused on biology instructors' perceptions and experiences of using MB in their introductory biology courses. Qualitative research involves naturalistic inquiry, which is where researchers study real-world settings inductively to produce rich narrative descriptions (Patton, 2015). With basic qualitative inquiry, participants'

descriptions of their opinions, attitudes, beliefs, or reflections based on their experiences of things in the real world are explored (Percy, Kostere, & Kostere, 2015). Many times, a basic qualitative design is used when other more focused qualitative approaches are not appropriate for one reason or another (Percy et al., 2015). Basic qualitative research fits well with many interpretive frameworks, such as connectivism, because it is not bound by the rules of a methodology (Kennedy, 2016). When the goal of a study is to describe or explore a phenomenon or process such as exploring teacher perceptions and experiences of using MB, then using a generic or basic qualitative study is an appropriate method (Kennedy, 2016).

For this study, I used snowball sampling, which is a purposeful sampling technique to recruit biology instructors that meet the inclusion criteria. As I am using a basic qualitative design a priori codes (Saldaña, 2013) were not used; instead, I developed codes after the first interview when the context of participants' experiences was established. Data analysis involved the identification of recurring themes. Using the study's findings, I was able to recommend strategies in Chapter 5 to improve educational practice that may help to promote student learning for all undergraduate students, including underrepresented groups such as women, Alaska Natives, Black Americans, Hispanic or Latino, Native Hawaiian or other Pacific Islander (AIBS, 2018). In addition,

this study also added to existing literature on BL and VLEs used in higher education settings.

Definitions

Blended Learning (BL): BL involves the use of mixed method delivery modes to promote learning opportunities where students learn at least in part through a combination of online and traditional F2F learning (Fisher, Bushko, & White, 2017; Nair & Bindu, 2016).

Introductory Biology: Introduction course based on fundamental biological principles emphasizing commonalities of all living organisms. In these courses, basic concepts such as cell structure and function, reproduction and genetics are covered (Lake Sumter State College, 2019; Valencia College, 2019).

Mastering Biology (MB): MB is created and maintained by Pearson Education, Inc. and is considered a VLE that is a repository for resources and place to complete learning activities, communicate with students, and allow for communication between students (Beard, 2017).

Virtual Learning Environment (VLE): A VLE is a web-based software system which includes tools and applications that allow for students and instructors to communicate and collaborate online to inspire learning, uploading of instructional content, student assessment, and instructor feedback (Cassidy, 2016).

Assumptions

I have identified three assumptions for this study. The first assumption was that participants provided authentic responses to the interview questions. To help create an

environment where participants could openly share their experiences, confidentiality was preserved, and participants could have withdrawn from the study at any time without ramifications. The second assumption was that the inclusion criteria for the study was appropriate and participants reported similar experiences involving the phenomenon. The third assumption was that instructors were willing to take part in the study because of its significance.

Scope and Delimitations

The scope of this basic qualitative research study encompassed introductory biology instructors who use BL and MB. These instructors needed to have taught introductory biology courses that use MB for at least one year. The goal was to interview 8–10 instructors to collate required data or conduct interviews until data saturation was reached. The scope of this study was established by using interview questions and conducting interviews, which were both developed specifically for a unique population of higher education biology instructors who use MB. This study was delimited by the accessibility of participants to participate in interviews. The study was limited by the availability of technology tools, such as virtual conferences, required to conduct interviews over the Internet. It is my hope that the results of these interviews will be transferable not only to biology instructors but also to instructors of other disciplines who use VLEs in their courses.

Limitations

A potential limitation of this study was in using an interview approach, and given that I am the only interviewer, the possibility of bias may exist. Qualitative research

involves bracketing researcher biases to mitigate the potentially adverse effects of preconceptions (Patton, 2015). One potential bias in this study was that I teach introductory biology courses. This bias was addressed with the use of bracketing (Patton, 2015), known as phenomenological reduction. With this method, the researcher suspends judgments of the topic by consciously bracketing them. A second potential limitation was the small sample size, which can limit the transferability of the results. Since this study is only focusing on introductory biology instructors, the results of the study will have limited generalizability to other populations of educators. A third potential limitation pertained to self-reporting or social desirability bias as educators may desire to be perceived positively; hence, they may not answer interview questions honestly. However, I assumed that participants openly and honestly shared their experiences and perceptions when answering all interview questions.

Significance

The significance of this study can be viewed from multiple perspectives. This study will contribute to the identified gap in research, exploring ways for educators to help increase student success in introductory biology courses, by providing insight into instructors' perceptions and experiences regarding the use of BL and MB in introductory biology courses. Information gained from this study can be used by higher education biology instructors and administrators to help inform biology educators about the potential value of using MB and other VLEs in introductory biology courses as tools that can contribute to promoting student learning. This study is innovative in researching a new learning tool MB in a new way by exploring teacher perspectives regarding the use

of this program in introductory biology courses. MB is a software-based learning tool that provides teachers and students with anytime, anywhere access to supplemental content including interactive activities and additional lecture material. Insights gained from the results of my study can provide positive social change by helping to inform educators about the usefulness of using BL and VLEs to help further promote student learning in introductory biology courses. Additionally, the results of this study can be used as a facilitator for additional studies on the use of BL and VLEs in other disciplines, as it can be replicated. I hope that I can work to expand on this study in the future and offer my assistance to other educators looking to begin or continue to use BL and VLEs in their higher education courses.

Summary

In this chapter, I introduced this qualitative study exploring the perceptions and experiences of introductory biology instructors regarding the use of BL and MB to promote student learning. The reasoning behind the development of this study was addressed, followed by background information regarding the current use of BL and VLEs in higher education institutions and the biology discipline. I introduced connectivism, which is the theoretical framework for this study. I also offered insight into the basic qualitative nature of the study, key terms, assumptions, scope and delimitations, limitations, and the significance of the study. The information in Chapter 1 lays the foundation for topics covered in Chapter 2 where I present the theoretical framework, connectivism, and the literature review. In the literature review, I offer a critique of studies involving four topical areas: the use of BL and VLEs in higher education, BL and

VLEs in the biology discipline, student and teacher perceptions of BL and VLEs, and challenges involving using BL and VLEs in higher education.

Chapter 2: Literature Review

Introduction

The current demand for employable biologists is increasing and is predicted to continue to increase over the next 10 years (AIBS, 2018). Many students who aspire to major in biology seem to have low success and pass rates in their introductory biology courses (Fuller, 2017). If low pass rates continue in introductory biology courses, it may be difficult to keep enough employable biologists. A need therefore arises to explore ways for educators to promote student learning in these courses. While research demonstrates that using BL and VLEs can help support student success in introductory biology courses, teacher perceptions and experiences about the use of BL and VLEs in this context have not yet been studied in detail, in particular, teachers' experiences using specific VLEs (Ates & Olpak, 2018; Herodotou et al., 2018). One VLE that many higher education institutes have started using in these courses is MB. The problem is that there are limited studies available from the perspective of biology instructors regarding the use of VLEs, specifically MB in introductory biology courses. In Chapter 2, I include the literature search strategies, theoretical framework, literature review, and a summary and conclusions.

Literature Search Strategies

I used the following databases and search engines in my literature review: Google Scholar, Education Research Complete, Science Direct, ProQuest, ERIC, SAGE Journals, and Academic Search Complete. I sought to gather literature relating to the use of BL and VLEs in higher education institutions. Keywords used in my search included the

following terms: *blended learning*, *blended learning pedagogy*, *virtual learning environments*, *introductory-level biology courses*, *higher education*, *college*, *university*, *Mastering Biology*, *student success and achievement in introductory biology-major courses*, and *teacher perceptions and student perceptions of BL and VLEs in higher education.*

Theoretical Framework

I used connectivism as the theoretical framework for my study. Siemens originally proposed the connectivism learning theory in a series of papers and a book (2005, 2006a, 2006b); he further developed the theory through his work with Downes (2005a, 2005b, 2008, 2011). Siemens (2005) developed connectivism based on eight concepts:

- Learning and knowledge rests in diversity of opinions.
- Learning is a process of connecting specialized nodes or information sources.
- Learning may reside in non-human appliances, such as computers or tablets.
- The capacity to know more is more critical than what is currently known.
- Nurturing and maintaining connections are needed to facilitate continual learning.
- The ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.

- Decision-making itself is a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information affecting the decision (Siemens, 2005, p.5)

For my study, I examined connectivism mainly through the scope that student learning can occur using non-human appliances, such as computers and tablets, and the connection between learning and knowledge is based on educators' individual perceptions and experiences. Hence, the connectivist theory provides educators with a framework of how technology can be used in courses to nurture and maintain continual learning (Siemens, 2005). Connectivism has gained support in many higher education institutions as a concept that can be used in explaining how technology affects student learning and knowledge (Downes, 2011; Siemens, 2006b). The connectivism learning theory centers on how higher education instructors can build knowledge and learn collaboratively using technology (Siemens, 2008). Because technology is continuously changing, connectivism helps to structure the way learners communicate and interact, which in turn changes the learning process.

Connectivism is premised on Siemens' belief that decisions in terms of learning and knowledge are founded on rapidly changing foundations, and new information is constantly being acquired by individuals (Siemens, 2005; Siemens & Conole, 2011). A central concept of connectivism is that learning, defined as actionable knowledge, can reside outside of humans in a database. In this study, the database that knowledge is

residing in is MB. Learning is centered on connecting sets of information and how these connections enable students to learn more so that new knowledge is more important than individuals' current state of knowing (Siemens, 2005). With the connectivism learning theory, knowledge is being distributed across various information networks and can be stored in an assortment of digital formats (Siemens, 2005).

Connectivism was established based on several concepts, including individual thoughts, diversity in terms of perspectives of others, lifelong learning, forging relationships, interdisciplinary connections, and current information (Siemens, 2005). These concepts can be found in current technologies that students use daily for educational purposes such as MB. I chose to use connectivism as the framework for this study because it is a model of learning that can be used to help educators recognize the importance of using new digital learning tools such as MB to help promote student learners in a digital era.

Connectivism Applied in BL and VLE Studies

Reese (2014) studied the application of connectivism and learning in higher education to show how the online learning environment could be used as a catalyst to get students involved in courses. The study was conducted using a systematic review of existing literature, published within the past 15 years, with the inclusion criteria that studies must focus on the use of VLEs in higher education along with how the connectivism learning theory is being utilized in courses to promote student engagement and learning. The results from the systematic literature review showed that the integration of active learning assessments using VLEs in courses enables students to not only receive

the materials but become participating members of the course. Reese and Siemens (2008) agreed that BL education has the potential to be an interactive environment where students can collaborate, communicate, share, and discuss.

Gerard and Goldie (2016) also conducted a systematic literature review to examine connectivism and its potential applications in education. The inclusion criteria for the literature review included existing literature, published within the past 15 years, on higher education medical courses in which the principles of connectivism were used in course design. The authors specified that knowledge is continuously changing, and thus its relevance will always be affected by new contributions made to the field. In turn, the way students learn will also be ever-changing. Results showed that in the learning process, students connect to a network to find new information and alter beliefs in terms of their new learning. Then, students reconnected to share and find more information. The findings of Gerard and Goldie can be used to inform my study of the potential applications of connectivism to help aid students in the learning process.

Bannister (2016) used the connectivist theory to discover how 10 higher education instructors experienced qualities of connectivism in their F2F and online undergraduate business courses. The author generated four themes based on the characteristics of connectivism: autonomy, which is fostering student self-direction and decision to learn, teacher openness, diversity, and interactivity/connectedness. The connectivism themes found by Bannister can be used to inform my study by showing how higher education instructors incorporate the connectivism theory into their courses.

The findings from Gerard and Goldie (2016) and Bannister (2016) indicated that many instructors are using the connectivism theory in their courses to build learning assignments that help promote student learning. Reese (2014) agreed that learning activities that are based on connectivist ideas help students be more engaged in learning activities while also promoting student learning in courses. Gerard and Goldie and Reese noted that the learning process is ever changing; therefore, educators' teaching practices must also continually evolve to keep up.

Use of BL and VLEs in Higher Education

In this literature review, I examined the use of BL and VLEs in higher education institutions. The literature that I reviewed concerns BL and VLEs across higher education institutions but concentrates mainly on how BL and VLEs are being used in introductory biology courses. In this literature review, several themes emerged in current research. These themes included the use of BL and VLEs in higher education, using BL and VLEs in introductory biology major courses, student and educator perceptions of BL and VLEs, and challenges of using BL and VLEs in higher education.

Leaders of many higher education institutions are prioritizing BL instead of traditional teaching methods such as F2F due to increased student achievement levels seen in BL courses when compared to traditional F2F courses. Vo, Zhu, and Diep (2017) conducted a meta-analysis using 122 articles based on the following criteria: dated after 2001, student performance evaluated by objective measures, and effect of BL on student performance in a higher education setting as measured by the effect size. The results from this meta-analysis showed an effect size of g =.327. Thus, the meta-analysis showed that

BL was a good alternative to the F2F courses with BL courses having higher student achievement levels compared to traditional F2F courses (Vo et al., 2017). Vo et al. noted that the meta-analysis only included a small portion of available literature and recommended a larger scale study follow.

Many instructors in various disciplines in higher education have begun to use BL and VLEs to promote student learning. Han and Ellis (2019) conducted a quantitative study using 387 undergraduate advanced financial reporting students to investigate the use of BL and discussions to help boost student learning. A closed-ended questionnaire, which used a 5-point Likert scale (1 = *strongly disagree*; 5 = *strongly agree*), was used to investigate conceptions of and approaches to discussions in a BL course. Han and Ellis used correlation, factor, and hierarchical analysis to identify possible patterns of quality of learning in the BL course discussions. The authors found a positive and moderate correlation with both the F2F (r=.64, $p < 0.01$) and online discussions (r =.58, $p < 0.01$). The results of the study were consistent with those of other studies in demonstrating the stability of utilizing a BL teaching method in discussions in higher education courses (see Vo et al., 2017). A limitation of the study is that the results are limited to a single course in the business discipline. Vo et al. (2017) and Han and Ellis noted limitations in the generalizability of their findings based on their sample selection.

In a qualitative study, Boda and Weiser (2018) used a pre and post course assessment and the final grades of 25 undergraduate General Chemistry I and 26 General Chemistry II students to determine if BL can be used as a potential teaching practice to improve student success. An analysis of covariance (ANCOVA) was used to compare the

pre and post course assessment scores between General Chemistry I and II students. This analysis showed no significant difference, F (1, 49) = 1.11, p >.05, between the General Chemistry I and II courses. An analysis of retention was also completed based on the percentages of students who met the departmental requirement for retention in the degree. This analysis showed that students who participated in the BL General Chemistry I courses were 36% more likely to receive a grade of a C or higher than those who did not take the BL General Chemistry I course (Boda & Weiser, 2018).

BL can supply learners with access to supplemental learning materials that can be used and completed at their convenience. Using online questionnaires with open and closed-ended questions, Weerasinghe (2018) examined student achievement and engagement of 75 undergraduate eLearning and instructional design students in blended courses. Findings revealed that 90% of students in the course were satisfied with the activities available to students through the VLE, such as interactive activities and online presentations, and the level of engagement that took place within these activities. One finding from the closed-ended questions in the study indicated that even though all the respondents were satisfied with the BL aspects of the course, the number of assignments sometimes overwhelmed the learners. Even though Weerasinghe did not use the biology discipline in the study, the results can still be used to inform the research questions of this study. Weerasinghe found that students in BL environments valued online discussions similarly to other types of learning activities, such as E-portfolio development, online assignment submission, and online presentations.

When a BL environment was used in higher education, student success rates increased as measured by different assessment methods (Boda & Weiser, 2018; Han & Ellis, 2019). Boda and Weiser (2018) used pre and post course assessments, whereas Han and Ellis (2019) used open- and closed-ended questionnaires to obtain data. Like Vo et al. (2017), Boda and Weiser said that the small sample size was a major limitation in the findings. Insufficiency in sample size was seen by Boda and Weiser (qualitative study) and Han and Ellis (quantitative study) as a threat to the validity and generalizability of the studies' results. Boda and Weiser and Han and Ellis noted that future researchers should investigate BL at the undergraduate level in multiple disciplines including but not limited to biology. As Han and Ellis's and Boda and Weiser's studies took place in nonbiology disciplines, their relevance in addressing the research questions is not as direct as Beard's (2017) work on MB.

The use of VLEs in higher education institutions continues to rise with the ongoing incorporation of technology into courses and teaching practices. Smith, Chungh, Sadouq, and Kandiah (2017) conducted a qualitative study to investigate how VLEs scaffold students' eLearning. In analyzing data from interviews of 122 undergraduate students, the authors found that students welcomed VLE content while using mainly laptops and smartphones to access video lectures and quizzes. Although students welcomed more VLE content into courses, they had several suggestions on ways to improve this content including video lecture and audio clip quality. Students' favorite VLE activity was videos of lectures because these videos helped students reflect on what they learned in class with no distractions (Smith et al., 2017). Smith et al. indicated that

their study only represents a snapshot of the student opinions in one pharmacy education program.

Cassidy (2016) conducted a mixed-methods study to examine the pre versus post use of VLEs in courses and the use of VLEs in core versus elective courses. The author used questionnaires that included closed-ended Likert-type and opened-ended statements to evaluate 128 second-year undergraduate students. The choices for the study included the response categories extremely/very satisfied, satisfied, neither, dissatisfied, and very/extremely dissatisfied. Findings showed that 40% of students were extremely/very satisfied with the use of a VLE in their course compared to the nonuse of a VLE in their courses. Regarding students' satisfaction with use of a VLE in core versus elected courses, there was not a statistical difference found in these levels. One theme found from the opened-ended questions was that VLEs provide students the ability to review course materials a second time after the initial lecture.

Cassidy (2016) and Smith et al. (2017) remarked that students used VLEs to access additional materials that were not presented in lecture. A limitation noted by Cassidy and Smith et al. is the generalizability of their findings is based on the limited sample information available. Cassidy identified that individual student differences, such as previous experience using VLEs and computer and Internet user-self-efficacy, likely played a part in the efficacy of VLEs. Results provided by Cassidy and Smith et al. offer insight into undergraduate students' use of and satisfaction with VLEs in courses. However, these studies do not help to directly inform the research questions for this study.

BL and VLEs as Innovative Approaches

Modern teaching pedagogies, such as BL and VLEs, offer educators the opportunity to use innovative approaches in their courses. In a qualitative study, Bower et al. (2017) used open-ended questions to understand how emerging technologies (VLEs) impacted the teaching practices of 33 undergraduate teachers. Through the data analysis and coding, Bower et al. concluded that the introduction of VLEs showed increased student collaboration and interaction during learning activities, greater teacher-student communication, and a reported safe environment for shy students to contribute when compared to a didactic teaching approach. Students agreed the emerging technologies enabled them access to learning from anywhere, allowed for the exchange of ideas, and promoted higher levels of engagement. Most students (79%) specified that they would be happy to see the BL approach and VLEs used in other courses in the future (Bower et al., 2017).

Bower et al. (2017) indicated that several pedagogical, technological, and logistical factors worked to enable communication, collaboration, and co-presence. Similarly, Cassidy (2016) and Smith et al. (2017) employed multiple strategies such as online activities, discussion boards, and video lectures to support effective interaction and learning in VLEs. Cassidy, Smith et al., Han and Ellis (2019), and Weerasinghe (2018) shared similar results where students were satisfied with the use of VLE activities in their courses.

Goeser, Hamza-Lup, Johnson, and Scharfer (2018) conducted a qualitative study to evaluate the use of a VLE, named Virtual Interactive Engineering on the Web (VIEW),

to determine if VIEW could be used in higher education engineering programs to increase student success and attainment. In the study, the authors developed the Virtual Tensile Testing Laboratory (VTTL) as a module in VIEW for students to use as a supplement, to help promote student learning, in an introductory engineering course. Goeser et al. utilized a two-fold approach to assess the effectiveness of the VTTL on students' learning and overall success in the course. The first approach was evaluating student perceptions using a student survey, and the second was comparing students' examinations performance with and without the benefit of VTTL. Findings revealed that 88% or 22 of the 25 respondents strongly agreed or agreed that the VIEW helped them to better understand important concepts studied in the course. Students agreed and saw the benefits of using a VLE for labs in this course and future courses (Goeser et al., 2018). A limitation of the study was that only one VLE VIEW was evaluated within one discipline, engineering. Boda and Weiser (2018), Bower et al. (2017), and Han and Ellis (2019) saw similar limitations. The research by Goeser et al. lays the foundation for the development of additional virtual models in not only other courses in the engineering discipline but also in other disciplines.

