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UNDERSTANDING ESSENTIAL FACTORS IN INFLUENCING TECHNOLOGY-SUPPORTED LEARNING: A MODEL TOWARD BLENDED LEARNING SUCCESS

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ABSTRACT

Aim/Purpose	In this study, we aim to understand factors that can influence technology-supported learning, specifically in the blended environment. To do that, a research model is developed by incorporating factors from three perspectives, including self-related factors, technology and systems factors, and the instructional design factor.
Background	Technology-supported learning has changed the way of instruction dramatically in higher education, from e-learning to the more recent blended learning. Because of the increased popularity and wide adoption of blended learning, it would be of importance for educators and researchers to know and understand factors that could lead to student success in the blended environment.
Methodology	The survey method was used in this study. The study site is a freshman-level, introduction to computer information systems class, at a major public university located in the United States, which adopts the blended learning instructional method. In total, 699 students completed the survey.
Contribution	This paper contributes to the existing literature by investigating potential, influential factors on blended learning success from multiple perspectives. In addition, a research model is developed and tested in order to systematically investigate and understand the impacts of those factors on student success in such a learning environment.

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Findings	Some interesting results have been identified. One is that students' computer self-efficacy doesn't play any significant role in influencing their perceptions of either the learning climate, task-technology fit, or the level of flexibility associated with blended learning. However, their own motivation to learn could significantly influence the first two of them. Another important result we find is that all four technology and systems related factors, including information quality, system quality, service quality, and media richness, have significant impacts on students' perceptions of learning climate, task-technology fit, and blended learning flexibility. We also find that the instructional design factor can significantly influence blended learning success.
Recommendations for Practitioners	The significant impacts of factors examined in this study on student success in blended learning could shape the design and adoption of technology-supported learning in educational institutions.
Recommendations for Researchers	This study offers a research model that researchers could adopt to evaluate student success in blended learning or technology-supported education in general.
Impact on Society	The higher education industry needs to gain a better understanding of how potential factors could influence student success in blended learning (or technology-supported learning in general) in order to ensure the success of the use of modern information technology and systems to assist students' learning.
Future Research	Future research can further examine and validate the research model proposed in this study on other class settings and with different types of study bodies. In addition, future research may identify other types of important factors and further extend the proposed research model.
Keywords	technology-supported learning, blended environment, self-related factors, technology and systems factors, instructional design factor, satisfaction, intention

INTRODUCTION

THE IMPACT OF INFORMATION TECHNOLOGY ON HIGHER EDUCATION

Internet and information technology have changed different aspects of people's lives, from shopping, transportation, voting, to higher education, and so forth. Over the years, with the increased popularity and advancement in technology, almost all essential operating activities around college students have become heavily reliant on advanced information technology and systems – from class registration, classroom scheduling, tuition payment and processing, to book borrowing and article searching in libraries, and most importantly, knowledge delivery in classes.

The advent of the Internet and related communication technology has enabled the way knowledge delivery in classes has changed from only face-to-face settings, which had been there for hundreds of years, to online education, where students don't have to physically be there, in a designated place, with their instructor and other classmates (Kulkarni et al., 2013; Teo et al., 2018). Such flexibility has provided a very important opportunity for many individuals who would like to gain a college degree or attend certain classes but have time and/or location constraints (Teo et al., 2018). Thus, e-learning has opened a whole new world to meet those needs.

ADVANCEMENT OF BLENDED LEARNING

However, everything has two sides. Over the years, people have observed certain disadvantages associated with e-learning. For example, it requires a considerable amount of time and monetary costs to set up, maintain, and ensure the effective use of the e-learning environment, and to provide related technical support promptly (Sun et al., 2008). It also takes time and effort for the instructor to either design an e-learning class from scratch or modify an existing face-to-face class to purely online. In addition, the fact that students don't have the opportunity to physically meet their instructor or other classmates to conduct any face-to-face communication (which is believed to be the richest communication channel) may give students a feeling of separation (eLearner Iowa State University, 2014). Another concern is that this learning environment may only fit highly motivated students, and for those who are less motivated may easily fall behind the class (eLearner Iowa State University, 2014).

To overcome those potential drawbacks, as well as to combine the advantages of both face-to-face instruction and e-learning, blended learning was recently created. Still with the support of Internet technology and information systems (as utilized in e-learning), the blended environment incorporates both the face-to-face components, in which students need to interact physically with their instructor and other classmates, and online components that consist of activities that students need to complete by themselves via the use of supporting technology and systems (Hung & Chou, 2015; Padilla-Meléndez et al., 2013). Over recent years, many universities and colleges have provided blended classes with the purpose of the increase in teaching effectiveness and improvement in student performance.

RESEARCH PURPOSE OF THE PRESENT STUDY

Inspired by the increased popularity and wide adoption of this type of technology-supported learning as mentioned above, this study aims to broaden our understanding of student success in such an environment. Specifically, we would like to investigate factors that could play an important role in influencing student learning around it. To do this, we look into factors from three perspectives. The first group of factors we choose to examine are students' self-related factors, since students themselves play the central role in such a student-centric learning environment. In addition, the effectiveness and efficiency of the supporting technology and systems in such a technology-supported learning environment could highly influence student success (Raspopovic & Jankulovic, 2017). Thus, we choose technology and systems related factors as our second group of factors to investigate. We also look into the instructional design as a third factor to student success. For each perspective, a set of specific factors is incorporated into a research model. We provide detailed discussions on those factors and the research model with hypothesis development in the next section.

LITERATURE REVIEW ON FACTORS RELATED TO TECHNOLOGY-SUPPORTED LEARNING AND HYPOTHESIS DEVELOPMENT

As discussed in the previous section, the purpose of this study is to broaden our understanding of student success in technology-supported learning, particularly blended learning, by investigating potentially influencing factors from multiple perspectives that are related to students themselves (including students' computer self-efficacy and motivation), supporting technology and information systems (including information quality, system quality, service quality, and media richness), and the instructional design (i.e., teaching method). A research model is developed to incorporate these factors and to understand their impacts on student learning. The following subsections provide detailed discussions on the research model and hypothesis development.

COMPUTER SELF-EFFICACY AND MOTIVATION

It is important to investigate factors related to students themselves because students are always in the center of the education system. The purpose of any innovation in education along history is to provide a better learning experience for students and to increase their learning performance. In technology-supported learning, such as blended learning, students' own efficacy in the use of computers and related techniques may influence their perceptions toward learning performance. In addition, their own motivation to learn in the technology-supported environment could be another important factor in influencing their learning performance.

