

The Influence of Learning Style Theory within a Blended Learning Environment: A Systematic Review

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Abstract. Blended Learning (BL), is about blending traditional classroom instruction with online learning activities using both asynchronous communication as well as real-time synchronous communication modes [1]. The complexity of designing a blended learning intervention comes into play when considering the variety of blended learning tools, both asynchronous and synchronous, and learning styles of students. This paper presents a systematic review of literature on how to create an effective blended learning intervention when considering learning styles. The literature reveals that there is a relationship between learning styles and blended learning. The research suggests that certain learning styles are better suited to a synchronous learning environment while others are more suited to an asynchronous learning environment. This study proposes two frameworks, which together provide educators with insight into the link between learning styles and the use of asynchronous and synchronous technologies in terms of learning effectiveness of students.

Keywords: Blended Learning, Learning Styles, Systematic Literature Review.

1 Introduction

1.1 Background

The way in which a student grasps and intellectualizes information, interacts with and observes their learning environment is unique to that individual [2]. This speaks to the idea of learning styles - the way in which different human beings learn and process information in different manners [3]. For example, certain students may show a higher ability of learning when information is provided through words, whereas other scholars have a greater learning ability when information is provided through pictures [4]. The concept of learning styles has gradually gained importance and acceptance not only amongst educators but also among parents of students and the greater public [3].

Over the last 30 years, more than 70 theories have been developed around learning styles [5]. As distributed in the literature there are numerous learning style models such as Visual, Auditory, and Kinesthetic Learning Styles (VAK), Kolb's Model, Honey and Mumford Model, Felder and Silverman learning style model and the list goes on [5]. The most broadly used model is the Felder and Silverman learning style model (FSLSM) which consists of four dimensions: active-reflective, sensing-intuitive, visual-verbal and sequential-global [6]. In each aspect, a student will be more suited to one or the other [2]. A student can be either an active learner (extroverted person, learn by doing things) or a reflective learner (introverted person, learn by evaluating things on their own). They can be either a sensing learner (practical thinker, favour facts and methods) or an intuitive learner (theoretical thinker, favour theories and principles). They may be a visual learner (learn better through information that is presented visually), or a verbal learner (learn better through written or articulated information) and lastly one can be a sequential learner (linear thinking process) or a global learner (holistic thinking process) [6]. Learning styles can be determined with tests and indicators such as the Myers-Briggs Type Indicator.

A vast amount of literature suggests that learning styles relate to student participation and can therefore affect the performance of a student [7], [8], [4]. The performance of a student can be compromised when the teaching style and method used by an educator is incompatible with the student's learning style. This leads to the student's tendency to find their environment uncomfortable, thus causing them to lack focus and interest in class, and become despondent in a course, which in certain circumstances can lead to dropping the subject itself [2]. Thus, it is vital for educators to address the different types of learning styles when creating or designing a module or course.

The idea of blended learning started in the late 1990's early 2000s and has increasingly gained popularity [9]. Blended learning is a modern-day learning approach that combines the best methods of traditional classroom learning with online learning to provide a learner with an effective yet flexible method to learn [9]. It is the integration of synchronous and asynchronous components. The synchronous component of blended learning is considered to be a real-time experience between the learner and facilitator. It is a face-to-face experience, which can be provided by means of a live e-learning virtual classroom or the traditional physical classroom experience [9]. The asynchronous component of a blended learning approach is not limited by time or place. It is combined self-paced formats such as online learning modules, online resource links, communities and discussion forums and within asynchronous learning, certain digital technologies such as gamification, online quizzes and videos may be used [10]. Educators can address a wider variety of student learning styles through the means of a blended learning approach [11].

Incorporating learning styles with blended learning in a higher education environment delivers different advantages to students as it uses a combination of various learning methods and approaches rather than that of a traditional learning approach that uses a single learning distribution platform [11]. Blended learning has been shown to decrease dropout rates, increase exam pass rates and provide students with a higher degree of satisfaction and motivation [7].

The research question this paper will address is: How can learning style theory guide educators when planning a blended learning intervention?

2 Method

This research makes use of a systematic literature review and content analysis.

2.1 Search Strategy

A WWHW table was used to assist in the creation of the key search terms and ultimately the research string. The WWHW table, table 1 is presented below. The development of the search string was an iterative process.

Table 1. The WWHW table used for refining the research string.