Studies in this section occurred in several higher education disciplines. However, these studies failed to focus specifically on the biology discipline. Multiple studies including Boda and Weiser (2018), Goeser et al. (2018), and Weerasinghe (2018) suggested that future studies should focus on larger scale evaluations of the use of BL and VLEs in multiple disciplines. The lack of studies related to biology BL and VLEs

reinforces the gap in the literature to inform best practices for introductory biology courses in my study.

Use of BL and VLEs in Introductory Biology Courses

In many higher education institutions instructors are teaching introductory biology in one of three methods including F2F, blended, or hybrid. Gonzalez (2014) conducted a quantitative study comparing 670 undergraduate general biology students to assess how, F2F, blended, and hybrid teaching methods influenced student success rates. Student success rate is defined as the percentage of students who earned a grade of a C or higher. The difference in these three teaching methods is the amount of time spent in the classroom and the use of online activities to help supplement lecture and lab materials. Gonzalez found the BL method yielded the highest percentages of student success at 69%, hybrid courses were second at 65%, and F2F at 55% (Gonzalez, 2014).

Gavassa, Benabentos, Kravec, Collins, and Eddy (2019) conducted a quantitative study using 2,303 undergraduate introductory biology students to compare student exam scores in courses that used F2F, blended (hybrid), and online teaching methods. Gavassa et al. performed statistical analyses using chi-square nonparametric tests to examine differences in student demographics and the student's current college level (freshman, sophomore, junior, or senior). The linear regression model, including SAT Math score, college level, ethnicity or race, and course format, explained a significant proportion of the variation in student performance ($r^2 = 0.387$, $F\ (12, 397) = 20.87$, $p < 0.001$). Gavassa et al. found that the lowest student exam scores were seen in the F2F format and the highest in the blended course sections. These results supported Gavassa et al. initial

hypothesis that blended or hybrid courses with high levels of in-class engagement and active learning assignments, such as activities that are completed in a VLE, will result in higher student exam scores than either F2F course or online courses (Gavassa et al., 2019). Gavassa et al. found no significant differences in the college level between students enrolled in the F2F and the hybrid course formats (F2F vs. hybrid: $\chi 2 = 5.8713$, $df = 3$, $p = 0.118$; Gavassa et al., 2019).

Gavassa et al. (2019) stated a limitation for offering the three formats of teaching methods, when self-enrollment is a factor, is there will be inequality in population for each specific format. With students being able to self-enroll into courses and certain student groups having preference for different class formats the generalizability of the results of the study is limited. Gavassa et al. also supported the literature showing positive results of BL courses on students' success. Gonzalez (2014) and Gavassa et al. found the BL method to have the highest rate of student success. Gonzalez and Gavassa et al. stated a strength of their studies included evaluating three main teaching methods, F2F, blended, and online instead of only focusing on one or two methods. By evaluating three teaching methods, Gonzalez and Gavassa et al. presented findings on multiple teaching methods within their studies.

Lax, Morris, and Kolber (2016) conducted a mixed methods study with 72 undergraduate students who were enrolled in two sections of introductory biology. The study investigated the effects of incorporating a partial flipped (blended) classroom (experimental group) in introductory biology on student success to a non-blended section (control group). Lax et al. analyzed the qualitative data from this study using the

Classroom Observation Protocol for Undergraduate Students (COPUS). The COPUS analysis helped the authors to quantify how students and instructors spent time in the control section compared to the blended section. By using the COPUS, Lax et al. found the instructors and students in the control section spent only about 50% of class time involved in the learning activities compared to the experimental group where students and instructors spent 75% of their time on learning activities. When looking at in-class formative assignments, students in the experimental group performed better on activities, such as clicker questions, and had higher confidence in the material ($p < 0.0001$) than the control group (Lax et al., 2016). Lax et al. indicated that utilizing a partial flipped (blended) classroom may help to boost student confidence in course materials and help improve performance on formative assessments. Fuller (2017) and Lax et al. agreed that students who had access to online materials, such as discussions and portfolios, are more likely to spend time on these activities than those who did not have access.

In many higher education institutions, introductory biology instructors are transitioning teaching pedagogies from F2F to a BL method that utilizes VLEs. Fuller (2017) used a quasi-experimental research design with 78 undergraduate introductory biology students to evaluate how formative assessments in combination with BL and a VLE (experimental group) can encourage interactions with course materials outside of the designated classroom time. Fuller found that many introductory biology students often feel disconnected from the course materials, which leads to a lack of student engagement throughout the course. Fuller used formative assessments, such as discussions and student learning portfolios, in the study to increase student engagement.

The results from Fuller indicated that students who had access to the formative assessments and the VLE (experimental group) utilized these resources 2.7 times more than those students who did not have VLE access (control group). Students in the experimental group (83%) had higher exam scores, a letter grade of C or higher, than the control group, where (72%) had a/an average letter grade of C or better.

Fuller's (2017) findings indicated that the use of formative assessments in addition to the use of VLEs is an efficient way to improve student success and engagement in introductory biology courses. The author focused on a small set of community college students and recommended that a larger scale study be conducted to continue to explore the linkage between online formative assessments and student engagement in introductory biology courses. Fuller also noted future research is needed in assessing teaching strategies and activities to further promote student success in introductory biology courses.

Wienhold and Branchaw (2018) used cross-sectional analysis to determine if implementing a BL style teaching model along with a VLE, Exploring Biology, would increase student performance in introductory biology courses. Wienhold and Branchaw used data from 400 student course evaluations, 183 surveys from alumni who completed an introductory biology one to three years prior; and institutional data on student academic performance in introductory biology courses. The institutional data met the following criteria: statistics for first-year students between the ages of 17-21 who completed Exploring Biology (experimental group) or the first semester of the two-semester introductory biology course (control group). Survey results showed that more

than 50% of participants had a positive view experience using the VLE, Exploring Biology. Wienhold and Branchaw determined Exploring Biology students continued to pass the second semester more often than comparison students (χ^2, $p = 0.0046$). Exploring Biology students who received a C in the first semester of Introductory Biology more often passed the second semester than comparison students who earned a C in the first semester ($\chi 2$, $p = 0.021$).These results indicate that the use of Exploring Biology in introductory biology courses can help to promote student learning. The data from Wienhold and Branchaw provided strong evidence for the effectiveness of using Exploring Biology to increase student success in introductory biology courses.

Fuller (2017) and Wienhold and Branchaw (2018) provided strong evidence that VLEs can be utilized to help increase student success and engagement in introductory biology courses. However, it is challenging, if not impossible, to attribute student success to a single learning experience or intervention (Wienhold & Branchaw, 2018). The information gained about the VLE, Exploring Biology, in Wienhold and Branchaw, can be used to inform the research questions for my study about how the use of MB can help promote student learning.

Yapici (2016) conducted a mixed method study to investigate the effects of utilizing BL to increase student academic achievement in undergraduate biology classrooms by evaluating the achievement test scores of 61 pre-service teachers in the biology education program. The results indicated that there was a significant difference, $t(59) = 2.87$, $p < .05$, between the achievement post-test scores of the experimental group (18.33) which used a BL method and the control group (13.50). Thus, the results

indicated that the use of BL teaching methods contributed more to the students' achievement than traditional teaching methods. A limitation of using BL in biology courses is the ability for all students to have access to the Internet (Yapici, 2016). Precautions to overcome the deficiency for access to Internet access would need to be taken.

Many instructors have begun to redesign introductory biology courses to include a change to the course structure to integrate more active learning activities, such as virtual learning content, to supplement lecture materials in the curriculum. In a qualitative study Goff et al. (2017) investigated the effectiveness of using a VLE as a stand-alone learning tool to educate students on the topic of meiosis in an undergraduate introductory biology course using 534 students in four sections. In the study, the course sections were randomly assigned to one of the two treatment groups, the online learning group, and the traditional lecture group where a pre and post test were used to evaluate the effectiveness of the online meiosis learning module. Goff et al. calculated normalized gain scores for each student and ran a multiple linear regression analysis to examine the impact of possible explanatory variables on normalized gain scores. An analysis of pre test scores indicated a low recollection of concepts relating to meiosis in the traditional lecture group and the online learning group. Goff et al. measured student achievement, using the normalized gain scores, with a post test and determined that students who interacted with the learning module revealed significantly higher normalized gain scores than students in the traditional lecture group (Goff et al., 2017).

The studies in the Use of BL and VLEs in Introductory Biology Courses section used various assessment methods including course evaluations (Wienhold & Branchaw, 2018), achievement tests (Yapici, 2016), pre and post tests (Goff et al., 2017), and student surveys (Wienhold & Branchaw, 2018), to obtain data that revealed similar results. These results indicated that the use of BL and VLEs helped promote students' academic success in introductory biology courses. Fuller (2017) and Goff et al. (2017) used formative assessments and found that students use VLEs as learning tools to interact with course materials after in-class lectures. Studies by Fuller, Gavassa et al. (2019) and Yapici (2016) revealed that students who took an introductory majors biology course that used BL teaching methods showed increased exam scores when compared to those students who took courses that did not employ BL teaching methods.

The results from the studies in Using BL and VLEs in Introductory Biology Courses section provided evidence that BL teaching methods and VLEs are currently being used in higher education introductory biology courses. Wienhold and Branchaw (2018) focused their study on Exploring Biology, but their study was one of the few found to explore specific VLEs in the biology discipline. The lack of information in the literature on specific VLEs utilized in introductory biology courses corresponds with the indicated gap of this study.

Course Specific VLE: MB

Since higher education introductory biology instructors are following the current trend and continuing to incorporate modern learning techniques, specifically BL and VLEs, in their courses. Many instructors are also looking to use course specific VLEs.

VLEs help to supplement lecture materials with additional online activities. One VLE that many introductory biology instructors are using is MB, which is created and maintained by Pearson Education Inc. In a mixed method study using 214 undergraduate biology students, Beard (2017) measured and monitored student engagement and attainment on the usefulness of MB. The author used summative and formative assessments to assess student engagement and attainment Throughout the monitoring period, students' engagement in the summative assessments, activities that were compulsory was high, with 94±3.2% of students attempting a minimum of one question on each summative assignment. Formative assignments, assignments that were non-compulsory were used in MB to provide students with extra resources. Student engagement in the formative assignments was significantly lower than the summative assignments, with 34±10.9% of students attempting a formative assignment per year. Beard calculated student attainment by using the mean score of student performances on the summative assignment by year. Attainment and engagement were closely linked where the more summative assignments that were completed, the more likely that students would have achieved a higher overall score for MB (Beard, 2017). Beard noted that by providing access to online support tools such as MB, students can better understand the lecture.

In a mixed methods study Collings, Gerrard, and Garrill (2018) used 223 general biology students to evaluate how the use of alternative teaching methods can be used to help continue student success. Instructors utilized MB to provide students with additional learning resources and quizzes. Collings et al. determined student success in general

biology courses by using an average of the number of questions correct was evaluated. Results revealed that the average marks for the MB multiple choice quizzes had a strong correlation (r^2= 0.812) to the average marks obtained for the multiple-choice component of their final examination. With these results, Collings et al. determined that MB could be used as a pool of resources that students can use not only as study materials but also to take quizzes for their courses (Collings et al., 2018).

Beard (2017) and Collings et al. (2018) agreed that MB can be used by students as a pool of learning resources to supplement lecture materials. Beard and Collings used formative assessments to gather qualitative and quantitative data that when analyzed supported the findings that MB can be used as a support tool to help increase student tests and online quiz scores. Beard noted that the use of MB can increase student engagement in biology courses. Beard's assessment of students' uses of MB to access additional learning resources aligns with Fuller's (2017) and Goff et al.'s (2017) studies where VLEs can be used as learning tools to help boost student success and engagement.

While researching MB, it became clear that there is limited information available regarding this VLE. The majority of research articles focused on VLEs in general and not specific VLEs. More research is needed regarding the use of specific VLEs such as MB in not only biology but also other disciplines (Beard, 2017; Fuller, 2017; Goff et al., 2017).

Student and Educator Perceptions of Using BL and VLEs to Promote Student Learning

The use of BL and VLEs are becoming more commonplace in higher education institutes and with the use of the modern teaching pedagogy comes the need to investigate student and educator perceptions of these methods. Herodotou et al. (2018) conducted a mixed-method study that utilized the surveys of 139 undergraduate biology students and 11semistructured interviews to compare student perceptions of the use of a VLE, virtual microscopes (VM) in a blended and online learning environment. The survey consisted of a set of 5-point Likert type questions, with the questions in the following categories: usage patterns, VM features most often used, occasions used, perceived learning used, satisfaction with VM, previous experiences with VM, and previous experiences using physical microscopes. The interviews were semistructured and targeted to triangulate insights from survey data. Herodotou et al. used mean comparisons and analysis of covariance (ANCOVA) between blended and online students to test for statistically significant differences. The comparison of means showed a statistically significant difference between the usage patterns of students in a BL and online learning environment. However, a follow-up ANCOVA was performed and indicated no statistically significant differences between the blended and online-only conditions (F (1, 108) =.476, p = .492).

Herodotou et al. (2018) used thematic analysis to analyze the data collected from 11 interviews with undergraduate biology students. A theme found included the perceived usefulness of VM due to the ability of students to use this tool at their own

time and pace. Herodotou et al. found students' overall usage of the VLE depended on the type of activities and assessments students were required to complete. Participating students also stated that the VLE was easy to access and navigate. The authors recommended that more studies are needed to gather teachers' perceptions about the integration of VLEs, such as VM in online courses and their experiences of using these tools with students to add additional information to the existing VLE literature.

In a mixed-method study, Ates and Olpak (2018) examined pre-service science teachers' perceptions towards additional instruction in biology laboratory applications in the scope of BL. In the research, a variety of tools were utilized to collect data from 69 undergraduate biology education students, including an academic achievement test, personal information form, student feedback form, and semistructured interviews. Ates and Olpak used a one-way ANOVA to analyze if the students who participated in the additional instruction (experimental group), final achievement scores differed significantly from those students who did not have any additional instructional strategy (control group). Results of this analysis indicated there was a significant difference ($F3$, 65), $p < 0.05$) between the experimental and control group (Ates & Olpak, 2018). The study used a student feedback form to obtain students' views on the BL process. Ates and Olpak analyzed the student feedback form using frequency, mean, and a one-way ANOVA, to examine satisfaction level. These analyses found that students in all groups had a high level of satisfaction with the BL biology course. One theme identified in the semistructured interviews was that the additional assessments, such as online quizzes,

reflection papers, and discussions helped students to engage in course materials (Ates & Olpak, 2018).

Ates and Olpak (2018) remarked that poor internet connection could have hindered students' progress in completing the online activities, such as discussion boards. Another limitation was the small sample population of students. Ates and Olpak concluded there is a need for future studies to use a larger population sample, at different educations levels, and different disciplines to continue to add to the relevant literature.

Krishnan (2018) conducted a quantitative study to investigate 56 undergraduate students' perceptions of the F2F mode and online mode in a hybrid or blended mathematics course. The instrumentation for this study was a five-point Likert-scale (1-Strongly Agree, 2- Agree, 3- Neutral, 4- Disagree, and 5-Strongly Disagree) questionnaire. The study used descriptive analysis and radar charts to display students' average responses to the items on the instrument. Krishnan found that 62.5% of the students agreed that mathematics courses should be taught as a hybrid course utilizing BL methods, a combination of F2F, and online instruction. Students who agreed that they can understand mathematics concepts better in the online learning environment was 35.8%, and who agree that online materials improve their ability to learn mathematics was 42.9% (Krishnan, 2018). A weakness displayed in Krishnan and Ates and Olpak (2018) is that only a specific section of student perceptions was explored and did not expand their research to include students of other sections. The information gained from Krishnan's study can be used to provide relevant background information on the current use of BL methods in higher education courses.

Pinto-Llorente, Sánchez-Gómez, García-Peñalvo, and Casillas-Martin (2017) conducted a quantitative study to explore 358 undergraduate English education students' perceptions of the use of technological tools in a BL environment. Students were assigned to complete a pre and post questionnaire, in a VLE. Pinto-Llorente et al. found of the 358 cases, 288 (80.4%) stated that it was the first-time students had studied under BL modality, so the students had no prior experience in this kind of environment. Pinto-Llorente et al. highlighted students' use of BL technology tools including podcasts (36.2%), videocasts (60.4%), online tests (46.8%), and the online glossary (47.1%). The results from the study indicated that students have a positive perception and attitude toward the use of BL and technological tools used in courses, although most of them stated they had limited experiences with the tools. The authors also noted the importance of utilizing BL and VLEs, along with technological tools in courses to help promote student learning. Even though Pinto-Llorente et al. used English education students in the study, the information gained from this study can be used to inform my study on the different ways BL and VLEs promote student learning.

Gulbinskienė, Masoodi, and Šliogerienė (2017) used quantitative questionnaires to gain feedback from 100 undergraduate students studying English for Specific Purposes to evaluate language learning on a VLE. Students had positive views and opinions regarding the use of a VLE as an environment to promote language learning. Gulbinskienė et al. found that using VLEs in language learning helped to increase student confidence to write (84%), read (81%), and communicate (81%). Results from Gulbinskienė et al. indicated that the use of VLEs provided an opportunity for educators

to help students take charge of their learning, to be more autonomous, develop their own strategies, and allow them to work at their own pace.

Badilla Quintana, Vera Sagredo, and Lytras (2017) conducted a mixed-method study to examine 10 pre-service teachers' perceptions about the use of VLEs, Second Life (SL), Open Simulator (OS), and Active Worlds, to improve teaching and learning. The authors used two data collection tools, an observation grid and a personal logbook. Using the observation grid, Badilla Quintana et al. collected students' performance data about the development of pedagogical activities while in teacher training. For the second instrument, students used the logbook to capture pre-service teachers' perceptions about the development of the planned activities and the pedagogical and technological development of learning activities. The authors used descriptive statistics mean and standard deviation, and inferential analyses for the observation grid. The results from the observation grids showed the highest level of achievement regarding pedagogical skills was teacher professionalism (SL $M = 6.80$, $SD = 0.81$; OS $M = 6.76$, SD = 1.00 respectively), which is the ability of students to find technical and instructive solutions. The authors employed grounded theory to analyze student logbooks using a constant comparison method. Results from this study indicated feedback was a key piece for the learning process, along with collaborative work. One limitation noted in the study was that when teachers use VLEs in courses there were technological difficulties, such as hardware and connectivity issues. Badilla Quintana et al. and Ates and Olpak (2018) agreed that internet connectivity is a main technological issue that can hinder the use of VLEs in many higher education courses.

Kurt and Tingöy (2017) conducted a quantitative study using questionnaires completed by undergraduate education students, 510 from Country A and 522 from Country B, to evaluate the acceptance and use of a VLE in higher education. Kurt and Tingöy assessed the results from the questionnaire using frequency distribution, regression analysis, and exploratory factor analysis (EFA). The effect of the performance expectancy, which tested for the expectancy of students to use the VLE on behavioral intention, was significant in the samples from the first country A ($\beta = 0.217$, $p < 0.01$) and the other country B ($\beta = 0.379$, $p < 0.01$). Findings showed students had favorable perceptions concerning the benefits of using VLEs in courses.

Kurt and Tingöy (2017) noted a limitation of the study was that the sample population might have been from two countries, but the students who participated were exclusively from only two universities. To gain the full perspective of the two countries more than two universities needed to be included in the study. Kurt and Tingöy's (2017) findings cannot account for entire university student population in both countries. The results of Kurt and Tingöy's study can be used as relevant background information to inform how students in undergraduate courses perceive the use of VLEs to help promote student learning.