Computer self-efficacy is defined as an individual's own belief about his/her ability to use computers effectively (Chen, 2014). Previous literature on technology-supported learning has examined the impact of students' computer self-efficacy in various ways. For example, Roca et al. (2006) found that students' computer self-efficacy could significantly influence their perception of the ease of use and satisfaction about the e-learning system. However, in a more recent study, Sánchez and Hueros (2010) found that the impact of students' computer self-efficacy was not significant on either the perceived ease of use or usefulness associated with the e-learning system. As to the blended learning environment, previous research found that students' computer self-efficacy had a significant, positive impact on their own expectations about their learning outcomes (Chen, 2014). Consistent results were reported by Wu et al. (2010), where they found a significant impact of students' computer self-efficacy on their performance expectations in blended learning.

In the context of education, motivation refers to the incentive that propels students to work hard and actively on the assigned learning activities and tasks (Wu & Hwang, 2010). There are two types of motivation, intrinsic and extrinsic motivation. If an individual has intrinsic motivation of doing something, it means that he/she enjoys doing it; however, extrinsic motivation is typically associated with the belief of worth doing it or must do it (Wu & Hwang, 2010). Previous literature has reported that intrinsic motivation is of the highest level, and is a critical success factor on student performance in technology-supported learning (Aharony, 2014; Wu & Hwang, 2010). For example, Kong et al. (2012) studied the online, game-based collaborative learning environment and found that motivation could positively influence students' intention to learn. In another study, Wu and Hwang (2010) found that motivation had a significant impact on students' use of the e-learning system.

Providing a pleasant learning climate is always something that educators and universities/colleges would like to achieve. This is even true in technology-supported learning, such as blended learning. Learning climate is defined as the atmosphere associated with student learning in a class or around a particular supporting platform (Chen, 2014). In our context, it is about the blended learning environment, which typically consists of a considerable amount of activities and tasks that students need to perform online via the use of supporting technology and information systems. Thus, students' own efficacy in the use of computer systems may influence their perceptions of the blended learning environment. In other words, if a student believes his/her level of efficacy in using computer systems is high, he/she would possess a more positive attitude toward the blended learning environment as a whole. In addition, if a student is highly motivated to learn in the blended environment, it can be expected that he/she would treat such an environment more positively. Therefore, we hypothesize:

- H1a: Computer self-efficacy can positively influence students' perception of the learning climate associated with blended learning.
- H1b: Motivation can positively influence students' perception of the learning climate associated with blended learning.

In technology-supported learning, such as blended learning, advanced techniques and systems are always utilized with the purpose to meet students' learning needs by providing better support to help them accomplish their learning tasks. This idea is related to the concept of task-technology fit, which states that information technology is more likely to have a positive impact on an individual's task performance if the functionality of the technology matches the requirements of the tasks that the user

needs to perform (Goodhue & Thompson, 1995). In the context of blended learning, tasks are about the various learning activities students need to perform, and technology refers to the techniques and systems adopted to help support students' learning activities. In our study, task-technology fit is defined as students' perception on the level of fit between the class-related exercises and projects they need to complete, and the supporting technology and information systems provided in the class for them to perform those exercises and projects.

As to technology-supported learning, Lin (2012) studied the adoption of a virtual learning system that was used to facilitate e-learning classes, and found that students' perceived task-technology fit could significantly influence their satisfaction toward and continuance intention to use the system. In another study, Lin and Wang (2012) assessed the adoption of an online system used in a blended class. They found that students' perceived task-technology fit had significant impacts on both their perceived usefulness of the system and system acceptance. However, few existing studies have examined factors that could potentially influence task-technology fit in the context of technology-supported learning. In this study, we propose that both computer self-efficacy and motivation could be potentially influential factors. That is to say, when a student perceives him/herself with a high level of computer self-efficacy, he/she would find it easy to get familiar with, and to become competent in using the supporting technology and information systems in the blended environment to complete the learning activities and tasks. This could then potentially lead to a feeling of a high level of fit between the supporting technology and information systems, and the learning tasks to be performed. Otherwise, a perception of a low level of computer self-efficacy could potentially lead to a negative feeling toward the fit between the supporting technology and information systems, and the learning tasks to be performed. In addition, students' own motivation to learn in the blended environment could also be expected to play an important role in influencing their perception of the level of fit between the supporting technology and information systems, and the learning tasks to be completed. When a student is highly motivated to learn in the blended environment, it would be more likely for him/her to have a positive view toward the technology and information systems utilized in supporting their learning needs, and therefore forming a more positive feeling on the level of match between those technology and systems and their learning tasks. Thus, we hypothesize:

- H2a: Computer self-efficacy can positively influence students' perceived task-technology fit associated with blended learning.
- H2b: Motivation can positively influence students' perceived task-technology fit associated with blended learning.

In addition to learning climate and task-technology fit, another important concept we look into in this study is blended learning flexibility. One major advantage associated with the blended learning environment is believed to be the flexibility that students have in completing their learning tasks by using supporting technology and systems. In blended learning, a significant part of learning takes place online, enabling students to conduct it in a flexible way (such as at their own pace and in their own place of choice) which helps better fit their own schedules and learning needs (Asarta & Schmidt, 2013; McKenzie et al., 2013). In this study, we define blended learning flexibility as the level of freedom that students have in performing their individual, out of class activities, in terms of time, pace, and location. For students with a high level of computer self-efficacy, they may like and appreciate this type of freedom enabled by the use of supporting technology and online systems, thus forming a positive attitude toward it. On the other hand, students whose computer self-efficacy levels are low may find such flexibility to be a burden, both cognitively and emotionally, thus forming a negative feeling toward it. In addition, when a student is more motivated to learn in the blended learning environment, it is more likely that he/she would prefer and favor the flexibility provided by this environment to be able to work at his/her own pace, on his/her own schedule, and in his/her own place of choice. Therefore, we hypothesize:

- H3a: Computer self-efficacy can positively influence students' perception of blended learning flexibility.
- H3b: Motivation can positively influence students' perception of blended learning flexibility.

INFORMATION QUALITY, SYSTEM QUALITY, SERVICE QUALITY, AND MEDIA RICHNESS

As stated in the DeLone and McLean IS Success Model (DeLone & McLean, 1992, 2003), which is one of the most well-known and widely adopted theories for assessing the success of information systems, three types of qualities are essential determinants of success on the adoption of an information system or technology. They are information quality, system quality, and service quality. In this study, we treat them as the technology and systems related factors.

