



Validating Guerra's Blended Flexible Learning framework for Engineering Courses

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Abstract

Guerra's BFL Framework adapts BFL pedagogies to engineering courses. This paper portrays a pedagogical framework for engineering courses that adapts to many constraints presented to students and instructors. The framework stands on Blended and Flexible Learning (BFL) theory, supports the design of a semester into modules and themes, and combines synchronous and asynchronous activities. The framework proposed by Guerra was validated through a 4-day workshop with over 100 engineering professors through North, Central and South America. The workshop showed Guerra's BFL framework, guided the participants to design at least one module in the proposed framework, and the workshop was formatted using such framework. From the responses of the participants, the authors discuss the adaptability and best practices to design courses under the proposed framework and explore the avenues academia could take to form new pedagogical approaches. Implications for research and practice are provided.

Introduction

The blended flexible learning (BFL) is a pedagogy that proposes synchronous and asynchronous activities allowing flexibility in time, physical location, and learning-teaching approach [1]. Notably, BFL outcomes increased student engagement with the subject and thus maximizes learning while teaching students to take on more responsibility [2]. BFL allow to adapt the learning process to students' needs and objectives. For example, if a student needs reinforcement, he can review recorded lectures or pre-design material. In addition, many tools are available to practice each of the topics at the rhythm at which each student learns. In addition, it allows certain students to update on the subject and to enjoy new challenges for those students who desire to be challenged [3]. It is worth mentioning that the versatility and adaptability of this teaching method is the reason why it is becoming more and more accepted by academics.

At the University of Western Sydney, impressive results were obtained in a study that lasted 4 years in 2017 before COVID 19 [3], [4]. The percentage of student satisfaction was 18% higher

compared to the traditional method [3]. This study was conducted with the subject "Fluid Mechanics" which is considered to have a "high failure rate" and with this method it was proved that under the same grading conditions, there was an increase in the average grade and the percentage of completion of the subject [3], [5], [6]. The traditional method is summarized in that the students attend the classes taught by the teachers and complete the assigned homework at home [4], [7]. The flipped classroom is one of the new teaching methods that aims to include the student in a much more active role where they themselves will study the theoretical concepts while in class they will clarify doubts or debate on the subject [7], [8].

This pedagogy can adapt the teaching/learning process to many circumstances. For example, BFL became widely used after the pandemic caused by COVID 19 due to its versatility, which made it possible to combine face-to-face and distance learning. Another example of such flexibility has also caused the attention of scholars' years before the pandemic, since it allowed for students to take classes while working on their internships, or to continue school while professors traveled for research.

Background

The first time the word blended learning was used was in 2007 in the book by Pete Sharma and Barney Barrett. In it they propose a new teaching method in which they mix the traditional method with online materials [9], [10]. This method is not only applied to virtual classes since students can work with the online material in the same classroom [11]. This method can be applicable for primary and secondary education, colleges, and universities [7], [12]. Any type of education that blends the face-to-face and online aspects is described as BFL [9], [13]. There are several ways to combine BFL activities resulting in various frameworks that are adapted to the type of subject being taught.

There are several examples of frameworks designed based on blended flexible learning such as the flipped classroom, but all of these are encompassed in the classification proposed by Staker and Horn in 2012. The categories explained below are (i) The rotation model, (ii) The flex model, (iii) The self-blend model and (iv) The enriched-virtual model [14], [15].

The first model, the rotation model, is a program where students rotate on a schedule between learning modalities where at least one must be online [9]. Within this category there are 4 subcategories which are: Station-Rotation model, Lab-Rotation model, Flipped-Classroom model, and Individual-Rotation model [14], [16]. The Station-Rotation model differs by having students rotate through all stations and not just the ones on their personalized schedules [14]. Some of these activities can be online instruction, collaborative activities, and teacher-led instruction. Instead of staying in the same classroom, students rotate physical space within the educational campus for a certain amount of time, which is what characterizes the Lab-Rotation

model [14], [17]. The main difference for the Flipped-Classroom model is that the main content is given online so that they can learn it at their own pace and this content will be put into practice in class with group work under the supervision of teachers while they resolve doubts about the theory [14], [18], [19]. And finally, the Individual-Rotation model is based on establishing an individual schedule for each of the student's needs, which can be established by a teacher or with some software. The interesting thing is that it is not necessary for students to go through each of the stations or all the modalities because it depends on the learning method that best suits each student [14], [20].

The second model, the flex model, is where the content of the class is taught online, and they do not have a fixed schedule since the teacher will always be in the classroom to provide face-to-face support in a flexible and adaptable way as needs arise. Content reinforcement activities can be small group instruction, individual tutoring, or group assignments and all of this is on a fluid schedule individually set.