Risquez, Raftery, and Costello (2015) conducted a mixed method study using an online survey instrument and open-ended questions to examine 21,000 undergraduate students' perceptions of VLEs. However, out of the 21,000 participants only 4%, 840 responded to the online surveys. This project is ongoing, open to participation by any educational institution within a European country and beyond. The survey results

suggested that many students use VLEs to access supplemental materials, submit work, and communicate with their peers. Students commented on the lack of VLEs being used by lecturers as a barrier, and students would like their lecturers to make more use of VLEs in courses. Many students reported that VLEs helped to make lecture materials more accessible to them than just having materials presented in class, with a third reporting that they would communicate with their lecturer using a VLE. Risquez et al. indicated that the study suffered from low response rates, which was as low as 4%, of the surveys. Risquez et al. and Herodotou et al. (2018) agree that the low response rate can be credited to the surveys being delivered to students by emails and announcements within the VLE system. Alternative delivery methods, such as announcements in class, for the surveys is needed to increase student response rates.

Gregg-Jolly et al. (2016) used a mixed methods approach to characterize the perceptions of 61 undergraduate science students on the use of new learning pedagogies in courses. The pedagogical reform included integrating engaged-learning, active learning activities, and multiple online activities. In the study, an online survey was used at the beginning of the semester to gain a better understanding of student experiences and mindsets. The authors used focus groups to gather multiple student perceptions on classroom environments and learning activities. Telephone interviews of 14 students explored students' perceived challenges and other final thoughts from the semester. A theme found in the focus groups and individual interviews was students' fondness of the BL style courses. Students commented positively on the use of active learning activities,

such as the use of discussions, group work, and demonstrations that took place in-class and online.

Gregg-Jolly et al. (2016) used an ANOVA to evaluate the pedagogical reform using pre and post tests and followed by post hoc pairwise comparisons for analysis. The results from the quantitative analysis indicated the successful completion rate, which is a letter grade of C or better, increased from 73 to 88% for biology students who participated in the intervention compared to those who did not. Qualitative and quantitative data supported that students who enjoy BL style activities see an increase in successful completion rates in their courses. Gregg-Jolly et al. concluded that students' perceptions from the study showed a positive outlook on BL strategies in science courses, along with the continued encouraging use of other support interventions.

In a quantitative study, Cohen and Sasson (2016) investigated the attitudes of 120 undergraduate life science students when using a VLE to complete online quizzes in an introductory physics course. There were multiple research instruments used in the study, including data logs and questionnaires. Data log files were retrieved from the online database to examine the students' behaviors, such as how many attempts students utilized on the quizzes and the improvements between the first and last attempts. Cohen and Sasson used a questionnaire to assess students' attitudes towards online quizzes as compared to written exams. The students were required to rank statements on the questionnaire on a scale of one to five, where 5 was strongly agree to 1 which represented strongly disagree. Findings revealed that students who completed the online quizzes more than once significantly improved their quiz scores (mean first attempt=53.38, *SD*=31.12,

mean last attempt =82.39, *SD*=22.99, *t*=-10.7, *p*<0.001, Cohen's *d*=1.380). Close inspection of the questionnaires revealed students' attitudes toward the use of online quizzes were positive. The authors found that a positive, statistically significant relationship was discovered between students' attitudes and their scores on online quizzes. However, the explained variance value (r^2) was low (*F*=16.065, *p*=0.000, r^2=13%). Cohen and Sasson emphasized the function of online quizzes, in a VLE, as a tool for formative assessment that enabled more interaction between the instructor and student.

In studies by Cohen and Sasson (2016) and Gregg-Jolly et al. (2016), students frequently commented on their fondness of using online activities in BL classrooms. Cohen and Sasson and Gregg-Jolly et al. sought to gain the perspectives of undergraduate science students on the use of BL pedagogies and online activities in biology courses. Even though the research questions for this study focus on instructor perceptions, the studies by Cohen and Sasson and Gregg-Jolly et al. provide background information on the types of activities that are currently being used in BL courses in the biology discipline.

Pinto-Llorente et al. (2017), Gregg-Jolly et al. (2016), and Cohen and Sasson (2016) indicated that students generally have a positive perception of utilizing BL and VLEs in courses. Students appreciate the plethora of resources that can be found in VLEs including online quizzes, videos, discussions, and podcasts (Ates & Olpak, 2018; Cohen & Sasson, 2016; Herodotou et al., 2018; Krishnan, 2018; Pinto-Llorente et al., 2017; Risquez et al., 2015). Cohen and Sasson and Kurt and Tingöy (2017) discovered that

students who utilized VLEs in courses were more likely to perform better on exams than those who did not. Studies by Kurt and Tingöy (qualitative), Pinto-Llorente (quantitative) and Risquez et al. (mixed-methods) each had a large population sample, which helped to increase the generalizability of the results.

Faculty Perceptions of the Use of BL and VLEs

In a qualitative study, Mozelius, Jaldemark, and Håkansson Lindqvist (2018) used semistructured interviews to examine 7 university teachers who were all subject matter experts and had experience teaching BL courses. The authors evaluated teacher perspectives and beliefs about the use of collaborative online tools in their BL courses. Mozelius et al. found that teachers agreed that some of the current tools which help to support BL have improved in the past decade. Another perspective of teachers is that with the rich plethora of tools and techniques today, teachers need to have continuous access to support tools. Also, teachers are optimistic and believe that the technology development has led to the improvement of BL in educational settings, and BL can be used across all disciplines (Mozelius et al., 2018).

Qvist et al. (2015) conducted a mixed-method study to track student engagement in a VLE, *Virtual Worlds*, and interviewed 29 undergraduate students and 16 instructors to gain their perspectives on VLEs. Qvist et al. developed a data gathering and learning analytic system to record the students touching or clicking on various objects and elements in the virtual laboratory. Qvist et al. found that students had mixed responses on using a VLE. One group (n=13) described using a VLE for the experiment was reasonably interesting and supported previous knowledge from past assignments and

lectures, and students learned something. Whereas another group (n=16) responded more critically, where about half of the students had no interest toward the laboratory VLE activity and failed to grasp its purpose. Out of the 16 instructors, 11 felt that utilizing this type of VLE would be an excellent method for training students with current laboratory procedure, safety and technical, to help them prepare for future laboratory courses. All the instructors expressed positive interest in the use of VLEs in their courses. Educators also indicated that it is important to be able to design appropriate assessment to assess disciplinary content and skills (Qvist et al., 2015). Qvist et al. remarked that even though the study used a specific VLE, the results regarding learning analytics can be applied to other VLEs. The information gained from Qvist et al. about the VLE, *Virtual Worlds,* can be used to inform the research questions for my study about the use of MB.

The information about interview processes and data analysis from Mozelius et al. (2018) can be used to inform the methods that are used to answer the research questions for my study. Qvist et al. (2015) and Mozelius et al. remarked that teachers are optimistic about the current and future use of VLEs in courses. Qualitative studies by Badilla Quintana et al. (2017) and Mozelius et al. (2018) had population samples of 10 or fewer participants, which was noted as a possible weakness by the authors due to the limited generalizability of the results.

The current literature on higher education teacher perceptions of the use of BL and VLEs in courses is limited. Most of the current literature focuses on student perceptions and not teacher perceptions. Herodotou et al. (2018) identified that teacher perceptions and experiences need to be further explored to look more into their thoughts

of the continued integration of VLEs into biology courses. Risquez et al. (2015) focused on students' perceptions of the use of VLEs; however, Risquez et al. recommended additional research is needed to put more focus on the benefits and challenges of using VLES in their courses.

Challenges of Using BL and VLEs in Higher Education

While many higher education instructors use BL and VLEs, there are still many challenges that educators face. Sorbie (2015) conducted a qualitative case study with 12 educators to explore teacher perceptions of the challenges of utilizing a BL environment in courses. Sorbie's study was grounded in the connectivism learning theory as a lens to show how educators can use new technologies to support their BL courses. The author collected data using a questionnaire, three observations, documents in the form of teacher screenshots, and interviews. Sorbie found that while teachers articulated many benefits to using BL in their classrooms, they disclosed many challenges as well. Challenges included students visiting game sites that do not pertain to their lesson, versus engaging in the lesson, devices breaking, and having issues with the building's Wi-Fi infrastructure. Another challenge was some teachers saw the amount of time it took to implement the BL approach effectively as a constraint.

Zeichner and Zilka (2016) conducted a quantitative study to examine the sense of threat and the sense of challenge among 578 pre-service teachers in two different learning environments, virtual and BL. Using questionnaires, Zeichner and Zilka categorized students' feelings into three main types: negative feelings, sense of threat, and sense of challenge. The negative learning feelings included lack of student and teacher

communication, technological difficulties, and lack of personal attention. The sense of threat included stress, threatening, and worrying. The authors found that negative feelings can change over time into a sense of challenge to improve achievements, satisfaction, and perseverance. Sorbie's (2015) study focused on teacher perceptions of utilizing BL environments in courses, whereas Zeichner and Zilka (2016) focused more on student perceptions. However, Sorbie's (2015) and Zeichner and Zilka's (2016) qualitative studies shared similar results in that one of the main challenges of utilizing BL and VLEs in courses is technological issues and lack of student and teacher communication.

Martín-Gutiérrez, Mora, Añorbe-Díaz, and González-Marrero (2017) conducted a literature review on the disadvantages and challenges of utilizing virtual technologies in education. Findings showed numerous implementations of innovative technologies, such as *Labhuman* laboratory and *Science Center*, which included a lot of digital activities. Martín-Gutiérrez et al. and Zeichner and Zilka (2016) concluded that when educators utilize VLEs in their courses, it is essential to ensure there is adequate communication between student and teacher. Without communication between student and teacher, many students feel either left behind or lost in the course.

Fabbian, Carney, and Grgurovic (2017) conducted a literature review that analyzed the successes and challenges encountered in designing and implementing basic level blended courses in public universities. After reviewing the existing literature, Fabbian et al. discovered one challenge in utilizing BL in courses is the initial time it takes to convert from F2F to blended. Previous research also identified additional

challenges BL instructors could run into, including the lack of time to cover the same materials as in the traditional class and technical difficulties.

Fabbian et al. (2017) discovered that when first utilizing BL methods in courses, the course material overload, integration of online materials, student preparedness, blended course development, and implementation presented some challenges. When first utilizing BL materials, such as videos, readings, and attendant activities, Fabbian et al. underestimated the time it would take for students to complete the assignments. Many students are not experienced with the BL method, so it was a challenge for them to transition into using and accessing the online assignments (Fabbian et al., 2017). Students being able to successfully connect the work done in F2F lecture with the online activities also posed a challenge. A limitation to Fabbian et al.'s study is that same-level course sections were used to collect data so there cannot be a comparison between courses of different levels and success of implementing the BL format.

Boelens, De Wever, and Voet (2017) conducted a systematic literature review based on 20 studies to outline four key challenges of utilizing BL in higher education courses. Inclusion and exclusion criteria were used to narrow down the studies. Inclusion criteria included: (a) BL had to be defined as a combination of F2F and online instruction; (b). studies had to focus on the design or development of BL activities; (c) the studies had to present a detailed description of the design. Exclusion criteria included: (a) studies focused on one specific learning tool; (b) short conference papers; (c) studies where the full text was not available; (d) book (chapter) reviews. Results signified multiple challenges when designing BL courses: incorporating flexibility, inspiring

student interactions, enabling students' learning practices, and fostering a resourceful learning climate. Boelens et al. noted a limitation in the literature review was that while many of the publications included information about their underlying framework, such as constructivism or connectivism, it was unclear how the theory was then translated into the design principles of the created assignments for students.

In a qualitative case study that utilized focus groups, Cahillane, Smy, and MacLean (2016) reported the perceived uses, enablers, and barriers of utilizing VLEs among a small group of 4 educators. Cahillane et al. collected data using two activities, individual surveys and a focus group. Survey data served as an introductory exercise to engage participants about their current and past use of VLEs. The focus group discussions focused on several questions including, experience using VLEs, length of experience and use of different VLE platforms, collective impressions of the differing features and functionalities, and perceived enablers and barriers associated with the use of VLEs as part of teaching practices. Participants viewed VLEs as allowing easy access to teaching and learning content. Cahillane et al. discovered multiple barriers in the use of VLEs, including the time to develop content, generate the tools and assessments to check student understanding, and adequately navigate the technology. Another barrier was many educators resist the use of VLEs for teaching activities due to limited technical literacy.

Cahillane et al. (2016) noted since a small sample size was used for the focus group, only basic conclusions can be drawn regarding VLE use in teaching practice. Cahillane et al. and Sorbie (2015) collected data from educators' perspectives and

discovered similar challenges of utilizing BL and VLEs in courses. The results from Cahillane et al.'s study can be used to inform the research questions of my study by providing insight to some of the challenges that educators experience when using a BL environment. Cahillane et al. and Fabbian et al. (2017) found that one of the main challenges of utilizing a BL course is the amount of time it initially takes to develop and organize the course activities.

In a qualitative study, Dayag (2018) explored the perception of 2 lecturers and 21 English foreign language undergraduate students on the significant concerns and challenges encountered when utilizing VLEs. Dayag conducted semistructured interviews to encourage the informants to freely offer their insight and observation on VLEs. Analysis of the interviews revealed that the informants, students and lecturers, generally had positive perceptions of VLEs. While using VLEs, lecturers and students encountered five challenges: difficulty to collaborate, time management, students' native language preference, lack of support, and weak internet connectivity. Findings revealed that through the interviews that these challenges must be addressed judiciously to ensure that students participate actively in their foreign language virtual classrooms and benefit from the perceived advantages of using VLEs. Meanwhile, according to Dayag, the success of VLEs depends on at least three primary concerns: interest of student and teachers, support of the administration, and time of the student and teacher. The author noted that the results of the study do not provide conclusive evidence on the effectiveness of VLEs because the study primarily focused on the participant's perceptions toward VLEs and not the students' actual learning performance after joining VLEs.

In their qualitative studies, Dayag (2018), Sorbie (2015), and Zeichner and Zilka (2016) concluded that a reoccurring challenge when utilizing a VLE in courses was technologically based. Technological issues ranged from limited Internet availability to computer malfunctions. Dayag and Zeichner and Zilka agreed that to correct Internet connectivity challenges, significant resources would need to be devoted to the issue. Dayag and Martín-Gutiérrez et al. (2017) indicated that while many students today have experience in using technology in everyday life, they are not as confident in using technology in their education. Dayag and Martín-Gutiérrez et al. (2017) concluded that with this lack of confidence, it can lead to students not communicating well with their teachers in courses.

The studies in this section, The Challenges of Using a BL Environment and VLEs in Higher Education Courses, helped to provide background information for my study by providing insight into the perceived challenges students and educators face when using BL and VLEs in courses. While there are a multitude of challenges that were identified in the section including technological issues, communication challenges, time constraints, and initial development and conversion of course content (Boelens et al., 2017; Cahillane et al., 2016; Dayag, 2018; Fabbian et al., 2017; Martín-Gutiérrez et al., 2017; Sorbie, 2015; Zeichner & Zilka, 2016) higher education faculty persevere in using the BL method and VLEs in their courses.

Conclusion

The focus of this literature review was to explore the use of BL and VLEs in higher education courses. The beginning of this chapter included literature on the basic

tenets of connectivism, the framework for my study, and how this theory can be applied to courses that utilize BL and VLEs. In this chapter, literature highlighted four themes including use of BL and VLEs in higher education, use of BL and VLEs in introductory biology courses, student and educator perceptions of using BL and VLEs to promote student learning, and challenges of using BL and VLEs in courses.

The literature review indicated that BL and VLEs are used in many higher education disciplines to help promote student learning in courses (Boda & Weiser, 2018; Han & Ellis, 2019; Smith et al., 2017; Vo et al., 2017). One discipline that currently utilizes VLEs in introductory courses is biology (Gonzalez, 2014; Lax et al., 2016). Research in this chapter demonstrated that utilizing BL and VLEs can help to promote student learning in introductory biology courses (Fuller, 2017; Gavassa et al., 2019; Gonzalez, 2014; Lax et al., 2016). However, teacher perceptions and experiences about the use of BL and VLEs in this context have not yet been studied in detail, especially teachers' experiences using specific VLEs (Badilla Quintana et al., 2017; Mozelius et al., 2018; Qvist et al., 2015).

My study addresses the gap in the literature by using a basic qualitative design to explore how the use of BL and VLEs in higher education introductory biology courses promotes student learning. Through in-depth qualitative interviews with biology instructors that have experience using MB in their courses, I explored the experiences and perceptions of instructors to understand further their beliefs on VLEs and their ability to promote student learning. In Chapter 3, I present the methods I used for conducting this

study. I also address issues of trustworthiness related to credibility, transferability, dependability, and confirmability, as well as a detailed description of ethical procedures.

Chapter 3: Research Method

The purpose of this basic qualitative research study was to explore experiences and perceptions of higher education biology instructors to understand how they believe using BL and MB promotes student learning. In Chapter 3, I describe the methodology that was used in this research study and the design, the rationale for using the basic qualitative design, methods for data collection, and data analysis procedures. I also reviewed measures taken to mitigate ethical concerns and ensure trustworthiness of this research project.

Research Questions

This study was designed to address the following questions:

RQ1: How do biology instructors use MB to boost student success in introductory biology courses?

RQ2: What are the perceptions of biology instructors regarding the efficiency and usefulness of BL and MB to promote student learning?

RQ3: What are biology instructors' recommendations for how MB and other VLEs can be used more effectively in introductory biology courses?

Research Design

I conducted this study using a basic qualitative design because the aim was to explore experiences and perceptions of higher education biology instructors to understand how they believe using BL and MB promotes student learning. Operating within a qualitative research approach, I used a semistructured interviewing technique where I conducted one interview with each participant.

In a basic qualitative study, the researcher focuses on examining how participants make sense of their experiences. While this design might inform practice, it also aims to expand knowledge (Merriam & Tisdell, 2016). A basic qualitative design yields descriptive accounts from participants, where their experiences with real-world scenarios help explain a phenomenon. These accounts are analyzed and interpreted since data analysis takes place prior to the interpretation of the results (Patton, 2014). In education, basic qualitative research is a common practice (Bryant, 2014; Burgess, 2003). Basic qualitative research allows the researcher to draw from concepts and models to frame the study while still focusing on a specific aspect of the teaching-learning experience (Merriam & Tisdell, 2016; Thorne, 2016).

Before choosing to use a basic qualitative design, I considered other research designs. Initially, I considered the phenomenological design. The use of qualitative research involves the perceptions of how individuals experience a phenomenon, but phenomenology explicitly involves seeking meaning, structure, and the essence of lived experiences (Patton, 2015). Phenomenology differs from basic qualitative inquiry in that it involves participants' perceptions of a phenomenon to uncover their ways of meaning-making (Patton, 2015). It requires in-depth interviewing to glean deeper meanings regarding the underlying structure of a phenomenon (Merriam & Tisdell, 2016). By contrast, the aim of basic qualitative inquiry involves understanding how individuals make sense of their experiences. While the purpose of basic qualitative inquiry is to uncover strategies and best practices, phenomenology does not involve examining such strategies and practices (Merriam & Tisdell, 2016).

Case studies can be explanatory, exploratory, or descriptive of an event (Patton, 2015). Case studies involve multiple data points to allow researchers the opportunity to describe activities that a specific group engages in (Merriam & Tisdell, 2016). Because this study was planned to collect introductory biology instructor perceptions regarding using a VLE to understand their experiences, I determined that a collection of multiple data points, which is used in a case study, were not necessary to address the research questions of my study.

I designed this study to explore the meaning of experiences. In this case, the experiences included the use of MB in introductory biology courses to promote student learning, explicitly for the purpose of improving student learning and success; therefore, the basic qualitative design is the most suitable. Because I focused on exploring the meaning of an experience, both a quantitative approach, which involves quantifying the problem by way of generating numerical data, and a mixed methods approach, which involves using qualitative and quantitative data, would not be appropriate.

Role of the Researcher

As the researcher, I was responsible for each portion of this research process. I worked to recruit participants, design methods, and conduct interviews as well as transcribe, analyze, and interpret the data. I performed data analysis with the assistance of the research software program NVivo.

As with most research, a possibility of bias existed throughout this project. In this case, I have experience teaching introductory biology courses that use MB. To recruit participants, I used social media sites, Facebook and LinkedIn or another teacher who

passed on information about my study. I had no personal relationship with the participants in this study. To mitigate the influence that my expectations may have had on this research, I took steps to monitor and manage my opinions during the data collection and analysis process. To limit the impact of biases, I adopted the method of bracketing known as phenomenological reduction, in which the researcher suspends judgments of the topic by consciously bracketing them.