Information quality refers to the quality of the information that a system is able to store, deliver, and/or generate, and is about the measure of the output of a system (DeLone & McLean, 1992, 2003; Rai et al., 2002). System quality means the overall quality of the system itself (DeLone & McLean, 1992). While information quality measures the semantic success of a system, system quality measures the technical success of it (DeLone & McLean, 2003). Service quality refers to the quality of support services that a system is able to deliver to its users (DeLone & McLean, 2003). Previous research on technology-supported learning found that all three of them could significantly influence users' perceptions of the usefulness, ease of use, and enjoyment of e-learning systems. In the context of blended learning, previous literature treated the three of them as a whole into one theoretical construct, referred to as either system functionality (Wu et al., 2010) or system characteristics (Chen, 2014). This construct was found to have a significant impact on students' expected learning performance (Chen, 2014; Wu et al., 2010), learning satisfaction (Chen, 2014), and the learning climate (Chen, 2014) associated with the blended environment.

In addition to the three types of quality, we also look into the theory of Media Richness (Daft & Lengel, 1986), which is one of the most well-known theories related to communication media choice. The theory views different communication media in terms of their richness levels. Face-to-face communication is commonly believed as the richest medium because of the many types of cues (such as verbal and visual) it can provide, while computer-mediated communication media, such as emails and online chat rooms, are believed to have a much lower level of richness (Markus, 1994; Trevino et al., 1987). Therefore, it can be expected that face-to-face instruction could have the highest level of richness, followed by blended learning, and then e-learning. In general, a communication medium with a higher level of richness is desired, because such a medium makes it easier for people to absorb the information being passed along and it typically leads to less ambiguity between the message sender and recipient. In technology-supported learning, media richness is referred to as the use of multiple and appropriate digital media to present learning content to students (Wu & Hwang, 2010). It was found that media richness could significantly influence students' perceived usability on the online learning system (Wu & Hwang, 2010).

Based on the discussion above, it is reasonable to expect that if a student believes the information provided by the supporting technology and systems used in blended learning is of high quality, he/she would be more likely to treat the blended learning environment positively, in terms of the overall climate it provides, the level of fit between the supporting technology/systems and the learning tasks to be completed, and the level of flexibility associated with their learning process. Similarly, if a student perceives the supporting technology and systems themselves to be of high quality, he/she may tend to have positive feelings in the same way. This could also be the case if the learning-related services offered by the supporting technology and systems are of high quality. In addition, if the supporting technology and systems can provide a desirable level of richness for meeting students' learning needs, it would be more likely for them to form positive feelings toward the blended environment. Therefore, we hypothesize:

- H4a-d: Information quality/system quality/service quality/media richness of the supporting technology and information systems can positively influence students' perception of the learning climate associated with blended learning.

- H5a-d: Information quality/system quality/service quality/media richness of the supporting technology and information systems can positively influence students' perceived task-technology fit associated with blended learning.
- H6a-d: Information quality/system quality/service quality/media richness of the supporting technology and information systems can positively influence students' perception of blended learning flexibility.

TEACHING METHOD

In technology-supported learning, the teaching method or course-related factors may also influence student learning. Previous research has examined course-related factors, including course flexibility and course quality, and found that both of them could significantly influence students' satisfaction (Sun et al., 2008). Other studies investigated and compared some specific methods used in technology-supported classes. For example, Sun et al. (2012) found that the use of e-textbooks could significantly enhance students' learning. Yourstone et al. (2010) compared students' performance between giving two attempts and four attempts for online quizzes. They found that giving four attempts did not provide a better learning outcome than giving two attempts. However, little research has been seen to treat the teaching method as a construct and to investigate its impact on students' learning in the blended environment.

In this study, the teaching method is defined as the variety of specific learning activities and tasks adopted in blended learning for students to perform and complete. It can be expected that if the learning activities and tasks adopted in blended learning can effectively support students' learning needs, students will be more likely to form a positive view toward the blended learning environment, in terms of the overall climate it provides, the level of fit between the supporting technology/systems and their learning tasks, and the level of flexibility associated with their learning process. Therefore, we hypothesize:

- H7: Teaching method can positively influence students' perception of the learning climate of blended learning.
- H8: Teaching method can positively influence students' perceived task-technology fit associated with blended learning.
- H9: Teaching method can positively influence students' perception of blended learning flexibility.

SATISFACTION AND INTENTION

User satisfaction and intention have been widely adopted as two important measures of success in the information systems adoption research area, and are typically used as essential dependent variables in related theoretical model development research (Venkatesh et al., 2003). By applying them to the context of technology-supported learning (Raspopovic & Jankulovic, 2017), in this study, we adapt them to our proposed research model. Specifically, satisfaction is defined as students' level of satisfaction on blended learning, and intention is defined as their willingness to take more blended classes in the future when available. We expect that students' perceptions of learning climate, task-technology fit, and blended learning flexibility could play important roles in influencing their satisfaction and intention. Therefore, we hypothesize:

- H10-12: Learning climate/task-technology fit/blended learning flexibility can positively influence students' satisfaction.
- H13-15: Learning climate/task-technology fit/blended learning flexibility can positively influence students' intention.

The research model and hypotheses are summarized in Figure 1.