	WHO	WHAT	HOW	WHERE	OTHER ISSUES
To what extent can learning style theory guide educators when planning a blended learning intervention?	Educators	Learning style theory	Guide / plan	Blended learning intervention	Digital learning tools / synchronous learning / asynchronous learning

The resultant research string was:

("blended learning" OR "hybrid learning" OR "mixed-mode instruction" OR "e-learning") AND ("learning styles" OR "learning style theory") AND ("distributed learning environment" OR "synchronous" OR "asynchronous") AND ("higher education" OR "tertiary education")

The bibliographic databases used for this study, were EBSCOhost Research database; Emerald Insight; Science Direct and Google Scholar. The search string remained unchanged when used in each of the selected databases. Both initial and secondary screening was conducted and the results were entered into Rayyan, a web-based application that is designed to help researchers create and manage their systematic reviews, [12].

The inclusion and exclusion criteria are included in table 2. below.

Table 1. Inclusion and Exclusion criteria.

INCLUSION CRITERIA	EXCLUSION CRITERIA
<ul style="list-style-type: none"> • E-learning; blended learning; hybrid learning; mixed-mode instruction • Higher education; university; college; tertiary education • Learning styles; learning style theory • Asynchronous; synchronous; distributed learning • Learning technologies; digital technologies 	<ul style="list-style-type: none"> • Not applicable • Not relevant (outdated) • No abstract • Full-text unavailable • Foreign language

Finally, a quality assessment tool consisting of fourteen (14) questions categorized under Design, Conduct, Analysis, Conclusion and General was used to filter each paper. Possible responses were: Yes, No and Partial.

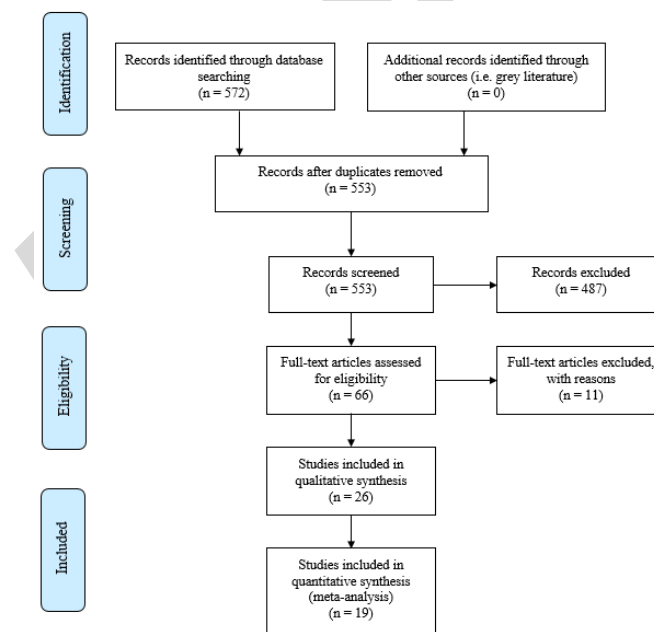
3 Findings

A total of 572 citations were identified and retrieved. The research was limited to studies from 2006 until present, with the exception of referred articles relating to the learning style models stated in many citations. See table 3. Below.

Table 2. Results of the initial search string.

Search String	“(blended learning” OR “hybrid learning” OR “mixed mode instruction” OR “e-Learning”) AND (“learning styles” OR “learning style theory”) AND (“distributed learning environment” OR “synchronous” OR “asynchronous”) AND (“higher education” OR “tertiary education”)
Database	Number of Hits
Emerald Insight	102
EBSCOHost	13
Science Direct	437
Google Scholar	20

Having applied the research string with the results as indicated in Table 3., a PRISMA diagram, which is used to provide a graphical representation of the flow of information through the different phases of the systematic review, was established for reporting the results from the conducted searches. See Figure 1. below.

**Fig. 1.** Systematic review PRISMA flow diagram.

A quality assessment was conducted on twenty six (26) articles that passed as eligible. This resulted in a total of nineteen papers (19) papers being considered appropriate for this systematic review.

Data extraction tables were used to display the results of the papers considered of value and significance to this research. This resulted in six (6) pages of data extraction tables. For expediency sake, the six (6) pages are summarised in table 4. below.

Table 3. Summary of Data Extraction Tables.