Additionally, I recorded all emergent ideas in an electronic journal, which is known as reflexive journaling. Reflexive journaling helped prevent me from relaying any sentiments that might influence interviews. By bracketing my biases, I approached the topic as if I were someone new to it. Last, I used an inquiry auditor, as suggested by Amankwaa, (2016), which is a peer with whom I engaged and discussed my perceptions and interpretations and who asked critical and challenging questions to help minimize the chance of biases.

Methodology

I designed this study to capture the perceptions and experiences of 8–10 higher education introductory biology instructors who use MB in their courses through semistructured interviews. Semistructured interviews allow researchers to explore general topics to reveal participants' viewpoints while allowing participants to structure their responses in their way. For this study, I used a responsive interview technique to help in developing a partnership with each of the participants (Rubin & Rubin, 2011).

Sample Size and Rationale

The sample size for this study was kept relatively small, as with many qualitative studies. Often in qualitative research, there are no exact rules for sample size (Patton, 2015). Instead, the number of participants depends on the number required to inform all essential elements of the phenomenon being studied. The sample size is satisfactory when additional interviews do not result in the identification of new ideas, which is also known as data or theoretical saturation (Patton, 2015; Sargeant, 2012). In basic qualitative studies, Patton (2015) recommended 10 participants but also encouraged a reduction in the sample size if saturation is reached before the completion of assessing the 10 participants. For this study, I recruited and interviewed participants until saturation occurred, and 10 biology instructors provided sufficient results.

Selection Criteria, Participation Recruitment, and Data Collection

I chose to use a snowball or chain sampling approach, which is a type of purposeful sampling, to select participants. With this type of sampling, I started with five relevant interviewees and then asked them for additional relevant contacts who could provide different perspectives (see Patton, 2015). The selection criteria included instructors who taught a BL undergraduate introductory biology course and had at least 1 year of experience using MB. Also, participants needed to have access to technology that allowed them to be interviewed remotely if required through a web conferencing tool. To use a web conferencing tool, the participant's computer required an Internet connection and a microphone and/or webcam.

I started by sending participation invitations (see Appendix A) to instructors who met the inclusion criteria, which included those with 1 year or more of experience teaching a higher education introductory biology course that uses MB. Participant contact information was gathered from their inquiry about the social media flyer or from another teacher who passed on information about my study. The interviews for this study took place either via a web conference tool or F2F. There was a possibility of the participant being located within 100 miles of my location in central Florida. Three participants met this criterion, so their interviews took place F2F at a public library. I kept the participants' contact information confidential by keeping the information on a password protected computer along with the email account that I used, which was also password protected. The participation email included a brief description of the research study, along with a brief overview of what would be expected of the participants. When a participant accepted the invitation via email, they were then sent an informed consent form via email, which provided full details of the study. Once I made the initial contact, an interview appointment was scheduled for each participant, either via email or telephone. Using Microsoft Outlook, a meeting request was sent to each participant, indicating the interview date, time, and modality. I offered participants the option of interviewing either F2F or via web-conferencing to provide flexibility. To protect each participant's identity during the recruitment and interview scheduling, I communicated with each participant individually in favor of sending group messages.

As part of the full disclosure process of the nature of the research, before the interview, I reviewed the informed consent process (which includes the study's purpose,

implications, and expectations) with each participant. I used pseudonyms to keep participants' confidentiality. The interview process incorporated a responsive interviewing technique (Rubin & Rubin, 2011) and was 45–60 minutes in duration. I used the audio recorder on my cell phone to record all F2F interviews so that I could later use the qualitative data analysis (QDA) software, NVivo Plus to transcribe the interviews. For interviews that took place using a web conference tool, I used the built-in recorder to record the interviews to transcribe later using NVivo. I notified participants of recording in the initial contact email in the consent form, and then I asked for permission to record right before I conducted the interview. After I initially used NVivo to transcribe the interviews, I then went back and listened to each interview word for word to verify the accuracy of the transcription and fix any mistakes. Participants were then sent member checking emails, which included a detailed summary of the interview and also asked any clarifying questions. I saved all data, including informed consent forms, audio recordings, transcripts, participant feedback, and field notes to a password-protected folder, located within the QDA software, NVivo and on an external hard drive. I own the external hard drive that I used for this study. When I was not using the hard drive, it was kept in a locked desk in my office to ensure safety and confidentiality.

Instrumentation

For basic qualitative studies, detailed in the following section, the key data collection instrument includes an interview guide with protocols, procedures, and questions prewritten and well-defined (Patton, 2015; Rubin & Rubin, 2012). Qualitative research relies heavily on participants' lived experiences and perceptions of events

(Seidman, 2006; Taylor, Bogdan, & DeVault, 2016). Interviews to obtain information from these experiences are used as the primary source of data to answer the research questions posed in this study (Creswell & Poth, 2017; Rubin & Rubin, 2012). As Yanow and Schwartz-Shea (2015) stated, "interviews offer a way to learn how individuals knit their conceptions together and put them to use" (p. 177). While operating within the basic qualitative study, I also employed a responsive interviewing technique, which allowed me to develop a partnership with each of the participants (Rubin & Rubin, 2011).

Interview Guide

To ensure consistency and equal exploration of important topics in the study, an interview guide was developed (see Appendix C; Taylor et al., 2016). Questions developed for this guide were formal, open-ended, and designed to set the participants at ease to create an environment that promotes openness and sharing. I developed the interview questions, including the open and closing statements, using the literature review and theoretical framework so that I maintained alignment within the study. I designed the semistructured interview questions to uncover instructor perceptions and experiences of using BL and MB in their introductory biology courses. I asked instructors to describe any challenges they have encountered while using MB.

I divided the interview guide (see Appendix C) into sections. In the first section, I introduced the research questions and methodology of the study. The second section provided an overview of the literature review discussing how higher education instructors use BL and VLEs in introductory biology courses. In the third section, I discussed the framework that helped to guide the development of the research questions of this study.

The final section of the interview guide outlined the questions that I asked the participant during the interview. The script started with a welcome statement and explanation of the purpose of the study. All interview questions were open-ended and free of opinion and bias. The interview concluded with a thank you note and an explanation of the agreement for a follow-up clarification email in the event any information needs to be reviewed or explored further. I designed the interview guide to explore experiences and perceptions related to practice, which leads to establishing trustworthiness and gaining authentic, reliable data (see Patton, 2015; Rubin & Rubin, 2012; Yin, 2015).

I developed the interview guide with the assistance of my dissertation committee, and it was also evaluated by two colleagues currently working in academic settings. These experts assisted in addressing the following three items: alignment between the research questions and interview questions, the format of the interview, and the structure of the interview questions. I used colleagues, who are considered experts, to review the interview guide were seasoned introductory biology instructors that have utilized BL and MB for more than 3 years in their courses. Their constant guidance and review helped to establish a final interview guide that addressed the needs of the study while maintaining proper alignment for a qualitative study.

After sharing the interview guide with two content experts, they provided a few recommendations to help improve the overall alignment, validity, and format of the interview process. One recommendation from both experts included, if possible, meeting with potential participants F2F when initially inviting them to participate in the study. A second recommendation made by experts was to revise the follow-up probe two for

Interview Question 3. Initially, the follow-up probe stated, “Can you give an example of the amount of time you think you spent on this process?” The experts suggested that I add to this question so that it now states. “Can you give an example of the amount of time you think you spent on this process compared to when you did not use a VLE?” One expert also recommended that instead of having two follow up probes for Interview Question 4 that I instead make another interview question with the probes. So, I added a question to the interview guide, now Interview Question 5. It asks, “Can you provide two or more examples of the activities you have your students complete through MB?” The recommendations from the experts helped me to reevaluate the interview questions to ensure their validity so that the information I obtained from participants answered my research questions.

Interview Questions

With hopes of better understanding the experiences of introductory biology instructors, I used interview questions to inquire about participants’ backgrounds in teaching these courses. Interview Question 1 asked participants to share personal details: “How long have you been teaching introductory biology courses?” This question had a follow-up probe of “When did you start using a BL style course with MB?” In inquiring about life experiences in the context of life history, the interview included “why” and “how” questions to encourage participants to recount important life details that inspired them to use BL and VLEs in their courses.

I constructed interview questions that would ensure the content validity to answer the three research questions for this study. When designing the interview guide, I wanted

to ensure that all three research questions would be answered in adequate detail with the interview questions. For each research question, I have a minimum of two main interview questions that I used to collect data. Each main interview question also had follow-up probes that I used to generate more details from participants. I have included Table D1 in Appendix D to show which interview questions I used to answer the different research questions.

Data Analysis

The researcher, in basic qualitative studies, is considered the primary instrument of data collection and analysis. For qualitative research studies that use a basic approach, the focus is to provide descriptive accounts of findings using frameworks and literature that influence the project (Merriam & Tisdell, 2016). Based on the recommended field methods of McLellan, MacQueen, and Neidig (2003), I utilized a modified qualitative data preparation and transcription protocol in this study to preserve the morphological naturalness; this ensures that the word and commentary forms and punctuation contained in the transcript capture the original speech as accurately as possible. This study used procedures described by Saldaña (2015) and Patton (2015). In reviewing transcript data, I assigned codes to the words or short phrases that represent the qualities of the text-based data collected from the interviews. When transcribing a participant interview phrases such as, “Higher education institutions are looking for ways to incorporate active learning strategies into their introductory courses” or “Technology is unreliable, many times students seem to have connectivity problems when trying to access homework” represent anticipated replies. An example of codes that I pulled from these phrases includes “active

learning" or "connectivity issues." Saldaña (2015) has described coding as a heuristic form of research whereby "most of qualitative researchers will code their data both during and after collection as an analytic tactic, for coding is analysis" (p. 9).

Due to the descriptive and interpretative nature of this qualitative study, and to avoid research bias, a priori codes were not used; instead, I used an emergent coding approach. Emergent coding allows the researcher to experience in-the-moment reactions and helps to remove the natural tendencies to lean on prior knowledge that may cause the researcher to filter knowledge (Saldaña, 2015). When researchers build codes during analysis, it is an inductive process. Codes emerged naturally and were established based on the participants' responses; thus, I completed the analysis using the emergent coding approach.

The first step in the analysis process was the verbatim transcription of the recorded interviews using NVivo Plus. During this phase, I took notes in an online journal throughout the interview. These notes were then included in the transcription of each interview in bold font to differentiate the participants' views from mine (Elliott & Timulak, 2005). After I used NVivo Plus to initially transcribe the interview data, then I went back and listened to each interview to ensure the accuracy of the transcriptions. I reviewed and coded transcription data in sequence, with a first cycle coding applied to single full sentences to entire pages of text, with emergent codes developing from these initial ideas. I then used second-cycle coding to refine and reconfigure the first cycle codes. Saldaña (2015) described coded datum as one-word capitalized codes, also known as descriptive codes, whereas codes developed directly from participants' own words and

rooted in their language are placed in quotation marks; these are known as in vivo codes. After these codes are fully developed, the researcher begins searching for patterns in the coded data, which will help to organize groups of codes into categories or families (Saldaña, 2015). I developed categories or families based on the researcher's reasoning and perceptions of participants' experiences. This process can be highly dependent on the researcher's background.

Saldaña's (2013) work has laid out a highly structured framework for coding; it is important to recognize that the researcher's relationship with participants, which may develop during the interview, influences the data collection, documentation, and coding of data. In this, the process of bracketing, or self-reflecting, is recommended by Creswell and Poth (2017) and is significant in controlling bias during the data analysis phase. When conducting data analysis it can be easy to become too involved, hence the need for the coding process to be structured so that the amounts of data, also known as the data corpus (Saldaña, 2013), will not exceed the most salient portions that are significant to addressing the research questions. Saldaña recommended that researchers focus on the collecting and coding of quality data rather than the amount of data.

Issues of Trustworthiness

Qualitative research relies on measures of reliability and validity to evaluate the effectiveness of a study; however, the trustworthiness of a study must also be evaluated (Shenton, 2004). Trustworthiness represents several concepts, including credibility, transferability, dependability, and confirmability (Patton, 2015). Credibility or truth-value in qualitative research is analogous to internal validity in quantitative research.

Frequently, in qualitative research, the discussion of trustworthiness and reliability centers around guaranteeing that data collection is sound (Shenton, 2004).

Credibility

Credibility works to establish that the results of qualitative research are believable from the perspective of the participant in the research. To ensure credibility, I utilized research procedures, such as member checking, reflexive journaling, semistructured interviews, and emergent coding. These procedures are well established in qualitative research (Shenton, 2004). The research methods that I have utilized in this study are from Patton (2015), Rubin and Rubin (2012) and Saldaña (2015). Member checking ensures not only the accuracy of interview results but also allows for the participants to make corrections or additions if needed (Patton, 2015). I also established credibility in this study by using tactics that help to ensure honesty in participants. These tactics included guaranteeing that each participant knew that participation in the study was voluntary and that participants were encouraged to be frank in the interview (see Shenton, 2004).

Transferability

Transferability, on the other hand, is analogous to the concept of external validity in quantitative research. Transferability is where the researcher attempts to determine whether the study results can be transferred to other contexts (Patton, 2015). For this study, the detailed descriptions from participants' experiences offered ample details that I used to describe the distinct context for the phenomenon. I employed reflexive journaling of my research experience throughout the interview and data analysis stages. Reflexive journaling allowed for the strengthening of the overall trustworthiness of the finding (see

Patton, 2015). The above approaches offered an adequate account of the phenomenon for improving the transferability of the study's findings.

Dependability

Dependability refers to the consistency of the study's results over time (Patton, 2015). The researcher must be able to justify changing the context in which the research is conducted and describe how such changes affect the research study. This practice is referred to as progressive subjectivity (Patton, 2015). The reflexive journaling that I completed through the interview and data analysis stages served as an audit trail, recording what I initially expected to discover from the study, describing any bias, and then noting all of my reflections about how my early implications evolved or completely changed over time (Shenton, 2004).

Confirmability

Confirmability works to establish whether the study is free of bias and prejudice (Patton, 2015). To ensure that my study was free of bias, I used the following techniques: peer debriefing and clarifying. In clarifying, I commented on past experiences, biases, prejudices, and orientations that could influence interpretations of the study. Peer debriefing, which requires the researcher to work together with one or several colleagues who hold impartial views of the study, was used to evaluate interview transcripts, final reports, and general methodology to ensure confirmability. As previously mentioned, I used member checking to strengthen confirmability.

Ethical Procedures and Concerns

Walden University requires that all researchers submit their research study protocol to the Institutional Review Board (IRB) for Ethical Standards in Research. I done this to ensure that all Walden University research complies with the institution's ethical standards, including any federal regulations. I obtained IRB approval before collecting any data. The review of the research study protocol included a review of the interview guide and verification that I would maintain the confidentiality of information provided by the participants, as well as all correspondence. To ensure data protection and privacy, I provided all participants with informed consent, which I developed using concise and clear language to describe the type of data collected and its use for the planned research. I reviewed the informed consent with each participant and allowed them to ask questions. Each participant was assigned a pseudonym for use in the study's results.

Ethical concerns in research mainly involve the requirements on the part of the researcher to protect the dignity of participants and the publication of the study's findings. For this study, the recruitment of participants was facilitated by myself, the researcher, using a snowball sampling approach. I sent out the participant email invitations. Data were stored electronically on password-protected QDA software, NVivo, and on an external hard drive that was also password-protected and stored in a locked compartment in my office desk.

Treatment of Data

For this study, I thoroughly considered data protection and privacy issues. I acquired data using various methods (e.g., email, F2F, and a web conference tool). I encrypted all audio recordings with a password, and all data was stored electronically using passwords, including transcripts of interviews. As the handling of personal data is a major concern in all types of research, this paperless approach, which includes password protection and data encryption, will render access difficult and offer the highest level of protection. Once I complete the study, all data will be maintained in a secure electronic fashion, on a password-protected hard drive, for 5 years. After the 5-year mark, I will delete all data related to this study.

Summary

Chapter 3 provided detailed information regarding the methodology for my study. The chapter reviewed the basic qualitative research method to be applied to this study focusing on semistructured interviews as a data collection tool to explore introductory biology instructor perceptions and experiences of using MB to promote student learning. Throughout Chapter 3, I detailed how decisions were made regarding procedure selecting participants, instrumentation, data collection, data analysis plan, and trustworthiness. I selected participants using snowball sampling, which is a purposeful sampling technique (Patton, 2015). I collected data through semistructured interviews using an interview guide. I developed a data analysis plan to show that I used coding o illustrate emergent themes from the transcribed interview data. In qualitative research, it is essential to ensure trustworthiness (Shenton, 2004). In this study, I used several methods to ensure

the trustworthiness of the study, including peer debriefing, member checking, and reflexive journaling. To guarantee that I followed ethical procedures, I kept all participants' personal data on a password-protected hard drive that I keep locked in my office desk. In Chapter 4, I present the study findings, including data collected from the participant recruitment and selection phase, and demographics of participants.

Chapter 4: Results

The purpose of this basic qualitative research study was to explore experiences and perceptions of higher education introductory biology instructors regarding the use of BL and MB to promote student learning. By exploring instructors' experiences and perceptions, knowledge gained from this study will help to inform biology instructors about how the use of VLEs such as MB may help to promote student learning in introductory biology courses. To derive meaning from instructors' perceptions and experiences associated with using BL and VLEs in their introductory biology courses, the theoretical framework was based on Siemens' (2005) theory of connectivism. Three research questions guided the exploration of experiences and perceptions of biology instructors regarding the use of BL and MB to promote student learning.

Research Questions

This study was designed to address the following questions:

RQ1: How do biology instructors use MB to boost student success in introductory biology courses?

RQ2: What are the perceptions of biology instructors regarding the efficiency and usefulness of BL and MB to promote student learning?

RQ3: What are biology instructors' recommendations for how MB and other VLEs can be used more effectively in introductory biology courses?

Chapter 4 includes the following sections: setting, demographics, data collection, data analysis, evidence of trustworthiness, results organized by research questions, and summary of the data. I used open-ended interview questions in this study to allow for

participants to openly express their thoughts. I analyzed, organized, and coded instructors' interview responses to find themes used for meaning-making purposes.

Setting

I initiated interviews with participants either from my home or office using a web conference tool on my personal password-protected laptop computer or in a private room at a public library. Four participants were at work, but alone in their classroom or office when participating in the interview. Three participants were at home. The remaining three participants were in a private room at a public library. Two interviews were briefly interrupted due to a call on the participant's cell phone. The average length of all interviews was 45 minutes. I had no control over the setting in which the participants were situated during the web conference interviews. I did have control over the F2F interviews that were in a private room at a public library. I was not aware of any personal or organizational conditions that could have influenced participants at the time of the study. I was also unaware of any personal or organizational conditions present that influenced the interpretation of the study results.

Demographics

Instructors who participated in this study were higher education introductory biology instructors with at least 1 year of experience using MB. Participants included six women and four men. All participants were located within the United States but were from different locations. Seven participants were located within Florida, one was from Tennessee, one was from New York, and one was from New Hampshire.

- Participant 1 was female and located in Tennessee. She has taught introductory biology since 2011 and used BL since 2012.
- Participant 2 was female and located in Florida. She has been teaching biology for 10 years. She started using BL and VLEs in courses in 2013.
- Participant 3 was male and located in New Hampshire. He has been teaching biology courses for over 23 years. He began using BL and VLEs in his courses in 1999.
- Participant 4 was male and located in Florida. He has been teaching biology for over 30 years. He began using BL and VLEs in 2011.
- Participant 5 was male and located in Florida. He began teaching biology in 2008 and started using BL and VLEs in 2014.
- Participant 6 was a female instructor located in Florida. She taught high school from 1988 to 2001. After that, she began teaching introductory biology courses at the state college level and using BL and VLEs in 2004.
- Participant 7 was a female instructor and located in New York. She started working in the education field in 2011. She began using BL and VLEs around 2014.
- Participant 8 was female and located in Florida. She has been involved in the biology field since 2011. She began using BL and VLES in courses in 2014.
- Participant 9 was female and located in Florida. She has been teaching biology for 4 years. She began using BL and VLEs in courses in 2016.

- Participant 10 was male and located in Florida. He has been teaching for 31 years. He began using a VLE in 2014.