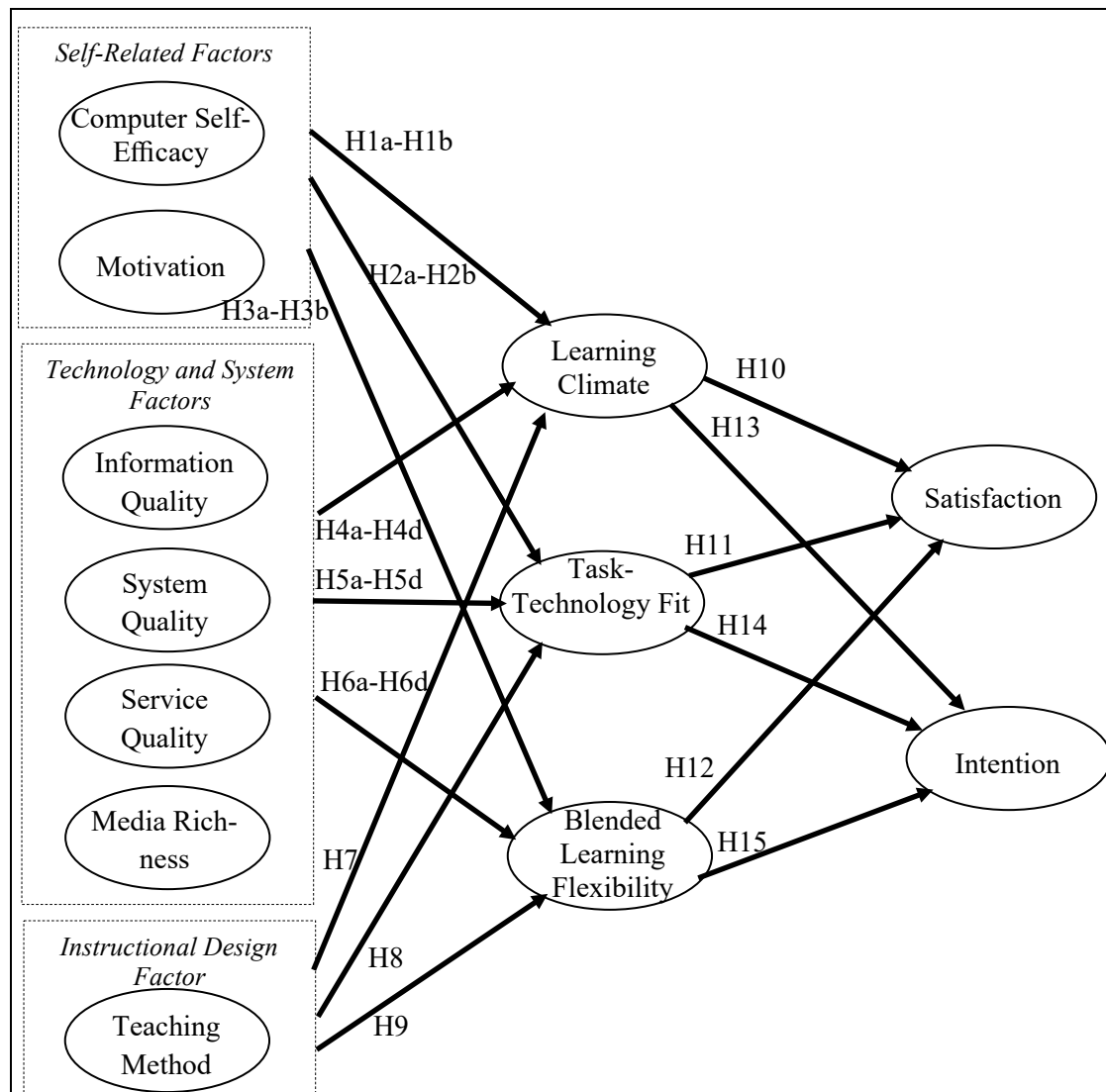


Figure 1. Research model and hypotheses

RESEARCH METHOD

STUDY SITE, INSTRUCTIONAL DESIGN, AND SUPPORTING TECHNOLOGY AND INFORMATION SYSTEMS

Our study site is a freshman-level, introduction to computer information systems class, at a major public university located in the United States. The class covers fundamental concepts related to information systems and hands-on Microsoft Office skills instruction (including Word, Excel, Access, and PowerPoint). It is a required class for students across different colleges of the university. It serves hundreds of students each semester with multiple, tightly coordinated sections, that adopt exactly the same instructional design.

Levering the blended learning instructional method, the class has both the offline (face-to-face) and online components. Overall, students meet their instructor and other classmates in a regular classroom once a week, and conduct a considerable amount of learning activities using the supporting online systems by themselves. When they meet in the classroom, they need to perform various of-line components through interactions with their instructor and classmates.

As a type of technology-supported learning, blended learning relies considerably on the supporting technology and information systems, especially for the online components of the class. Those technology and information systems are critical to the success of blended learning. In this class, various online technology and information systems are utilized, including an online digital textbook, an online project assignment and submission system, and a learning management system. Each of them is aimed to provide effective support to students' online-related learning activities. A brief summary of the specific activities that students need to perform by using them is as follows.

The user-interactive, multimedia, digital textbook: The digital textbook is user-interactive, aiming to provide students fundamental, but important, information and knowledge on each chapter topic. In addition to the traditional presentation of content as the description in paragraphs and sections, each chapter also provides YouTube videos, RSS feed links, and news stories to current events that are updated each week to ensure the currency of information. Further, it enables the keyword-based search function, making it easier for students to locate the content they would like to find or focus on. The digital textbook also contains a section with video tutorials that walk students through various techniques in the Microsoft Office package, including Word, Excel, Access, and PowerPoint.

The online project assignment and submission system with automatic grading and feedback providing capability: In addition to completing the projects mentioned above by exactly following the video tutorials, students also need to work on more challenging projects to enhance their mastery of techniques about the Microsoft Office package, supported by an advanced online project assignment and submission system. For each technique in Microsoft Office, they need to complete two to four individual projects via using the system. Once done, students need to submit their completed project files to the system for automatic grading. After a few minutes, the system returns the result and comments (if points are deducted) back to the student. Considering the complexity and difficulty levels of many of the projects, as well as to motivate students to work hard, multiple attempts (up to five) are allowed for each project.

The learning management system with integrated access to course materials and resources: The class also employs a learning management system, which provides integrated access to all class resources. The purpose of this tool is to help keep the class well organized; and in the meanwhile, provide students with an overall picture of the class structure. Since a lot of resources are utilized in the class, we believe this integrated access could better help keep students on track and make it easier for them to find the related resources they need in order to complete the required class activities. With this system, students do not have to worry about how (and when) to access each individual resource to perform the class-related tasks. Instead, they will see everything they need at one glance. To use the learning management system, once logged in, students can find the links to the digital textbook and the online project assignment and submission system. It also provides the quiz tool that students need to use to complete both an individual before-class quiz and an individual after-class quiz each week (in addition to the in-class quiz they work in groups). Each of these individual quizzes allows two attempts, with questions randomly picked from the test bank each time. The higher score between the two attempts is recorded as the final grade. In addition, the learning management system also is used for information sharing and communication purposes, where students can download slides and reading materials posted by their instructor and exchange messages with their instructor and other classmates. They also can keep track of their own progress by using the gradebook function.

Overall, in addition to the various in-class activities, the course relies heavily on information technology and systems to support a considerable number of online learning activities that students need to perform individually by themselves. All online related projects and quizzes are open on the first day of class with different due dates. Students have the flexibility to work on them at their own pace, on their own schedule, and in their own place of choice.