Sub-categories	Blended Learning			Digital Tools / Components		Digital Tools and Components	
	Components	Relationships / interactions	Importance of learning styles and the	Type of learning style	Participation, performance and prefer.	Synchronous components and tools	Asynchronous components and tools
Citing	14	10	12	16	13	9	8

As may be seen in Table 4., the majority of papers relating to Blended Learning, 14, focused on blended learning components followed by 12 papers relating to blended learning styles. A remaining 10 papers focused on relationships and interactions in a blended learning environment. Under the category, learning styles, the majority, 16 papers, focused on the type of learning style, while 13 papers investigated participation, preferences and performance. Finally, under the category of digital tools, 9 papers focused on synchronous components while 8 papers discussed asynchronous components.

4 Results

4.1 Data Synthesis

The Data synthesis report aims to display the information collected from the data extraction process. The report will consist of each theme that arose from the data extraction table and the relevant evidence found within each theme. This report will allow the reader to view a summarized version of results from the numerous studies to obtain an understanding of the overall findings that relate to the research problem posed in this study.

Blended learning

The blended learning components. Out of the 19 papers, 12 speak to the nature of blended learning environments. Nine of the papers address blended learning as a combination of traditional classroom and web based/online teaching methods – a multimedia approach to learning, mainly being that of a synchronous and asynchronous nature. [10] speaks of the three major components of blended learning: learning environment, media and instructional. The three e-learning tools commonly used are that of interactive e-learning, non-interactive/learner-centred and non-interactive/teacher-centred [13].

The relationships and interactions within the blended environment. There are three main types of interactions within a blended environment, these being a learner-learner/student-student interaction; learner-content/student-content interaction and learner-instructor/student-instructor interaction [11], [14], [15], [16]. The support provided by educators can contribute towards a students' success and course satisfaction [4]. Increased student-centeredness within a blended environment can contribute positively to student performance [17].

The importance of learning styles and the blended environment. Three papers address the mismatch between course delivery and learning preference; traditional teaching styles and learning styles of students and what students expect out of e-learning and the delivery of an e-learning course [13], [6]. A blended learning environment supports students' engagement and learning due to the various teaching mediums that accommodate diverse types of learning styles [17]. Two studies suggest that students' performance and satisfaction are higher when teaching methods complement their learning style [15], [16]. One author suggests that catering for different learning styles in a blended/ e-learning environment can result in greater retention of students [18]. This is supported by [19] who state that if a blended learning environment accommodates various learning styles it will increase learning performance and the gaining of course knowledge of learners.

Learning styles

Type of learning style. Various models and indicators can determine the type of learning style one has but the four most commonly used among all the studies were the Felder and Silverman Learning Style Model (FSLSM), Kolb's learning style model, Myers-Briggs Type Indicator (MBTI) and VAK model. Eight out of the nineteen papers referred to the FSLSM to define the type of learning style as it the most commonly used model. The FSLSM consists of four dimension of learning styles: processing information, active-reflective; perceiving information, sensory-intuitive; receiving information, visual-verbal; understanding information, sequential-global [22], [8], [11], [6], [21], [4], [16]. The measurement tool utilized to determine the learning style of individuals in the FSLSM is the FSLSM questionnaire- ILS (inventor of learning style) [22], [8], [11], [6], [21], [4], [16], [5].

Six out of the 19 papers referred to the Kolb's learning style model to define the learning style [22], [13], [11], [9]. The Kolb's learning style theory separates learning preference by using two continuums: active-reflective and abstract-concrete. From there four types of learning styles can be described: active-abstract (converging); active-concrete (accommodating); reflective-abstract (assimilating) and reflective-concrete (diverging) [9]. The KLSI is the tool utilized to measure the learning style of individuals in Kolb's learning style model [13], [21], [9].

Two papers used the Myers-Briggs Type indicator to define the type of learning style. The MBTI addresses the four learning style dimensions as: Extrovert (E)-Introvert(I), Sensing(S)-Intuition(N), Thinking(T)-Feeling(F) and Judging(J)-Perceiving(P) [24]. The VAK (visual, auditory and kinaesthetic) model was used as a determinant in one study [21].

Performance, participation and preferences. Active learners obtain more central position than reflective learners, active students respond better to synchronous activities, reflective and sensing learners respond better to asynchronous activities. Visual-verbal learners depend on the educators' study materials and techniques, there is no significance with regards to participation and performance relating to sequential-global learners [22], [6], [21]. There is a correlation between learning styles and student performance. The more central a learners' position is in the environment the better their academic performance [21].