Data Collection

Upon receiving IRB approval on 11/20/2019 with approval number 11-20-19-0723498 to conduct the basic qualitative study with interviews, I posted the social media flyer (see Appendix B) to Facebook and LinkedIn. I sent an email invitation (see Appendix A) to participants who responded to the social media flyer. I sent 12 email invitations. The participants who responded to the email invitation were then sent the consent letter. I sent a total of 12 consent letters. I received responses from all 12 potential participants. When I received participant consent emails, I then emailed to set a date and time to complete interviews. However, only 10 completed interviews. I sent two participants who responded to the consent form replies to schedule a time for interviews, but they did not respond. Data collection was initiated on December 3, 2019 and completed on January 7, 2020.

After I received email consent forms, I then emailed participants asking for their preferred type of contact (virtual conference or F2F meeting) and dates and times that would work well for them to participate in interviews. I considered that since I was interviewing instructors, their daytime schedule may be full due to their course schedules. I also took into consideration that some of the participants were in different time zones, so I remained flexible when scheduling participant interviews.

I used an interview protocol (see Appendix C) that contained open-ended questions that I designed to elicit open-ended feedback from participants. I used a hard

copy of the interview guide for each interview for notetaking and journaling. I also maintained a reflective journal during data collection and analysis as an audit trail. Reflexive journaling allowed me to establish an audit trail to maintain dependability and confirmability of the study.

I recorded interviews using the recorder on my cell phone, which is password-protected to ensure participant confidentiality. After I completed each interview, I moved audio files to my password-protected computer. I used NVivo to transcribe all interview audio files. NVivo was installed on my computer and is also password protected.

After initially using NVivo for audio transcription, I went back and carefully reviewed each transcript while playing back the audio recording of each interview. I used this process to verify the accuracy of the transcripts and to gain a better insight into each participant. After going back to verify transcript data, I determined that NVivo was fairly accurate in terms of initial transcription. I only had to make minor edits to transcripts. I did not find any unreasonable transcript errors. Once verified for accuracy, each transcript was analyzed using an emergent coding process. No variation in data collection from the plan outlined within Chapter 3 occurred, and I did not encounter any unusual circumstances in the data collection process.

Data Analysis

I analyzed participant interviews as part of this study. Data analysis included organizing the data and working on analyzing the data against the research questions in my study. I started by coding and categorizing data from each participants' interview. I used emergent coding so that codes could emerge naturally, and codes were based solely

on participants' responses (Saldaña, 2015). I manually analyzed participant interviews for themes and patterns to establish codes that were derived inductively. The data analysis process was iterative so that I could see as many connections in the data as possible. After I completed the individual manual analysis for all instructor interview transcripts, I then analyzed the transcripts by research question for further analysis. To better organize the coded interview data, I created a table for each interview question (see Table 1). The tables that I created included the following columns: code, definition, pattern, and theme. In the first column of each table, I placed the codes that I identified from the first-cycle coding. The second column in each table included a definition for each code. In some cases, codes had similar definitions, so they were placed together. In the third column, I included any patterns that I identified throughout the coding process. The fourth column I used to identify the themes that emerged from the interview data. The final themes were:

- *RQ1:* Adapt to student needs, supplemental materials, interactive activities, and student involvement
- *RQ2:* Student enhancement, overwhelming, adaptable, student success, and innovative
- *RQ3:* Communication, concise, frustrations, and outside resources

At first, I coded and categorized data from each participant's interview. After I assembled the codes for the instructor's interviews, additional insight about answering the research questions was gained. I organized the codes by research question to tease out emergent themes and patterns. This helped to establish the confirmability of my study.

Table 1

RQ1 Coding Table

Code	Definition	Patterns	Themes
Years of experience	The number of years and experience that introductory biology instructors have devoted to using BL and VLES.	Educators have multiple years of both teaching introductory biology with and without mastering biology.	Experience is helpful.
Variety student needs learning styles improve student success	VLEs offer educators a variety of resources to help promote student learning.	Instructors began using BL and VLEs in a course for multiple reasons, but the main one was to support student needs.	Adapt to student needs
Requirement	Many higher education institutions require some instructors to use a VLE since the student was required to purchase the code.		
Access	Gaining access to MB the first time for both students and instructors can be difficult.	All instructors noted that when they first began using a VLE, getting everyone access was frustrating. For example, students had to purchase the code and then insert it online.	
Alterations	When first using MB, there are many alterations to the pre-created homework assignments that must be done.	All instructors noted that many alterations or changes had to be made to the pre-created homework assignments.	
Supplemental materials Extra credit Enhancement Enrichment Improvement	Terms used to describe how biology instructors use MB or other VLES in their courses.	All instructors stated that they use MB to supplement lecture content.	Supplemental materials
Student needs	Evaluate student needs and then develop VLE activities to fit.	All instructors indicated that when creating activities, they first evaluate their student needs.	

(*table continues*)

Code	Definition	Pattern	Theme
Homework Practice tests Labeling assignments Chapter review Questions Study modules Interactive activities Videos Supplemental activities	These are examples of the assignments and activities that instructors use in their introductory biology courses.	There are multiple types of assignments that can be utilized on MB to promote student learning. All instructors indicated that students responded well to interactive assignments.	Interactive activities
Participation individual student	Participation in VLE assignments depends on the individual student.	Five of the participants agreed that success is related to each student participation.	Student involvement
Reinforcement	VLEs can be used to reinforce lecture content.	All instructors indicated that they use a VLE MB to reinforce lecture content.	

Discrepant Case

Most of the introductory biology instructors use BL and VLEs in their courses to promote student learning. However, Participant 4 started using MB, but stopped after a few years. His reasoning for stopping to use MB, based on his interview answers, was due to the lack of student grade improvement after completing MB activities. Other data from his interview were included in this study because he still initially used MB and he also indicated he was thinking about going back to using it.

Evidence of Trustworthiness

In qualitative research, reliability, validity, and trustworthiness are generally used to evaluate the effectiveness of a study (Shenton, 2004). When considering the trustworthiness of a qualitative study, several concepts must first be considered, including credibility, transferability, dependability, and confirmability (Patton, 2015). The

discussion of trustworthiness and reliability helps in guaranteeing that data collection is sound (Shenton, 2004).

Credibility

In qualitative research, credibility refers to the study's findings being believable or truthful (Patton, 2015; Shenton, 2004; Streubert-Speziale, 2007). I established credibility by using the following strategies: member checking, reflexive journaling, semi-structured interviews with biology instructors, and emergent coding. By using member checking emails (see Appendix E), it helped to establish credibility by sending a summarizing email to each participant to ensure that I captured the essence from their interview. Overall, all participants were satisfied with their member checking emails. Only two participants had additional thoughts to add to their interview data. These additions were minimal, where they only wanted to clarify a previous statement.

Transferability

In qualitative research, transferability refers to the extent to which the findings of one study can be applied to other situations (Patton, 2015; Shenton, 2004). To establish transferability, I used detailed descriptions from participants' experiences, which offered ample details. I used the details to describe the distinct context for the phenomenon. I employed reflexive journaling of my research experience throughout the interview and data analysis stages. By using reflexive journaling, it allowed for me to distinguish my thoughts from the participants.

Dependability

In qualitative research, dependability is when the researcher employs techniques to show, if the study was repeated, in the same context, with similar settings and participants, similar results would be obtained (Patton, 2015; Shenton, 2004). I addressed the dependability for my study's results when I created the audit trails, which included the transcripts of instructor interviews and the member checking emails. The detailed descriptions of how I coded the interview data using NVivo and manual coding, will allow researchers to replicate my work in the future even though the possibility for different results exists.

Confirmability

I addressed confirmability by using member checking and reflexive journaling. The member checking emails helped me to clarify the main concepts that I got from each participant's interview. Member checking emails also allowed each participant to add additional content to the interview. The reflexive journaling allowed me to keep my thoughts separate from the participants. This process allowed me to ensure that my study is free of my personal bias and prejudice.

Results by Research Question

I conducted this basic qualitative study to explore experiences and perceptions of higher education introductory biology instructors regarding the use of BL and MB to promote student learning. The source of data included in-depth biology instructor interviews. The results of my study can be used by higher education biology instructors and administrators to help inform biology educators about the potential value of using

MB and other VLEs in introductory biology courses as tools that can contribute to promoting student learning.

RQ1

RQ1 asked: How biology instructors use MB to boost student success in introductory biology courses. Based on this research question, four themes emerged, including adapting to student needs, supplemental materials, interactive activities, and student involvement. I organized this subsection based on the four major themes.

To answer RQ1, I asked participants why they began to use BL and a VLE, experiences when first using MB compared to now, and how they utilized MB to promote student learning. Results showed that all instructors had multiple ways and reasons for how they currently use MB in their introductory biology courses.

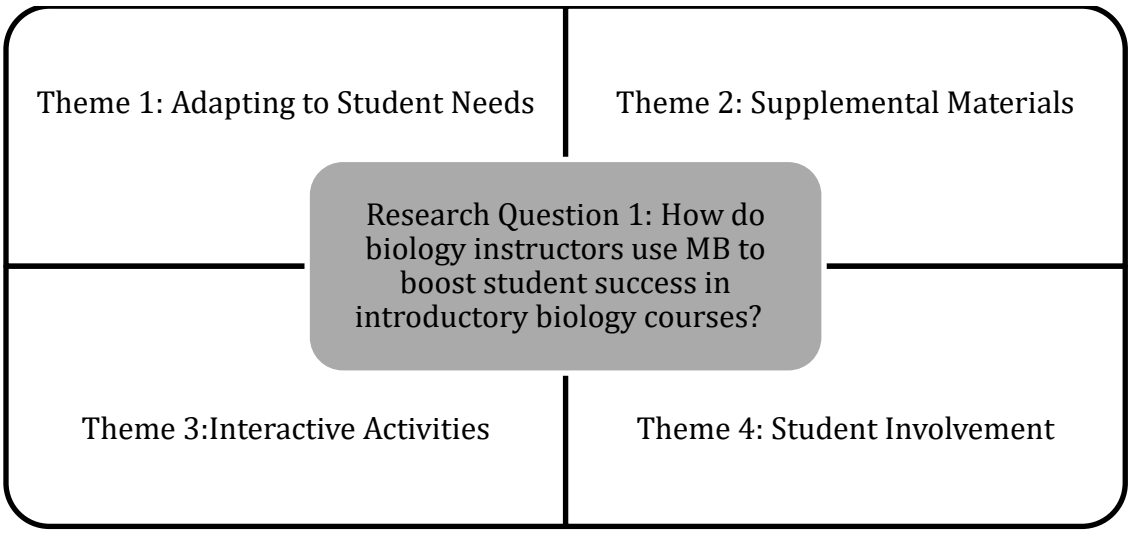


Figure 1. Themes related to RQ1.

Theme 1: Adapt to student needs. Concerning the first research question, all participants confirmed their use of BL and MB was due to having to adapt to student needs to promote student learning. Participant 6 noted that in today's age, many students

use technology in all aspects of their lives. This includes using cell phones, tablets, laptops, and desktop computers. Participant 6 described the reasoning behind using a VLE in introductory biology courses as follows:

> Students, in the beginning, found using a VLE similar to playing a game. With this similarity, students enjoyed using the VLE in courses. It was a new concept to them but using a VLE in courses allowed for educators to adapt to students' increasing use of technology.

I saw similar reasoning throughout all interviews. Participant 2 also indicated:

> Initially, I began using MB because students were required to purchase the code, so, instructors were forced to incorporate the VLE into courses. However, using the VLE allowed me to meet student needs by incorporating more technology into my courses.

Participants 1 and 2 agreed that students have a variety of ways they learn the best. For example, Participant 1 noted that some students are visual learners, while others may be auditory learners. She expressed that by using a VLE such as MB it allows instructors to offer content that fits all styles of learning. Participant 1 remarked about the interactive activities within MB that learners of all styles can find useful. Participant 1 said:

> Many of my students are on different levels of learning abilities, and by using MB, it allows me to cater to all types of learners. BL allows me to use different learning techniques to allow students to have access to learning resources on their level.

Participants 3 and 4 agreed on the initial reasons they choose to implement a VLE. Participants 3 and 4 wanted to use VLE to adapt to student needs, and they were curious if using MB would help to improve student success in the course. Participant 4 described their initial use of MB, stating, "I mainly began using MB because of my curiosity to see if there was something in it that was different from what I saw in courses. Also, to see how students would respond." Five of the 10 participants also noted that many of their students are nontraditional and go to school and work full-time jobs. Participant 8 remarked that by using a VLE in their courses, it allows freedom and flexibility for students to access course content and complete assignments. Participant 7 described students' ability to access course content as "The ability to give students more a freedom of where they are learning and when. BL and VLEs are at your own pace. However, some activities are still timed."

Participants 1, 2, 3, 4, and 6 reported that the primary reason for beginning to utilize a MB in courses was due to adapting to student needs. While Theme 1 for this research question was adapting to student needs, within the same theme, instructors had varying thoughts on their students' needs. Examples of students' needs, as reported by the Participants 7 and 8 included varying learning abilities, students' freedom to access lecture content and assignments anywhere, and the flexibility for students to complete assignments at their own pace.

Theme 2: Supplemental materials. Regarding Research Question 1, 10 participants confirmed they utilize MB to supplement their lecture content. Participant 9 described her use of MB as "used as a supplement for enrichment." Participant 1

described their use of MB as: “The ability for me to offer students the access to extra materials and more examples of content learned in lecture.” Participant 10 had a similar description to Participant 1 of how they utilize MB. However, Participant 10 added additional details:

> I use MB because it is an alternative way that students could get information, and it is interactive. I am always trying to experiment with innovations in my courses, and at the time, MB was the newest thing. So, I thought well, why not try it to see how students react and how it impacts their success in the course.

In addition to instructors using MB as supplemental materials, Participant 6 indicated:

> While students seem to like using MB to review materials that they learned in lecture, they would often complain about how long some of the supplemental activities took. So, I had to go back into some of the assignments to edit the content and make the assignments shorter. The max time I want students to spend on one assignment is 15 minutes. After this point, students lose interest.

In interviewing 10 participants, there was a split between how instructors used MB as supplemental material, including those who used MB as extra credit, course credit, which is mandatory and graded, and mixed, a combination of extra credit and course credit. Out of the 10 participants, Participant 2 used it for credit, Participants 1 and 4 used it as an extra credit assignment, and Participants 3, 5, 6, 7, 8, 9 and 10 used a combination of extra credit and credit. Participant 7 described their use of MB as a combination of extra credit assignments and assignments for credit. Participants 7 said:

> I think it should be mixed. I like doing some of the bigger topics that are absolutely necessary that are going to be discussed in class as mandated homework assignments. Then the other topics that are easier as extra credit points.

Participant 4 currently only offers MB activities as extra credit; however, due to lack of participation, he is looking into changing some of the activities to be mandated and worth credit points. Participant 4 stated, "giving incentives to do assignments acts as great extrinsic motivation." Participant 1's description of her use of MB follows:

> You want to make sure that students understand that anything they do is going to get them some type of credit. Sometimes as an extra grade to help boost another low grade. Students, no matter what age, are the same in the fact that if they are going to do an assignment, they want some type of credit.

Participant 2 stated that she initially made MB homework assignments mandatory. However, now she has one mandatory assignment and the other extra credit. Her reasoning behind this change detailed:

> Students are forced to purchase an access code, which means they cannot borrow or rent the textbook. So that is like a crutch, and I do not like it. So, I ended up having one assignment required and the rest optional. I choose to make the scientific method assignment required.

Throughout interviews, participants 5 and 7 indicated that by using MB as supplementary materials, it allows for them to work to enhance student learning. Participant 5 indicated that he uses MB as supplemental materials to help enhance student activities. Participant 5 stated, "By using MB to enhance activities, it allows for students

to have a resource that they can use to go back to a word or lesson that they did not understand in class and review." Participant 7 described her use of MB as a mix of mandatory homework assignments and extra credit points. She stated:

> I think it should be mixed. I like some of the bigger topics that are necessary and that are going to be discussed in class as mandated homework assignments. Then the other topics that are easier could be extra credit points.

The primary way the10 instructors use MB in their introductory biology courses was to supplement lecture content. While Theme 1 for this research question was supplemental materials, instructors had differing thoughts about the best way to use the supplemental materials to promote student learning. While all participants used MB to supplement lecture materials, there was a difference in opinion on if the assignments should count for credit, extra credit, or a mixture of both. Instructors also used MB to enhance assignments and offer a resource so students can review all material at their convenience.

Theme 3: Interactive activities. When asked, 10 participants indicated they use various activities and assignments on MB to promote student learning. However, not all participants used the same activities. When asked, participants listed off some of the activities that they found to work best in their introductory biology courses. Even though instructors used different activities and assignments, all 10 listed various types of interactive activities. Participant 7 described interactive activities, "where they get to do something other than reading a passage and answer questions." Examples of interactive activities that participants mentioned include practice tests, labeling assignments, study modules, chapter review questions, and videos. According to the 10 participants, the

above activities make students use a combination of tools, including their textbook, Internet, and lecture notes.

Participant 1 described her use of interactive activities as follows:

> I like the very interactive activities. I like the ones with animations because the animations you usually view a clip and then answer questions. I really liked the scientific method assignment, and the videos are awesome.

Participant 7 had similar views on the effectiveness of videos as Participant 1. However, Participant 7 noted, "I think it depends on the video because some are more upbeat that work well to keep your attention and others are very mild and make it difficult to keep students' attention." Participant 7 mentioned several times throughout the interview that the effectiveness or success of interactivities is up to each individual student.

Participant 6 stated, "While I am not using MB this semester, I am probably going to go back and add in some drag and drop activities and labeling activities." She does not currently use MB because she wanted to try open sources for her courses to cut back on textbook costs. Participant 6's reasoning behind moving back to MB was because she can see students progressing and completing each online activity. Participant 6 also noted that she uses MB videos in her introductory biology; however, she has noticed that shorter videos seem to keep the students' attention the best.

Participant 3 described himself as an "early adopter" of MB. When asked what resources he uses from MB, he stated," I use just about everything. I use most of the item library except for the essay questions." Examples of interactive activities that he either

currently uses or has used in the past include homework, videos, New York Times activities, drag and drop, and labeling.

Participant 8 used the same activities as Participant 3. Participant 8 also made use of the essay questions and clicker questions. She described her use of clicker questions as:

> It allows for students' questions in a group setting, but anonymously. Then the answer is revealed, and a discussion can take place on why that answer was correct or why other answers were incorrect.

Participant 5 used homework activities, quizzes, videos, and practice tests. He also mentioned liking the e-textbook offered through MB. He stated, "I also like the e-text because the students can go right in there and find a definition or any topic; they want more information on."

From participants' example responses, all utilized interactive activities to promote student learning. However, each participant used different combinations of activities and assignments with their students. Some participants made use of the videos while others used the homework assignments that allow for a mix of interactive activities.

Theme 4: Student involvement. Regarding Research Question 1, 7 of the 10 participants indicated that participants in VLE assignments depend on the individual student. These 7 participants agreed that student success is related to each individual student's participation. Participant 1 described student success as "It goes back to the individual student. It also goes back to I guess you could say the intrinsic motivation that they have." Regarding student success, Participant 3 stated, "It also goes into how much

effort students put into the MB assignments." Participant 5 had similar thoughts on the individual use of MB as Participant 1 and Participant 3, except he added:

> If students utilize it, I think they can get a lot out of it, especially for those that say they are more visual learners. With student testimonies, a lot of them will attest to how they really enjoy or like having access to the videos.

Participant 4 described his thoughts about how individual students use MB as, "What I found most was the better students were more into the activities, and then some students weren't into them."

Many instructors noted the effectiveness of videos from MB and other online resources depends greatly on the individual student. Participant 8 noted that while she used videos in her course, she tried to stick with the shorter videos because of individual students' attention spans. Participant 6 shared similar experiences when using videos as Participant 8. Participant 6 noted that students do not like to sit for 20-30 minutes watching videos. Instead, students like videos that are shorter than 5 minutes. She stated, "They will watch these easily and pay attention."

As seen in the above examples, 7 participants described the overall success of using MB and its resources as being up to each individual student. Each student was responsible for completing the assignments in MB. Participants 1, 4, and 7 indicated that the overall success of MB to promote student learning remains at the individual student's level and focuses on their willingness to participate in interactive activities.