RESEARCH PROCESS AND DATA COLLECTION

The survey method was used in this study. The survey invitation was sent out to all students who enrolled in the class a few weeks before the end of the semester. We believe that this timing is appropriate as students already experienced and were familiar with different supporting technology and systems adopted in the class. Upon agreement to participate, a survey with a set of questionnaire instruments related to the constructs in the proposed research model was sent to the participants. Extra credit (1% of total course points) was provided as an incentive for students' voluntary participation. In total, we received 699 responses, with 297 being completed by male students and 402 by female students.

MEASURES

The 7-point Likert scale was used for each measurement item included in the survey, with 1 being "strongly disagree" and 7 being "strongly agree." To measure students' computer self-efficacy, we adopted the related items on student characteristics from Selim (2007) with wording changes to fit the context of our study. The measurement items on motivation were adopted from Gomez et al. (2010).

Measures on both information quality and system quality were adopted from Al-Busaidi (2012). To measure service quality, we adopted and condensed the related measures from both Al-Busaidi (2012) and Cheng (2012) with changes to fit the context of this study. To measure media richness, we adopted and condensed the items from Lan and Sie (2010) with modification to better fit our context.

Since the teaching method used in a class is unique and different from each other, we developed our own measurement items on it. Particularly, seven items were created, each focusing on one aspect of the instructional method used in the class.

The measurement items on learning climate were adopted from Chen (2014), and items on task-technology fit were partially adopted from Lin and Wang (2012) with changes to fit our context. To measure blended learning flexibility, we partially adopted the items related to e-learning course flexibility from Selim (2007), with our own development to better fit the context of this study. In addition, measures on satisfaction were adopted from Mohammadi (2015). To measure intention, we adapted and applied the measures on users' intention to use an information system, as reported in Venkatesh et al. (2003) to the blended learning context. Specific measurement items on all constructs used in this study are listed in the Appendix.

DATA ANALYSES AND RESULTS

Based on the concepts and following the original measurement sources, indicators of all constructs in the proposed research model, except for teaching method, are modeled as reflective measures. Indicators of teaching method are modeled as formative measures, since each indicator is about one particular instructional method used in the class, thus contributing to one specific aspect of the corresponding latent construct.

To assess the proposed research model, we leverage the Structural Equation Modeling (SEM) techniques, which consist of a group of multivariate statistical analysis techniques used to analyze structural relationships (Chin, 1998). In general, there are two streams of SEM techniques that can be used to measure causal models, including covariance-based (e.g., SAS and LISREL) and component-based (e.g., SmartPLS and PLS-Graph) SEM. In this study, the proposed research model was tested using the partial least square (PLS) method, since PLS is a component-based statistical method specifically designed/intended for assessing causal models, and therefore can handle both formative and reflective constructs (Chin et al., 1988; Chin, 1998). Studies have reported that PLS has several ad-

vantages compared with other types of model testing techniques in terms of measurement level, sample size, etc. (Akter et al., 2011; Chin et al., 1988; Chin, 1998; Gao & Waechter, 2017; Sharma et al., 2013). Specifically, we used Smart PLS 2.0 (M3) beta (Ringle et al., 2005), a widely adopted PLS tool for causal model analysis (Hossain & Quaddus, 2015; Sharma et al., 2013) in this research.

MEASUREMENT MODEL ASSESSMENT

Reliability and validity tests are conducted for the latent constructs in the research model. Table 1 shows the reliability test results. The loadings for all reflective measures are greater than the threshold value of 0.7 (Au et al., 2008), and are statistically significant, indicating satisfactory item reliability. Except for TM5, the weights for all formative measures are statistically significant. TM5 is dropped from later analyses. In addition, the Cronbach's alpha values for all reflective constructs are greater than the 0.7 guideline (Hair et al., 1998; Nunnally, 1978).

Table 1. Reliability test results

Construct	Cronbach's Alpha	Item	Loading	Weight	T-statistics
Computer Self-Efficacy (CSE)	0.903	CSE1	0.899		94.227*
		CSE2	0.922		86.718*
		CSE3	0.923		116.002*
Motivation (M)	0.956	M1	0.944		167.164*
		M2	0.968		281.449*
		M3	0.964		241.026*
Information Quality (IQ)	0.925	IQ1	0.807		49.620*
		IQ2	0.881		104.645*
		IQ3	0.883		116.823*
		IQ4	0.813		49.556*
		IQ5	0.887		92.157*
		IQ6	0.844		50.133*
System Quality (SQ)	0.907	SQ1	0.837		63.989*
		SQ2	0.812		41.516*
		SQ3	0.885		89.555*
		SQ4	0.863		80.482*
		SQ5	0.872		84.149*
Service Quality (SVQ)	0.935	SVQ1	0.880		85.922*
		SVQ2	0.914		126.776*
		SVQ3	0.900		105.192*
		SVQ4	0.877		70.662*
		SVQ5	0.884		85.950*
Media Richness (MR)	0.936	MR1	0.885		82.167*
		MR2	0.928		135.696*
		MR3	0.927		144.866*
		MR4	0.921		139.187*
Teaching Method (TM)		TM1		0.426	12.129*
		TM2		0.173	4.767*
		TM3		0.136	3.270*
		TM4		0.068	2.313*
		<i>TM5 (dropped)</i>		<i>0.023</i>	<i>0.804</i>
		TM6		0.166	4.750*
		TM7		0.275	7.867*
Learning Climate (LC)	0.946	LC1	0.912		131.764*
		LC2	0.949		239.138*
		LC3	0.950		236.391*
		LC4	0.897		102.097*

Construct	Cronbach's Alpha	Item	Loading	Weight	T-statistics
Task-Technology Fit (TTF)	0.960	TTF1	0.953		239.907*
		TTF2	0.960		270.651*
		TTF3	0.953		206.198*
		TTF4	0.915		128.898*
Blended Learning Flexibility (BLF)	0.912	BLF1	0.915		118.227*
		BLF2	0.922		111.713*
		BLF3	0.929		132.218*
Satisfaction (SAT)	0.975	SAT1	0.970		341.535*
		SAT2	0.964		228.684*
		SAT3	0.971		351.156*
		SAT4	0.953		223.864*
Intention (INT)	0.968	INT1	0.966		234.363*
		INT2	0.970		359.121*
		INT3	0.971		340.705*

Note. * Significant at the 0.05 level.