[4] speak to four types of online participation: information access, interactive learning, networked learning and materials development. Sensing learners respond to information access, interactive learning and networked learning. Reflective learners prefer materials development. When looking at the Kolb's learning style model, two papers found that Assimilators respond to information presented in an organised manner and benefit on reflective tasks. Diverges require more interactions with peers and educators as they are emotional and sensitive to people. When comparing learner types of Kolb's learning style model, it was said that an Accommodator learning type preferred email as a communication tool. An assimilator learning type preferred offline meetings and general discussion board as a communication tool; diverges appeared to prefer asking an educator as a communication tool and lastly converges have no significant preference for a particular communication tool [18], [25].

One paper specifically states that learning styles do not affect academic performance in a blended environment but can act as a guide [22]. Another mentions that learning styles are related to academic performance of students in a synchronous environment whereas in an asynchronous environment there is no relation between learning styles and academic performance of students [9].

The synchronous and asynchronous components and digital tools

Synchronous components and digital tools. The synchronous component of blended learning consists of real time interaction [20], [17], [6]. Synchronous learning originated from three key influences: the classroom, the media and the conference [9]. The various synchronous tools are audio-conferencing, video-conferencing, live classroom/virtual classroom, live product practice, interactive chatrooms, cyber-whiteboard, internet telephony and two-way live broadcasts [20], [17], [9], [6], [14], [9], [16]. Within a synchronous e-learning environment, there is a difference between learning styles and academic performance [9]. The most preferred learning style in a synchronous e-learning environment is the assimilating learning style. To match this learning style the synchronous e-learning tools should include interactive synchronous tutorials, theory and analytical models, lectures, e-face to face communications with educators [9].

Asynchronous component and digital tools. The asynchronous e-learning environment is not limited by time or location [9]. The asynchronous component caters for students who think deeply, it involves self-paced learning that is internet-based [17]. The asynchronous digital tools are learning management system (LMS), e-mail, scheduled online assignments, online bulletin boards, listservs, online communities, on-demand videos, LMS Moodle-post readings, wikis, forums, blogs [20], [10], [6], [14], [9], [4], [16].

5 Discussion

The purpose of this study was to conduct a systematic review on any accessible literature pertaining to blended learning and learning styles, with the goal to discover to what extent learning style theory can guide educators when planning a blended learning intervention.

5.1 Discussion of the Review Process

There is a strong debate about the extent to which learning styles influence student satisfaction and performance within a blended learning environment. Some authors such as [20] suggest there is no influence however they argue in favour of using learning style to guide teaching interventions. Other authors suggest that catering for learning styles can increase student interest and engagement, retention, satisfaction and their academic results [8], [18], [21], [16], [4].

It is evident that the four most frequently used models are the Felder and Silverman Learning Style Model, Kolb's model, Myers-Briggs Type Indicator and VAK model. [6] argue that in terms of the Felder and Silverman Learning Style Model and blended learning, Active learners benefit from face-to-face interaction such as a real-time video as they study better through conversations and group work, Reflective learners benefit from on-demand videos. Active learners obtain more of a central position than reflective learners and learn better in a synchronous environments where they can interact

with lecturers and or peers. Reflective and sensing learners learn better in an asynchronous environment due to the nature of off-line time to reflect and assimilate the information. Sensing learners learn well through online quizzes, simulations and learning games as they respond to interactive learning [4]. Intuitive learners retain more knowledge through on-demand videos as well as face-to-face interactions. Visual and verbal learners depend on what study materials and techniques are used. In a blended environment there is no significance in regard to participation and performance relating to sequential-global learners [20], [6], [21].

Kolb on the other hand, proposes four types of learners; Assimilators respond to information presented in an organised manner and benefit on reflective tasks. Accommodators prefer email as a communication tool, prefer reading a handbook and relate best to their personal experiences [19]. Diverges require more interaction with peers and educators, Converges have no significant preference for a particular communication tool, they organize knowledge into models/frameworks and prefer analysing data [18], [23], [9].

The following section links the learning style theories with the environmental demands of both synchronous and asynchronous blended learning.

Synchronous components in support of a blended learning approach. The synchronous component of blended learning is a live, real time interaction. An educator conducts these interactions. Examples of the various synchronous digital tools are audio-conferencing, video-conferencing, live classroom/virtual classroom, live product practice, interactive chatrooms, cyber-whiteboard, internet telephony, two-way live broadcasts, round table discussions [20], [17], [10], [6], [14], [9], [16].