RQ2

RQ2 asked: What are the perceptions of biology instructors of the efficiency/usefulness of BL and the VLE tool MB to promote student learning. Based on this research question, four themes emerged: student enhancement, overwhelming, adaptable, and student success. I organized this subsection based on the four themes.

To answer RQ2, I asked participants to provide examples of how they used MB in their courses, which virtual learning activities worked better, and which activities did not seem to work to promote student learning. Results showed that all instructors had different perceptions of the efficiency/usefulness of utilizing BL and a VLE in their introductory biology courses.

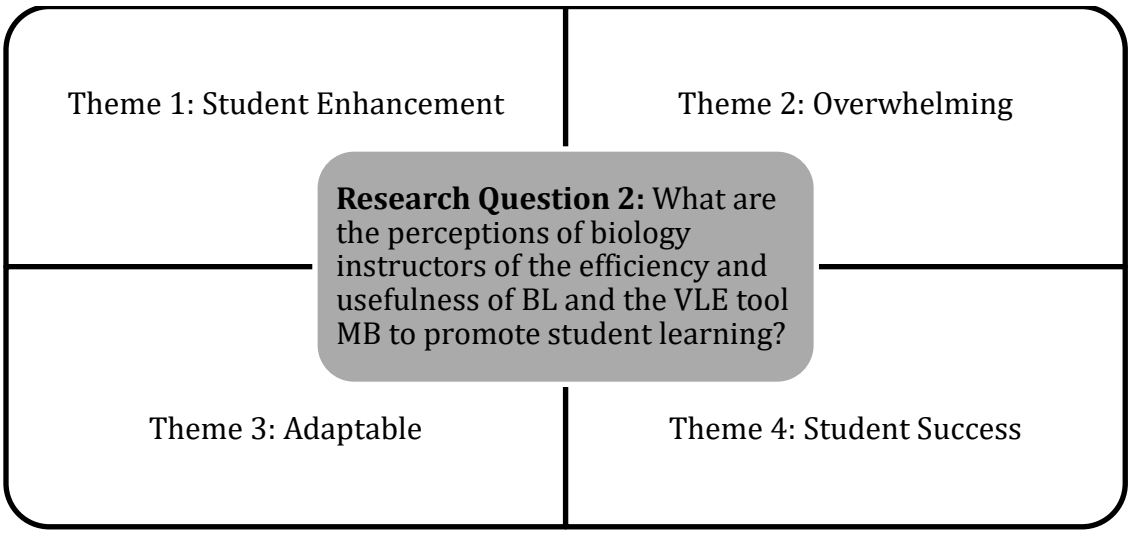


Figure 2. Themes related to RQ2.

Theme 1: Student enhancement. Concerning RQ2, 10 participants agreed that they perceive BL and MB as being an effective way to promote student enhancement; however, there were varying ways participants described student enhancement.

Participants' descriptions included enrichment, student motivation, and student engagement.

Participants 9 and 2 indicated that their use of BL and MB was to enrich and enhance student learning. Participant 9 stated:

> I mostly use MB in courses as enrichment and practice to solidify learning concepts. I use blended learning and Mastering Biology as a means to enhance learning; it provides opportunities to work with the content more than a lecture would; therefore, I believe it promotes the movement of surface knowledge to deep knowledge.

Participant 2 indicated that she uses BL and MB in courses to enhance the materials and make life easier for students to access additional content.

Participant 8 stated, "Using Mastering Biology was just a way for the students to get engaged in the materials and be exposed to the materials outside of a lecture hall." Participant 4 described student engagement in using Mastering Biology as, "Some students were, and some were not. What I found most was the better students were more involved in the activities and the other students not as much." Participant 7 indicated that to ensure student engagement, she tried to keep all activities, such as homework and quizzes, to a maximum of 30 minutes. She also noted this is because students lose focus or interest and then want to be done with the activity or assignment.

Participants 1 and 6 agreed that student motivation plays a large role in the usefulness/efficiency of using MB in introductory biology courses. Participant 1 noted, "that some students need to be motivated to complete the interactive activities on

Mastering Biology while on the other hand some students are the opposite and need no motivation." Participant 6 indicated, "If you just tell students that the Mastering Biology activities are just to help them learn, they are not going to do it except the truly motivated students."

From participants' example responses, the 10 participants perceive that BL and MB can be useful/effective in promoting student learning. However, each participant described how BL and MB be useful differently. Participants' descriptions of BL and MB included enrichment, student motivation, and student engagement.

Theme 2: Overwhelming. When asked, the 10 participants indicated some form of frustration and the feeling of being overwhelmed at some point while using MB in their courses. Participants noted that the main source of frustration is when instructors initially must set up a course for the first time. Participants' descriptions of these frustrations included difficulty, headache, slow start, extra work, time-consuming, and burdensome. Participant 6 described her experiences when first using MB as:

> It generally took me about 8 to 10 hours to set up a new course in MB because a lot of the time, I would put in an assignment, and it may not work, or I had to edit the content. Content editing took the most time.

Participant 4 also indicated that setting up a new course in MB is time-consuming. Participant 4 stated, "When I first started using MB, it took some time to set everything up. The time was significant. I would say it took about 8 to 10-man hours."

Participant 2 expressed her frustrations when initially setting up MB as a "headache." She stated:

> Headache because you know you have to do so much work to get everything set up. The first time I used Mastering, I edited chapter by chapter. So, I would say it was a lot. There were some chapters I would spend more than an hour on editing the content.

Participants 7 and 5 experience when first setting up a new course in MB was different from Participants 6, 4, and 2 in that the amount of time to set up the course was 1 to 2 hours instead of 8 to 10. Participant 7 noted that she has seen that sometimes if the professor is not confident or efficient in using technology, then the initial set up time seems to be longer. Participant 5 indicated that the initial set up process was automated and did not take him that long.

Participant 1 mentioned that her initial experience with MB was time-consuming and overwhelming. However, she then went on to state:

> Setting up Mastering Biology is just like teaching a course for the first time. You really have to put a lot of time and effort into getting your lessons together. Mastering Biology is similar to setting up a course syllabus or course outline, but then once you have the foundation, it definitely becomes a lot easier.

All 10 participants indicated that after setting up a new course in MB that when copying the course, the next semester, the process was easier and took less time. Participant 9 reported her experience with MB in the beginning as burdensome. However, after initially setting up the course, the transition semester to semester was easier and took less time. Participant 3 described the time it takes to create a new MB course as:

> Just like anything else, a new prep takes a significant bit of time, and then it gets easier and easier after that. So, I would say that now, in my 12th semester of using Mastering that I probably only spend an hour deploying it. Most of the assignments are pre-built, and it is just a matter of changing the dates and things like that.

While the 10 participants noted feelings of frustration and being overwhelmed when setting up a course for the first time in MB, participants also indicated that after initially getting a course set up, the transition from semester to semester is easier and less time-consuming. Participants also noted that while they occasionally feel frustrated and overwhelmed, they still find the usefulness/effectiveness of using MB to promote student learning.

Theme 3: Adaptable. Six of the 10 participants mentioned the ability for them to be able to adapt MB activities and assignments to fit student needs. When participants mentioned MB being adaptable several terms were also mentioned, including flexibility, freedom, and challenge. Participant 6 stated:

> I think everyone liked hybrid courses because it gives them the freedom to do assignments. Students can do activities and assignments at home in their pajamas or do it wherever, maybe at the beach. Students feel like they are controlling the setting.

Participant 8 had similar thoughts on the freedom that MB gives students to do their assignments anywhere and not just in class. Participant 8 indicated:

> From what I have noticed, it seemed that a lot of faculty teaching at the university level felt that having a BL learning style in the classroom allows students to be able to work on assignments from home.

Participant 1 noted on the flexibility of MB, "If you make sure they (students) understand how Mastering Biology works, they can go in and complete assignments and activities at their own pace."

Many of the participants seemed to think that students were receptive to using BL and MB in their introductory biology courses. Participant 10 noted, "My majors biology courses really grasped on to using Mastering Biology." Participant 4 indicated, "Students were receptive to blended learning. I was not their only instructor using it, but yea, they were receptive." Participant 6 expressed her students' response to using MB in courses as positive, and they enjoyed completing the online activities.

Theme 4: Student success. The 10 participants mentioned student success when using BL and MB. However, not all participants saw positive student success while using MB. Out of the 10 participants, 5 saw positive student success, 4 had mixed responses, and 1 was a discrepant case and did not see student success.

Participants 1, 3, 5, 6, and 8 noted positive student success when using MB and BL in their introductory biology courses. Participant 1 stated, "If students go in and complete the activities and use the resources, then you will see positive growth." Participant 6 saw improvement in her students as a result of using MB. She indicated, "It [MB] improves learning because it makes it more interactive to them, and they respond well to it." Participant 8 remarked, "So far from what I have noticed it [MB] greatly

impacts student learning." Participant 5 shared similar thoughts with Participant 8 in that when using MB in their courses, they have seen a positive impact on student success.

Participants 2, 7, 9, and 10 indicated mixed responses to if using MB helps to promote positive student success. Participants 7, 2, and 9 reported that the success of MB depends upon each student. Participant 7 stated, "It depends on each student. There are some individuals that can really excel in an online learning environment because they have the motivation to complete assignments on their own." Participant 2 remarked that some students respond well to certain activities, and then other activities students do not. Participant 2 noted, "I have to say the videos are awesome. Some videos like the ones for cellular respiration are very effective." Participant 9 described her students' use of MB, similar to Participant 2, in that students respond better to certain activities than others.

Participant 2 mentioned student success, but not in a positive way. Participant 2 stated:

> I did not see the results in student grades. So, while I can say that I thought Mastering had some really neat exercises and some neat ways of presenting materials, I just didn't see the results in the grades. If it is not promoting student learning, then why are the students buying the materials?

Participant 2 also went on to note that maybe the trick to seeing more student success when using MB is to make the activities and assignments worth points or extra credit.

As seen by the above participants' responses, there are multiple ways that instructors define or evaluate student success. Participants 1, 8, and 5 indicated student

success as seeing positive student growth. Whereas participant 2 measured student success in terms of an increase in student grades.

RQ3

RQ3 asked: What are biology instructors' recommendations on how MB and other VLEs can be used more effectively in introductory biology courses. Based on this research question, four themes emerged: communication, conciseness, frustration, and outside resources. I organized this subsection based on the four themes.

To answer RQ3, I asked participants to describe their experiences when using MB in their courses, provide examples of what activities work better to promote student learning, and to explain some of the challenges or frustrations they have encountered when using MB. Results indicated that the 10 instructors had different experiences and recommendations when using BL and a VLE in their introductory biology courses.

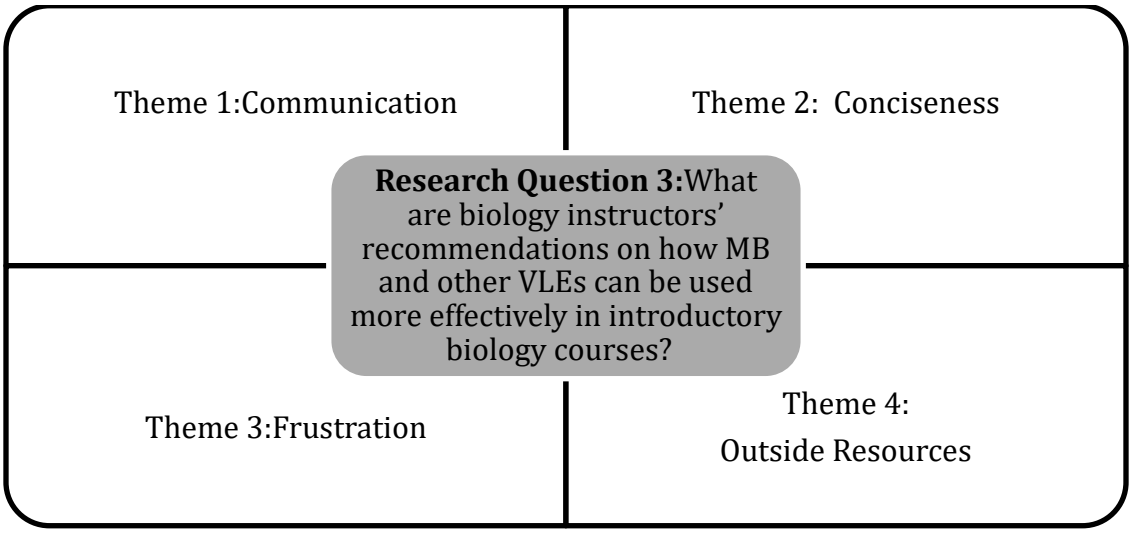


Figure 3. Themes related to RQ3.

Theme 1: Communication. Four out of the 10 participants agreed that communication is the key to using any type of VLE successfully. Participant 8 noted that

communicating with students when their assignments are due will help to increase student success in courses. Participant 8 also mentioned the importance of communicating with the VLE publisher to seek help in creating assignments. Participant 6 also commented on the publisher resources that are available from MB. Participant 6 described her experiences with communication with representatives as:

> At the beginning, I enjoyed using MB. I had great technical support from the publisher, but then as time went on, the publishers were not as forthcoming with help on how to solve problems, not only for me but the students also.

Participant 5 suggested that at times students can feel that they are left on their own when completing assignments in a VLE. Participant 5 said:

> Students can sometimes feel that they do not have enough contact with the instructor or with each other. I try really hard throughout the semester to stay in contact with students. I respond to emails and set up meetings with students.

Participant 7 remarked several times on the importance of communication between students and the instructor. When asked for her recommendations to students, she stated:

> Ask questions if you do not understand something. Sometimes a student's computer may work differently from the instructors, and that could cause issues with the student completing assignments. This can be due to a lack of communication between the student and the instructor.

Participants 1 and 5 shared similar thoughts on the importance of being in communication with students. Participant 1 described her thoughts on communication as:

> Well, as an instructor, you have to make sure that you yourself are logging in to the VLE and checking on student progress. The key is open communication. Check emails, so you know if students sent you a message and maybe having difficulties.

Four participants recommend having open communication between students and instructors. Participants indicated that open communication is crucial to seeing student success in their courses. Two participants also noted the importance of communication between instructors and VLE publishers.

Theme 2: Concise. Four out of the 10 participants mentioned the importance of being concise when using a VLE in courses. When participants remarked on being concise when using MB, they often also used the term simple. Participant 5 described his methods for designing MB activities as:

> Keep it simple. Think about it like you are almost building a website for a business, and you want happy customers. You want it to be easy to access, and you want students to be able to get through it and access the information quickly and easily with as little frustrations as possible.

Participant 8 stated, "If you do not want to take time to make your own questions, then just use multiple choice. You know, since it is easy." Participant 7 recommended not to make using a VLE such a heavy part of the course or students' grades. She stated:

> When you put so much emphasis on this virtual learning component, it kind of takes a hit in the face-to-face component. Also, some of the virtual learning environments can be difficult to understand.

Participant 9 suggested that after instructors initially set up MB, then they should be consistent with using it. Participant 9's suggestions aligned with Participant 5 in that when using any VLE, instructors should be consistent and concise when choosing assignments.

Theme 3: Frustrations. The 10 participants voiced frustrations that either they or their students encounter when using a VLE. When I asked participants about frustrations, they often included the following two items: general technical issues and cost. Participant 8 noted that two of her main frustrations when using a VLE is the cost and connectivity. She described her frustrations as:

> So, for me as an instructor, the frustrations that I can point out right away is because I have already had issues is where a student puts the correct answer in; however, it wasn't one of the possibilities I that they would put in. So, I have to go in and completely modify a quiz and put the correct answer. This takes time.

Participant 1 mentioned that one frustration of some of her students was limited access to the internet at home. She said:

> You have to have good internet access, and if you don't, then you will not be able to log in to Mastering Biology. So, there have been a few panic times for students over the years.

Participant 4 described his frustrations with using a VLE as, "There are some connectivity issues that students had, but it was always on their end." He also mentioned that several students had frustrations with the cost of buying the textbook with a VLE. However, he went on to state, "That cost was a concern a while back, but now the

publishers are getting wind of a lot of VLE stuff, so the costs are dropping." Participant 2 stated, "The greatest reason that I choose to use certain virtual learning environments and not others is because of the cost." She also remarked:

> That even though it (the Internet) is accessible for some students, it may not be for every student. We assume that everyone has access to technology regularly, but not every student has a computer. So, some students have to actually come to school and use the computers here. So, it's a challenge.

Participant 3 described similar frustrations as Participants 4 and 2. Participant 3 described his challenges and frustrations with using a VLE a:

> The primary challenge is on of access that students you know would not buy their course materials until after they come to class to make sure that I really do want them to spend these 80 to 90 dollars or even more. It takes a little while to get, or they are waiting on the money. I am trying to implement this program from the beginning, so this causes problems. So, it creates this problem of technology lag.

Participant 7 agreed with Participants 2 and 4 that one of her main frustrations stems from technical issues, such as internet connectivity. Participant 6 also mentioned cost issues were a frustration of students and instructors. However, she agreed with Participant 4 that even though VLEs are expensive for students to purchase, the prices have dropped dramatically.

It can be seen from example participant responses that there are several frustrations that instructors and students face when using a VLE in courses. The main frustrations faced included Internet connectivity, general technical issues, and cost. Many

of the participants also noted that they have no recommendations for these frustrations except to work with students to overcome them.

Theme 4: Outside resources. The 10 participants agreed that students could use outside resources, such as the library, learning centers, and public places with Wi-Fi to access VLEs. Participant 4 recommended that if students are having an issue with Internet connectivity, then they should come in and view the online content on the computers in the library or learning center on campus. Participant 2 stated:

> I let them [students] know that I do not do extensions because they know there are so many resources here [school]. There is no excuse. Students can check out laptops and tablets from the library to use.

Participant 6 agreed with participants 4 and 2 that students have access to computers and the Internet at school. However, Participant 6 also mentioned that many resources in the community provides free Wi-Fi. She stated, “Students can go to a public library. I can go to McDonald's or Starbucks and have free Internet.” Participant 7 noted, “There is all kind of different places all over campus that students can get access to a computer and Internet.” Participant 1 recommended that if instructors know several students may not have easy access to computers or the Internet, then take a day or two each semester and meet in the computer lab for students to complete assignments.

Summary

In Chapter 4, I presented findings based on the data analysis that answered the three research questions. I coded the data, and multiple themes emerged for each of the three research questions. The themes that emerged from RQ1 included adapting to

student needs, supplemental materials, interactive activities, and student involvement. The themes that emerged from RQ2 were student enhancement, overwhelming, adaptable, and student success. The themes that emerged from RQ3 were communication, concise, frustrations, and outside resources.

The results of my study showed how introductory biology instructors use BL and MB in various ways to help promote student learning and engagement. Instructors explained their experiences, perceptions, and recommendations when using BL and a VLE in their courses. In Chapter 5, I will discuss the purpose of the study, interpretations of the findings of the study, limitations of the study, my recommendations, and implications for positive social change.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this basic qualitative research study was to explore the experiences and perceptions of higher education introductory biology instructors regarding the use of BL and MB to promote student learning. I conducted this study to provide insight into how the use of MB may promote student learning in introductory biology courses. The theoretical framework undergirding the study was based on Siemens' theory of connectivism. I conducted 10 interviews with higher education introductory biology instructors (six women and four men). After conducting, transcribing, and coding the interview data, I aligned the transcripts and recordings for accuracy. I also used reflexive journaling to avoid bias when interpreting instructors' responses.

When using BL and VLEs in higher education introductory biology courses, instructors found that MB helps to increase student success and promote student learning. A key finding related to RQ1 was that participants use BL and MB to adapt to student needs. A key finding related to RQ2 was that all participants agreed that using MB was an effective and useful way to promote student learning. A key finding related to RQ3 was that all participants faced some type of frustration when using a VLE. In addition, each participant had his or her way of dealing with these frustrations. The above key findings are described in detail in the Interpretation of the Findings section.

In this chapter, I discuss and interpret findings according to each research question. The chapter also includes a discussion of the limitations of the study,

implications of my study related to social change, and recommendations for future research and practice. The chapter ends with a conclusion.