Table 2 shows the descriptive statistics, and Table 3 shows the composite reliability, average variance extracted (AVE), square root of AVE, and correlations among constructs. The composite reliability values of all reflective constructs are above the recommended level of 0.70, indicating adequate internal consistency between items (Au et al., 2008). Convergent validity is demonstrated as the AVE values for all reflective constructs are higher than the suggested threshold value of 0.50, which is the same as the requirement of the square root of AVE to be at least 0.707 (Gefen et al., 2000). Comparing the square root of AVE with the correlations among the constructs indicates that each reflective construct is more closely related to its own measures than to those of other constructs, and discriminant validity is therefore supported (Chin et al., 1988; Chin, 1998).

Table 2. Descriptive statistics

Construct	Mean	Std. Dev.
Computer Self-Efficacy (CSE)	5.419	1.282
Motivation (M)	4.723	1.559
Information Quality (IQ)	5.433	1.226
System Quality (SQ)	5.536	1.168
Service Quality (SVQ)	5.344	1.236
Media Richness (MR)	5.357	1.322
Teaching Method (TM)	5.152	1.232
Learning Climate (LC)	4.721	1.511
Task-Technology Fit (TTF)	5.095	1.458
Blended Learning Flexibility (BLF)	5.504	1.394
Satisfaction (SAT)	5.059	1.596
Intention (INT)	4.724	1.798

Table 3. Internal consistency and validity test results

Construct	Composite Reliability	AVE	BLF	CSE	IQ	INT	LC	MR	M	SAT	SVQ	SQ	TTF	TM
BLF	0.944	0.850	0.922											
CSE	0.939	0.836	0.324	0.914										
IQ	0.941	0.728	0.568	0.397	0.853									
INT	0.979	0.939	0.629	0.310	0.563	0.969								
LC	0.961	0.860	0.560	0.335	0.594	0.763	0.927							

Con-struct	Com-posite Relia-bility	AVE	BLF	CSE	IQ	INT	LC	MR	M	SAT	SVQ	SQ	TTF	TM
MR	0.954	0.839	0.658	0.368	0.728	0.663	0.672	0.916						
M	0.971	0.919	0.493	0.379	0.530	0.639	0.713	0.572	0.958					
SAT	0.982	0.931	0.711	0.332	0.656	0.834	0.766	0.771	0.647	0.965				
SVQ	0.951	0.794	0.630	0.398	0.757	0.584	0.650	0.754	0.543	0.703	0.891			
SQ	0.931	0.730	0.634	0.386	0.817	0.510	0.571	0.746	0.468	0.652	0.798	0.854		
TTF	0.971	0.894	0.640	0.388	0.721	0.706	0.709	0.821	0.615	0.810	0.724	0.703	0.945	
TM	n/a	n/a	0.745	0.363	0.660	0.684	0.673	0.768	0.605	0.764	0.680	0.651	0.747	n/a

Note. Diagonal elements in the bold case are the square root of average variance extracted (AVE) by latent constructs from their indicators; off-diagonal elements are correlations among constructs.

STRUCTURAL MODEL ASSESSMENT

The hypothesis test results are summarized in Table 4. For the impacts of the two self-related factors on learning climate, the results showed that motivation could significantly influence students' perception of the learning climate associated with blended learning, with the path coefficient of 0.419. Thus, H1b was supported. However, no significant impact was found about computer self-efficacy on learning climate (i.e., H1a). Similarly, motivation had a significant impact on task-technology fit (with the path coefficient of 0.131), in support of H2b. But the impact of computer self-efficacy on task-technology fit (i.e., H2a) was not significant. As to the impacts on blended learning flexibility, neither of the two factors (about H3a and H3b) were significant. Overall, the results indicate that students' computer self-efficacy doesn't play a significant role in influencing either their perceptions of the learning climate associated with blended learning, the level of fit between the supporting technology/systems and their learning tasks, or the level of flexibility associated with blended learning. However, their own learning motivation can play a significant role in influencing their feelings toward the learning climate associated with blended learning, as well as the level of fit between the supporting technology/systems and their learning tasks.

For the four factors related to the technology and systems perspective, the results showed that both service quality and media richness had significant impacts on learning climate, with path coefficients of 0.193 and 0.166, respectively. Therefore, both H4c and H4d were supported. However, no significant impact was found from either information quality or system quality to learning climate (i.e., H4a and H4b). Further, information quality, service quality, and media richness were found to have significant impacts on task-technology fit, with path coefficients of 0.133, 0.082, and 0.425, respectively. Thus, H5a, H5c, and H5d were supported. No significant result was found from system quality to task-technology fit (i.e., H5b). As to their impacts on blended learning flexibility, significantly positive results were found about system quality and service quality, but not about media richness. Therefore, H6b and H6c were supported, with path coefficients of 0.246 and 0.102, respectively. In addition, although it was statistically significant, the coefficient associated with the path from information quality to blended learning flexibility was negative. This is somewhat unexpected and may need further validation by future research.

For the impact of the instructional design factor (i.e., teaching method), it was found that it could significantly influence learning climate, task-technology, and blended learning flexibility, with path coefficients of 0.171, 0.169, and 0.528, respectively. Therefore, H7-H9 are all supported.

The impacts of learning climate, task-technology fit, and blended learning flexibility on satisfaction (with path coefficients of 0.327, 0.407, 0.267), as well as on intention (with path coefficients of 0.482, 0.228, 0.214) were all significant in support of H10-H15.