In terms of the FSLSM and the MBTI, active learners, sensing learners, extroverted learners and perceiving learners are better suited in a synchronous environment as they thrive off interacting and engaging with people [6], [21]. The synchronous tools that address active and extroverted learning styles is live/virtual classroom, on demand videos [6]; [21]. Sensing learners come across as participating well in both synchronous and asynchronous environments. One study suggests that sensing students participate in interactive learning, networked learning and information access. Interactive learning has a synchronous focus whereas networked learning has a more asynchronous focus. Thus, sensing learners as well as perceiving learners can be accommodated in a synchronous environment through interactive games and live classrooms [4].

In terms of Kolb's learning style model, the most preferred learning style in a synchronous e-learning environment is the assimilating learning style followed by the divergent learning style, the subsequent learning style is the converging and accommodating. Therefore, to accommodate students with an assimilating or divergent learning style, the synchronous e-learning tools should include interactive synchronous tutorial concepts, theory and analytical models, lectures, e-face to face communications with instructors [9].

Asynchronous components in support of a blended learning approach. The asynchronous component of blended learning is internet based and it is not limited to time or location. Examples of the various asynchronous digital tools are learning management system (LMS), e-mail, scheduled online assignments, online bulletin boards,

listservs, online communities, on-demand videos, LMS Moodle-post readings, wikis, forums, blogs [20], [10], [6], [14], [9], [16].

In terms of both the FSLSM and MBTI instruments, reflective learners and introverts learn better in an asynchronous environment. Asynchronous tools such as on-demand videos, blogs, and reflective independent online assignments address these particular learning styles [6], [21]. Sensing learners learn effectively in both a synchronous and asynchronous environment. They participate in networked learning which has a focus on online forums and wikis that are asynchronous tools [4].

In terms of Kolb's learning style model, the most preferred learning style in an asynchronous e-learning environment is the converging learning style [9]. The subsequent learning style preference is accommodating, assimilating and divergent. The asynchronous tools that address a converging learning style should include a learning management system that includes activities such as individualized learning projects, practical application of theories and concepts. Accommodators communicate best through E-mail. An assimilating learning style once again can be addressed in both a synchronous or asynchronous environment; the asynchronous tools that address this learning style is online forums and discussion boards [23].

Through the discussion of the results and the answering of the sub-questions it is evident that learning styles can, to an extent, act as a guide for educators when planning a blended learning intervention. Studies suggest there is evidence of a relation between-learning styles and blended learning. When a students' learning style correlates to a suitable technology, participation and satisfaction increases.

6 Recommendation

In order to conceptualise themes raised in the systematic literature review and to guide educators when planning a blended learning intervention, two frameworks are proposed. The Blended Learning Effectiveness Framework, Figure 2 below, displays how learning styles contribute to the overall effectiveness of a blended learning intervention. The second framework, Table 5 below, is an extension of the first framework. Both frameworks have been constructed to link asynchronous and synchronous learning tools to the FSLSM, MBTI and Kolb's learning style models. Framework one (Figure 2.) displays how learning styles and the two main components of blended learning (synchronous and asynchronous) when combined, can provide an optimal learning environment for learners with a particular learning preference. As indicated, the pillars that support blended learning are the synchronous and asynchronous components. Together with learning styles, these pillars create an effective blend by taking into consideration the learning styles best suited to each component. Within this framework the learning styles that are most prominently suited to each pillar are highlighted by their wider/darker boarder. Taking learning styles into consideration when creating a blended learning intervention can support the overall effectiveness of the intervention by increasing the satisfaction and participation of the learner.

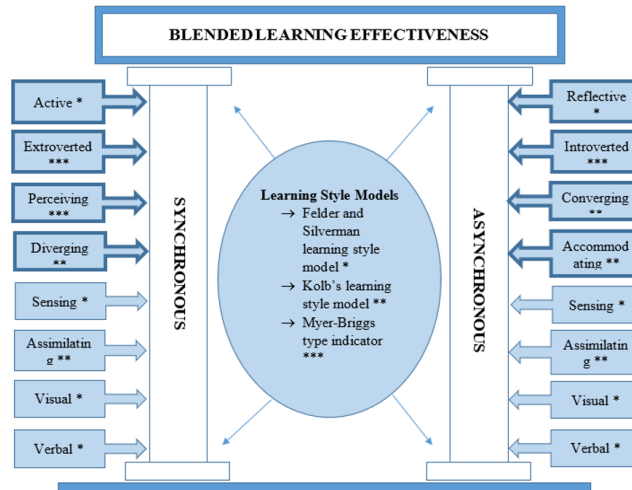


Fig. 1. Blended Learning Effectiveness Framework.