Interpretation of the Findings

I drew from Siemens' framework of connectivism to analyze the experiences of 10 higher education introductory biology instructors using BL and MB. The findings from my study were consistent with the concepts of connectivism as described by Siemens. Siemens' conception of connectivist learning was premised on the distribution of knowledge via technologies, such as computers and VLEs to foster student learning (Downes, 2011; Siemens, 2006b; Siemens & Conole, 2011). In the current study, the use of BL and MB created opportunities for instructors to promote student learning in their introductory biology courses.

Through analysis of the data collected in my study, I identified 12 themes regarding perceptions and experiences related to each research question. In the following sections, I describe the alignment between the research questions and themes. I also relate the findings to the connectivism framework and current literature.

RQ1

In RQ1, I focused on how biology instructors use MB to boost student success in introductory biology courses. Instructors stated that their reasoning for using MB in courses was due to their desire to adapt to students' needs to promote student learning. As new technology emerges, there is a continuous need for instructors to adapt to and use these innovations in their courses (Sorbie, 2015; Wienhold & Branchaw, 2018). Emergent technologies that instructors currently use in their courses include cell phones,

tablets, laptops, and desktop computers. A few instructors indicated that MB helps them to adapt to student needs by offering students a variety of ways to access and use materials. Some students are visual or auditory learners, and MB offers materials that can fit both types of learning. In this way, MB allows instructors to offer content that fits all styles of learning.

All instructors in the study used MB to supplement their lecture content. They described their use of supplemental materials in varying ways. Several instructors commented that they used MB to offer students access to additional materials that could help to reinforce lecture content. Additionally, some of the participants used MB as a supplement for enrichment. Instructors had differing thoughts about the best way to use supplemental materials to promote student learning. There was a split between instructor participants in terms of how they used MB as supplemental materials, including those who used MB as extra credit, those who used it as course credit, which is mandatory and graded, and those who used a mixed approach involving a combination of extra credit and course credit. The instructors who used MB activities for credit indicated that they had more student engagement and participants than when they offered the same activities for extra or no credit.

Participants used a wide array of supplemental activities, including practice tests, labeling assignments, study modules, chapter review questions, and videos. Each participant had his or her preferences regarding what activities he or she used and did not use in MB. However, there was a consensus that MB had an abundance of interactive activities that could promote student learning and engagement. Several participants also

agreed that the overall success of interactive activities is up to the individual student and the effort and time he or she spends on the activities. According to participants, some students are more likely to take advantage of the supplemental materials, while others are less likely to complete the activities.

The studies discussed in the literature review in Chapter 2 all had similar findings with regard to using interactive activities to promote student learning and engagement. The participants' use of MB and interactive activities to promote student learning and engagement was similar to Fuller's (2017) and Wienhold and Branchaw's (2018) findings that the use of VLEs led to increased student success and engagement during learning activities. The instructors' use of MB in their courses to promote student learning and success also aligns with Beard's (2017) finding that providing students with access to online support tools such as MB enables them to better understand lecture content. In addition, the participants' use of various types of interactive activities to promote student learning confirms Ates and Olpak's (2018) finding that additional assessments such as online quizzes increase students' engagement in course materials. Finally, the use of MB by instructors is consistent with Siemens' connectivist model, in which knowledge is distributed across various information networks and can be stored in an assortment of digital formats. In my study the digital format that was used to distribute and store information was MB.

RQ2

For RQ2, I focused on the perceptions of biology instructors regarding the efficiency and usefulness of BL and MB to promote student learning. Instructors all had

varying perceptions of the efficiency and usefulness of BL and MB in their courses. Initially, all instructor participants agreed that using BL and MB was an effective way to promote student enhancement. However, participants defined student enhancement differently. Their descriptions of student enhancement included enrichment, student motivation, and student engagement.

Most instructors (six out of 10) in the study indicated that, at some point, usually when initially beginning to use MB, they had felt overwhelmed. This feeling seemed to stem from how long it took some instructors to set up their introductory biology courses. However, not all participants reported feeling overwhelmed. Four participants indicated that the initial setup of a course in MB was easy and automated. All participants agreed that, after initially setting up courses, the transition from semester to semester was seamless.

Participants in the study also indicated that the use of MB allowed them to adapt interactive activities to fit their needs and those of students. The participants used terms including flexibility, freedom, and challenge when referring to the adaptability of MB. Many participants, but not all also mentioned the increase of student success, which is defined as an increase in either test grades or final course grades, when using MB. While participants had mixed feelings regarding student success, most of the instructors, 9 out of 10, indicated that MB helped to increase student success. However, one participant was adamant about the lack of student success or improvement when using MB.

The themes found in this study related to educators' perceptions of the usefulness and effectiveness of a VLE were consistent with the literature I reviewed prior to

conducting the study. The participants' perceptions of the effectiveness/usefulness of BL and MB concurred with the studies of Goeser et al. (2018) and Goff et al. (2017), who found that instructors perceived that using a VLE helped students to better understand important concepts studied in the course. My findings also align with Halverson et al.'s (2017) and Kurt and Tingöy's (2017) studies, which indicated that the use of BL and VLEs in courses gave students the freedom and flexibility to access and complete assignments. Similarly, Yapici (2016) found that the majority of the instructors in their studies reported an increase in student success after using a VLE.

The perceptions of the current study's participants regarding the effectiveness/usefulness of BL and VLEs align with Siemens' theory, which suggests that learning using traditional pedagogies, such as F2F courses, may be limited due to the rapid changes brought about by technology. My findings are also in alignment with Reese and Siemens (2008), who agreed that BL education has the potential to create an interactive environment in which students can collaborate, communicate, share, and discuss.

RQ3

For RQ3, I focused on the biology instructors' recommendations on how MB and other VLEs can be used more effectively in introductory biology courses. The participants had varying recommendations on how to use MB and other VLEs more effectively. One recurring recommendation was that instructors should communicate with their students on the due dates of assignments posted in MB. The participants also

indicated the importance of communicating with the publisher of MB or any VLE if they need assistance.

Further, the participants recommended being concise when assigning VLE activities. When using a VLE in courses, a few instructors not only used the term concise but also the term simple, in the sense of not overwhelming students with VLE activities. The instructors who used videos in their activities were adamant that the videos should not be longer than five minutes—if the videos are too long, then the students will lose focus.

All participants indicated some level of frustration when either they or their students use a VLE. There were many different frustrations and recommendations on how to overcome them throughout the study. The main frustrations or challenges included general technical issues and cost. The general technical issues included Internet connectivity, lack of a computer, and other general technical computer issues. Cost was a challenge because some students cannot afford to purchase the access codes that are required for the VLE. Moreover, some instructors did not feel that the VLE was effective enough to justify the price.

The participants had several recommendations on ways to alleviate some of these frustrations, mainly the general technical issues. However, the main recommendation was for students to access outside resources. These resources included places on campus, such as the library or learning center, which usually have computers, allowing students to access the Internet to work on their VLE activities. A few participants suggested that, if

students did not have access to the Internet, then they could go to public places like coffee shops and fast food restaurants and use their free Internet.

The participant's frustrations and challenges related to using MB, which included general technological issues, aligned with the ones found by Zeichner and Zilka (2016) and Martín-Gutiérrez et al. (2017). Sorbie (2015) noted that technological issues are a key frustration for students and instructors when trying to complete VLE activities. Sorbie's finding is consistent with my study, in which one of the largest frustrations of the instructors was Internet connectivity. One finding of my study that was not expected, based on the literature review, was the instructors' frustration regarding the cost of VLEs.

Connectivism provides a model of learning that can be used to help educators recognize the importance of using new learning tools (Siemens, 2005). The findings of my study align with the connectivist learning model in that, even though instructors face challenges and frustrations, they still use MB to promote student learning. The connectivism themes found by Bannister (2016) are in alignment with my study, as higher education instructors incorporate connectivism theory into their courses.

Limitations of the Study

I considered four limitations when analyzing the study findings. When conducting qualitative research, there is always a limitation associated with the relatively small sample size. I used a small sampling group of 10 higher education biology instructors who work in various colleges across the United States. The inclusion criteria could also be a limitation. They included higher education introductory biology instructors who

either currently use MB or have previously used MB for at least one year. The small sample size and inclusion criteria could limit the generalizability of the results.

In addition, I used snowball sampling, which can be seen as a limitation due to the possibility that the technique can result in biased samples. Since people refer to people they know and who have similar traits, this sampling method has the potential for sampling bias. There is also the possibility that participants could encourage others to participate in the study.

Research bias is another limitation of my study. My experience with teaching introductory biology and using VLEs as well as the possibility that I might interpret the instructors' responses based on my personal views were taken into consideration when conducting the interviews. I used bracketing and reflexive journaling to mitigate the potentially adverse effects of preconceptions. This journaling helped to heighten my awareness of my perceptions, which helped to lessen the likelihood that my personal experiences and views would affect my interpretation of the instructors' responses.

Recommendations

The use of BL and VLEs offers students and teachers access to unlimited learning resources. The use of technology in classrooms provides students with freedom and flexibility when accessing learning resources. Because BL and VLEs have the potential to promote student learning in introductory biology courses, there is a need for further research on specific VLEs used in multiple disciplines (Boda & Weiser, 2018; Goeser et al., 2018; Weerasinghe, 2018). Additional studies are needed in the following four areas:

- Further basic qualitative research on students' experiences with and perceptions of BL and VLE use in courses.
- Exploring the perceptions and experiences of higher education instructors' use of BL and VLEs in other disciplines (Ates & Olpak, 2018).
- Additional research focused on the benefits and challenges of using VLEs in higher education courses (Risquez et al., 2015).
- Quantitative research focusing on student success/outcomes in BL courses versus traditional F2F courses.

Additionally, I hope that in the future I can continue to work to expand this study by completing an additional qualitative study with a larger sample size. I would also like to offer my assistance to other educators at all levels, not just those in higher education looking to begin or improve the use of BL and VLEs in their courses.

Implications

This study establishes a framework for how higher education introductory biology instructors' experiences and perceptions influence their use of BL and VLEs in their courses. Moreover, the study adds valuable insight to a limited field of research by addressing how the use of BL and MB may (a) promote student learning, (b) influence technology use in higher education classrooms, and (c) create a positive attitude toward using a BL-style course that includes a VLE.

The results of my study indicated that the instructors' use of BL and VLEs impacted overall student success in their courses. The information gained from the study could support positive social change, as higher education biology instructors and

administrators can use the findings to help inform other biology educators about the potential value of using MB and other VLEs in introductory biology courses. Moreover, the findings showed that BL and VLEs can be used as tools to promote student learning. The results can also provide educators with additional insights into what strategies and tools their peers are currently using in their introductory biology courses to enhance student success.

By providing a deeper understanding of instructors' experiences and perceptions of using BL and a VLE in their courses, this study may also help to inform educators about the usefulness of utilizing BL and VLEs to help promote student learning in introductory biology courses. Additionally, the results can be used as a foundation for additional studies on the use of BL and VLEs in other disciplines.

Conclusion

Student success rates, defined as students who receive a letter grade of C or better in introductory biology courses, are low (Batz et al., 2015; Fuller, 2017). Due to this low success rate, researchers have projected that it will be difficult to meet the increasing need for biologists, nurses, and other related fields in the future (BLS, 2018). Higher education instructors are looking for ways to help increase student success and promote student learning. One method that instructors are currently using includes BL and VLEs as an innovative way to promote student learning in introductory biology courses (Wienhold & Branchaw, 2018). The participants in my study were all higher education introductory biology instructors who either currently use or have used MB for at least one

year. The one-year inclusion criterion was used because, when educators start to use any type of innovation in their courses, it takes time for them to adjust.

The findings of my study demonstrated that, when using BL and VLEs in higher education introductory biology courses, most instructors found that MB helps to increase student success and promote student learning. They use VLEs to give students access to additional resources to supplement lecture content. However, the instructors encountered barriers that impact themselves and students when using BL and VLEs in courses. These barriers included the initial VLE set-up time, Internet connectivity, and the cost of the products. Most instructors indicated that working to alleviate these barriers is essential to the overall success of BL and VLE use in courses. Participants offered suggestions for overcoming these barriers, including using school resources, such as libraries or learning centers, to provide access to computers and the Internet. Some participants also noted students who have computers can go to public places that offer free Internet, such as public libraries, fast food restaurants, and coffee shops.

This study provides educators with an opportunity to use the results as a guide for potential useful and effective, and innovative tools that can be used in courses to promote student success and learning. Higher education administrators should also be included in this effort in terms of providing additional support to instructors to promote the use of innovative technological tools in courses. Instructors and administrators have a responsibility to help students succeed in their coursework to help them achieve a better future. Accordingly, instructors should look for ways to increase student success and promote student learning in their courses.

This study focused solely on introductory biology courses due to the low student success rates in these courses. However, the results may be used in other disciplines as a guide for other higher education instructors regarding what their peers in the biology discipline are doing to promote student success and learning. To determine which innovative learning tools are most effective for promoting student success and learning, instructors must share their best practices with others, not only in their own disciplines but also in other disciplines.

The potential benefits of increasing student success in introductory biology courses span all levels of society, including the micro (individual and family) level, the meso (community) level, and the macro (nation, region, or world) level. Research has shown that the number of biologists that are needed will continue to increase over the next 10 years (BLS, 2018). However, if there is a continued low student success rate in introductory biology courses, then there will not be enough employable biologists to meet this demand. Therefore, it is essential for instructors to find learning tools and instructional methods that will help to increase student success rates in these courses. The results from the current study indicated that BL and VLEs are working—in most cases—to promote student success and learning.

I challenge higher education instructors and administrators to not only continue to identify ways to promote student success and learning but also to invite other instructors to use these innovative practices. In doing so, we, as educators, can aspire to increase student success and learning in courses to ensure that our students have the best chance to succeed in their future careers.

References

Amankwaa, L. (2016). Creating protocols for trustworthiness in qualitative research. *Journal of Cultural Diversity*, *23*(3). Retrieved from http://www.tuckerpub.com/jcd.htm

American Institute of Biological Sciences. (2018). Careers in the biological sciences. Retrieved from https://www.aibs.org/careers/

Ates, H., & Olpak, Y. Z. (2018). Pre-service science teacher perceptions toward additional instructional strategies in biology laboratory applications. *Science Education International*, *29*(2). Retrieved from http://www.icaseonline.net/journal/index.php/sei/index

Badilla Quintana, M. G., Vera Sagredo, A., & Lytras, M. D. (2017). Pre-service teachers' skills and perceptions about the use of virtual learning environments to improve teaching and learning. *Behaviour & Information Technology, 36*(6), 575–588. doi:10.1080/0144929x.2016.1266388

Bannister, J. (2016). Instructors' perceptions of connectivist characteristics in adult undergraduate education courses (Doctoral dissertation). Retrieved from https://www.proquest.com/

Batz, Z., Olsen, B. J., Dumont, J., Dastoor, F., & Smith, M. K. (2015). Helping struggling students in introductory biology: A peer-tutoring approach that improves performance, perception, and retention. *CBE—Life Sciences Education, 14*(2), ar16. doi:10.1187/cbe.14-08-0120

Beard, L. H. (2017). 'Incentivized reading': Using an online VLE to measure engagement and attainment in student learning. *International Journal for Innovation Education and Research*, *5*(11), 74-86. Retrieved from http://ijier.net

Boda, P., & Weiser, G. (2018). Research and teaching: Using POGILs and blended learning to challenge preconceptions of student ability in introductory chemistry. *Journal of College Science Teaching, 48*(1). doi:10.2505/4/jcst18_048_01_60

Boelens, R., De Wever, B., & Voet, M. (2017). Four key challenges to the design of blended learning: A systematic literature review. *Educational Research Review, 22,* 1-18. doi:10.1016/j.edurev.2017.06.001

Boulton, C. A., Kent, C., & Williams, H. T. (2018). Virtual learning environment engagement and learning outcomes at a 'bricks-and-mortar' university. *Computers & Education*, *126*, 129-142. doi:10.1016/j.compedu.2018.06.031

Bower, M., Lee, M. J., & Dalgarno, B. (2017). Collaborative learning across physical and virtual worlds: Factors supporting and constraining learners in a blended reality environment. *British Journal of Educational Technology*, *48*(2), 407-430. doi:10.1111/bjet.12435

Bryant, W. L. (2014). *Education and technology in the 21st century experiences of adult online learners using Web 2.0* (Doctoral Dissertation). Available from ProQuest Dissertations & Theses Global. (1524003159)

Bureau of Labor Statistics. (2018). Biological technicians. Retrieved from https://www.bls.gov/ooh/life-physical-and-social-science/biological-technicians.htm

Burgess, K. R. (2003). *Why they don't practice what we teach: Teachers' perceptions of culture and context in adult basic education* (Doctoral Dissertation). Available from ProQuest Dissertations & Theses Global. (305325486)

Cahillane, M., Smy, V., & MacLean, P. (2016). A case study of the barriers and enablers affecting teaching staff E-learning provision. *ICICTE Proceedings*, 168–176. Retrieved from http://dspace.lib.cranfield.ac.uk/handle/1826/10539

Cassidy, S. (2016). Virtual learning environments as mediating factors in student satisfaction with teaching and learning in higher education. *Journal of Curriculum and Teaching, 5*(1). doi:10.5430/jct.v5n1p113

Cheok, M. L., Wong, S. L., Ayub, A. F., & Mahmud, R. (2017). Teachers' perceptions of eLearning in Malaysian secondary schools. *Malaysian Online Journal of Educational Technology*, *5*(2), 20-33. Retrieved from https://eric.ed.gov/

Cohen, D., & Sasson, I. (2016). Online quizzes in a virtual learning environment as a tool for formative assessment. *JOTSE*, *6*(3), 188-208. Retrieved from http://www.jotse.org/index.php/jotse

Collings, D. A., Gerrard, J. A., & Garrill, A. (2018). Shaking up biology – our experiences teaching cell biology and biochemistry to a first-year undergraduate class through the Canterbury (New Zealand) earthquakes. *Journal of Biological Education*, 1–14. doi:10.1080/00219266.2018.1472134

Creswell, J. W., & Poth, C. N. (2017). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.

Dayag, J. D. (2018). EFL virtual learning environments: Perception, concerns and challenges. *Teaching English with Technology*, *16*(4), 20-33. Retrieved from https://tewtjournal.webs.com/

Downes, S. (2005a). An introduction to connective knowledge. Retrieved from http://oapen.org/home

Downes, S. (2005b). *Learning networks: Theory and practice*. Retrieved from 100 http://www.downes.ca/presentation/32

Downes, S. (2008). Places to go: Connectivism & connective knowledge. *Innovate*, *5*(1), 6. Retrieved from https://nsuworks.nova.edu/innovate/

Downes, S. (2011). How to participate in MOOC. Retrieved from http://halfanhour.blogspot.com/2011/09/how-to-participate-inmooc.html

Elias, J. E., & Merriam, S. (1980). Philosphical Foundations of Adult Education. Roberte E. Malabar, FL: Krieger.

Elliott, R., & Timulak, L. (2005). Descriptive and interpretive approaches to qualitative research. *A Handbook of Research Methods for Clinical and Health Psychology* (pp.147–159). New York, NY. Oxford University Press.