The third model, the self-blend model, is about students, who wish to voluntarily take courses completely online to complement traditional courses. Lastly, the fourth model is the enriched-virtual model that is about a model that is for the whole school where they occasionally attend the campus. Here students divide their time between attending a physical campus and learning remotely by delivering content and instruction online [14], [21].

BFL pedagogy consists of several activities which vary depending on the design of the framework. In this case, synchronous and asynchronous components, individual and group tasks are some of the activities used as a resource for learning [22]. The asynchronous component is the one where the student receives the information in real time, this can be face-to-face or virtual [9], [23]. The difference with the asynchronous component is that it imparts knowledge through videos or readings without the teacher being in real time with the students. The video presented by the teacher can be recorded by the teacher or by someone else. The individual and group assignments are used to reinforce the knowledge learned through tasks in which they are put into practice.

The versatility of the BFL is reflected in how it adapts to different situations that may arise in a classroom. In the past, if for some reason it was impossible to attend the classroom, it was a lost day of learning. Furthermore, thanks to technological advances, the methodology can be adapted to virtual systems in situations such as: students in another city, teachers who must travel for research or conferences, students who are professionals (working and studying at the same time) or in the case of COVID 19 [24], [25]. Although this framework was not developed with COVID 19 in mind, it was useful during the pandemic.

By now, some of these pedagogical frameworks have already been implemented several times and it is for this reason that we can already observe the impact of studying with BFL on students in different careers. According to the study done by [26], [27] they found 3 needs for BFL to work which were: every school or university needs an e-learning platform, a development of skills to use the e-learning platform and new approaches to competency-based e-learning [28], [29]. This study resulted in students studying the subject for more hours and feeling a sense of satisfaction in studying the subject. In addition, teachers should work with students while learning how their students behave for each course to establish the speed and activities they perform [18], [26].

There has been a resistance by the academic staff to modify teaching methods and continue with the classics [30]. For this reason, even when new methodologies based on BFL were presented, they were not always adopted, but this changed after COVID 19 [31], [32]. This pandemic forced the use of this type of pedagogy and now that its effectiveness has been proven, many will not go back to traditional methods. Since BFL proved to be a much more dynamic framework for students where they have a more active participation in classes, it will be used in many classrooms around the world.

Research Objective

The objective of this study, reported in this paper, was to validate Guerra's BFL Framework for engineering courses and to obtain learning lessons to improve such framework. This article presents the responses given by professors from the Americas after having learned and experienced Guerra's BFL Framework.

Methodology

For this study, 102 engineering professors from North (7), Central (32) and South America (63) participated in 4-day workshops, during the summer of 2020, to learn and test Guerra's BFL Framework. The workshop consisted in 4 sessions where the Framework author taught how it works and its applicability. The course pedagogy was Guerra's BFL Framework, so the professors not only learned about the framework but also experienced it. Finally, professors were asked to develop one module—typically a one- or two-week module—from a course of their upcoming semester. Finally, professors discussed the adaptability and best practices to design courses under the proposed framework and explore the avenues academia could take to form new pedagogical approaches.

To get our data, opened- and closed-ended questions survey was administered to the participants. The survey was taken online through the Qualtrics platform. Those professors who attended all modules of the training were asked to complete the survey. There were 37 responses which were included in the content analyses process. Participants' responses were coded to measure the

frequency of concepts used during their design. The coding method is similar to previously developed coding methods (Thomas 2006) used in disciplines such as design (Blizzard and Klotz 2012) and healthcare (Blizzard and Klotz 2012; Weiskopf and Weng 2013). The participants reflections were downloaded into an Excel database. The original wording of the response was maintained, but the responses sometimes comprised entire paragraphs. Those responses were divided into multiple individual codes, with each code only containing one idea. All codes were then coded for keywords and concepts, to then cluster them according to them. The authors acted as Coders 1 and 2, having a 91% of agreement in the coding. The average percent agreement was determined by the sum of discrepancy between the coders and the number of times an additional coder suggested another category for a particular code. Discrepancies were then discussed and resolved.

Results

Based on 37 tabulated responses and extracting the most striking answers, different types of results were obtained. They commented on what they thought of the proposed framework and what they thought of the provided. As part of what they think about the method, there were several responses which are grouped in benefits and challenges. On the other hand, with respect to the opinions of what they thought about the capacitation, we have the positive aspects and the improvements to be made.

When talking about the proposed framework, it was found that several people had similar doubts, recommendations, and opinions about it. The benefits found were grouped into 3 groups which are: the effect of the methodology on the students, the characteristics of this method and the adaptability of the methodology. The challenges they faced were found by their own experience in the example that was used when giving the capacitation and some that occurred to them that could occur.