Table 4. Hypothesis test results

Hypothesis	Path	Path Coefficient	T-Statistics	Result
H1a	Computer Self-Efficacy -> Learning Climate	-0.024	0.917	Not Supported
H1b	Motivation -> Learning Climate	0.419	12.679*	Supported
H2a	Computer Self-Efficacy -> Task-Technology Fit	0.023	1.100	Not Supported
H2b	Motivation -> Task-Technology Fit	0.131	5.005*	Supported
H3a	Computer Self-Efficacy -> Blended Learning Flexibility	0.012	0.473	Not Supported
H3b	Motivation -> Blended Learning Flexibility	0.029	0.900	Not Supported
H4a	Information Quality -> Learning Climate	0.016	0.374	Not Supported
H4b	System Quality -> Learning Climate	-0.018	0.418	Not Supported
H4c	Service Quality -> Learning Climate	0.193	4.348*	Supported
H4d	Media Richness -> Learning Climate	0.166	3.801*	Supported
H5a	Information Quality -> Task-Technology Fit	0.133	3.755*	Supported
H5b	System Quality -> Task-Technology Fit	0.032	0.799	Not Supported
H5c	Service Quality -> Task-Technology Fit	0.082	2.126*	Supported
H5d	Media Richness -> Task-Technology Fit	0.425	10.126*	Supported
H6a	Information Quality -> Blended Learning Flexibility	-0.122	2.755*	Reversely Supported
H6b	System Quality -> Blended Learning Flexibility	0.246	5.417*	Supported
H6c	Service Quality -> Blended Learning Flexibility	0.102	2.256*	Supported
H6d	Media Richness -> Blended Learning Flexibility	0.062	1.357	Not Supported
H7	Teaching Method -> Learning Climate	0.171	4.113*	Supported
H8	Teaching Method -> Task-Technology Fit	0.169	5.015*	Supported
H9	Teaching Method -> Blended Learning Flexibility	0.528	11.217*	Supported
H10	Learning Climate -> Satisfaction	0.327	10.291*	Supported
H11	Task-Technology Fit -> Satisfaction	0.407	10.492*	Supported
H12	Blended Learning Flexibility -> Satisfaction	0.267	9.563*	Supported
H13	Learning Climate -> Intention	0.482	12.373*	Supported
H14	Task-Technology Fit -> Intention	0.228	5.225*	Supported
H15	Blended Learning Flexibility -> Intention	0.214	7.086*	Supported

Note: * Significant at the 0.05 level.

The R-squared values are reported in Table 5. Specifically, the R-squared value associated with learning climate is 0.642, meaning that the significant independent variables together explained 64.2 percent of its variance. The R-squared values associated with task-technology fit, blended learning flexibility, satisfaction, and intention are 0.742, 0.602, 0.770, and 0.663, respectively. These results indicate that the significant independent variables associated with each of those dependent constructs explained 74.2, 60.2, 77.0, and 66.3 percent of the variance, respectively.

Table 5. R-Squared values

Construct	R-Squared values
Learning Climate	0.642
Task-Technology Fit	0.742
Blended Learning Flexibility	0.602
Satisfaction	0.770
Intention	0.663

DISCUSSION

Technology-supported learning has become very important in higher education. With the recent advancement in information technology and systems, blended learning has been created with increased popularity and adoption. With the purpose of combining the advantages of both face-to-face instruction and e-learning, blended learning has both the offline and online components. Students need to conduct various types of activities both in the classroom with their instructor and other classmates,

and out of the classroom via the use of advanced supporting technology and information systems. In this study, we aim to gain a better understanding of blended learning success, particularly by investigating potential factors that could influence student learning in this environment. To do it, we have developed a research model, which incorporates factors from various perspectives.

Several research contributions are made in this study. The first is the investigation of potential, influential factors on blended learning success from multiple perspectives. Previous research has developed blended learning success models (Ahmed, 2010; Padilla-Meléndez et al., 2013), but either mainly based on one particular theoretical perspective (such as Technology Acceptance Model) (Padilla-Meléndez et al., 2013; Tselios et al., 2011) or with a limited number of factors (Ahmed, 2010). Few of them has included a relatively comprehensive set of factors from different perspectives. To address this gap, in this study, we look into three groups of factors, all of which are believed to be of importance to the blended environment. Since students are the ultimate consumers of education in general, the first group of factors we turn into is about students themselves, including their computer self-efficacy and their own learning motivation. As a type of technology-supported learning, blended learning always heavily leverage information technology and systems, especially to support students' numerous amounts of online learning activities. Therefore, the second group of factors we decide to include are related to the supporting technology and information systems used to support blended learning. The specific factors we have examined are information quality, system quality, service quality, and media richness. The third group of factors we look into is about the instructional design – more specifically, the detailed teaching method that instructors used to enable blended learning. To the best of our knowledge, this study is one of the first to assess student learning and success in the blended learning environment from all these three perspectives with detailed factors/theoretical constructs to examine in each of them.

The second contribution is the development of the proposed research model. To systematically assess the impacts of the three groups of factors on student learning, we put them into a nomological network to investigate their influence on constructs related to students' perceptions of the blended environment. Specifically, we examine the impacts of the three groups of factors on students' belief toward the overall climate associated with blended learning, the fit between the supporting technology/systems and the learning tasks they need to perform, and the level of flexibility provided in the blended learning environment. We, then, further investigate the influence of learning climate, task-technology fit, and blended learning flexibility on students' learning satisfaction and their intention to learn in the blended environment.

Another contribution is that we empirically test the proposed research model on a large-scale blended class. Some interesting results have been found in our data analyses, which could contribute to existing research on blended learning and technology-supported learning in general. One interesting result we find is that students' computer self-efficacy doesn't play any significant role in influencing their perceptions of either the learning climate, task-technology fit, or the level of flexibility associated with blended learning. However, their own motivation to learn could significantly influence the first two of them. This indicates the importance of students' own motivation in the success of blended learning; however, their level of proficiency in using the computer and information technology does not seem to matter that much. These findings could contribute to existing literature in blended learning adoption, since to the best of our knowledge, we are unaware of empirical investigations on these relationships from existing literature.

Another important result we find is that all four technology and systems related factors, including information quality, system quality, service quality, and media richness, have significant impacts on students' perceptions of learning climate, task-technology fit, and blended learning flexibility. This emphasizes the importance of technical support in the blended learning environment. To ensure the success of blended learning, it is essential to put enough investment in time, money, effort, and potentially personal, in order to develop, adopt, and maintain a high level of technology infrastructure

for effective support on blended learning. These results are somewhat consistent with findings in existing literature. Previous research on e-learning has identified the significant impacts of the three types of qualities (i.e., information, system, and service qualities) on student learning, particularly on perceived usefulness, ease of use, and/or perceived enjoyment (Cheng, 2012). As to blended learning, previous research found that system functionality (or system related characteristics) could significantly influence performance expectancy (Chen, 2014; Wu et al., 2010). However, no existing research has specifically examined the impacts of the three types of qualities on the constructs we incorporated in our research model (i.e., learning climate, task-technology fit, and blended learning flexibility) in the blended learning context. Therefore, our findings brought some new results to existing literature.

As to task-technology fit, previous research on blended learning found that it could significantly influence perceived usefulness (Lin, 2012). In addition, in the context of e-learning, it was found that it (termed as “perceived fit”) could significantly influence user satisfaction and intention to use the supporting system (Lin, 2012). In our study, significant results were found about its impact on learning climate, task-technology fit, and blended learning flexibility.