Fabbian, C., Carney, E. Z., & Grgurovic, M. (2017). Lessons learned: Design and implementation of Italian blended language courses. *Italica*, *94*(2). Retrieved from https://aati.uark.edu/

Fisher, J. F., Bushko, K., & White, J. (2017). Blended beyond borders: A scan of blended learning obstacles and opportunities in Brazil, Malaysia, & South Africa. Retrieved from https://eric.ed.gov/

Fuller, K. (2017). Beyond reflection: Using ePortfolios for formative assessment to improve student engagement in non-majors introductory science. *The American Biology Teacher*, *79*(6), 442-449. doi:10.1525/abt.2017.79.6.442

Gavassa, S., Benabentos, R., Kravec, M., Collins, T., & Eddy, S. (2019). Closing the achievement gap in a large introductory course by balancing reduced in-person contact with increased course structure. *CBE—Life Sciences Education, 18*(1). doi:10.1187/cbe.18-08-0153

Goeser, P. T., Hamza-Lup, F. G., Johnson, W. M., & Scharfer, D. (2018). VIEW: A virtual interactive web-based learning environment for engineering. *IEEE Advances in Engineering Education Journal, Special Issue on Research on e-Learning in Engineering Education (2011), 2*(3), pp. 1-24. doi:1811.07463

Goff, E. E., Reindl, K. M., Johnson, C., McClean, P., Offerdahl, E. G., Schroeder, N. L., & White, A. R. (2017). Efficacy of a meiosis learning module developed for the virtual cell animation collection. *CBE—Life Sciences Education, 16*(1). doi:10.1187/cbe.16-03-0141

Goldie, J. G. S. (2016). Connectivism: A knowledge learning theory for the digital age? *Medical Teacher, 38*(10), 1064–1069. doi:10.3109/0142159x.2016.1173661

Gonzalez, B. (2014). Two-year community: A six-year review of student success in a biology course using lecture, blended, and hybrid methods. *Journal of College Science Teaching, 043*(09). doi:10.2505/4/jcst14_043_06_14

Gregg-Jolly, L., Swartz, J., Iverson, E., Stern, J., Brown, N., & Lopatto, D. (2016). Situating second-year success: Understanding second-year STEM experiences at a liberal arts college. *CBE—Life Sciences Education, 15*(3), ar43. doi:10.1187/cbe.16-01-0044

Gulbinskienė, D., Masoodi, M., & Šliogerienė, J. (2017). Moodle as virtual learning environment in developing language skills, fostering metacognitive awareness and promoting learner autonomy. *Pedagogika, 127*(3), 176–185. doi:10.15823/p.2017.47

Halverson, L. R., Spring, K. J., Huyett, S., Henrie, C. R., & Graham, C. R. (2017). Blended learning research in higher education and K-12 settings. *Learning, Design, and Technology*, 1–30. doi:10.1007/978-3-319-17727-4_31

Han, F., & Ellis, R. A. (2019). Identifying consistent patterns of quality learning discussions in blended learning. *The Internet and Higher Education, 40*, 12–19. doi:10.1016/j.iheduc.2018.09.002

Herodotou, C., Muirhead, D. K., Aristeidou, M., Hole, M. J., Kelley, S., Scanlon, E., & Duffy, M. (2018). Blended and online learning: a comparative study of virtual microscopy in Higher Education. *Interactive Learning Environments*, 1-16. doi:10.1080/10494820.2018.1552874

Kennedy, D. M. (2016). Is it any clearer? Generic qualitative inquiry and the VSAIEEDC model of data analysis. *The Qualitative Report, 21*(8), 1369-1379. Retrieved from https://nsuworks.nova.edu/tqr/vol21/iss8/1

Krishnan, S. (2018). Students' perceptions of learning mode in mathematics. *MOJES: Malaysian Online Journal of Educational Sciences*, *4*(2), 32-41. Retrieved from https://mojes.um.edu.my

Kurt, E. Ö., & Tingöy, Ö. (2017). The acceptance and use of a virtual learning environment in higher education: an empirical study in Turkey, and the UK. *International Journal of Educational Technology in Higher Education, 14*(1). doi:10.1186/s41239-017-0064-z

Lake Sumter State College. (2019). Course catalogue. Retrieved from https://lssc.smartcatalogiq.com/2019-2020/Catalog-and-Student-Handbook/Courses/BSC-Biological-Sciences/1000/BSC-1010C

Lax, N., Morris, J., & Kolber, B. J. (2016). A partial flip classroom exercise in a large introductory general biology course increases performance at multiple levels. Journal of Biological Education, 51(4), 412–426. doi:10.1080/00219266.2016.1257503

Martín-Gutiérrez, J., Mora, C. E., Añorbe-Díaz, B., & González-Marrero, A. (2017). Virtual technologies trends in education. *EURASIA Journal of Mathematics Science and Technology Education, 13*(2), 469-486. Retrieved from http://www.ejmste.com/

McLellan, E., MacQueen, K. M., & Neidig, J. L. (2003). Beyond the qualitative interview: Data preparation and transcription. *Field methods*, *15*(1), 63-84. doi:10.1177/1525822x02239573

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation, 4th Edition.* San Francisco, CA: John Wiley & Sons, Inc.

Mozelius, P., Jaldemark, J., & Håkansson Lindqvist, M. (2018). Teachers' beliefs about professional development and the use of collaborative online tools in higher educational settings. In *Networked Learning Conference 2018* (Vol. 11, pp. 361-364). Retrieved from www.diva-portal.org

Nair, T. S., & Bindu, R. L. (2016). Effect of Blended Learning Strategy on Achievement in Biology and Social and Environmental Attitude of Students at Secondary Level. *Journal on School Educational Technology*, *11*(4), 39-52. doi:10.26634/jsch.11.4.6011

Patton, M. Q. (2014). Qualitative research & evaluation methods (4th ed.). Thousand Oaks, CA: Sage Publications.

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice.* Thousand Oaks, CA: Sage Publications.

Pearson. (2018). Mastering biology: Efficacy report summary. Retrieved from https://www.pearsonmylabandmastering.com/northamerica/results/files/Mastering-Biology-v3-summary.pdf?v1538993530

Percy, W. H., Kostere, K., & Kostere, S. (2015). Generic qualitative research in psychology. *The Qualitative Report*, *20*(2), 76-85. Retrieved from https://nsuworks.nova.edu/

Pinto-Llorente, A. M., Sánchez-Gómez, M. C., García-Peñalvo, F. J., & Casillas-Martin, S. (2017). Students' perceptions and attitudes towards asynchronous technological tools in blended-learning training to improve grammatical competence in English as a second language. *Computers in Human Behavior*, 72, 632-643. doi:10.1016/j.chb.2016.05.071

Qvist, P., Kangasniemi, T., Palomäki, S., Seppänen, J., Joensuu, P., Natri, O., … Nordström, K. (2015). Design of virtual learning environments: Learning analytics and identification of affordances and barriers. *International Journal of Engineering Pedagogy (iJEP), 5(*4), 64. doi:10.3991/ijep.v5i4.4962

Reese, S. A. (2014). Online learning environments in higher education: Connectivism vs. dissociation. *Education and Information Technologies, 20*(3), 579–588. doi:10.1007/s10639-013-9303-7

Risquez, A., Raftery, D., & Costello, E. (2015). The open dataset on students' perceptions of virtual learning environments in Ireland: Collaborating to listen to the student voice. *British Journal of Educational Technology, 46*(5), 1070–1074. doi:10.1111/bjet.12323

Rubin, H. J., & Rubin, I. S. (2011). *Qualitative interviewing: The art of hearing data* (2nd ed.). Thousand Oaks, CA: Sage.

Rubin, H. J., & Rubin, I. S. (2012). *Qualitative interviewing: The art of hearing data* (3rd

ed.). Thousand Oaks, CA: Sage.

Saldaña, J. (2013). *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage Publications.

Saldaña, J. (2015). *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage Publications.

Sargeant, J. (2012). Qualitative research part II: Participants, analysis, and quality assurance. *Journal of Graduate Medical Education, 4*(1), 1–3. doi:10.4300/jgme-d-11-00307.1

Scott, A., McNair, D., Lucas, J., & Land, K. (2017). Research and Teaching: From Gatekeeper to Gateway: Improving Student Success in an Introductory Biology Course. *Journal of College Science Teaching, 046*(04). doi:10.2505/4/jcst170460493

Seidman, I. (2006). *Interviewing as qualitative research: A guide for researchers in education and social sciences* (3th ed.). New York, NY: Teachers College Press.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22* (2). 63-75.doi:10.3233/efi-2004-22201

Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, *2*(1), 3–10. Retrieved from http://er.dut.ac.za/handle/123456789/69

Siemens, G. (2006a). Connectivism: Learning theory or pastime of the self-amused. Retrieved from http://www.elearnspace.org/Articles/Connectivism_response.doc

Siemens, G. (2006b). *Knowing knowledge*. Lexington, KY. Lulu.

Siemens, G. (2008). Learning and knowing in networks: Changing roles for educators and designers. *ITFORUM for Discussion*. Retrieved from http://www.unigaiabrasil.org/pdfs/educacao/Siemens.pdf

Siemens, G., & Conole, G. (2011). Special issue-Connectivism: Design and delivery of social networked learning. *International Review of Research in Open and Distance Learning, 12*(3). Retrieved from http://www.irrodl.org/index.php/irrodl/issue/view/44

Smith, J. R., Chungh, M. K., Sadouq, S., & Kandiah, A. (2017). Learners' Perspectives on Pure Science Content in Vocational Degree Programs: Chemistry for Pharmacists. *Science Education International*,*28*(3), 182-189. Retrieved from http://www.icaseonline.net/seiweb/index.php

Sorbie, J. (2015). Exploring teacher perceptions of blended learning (Doctoral dissertation). Retrieved from Retrieved form https://www.proquest.com/

Streubert-Speziale, H. J. (2007). Designing data generation and management strategies. In H. J. Streubert-Speziale & D. R. Carpenter (Eds.), *Qualitative research in nursing: Advancing the humanistic imperative* (pp. 35–56): Philadelphia, PA: Lippincott Williams and Wilkins.

Taylor, S. J., Bogdan, R., & DeVault, M. J. (2016). *Introduction to qualitative research methods: a guidebook and resource*. Canada: JohnWiley & Sons.

Thompson, E. D., Bowling, B. V., & Markle, R. E. (2017). Predicting student success in a major's introductory biology course via logistic regression analysis of scientific

reasoning ability and mathematics scores. *Research in Science Education, 48*(1), 151–163. doi:10.1007/s11165-016-9563-5

Thorne, S. (2016). Interpretive description: Qualitative research for applied practice (2nd edition). New York, NY: Routledge. United Stated Department of Labor. (2018). Occupational employment statistics. Retrieved from https://www.bls.gov/oes/current/oes191029.htm

United States Department of Labor. (2018). Occupation employment statistics. Retrieved from https://www.bls.gov/oes/current/oes191029.htm

Valencia College. (2019). Course descriptions. Retrieved from https://catalog.valenciacollege.edu/coursedescriptions/coursesoffered/bsc/

Vo, H. M., Zhu, C., & Diep, N. A. (2017). The effect of blended learning on student performance at course-level in higher education: A meta-analysis. *Studies in Educational Evaluation*, *53*, 17-28. doi:10.1016/j.stueduc.2017.01.002

Weerasinghe, T. A. (2018). An evaluation of different types of blended learning activities in higher education. 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT). doi:10.1109/icalt.2018.00017

Wienhold, C. J., & Branchaw, J. (2018). Exploring biology: A vision and change disciplinary first-year seminar improves academic performance in introductory biology. *CBE—Life Sciences Education*,*17*(2). doi: 10.1187/cbe.17-08-0158

Yanow, D., & Schwartz-Shea, P. (2015). *Interpretation and method: Empirical research methods and the interpretive turn*. New York, NY. Routledge.

Yapici, İ. Ü. (2016). Effectiveness of blended cooperative learning environment in biology teaching: Classroom community sense, academic achievement and satisfaction. *Journal of Education and Training Studies*, *4*(4), 269-280. doi:10.11114/jets.v4i4.1372

Yin, R. K. (2015). *Qualitative research from start to finish*. New York, NY. Guilford Publications.

Zeichner, O., & Zilka, G. (2016). Feelings of challenge and threat among pre-service teachers studying in different learning environments -virtual vs. blended courses. *i-Manager's Journal of Educational Technology, 13*(1), 7. doi:10.26634/jet.13.1.6014

Appendix A: Participant Invitation

Dear Invitee,

My name is Whitley Webb. I am a doctoral student at Walden University's Education Program. I am kindly requesting your participation in a doctoral research study that I am conducting titled, *Faculty Perceptions of the Use of Virtual Learning Environments in Introductory Biology Courses*. The intention is to explore teachers' perceptions and experiences of the use of virtual learning environments (VLEs) in higher education introductory biology courses to promote student learning.

The study involves completing basic demographic information and one interview. Participation is completely voluntary, and you may withdraw from the study at any time. The study is completely anonymous; therefore, it does not require you to provide your name or any other identifying information.

If you would like to participate in the study, please read the Informed Consent letter below. Your participation in the research will be of great importance to assist in social change in ensuring that students in our educational system are receiving adequate and effective educational experiences that prepare them for the fields of study in which they will enter.

Thank you for your time and participation

Sincerely,

Whitley Webb M.S, Doctoral Student, "Walden University"

Appendix B: Social Media Flyer

Attention

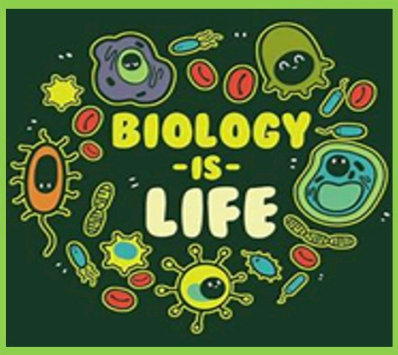
Attention

Higher Education Introductory Biology Instructors Wanted for Research Study

Participants needed: Biology instructors that either currently use the Virtual Learning Environment (VLE), Mastering Biology or have used this VLE in the past for at least a year.

Mastering Biology

Participants expectations include: Consenting participants will be completing a 45-60-minute interview either face-to-face or via Skype, depending on your location. I am located close to central Florida. I am willing to drive 100 miles for face-to-face interviews. The face-to-face interviews will be conducted in a public library close to your home.



Research Study

If you would like to participate in the study please contact me at whitley.webb@waldenu.edu

This study is for a Walden University Dissertation.

All participant information and data collected will be kept confidential.

Appendix C: Interview Guide

Introductory Statement

[Read to interviewee] This research project is to explore experiences and perceptions of higher education biology instructors who teach introductory biology-major courses regarding the use of the virtual learning environment (VLE), Mastering Biology (MB) to promote student learning. As part of this research purpose, this project study will explore instructor perceptions about the successes and challenges of using blended learning (BL) and VLEs, including the use of MB, to promote student learning. The results of this study will potentially identify specific components of MB and how using a BL environment along with a VLE to assist instructors in creating a learning environment to promote student learning better. The information you provide today will be kept confidential and secured in a safe place for five years upon, which it will then be destroyed. This interview will last between 30 to 45 minutes and will be recorded with your permission.

[Turn on computer recording software and test.]

Interviewee's Name: _____

Interview Date: _____

Interview Start Time: _____

Interview Finish Time: _____

Courses Currently Teaching: _____

Interview Questions

1. How long have you been teaching introductory biology courses?
    a. Follow-up probe: When did you start using a blended learning style course with, MB?
2. Can you describe why you decide to start using a VLE in your courses?
    a. Follow-up probe: How did you beginning using a VLE in your courses? For example, did you start sing a VLE in all of your courses at once or just a course at a time?
    b. Follow-up probe: Think in terms of when you switched from using a traditional F2F teaching style to a BL style that incorporates VLEs.
3. Can you tell me about your experience when you were first starting to use MB in your courses to now?
    a. Follow-up probe: When first starting to use MB was the initial set-up for courses time-consuming?
    b. Follow-up probe: Can you give an example of the amount of time you think you spent on this process?
    c. Follow-up probe: Now when you use MB in your courses what is the set-up time?
4. How do you or have you utilized MB in your courses to promote student learning?
    a. Follow-up probe: Can you provide two or more examples of the activities you have your students complete through MB?

5. Which of the virtual learning activities, in your opinion, work better than others to promote student learning?
    a. Follow-up probe: Why do you think these activities work better than others?
6. Based on the activities you have used in MB; which activities seem to not work to promote student learning?
7. Based on your experiences, how do you feel the utilization of BL and VLEs impacts student learning?
    a. Follow-up probe: Can you provide me with a few examples?
8. Please explain some of the challenges or frustrations that you encounter when utilizing MB or any VLE in your courses.
    a. Follow-up probe: How do you overcome these challenges?

Conclusion Statement

I want to thank you for taking the time to meet with me today. You have given me a very clear picture of your thoughts and experiences on using BL and, MB, in your course. Is there anything else that you would like to add before we end this interview? If not, I would like to thank you again for meeting with me today. I will be transcribing this interview in the next few days and will get an email out to you so you can check to ensure that all of your thoughts were adequately recorded. If you think of anything else, you like to add you can do so when I send the member check email out. You may also receive a few clarification questions, but those will be limited to no more than five. This

will all be sent to you via email. Again, thank you for your participation in this study. If you have any other questions or concerns, please feel free to contact me.

Appendix D: Interview Question Table

Table D1

Interview Question Table

Interview Question	Research Question Answered (RQ)
Question 1: How long have you been teaching introductory biology courses? **b. Follow-up probe: When did you start using a blended learning (BL) style course with the virtual learning environment (VLE), Mastering Biology (MB)?**	Provides basic demographic and background information for the study.
Question 2: Why did you decide to start using a VLE in your courses?	This question works to inform RQ 1
Question 3: Can you tell me about your experience when you were first starting to use MB in your courses to now? **a. Follow-up probe: When first starting to use MB was the initial set-up for courses time-consuming?** **b. Follow-up probe: Can you give an example of the amount of time you think you spent on this process?**	This question works to inform RQ 1 and 3
Question 4: How do you or have you utilized MB in your courses to promote student learning? **a. Follow-up probe: Can you provide two or more examples of the activities you have your students complete through MB?**	This question works to inform RQ 2

Question 5: Which of the virtual learning activities, in your opinion, work better than others to promote student learning? **a. <u>Follow-up probe:</u> Why do you think these activities work better than others?**	This question works to inform RQ 2 and 3
Question 6: Based on the activities you have used in MB, did any seem to not work to promote student learning?	This question works to inform RQ 2
Question 7: Based on your experiences, how do you feel the utilization of BL and VLEs impacts student learning? **a. <u>Follow-up probe:</u> Can you provide me with a few examples?**	This question works to inform RQ 1
Question 8: Please explain some of the challenges or frustrations that you encounter when utilizing MB in your courses. **a. <u>Follow-up probe:</u> How do you overcome them?**	This question works to inform RQ 1 and 3

Appendix E: Sample Member Checking Email

Hi Participant name I hope that you are well!

First, I want to thank you again for participating in my qualitative research study titled *Faculty Perceptions of the Use of Virtual Learning Environments in Introductory Biology Courses.* Below I am going to provide you with a brief summarization of the main points that I gained from your interview. If you would like a copy of the full transcript of your interview, please let me know, and I will be happy to provide you with a copy.

The purpose of this study was to explore faculty perceptions and experiences of their utilization of blended learning (BL) and virtual learning environment (VLEs) specifically Mastering Biology (MB) in introductory biology courses. The research questions in this study were:

1. How do biology instructors use MB to boost student success in introductory biology courses?
2. What are the perceptions of biology instructors of the efficiency and usefulness of BL and the VLE tool MB to promote student learning?
3. What are biology instructors' recommendations on how MB and other VLEs can be used more effectively in introductory biology courses?

Below is a summary of the interview and my observations.

You have used BL and VLEs in your courses since around 2012. You seemed to have several reasons for first starting to use BL and VLEs in your courses. However, the main reasoning that I gained from your interview was because it offers students with

various levels of learning and learning styles a place to study and complete activities. Also, by using VLEs it allows students to work more at their own pace. You also mentioned several times that some students are still leery with using this type of technology in courses, so there is a learning curve.

In terms of the initial set up time, for when you first started using MB, it seemed that it took you a while, anywhere from four to six hours, to set up a new course. However, after the course is set up, the transition from semester to semester is practically seamless. When using MB in your courses, you also seem to use a multitude of resources to help promote student learning, including:

- Homework Activities
- Quizzes
- Videos
- Study Area

Throughout the interview, you noted several times that students get out what they put into the assignments on MB. So, for example, the more effort and time students put into MB, the more they are likely going to get out the VLE. I also took from your study that you have not noticed any activity or assignment working better than others to help students. You mentioned the usefulness of the videos and interactivities several times through the interview.

Lastly, when we were talking about frustrations and challenges of using BL and VLEs in courses, you mentioned a few, including:

- Connectivity
- Cost
- General Technical Issues

If you have anything, you would like to add to the above summary or clarify, please feel free to do so. Also, I have two more questions for you. If you do not mind answering these in a reply email.

1. What recommendations do you have for instructors that are new to using BL and VLEs in their courses?
2. How do your students seem to respond to using VLEs in your courses?

Thank you again for your participation in my research!

Whitley Webb