The second part of the framework (Table 5.) can assist educators when planning a blended learning intervention. The learning styles are matched according to which blended component they are best suited to and the suggested tools are identified. In a blended environment, there is no significance in regard to participation and performance relating to a sequential-global learner. Educators should provide their students with either one of the three learning style tests: the FLSM questionnaire, Kolb's learning style questionnaire, MBTI, in order to determine the preferred learning style of their students. Being aware of student preferences would assist educators in their choice of a/synchronous learning interventions. It may also be to the advantage of the students to have some insight of their own learning style preferences. The framework is presented in a tabular format below.

Table 5. Learning Styles and A/Synchronous Tools

Learning Styles	Synchronous tools
Active / Extroverted	<ul style="list-style-type: none"> • Live/virtual classroom • Group work • Interactive in class activities
Sensing / Perceiving	<ul style="list-style-type: none"> • Interactive games • Interactive chatrooms • Virtual lectures
Assimilating/ Diverging	<ul style="list-style-type: none"> • Interactive synchronous tutorial concepts • Theory and analytical models • Virtual lectures • E-face-to-face communication with instructors
Visual	<ul style="list-style-type: none"> • Video conferencing • Graphic content • Visuals such as flow charts, timelines • Demonstrations
Verbal	<ul style="list-style-type: none"> • Audio conferencing • Discussion and debates
Learning styles	Asynchronous tools
Reflective / Introvert	<ul style="list-style-type: none"> • Learning management system Moodle post readings • Blogs • Reflective independent on-line assignments • Videos of lecture content
Sensing	<ul style="list-style-type: none"> • Forums • Wiki • Online quizzes
Converging	<ul style="list-style-type: none"> • Individualized learning projects • Online practical application of theories and concepts
Accommodating	<ul style="list-style-type: none"> • E-mail • Learning management system Moodle post readings • Course material handouts posted online
Assimilating	<ul style="list-style-type: none"> • Discussion boards/Forums/chatrooms • Bulletin boards
Visual	<ul style="list-style-type: none"> • Good graphic video content • Course material/handouts including visuals such as pictures, diagrams, flowcharts and time lines.
Verbal	<ul style="list-style-type: none"> • Recorded lectures with good audio. • Discussion forums/ chatrooms

7 Conclusion

This report presents a systematic review of literature on identifying the link between learning styles and blended learning to allow for the establishment of a guideline for educators when planning a digital teaching intervention. The objective of this research paper is to provide educators with insight into the link between learning styles and the use of asynchronous and synchronous technologies in terms of learning effectiveness of students. The researcher took this as the research problem and from it stemmed the main research question:

How can learning style theory guide educators when planning a blended learning intervention?

This question along with its sub-questions were discussed. Existing literature identified that there is indeed a relationship between learning styles and blended learning. It showed that student engagement, participation and satisfaction, key elements to successful learning, increased when teaching methods were complementary to their learning style.

In an attempt to simplify the complex relationship between various learning styles and blended learning technologies, two frameworks were developed, Figure 2. and Table 5., based on FSLSM, MBTI and Kolb's learning style models. The proposed frameworks were developed with the knowledge gained from the findings and results of the literature used in this review. The first framework (Figure 2) is designed to highlight the effectiveness of blended learning when considering learning styles. The second framework (Table 5) integrates learning styles with their suited asynchronous and synchronous technologies. The purpose of both frameworks is to guide educators when planning and developing a blended learning intervention in order to accommodate their students learning styles.

There is some deliberation amongst educators that it is impractical and unrealistic to cater for every student's learning style and that the onus is on the student to change their learning style according to the educators teaching style. What these frameworks propose, however, is that it is possible to design a blended learning intervention that caters for the majority of learning styles. After all, blended learning is about "blending" synchronous as well as asynchronous teaching methods. By definition, this means that a variety of tools and technologies should be included when planning for a particular course. It is believed that any blended learning intervention should surely benefit both educators and students if indeed there is an awareness of learning styles amongst both groups.

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