Not surprisingly, we also find that the instructional design factor can influence blended learning success, indicating the importance of course design, such as the development of class activities and specific instructional methods that can effectively support both the offline and online components of a blended class. Previous literature on e-learning also found the class design factor to be an important determinant in student success, particularly on perceived usefulness and ease of use (Liu et al., 2010). In our context, we found its impact on learning climate, task-technology fit, and blended learning flexibility to be significant.

The analysis results also show that students’ perceptions of learning climate, task-technology fit, and blended learning flexibility can significantly influence their learning satisfaction and intention. This indicates the importance of providing a positive learning climate, making sure the supporting technology and information systems are sufficient, reliable, and effective, and offering the desired level of flexibility in students’ learning process. Our findings about the significant impacts of learning climate on satisfaction and intention are consistent with existing literature on blended learning (Chen, 2014; Wu et al., 2010). For the impact of task-technology fit, somewhat consistent with what we found in this study, previous research has reported the significant impact of fit (termed as “perceived fit”) on learner satisfaction and intention in the e-learning context (Lin, 2012). However, no existing research has been seen to specifically investigate the impact of blended learning flexibility on learner satisfaction and intention.

Future research can further improve the current study in a couple of directions. First, we only empirically tested the proposed research model in one blended class, which consisted of students who were mostly freshmen and sophomores. Future research can further examine and validate the research model on other classes and with other groups of students such as juniors and seniors, or even graduate students. Further, in addition to the three groups of factors examined in the current study, with the evolvement of technology innovation and instructional development over the years, future research may identify other types of important factors and further extend the research model proposed in this study accordingly. In addition, future research may consider validating and applying the proposed research model to assess other types of technology-supported learning and in a context other than higher education, for example, about employee training across various types of organizations and companies, when applicable.

CONCLUSION

Many areas have benefited a lot from the development and advancement of modern information technology and systems, one of which is education. Different from the traditional face-to-face environment, technology-supported learning has changed the way of instruction dramatically in higher

education, from e-learning which heavily relies on the Internet technology and information systems, to the more recent blended learning which combines the advantages of both face-to-face instruction and e-learning. In this study, we aim to understand factors that can influence technology-supported learning, specifically in the blended environment. To do that, a research mode is developed by incorporating factors from three perspectives, including: self-related factors, technology and systems factors, and the instructional design factor. The empirical results indicate that most of these factors can significantly influence learning climate, task-technology fit, and blended learning flexibility, which in turn, have significant impacts on learning satisfaction and intention. We hope and believe this study could contribute to existing research on blended learning, as well as technology-supported learning in general.

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APPENDIX. MEASUREMENT ITEMS

Computer Self-Efficacy

- CSE1: I enjoy using computers.
- CSE2: I am confident about using computers.
- CSE3: In general, I am comfortable with using computers and software applications.

Motivation

- M1: The blended learning environment motivates me to learn the course content.
- M2: I feel my motivation to learn the course content increases in the blended learning environment.
- M3: The blended learning environment helps enhance my motivation in learning the course content.

Information Quality

The information provided by the various online systems and technology used in the blended class is:

- IQ1: relevant for my learning.
- IQ2: easy to understand.
- IQ3: very good.
- IQ4: up-to-date.
- IQ5: complete.
- IQ6: accurate.

System Quality

The various online systems and technology used in the blended class:

- SQ1: offer flexibility in learning as to time and place.
- SQ2: offer multimedia (audio, video, and text) types of course content.
- SQ3: have sufficient functions for my learning.
- SQ4: In general, the various online systems and technology used in the blended class are reliable.
- SQ5: In general, the response time of the various online systems and technology used in the blended class is reasonable.

Service Quality

- SVQ1: The system and technology support of the blended class is prompt.
- SVQ2: The system and technology support of the blended class is reliable.
- SVQ3: The system and technology support of the blended class is accessible.
- SVQ4: The system and technology support of the blended class is convenient.
- SVQ5: Overall, the system and technology support of the blended class is satisfactory.

Media Richness

- MR1: In addition to the face-to-face class time, the blended class also uses a wide range of online media to support my learning, including text, images, and videos.
- MR2: The various types of online media (including text, images, and videos) used in the blended class are effective for my learning needs.
- MR3: The various types of online media (including text, images, and videos) used in the blended class are helpful for me to complete the assignments/projects.
- MR4: Overall, the blended class provides a wide range of media that are rich enough to assist my learning.

Teaching Method

TM1: I have a positive feeling toward using the digital textbook in this class.

TM2: The video tutorials are helpful for me to learn techniques in Office 2013.

TM3: Having weekly concept quizzes is helpful for me to learn the concepts covered in the course.

TM4: Having the opportunity to make multiple attempts is helpful for me to learn the concepts covered in the course.

TM5: Taking notes helps me learn the concepts effectively.

TM6: The in-class activities done in the classroom are useful to help me learn the course subjects.

TM7: Making all online assignments open from the start of the course with designated deadlines each week is helpful to keep me moving forward during the semester.

Learning Climate

LC1: The process of using the blended learning environment to assist my learning is pleasant.

LC2: I have fun with the blended learning environment.

LC3: I find the blended learning environment to be enjoyable.

LC4: The learning climate provided by the blended learning environment could motivate my spontaneous learning.

Task-Technology Fit

The various online systems and technology used in the blended class:

TTF1: match my learning needs.

TTF2: are compatible with my learning needs.

TTF3: suit my learning needs.

TTF4: My learning goals and needs are met by utilizing the various online systems and technology used in the blended class.

Blended Learning Flexibility

Meeting my instructor once a week in the classroom and working on the lab projects at my own place of choice (either in the lab or at home):

BLF1: give me more flexibility to learn in this class.

BLF2: allow me to learn and complete the assignments at my own pace.

BLF3: allow me to arrange my study for the class more effectively.

Satisfaction

SAT1: Overall, I am pleased with the blended learning environment.

SAT2: Overall, the blended learning environment is pleasant to me.

SAT3: Overall, I am satisfied with the blended learning environment.

SAT4: Overall, the blended learning environment satisfies my learning needs.

Intention

INT1: If available, I intend to take more blended classes in the future.

INT2: If available, I am willing to take more blended classes in the future.

INT3: If available, I would like to take more blended classes in the future.

BIOGRAPHIES



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