Themes from the participants responses		
About BFL	Benefits	The effect of the methodology on the students
		The characteristics of this method
		The adaptability of the methodology
	Challenges	
Training	Positive aspects	
	Improvements to be made	

Table 1. Themes emerged from participants responses

The first benefit instructors reported is the effect of the methodology on the students, several opinions were expressed, such as that it improves the accompaniment of the students. This was

said by 3 people "the good thing is that this pedagogy allows important levels of interaction as well". In other words, it refers to the fact that students allow considerable interaction between the student and the teacher compared to a completely online methodology. Another important point to mention is that students are not overloaded with work as they literally said, "avoiding overcharging" and "It allows the student to learn, without overloading him". By way of explanation, they say that this is a positive point because when students are overloaded with work, they simply do not all do it or they do not do it conscientiously. It is for this reason that precise and short assignments are what a teacher prefers for his students. Finally, the respondents also realized that it generates student independence. Some people explained it as follows "I see in BFL the opportunity to give you greater autonomy and independence in the learning process". Scilicet, students also have responsibilities and if they wish they can get ahead in the subject or learn more, this being the independence and autonomy described by the respondent.

The second benefit instructors reported is the characteristics of this method, there were several responses such as that it adjusts very well for engineering and STEM courses. One person said that "can even be applied with STEM programs for teenagers" and another that "Suitable for STEM courses". This is a methodology for any discipline, but in these testimonials, we see that it is also applicable for these types of courses. They also qualify the method as easy to understand and that they have reinforced learning in the following quotes; accordingly: "simple to understand and apply to specific topics" and "Increased learning reinforcement". Another point to consider is the flexible learning since they said that "one can access at any time and adapt in their daily work routine from home or sometimes mixed" showing that the schedule that each student adapts to is their choice and progresses at their own speed. Finally, the point that attracted the most attention was how orderly the method allows you to be. 12 people gave their opinion about this benefit, for example in these testimonies; "Allows for a more thoughtful design of the activities to be developed class by class.", "It allows for better organization of knowledge and time management", and "Allows systematization of planning".

The third benefit instructors reported is the adaptability. The opinions were expressed in reference to the confinement caused by COVID 19, since this is one of the many situations in which this method may be chosen. Respondents felt that "Adequate for today's times (pandemic caused by COVID 19)" and that it helps to "avoid contagion". It is very important to mention these opinions because this pandemic locked the whole world for so long forcing to leave aside the classical methods and giving the opportunity to modern and flexible methods to be used.

In terms of the challenges that they had to face are that is hard to leave the classic methods, the submitted assignments must be very clear and. The first challenge instructors reported that leaving the classic methods is difficult. This was expressed in the following comments: "although at the beginning it involved a total change of thinking on my part, that cost me to perform the first task" and "adapting it in my workplace is complex". The fact of having to adapt

to a method to which one is not accustomed results in a challenge for students as well as for instructors and this is what was stated in the previous quote. Along the same lines of this challenge, a transition from one method to the other can be considered so that the change is less abrupt and marked. This was expressed in this quote: “gradually make the transition to BFL”. Lastly, when taking the class with this method, they encountered the problem that the teacher must be very clear when sending the assignments because if the students do not understand, the method does not work as it should. They explained it in this quote: “be a little clearer when giving assignments”.

The opinions were grouped into 2 themes which are the positive aspects and the improvements to be made. A positive aspect was that they were pleased that the training is given with this method because they have a clear example of how the proposed framework can be applied. This was expressed as follows: "we had the opportunity to apply what we learned in the tasks formulated, related to the macro and micro planning of our own courses" and "He has applied BFL to the present course, demonstrating the potential of this strategy". As for the improvements they recommended, a guide was needed to be able to follow the class and have all the information ready and ordered. This was expressed as follows: "written content can be enhanced with a brief guide to the framework and a template". Other comments are: "A glossary and a terminology homologation session or forum would help us a lot for the next one" and "Provide a glossary in preparation for the course. Adhere to the use of these definitions". They say this because the training was given to several countries in South America where each country has different ways of expressing themselves and there could have been confusion with the speaker's expressions. And in closing, they asked for more training time, this being a great achievement because it shows interest on the part of those who took it, expressing it as follows: "It can be the time of the sessions, probably extend it more and with the participation of other specialists" and "Maybe some other session to not compress the contents so much".

Discussion

In a world with so much movement, people cannot always be in the same place and the desire to continue studying has increased. It is for this reason that a method of learning where it is not 100% compulsory to be present in person is the key for each person to organize themselves to fulfill all the activities they want to do. Thanks to the adaptability of the method, it is possible to adapt this methodology to cases where the instructor has to travel to another country for some reason. Another example where it was used was the situation that the whole world had to go through, which was the confinement due to the pandemic.

In this approach, the student's independence is as important as the teacher's support. It is also of utmost importance that each student knows the speed at which he/she learns and the reinforcement he/she needs. This can have other benefits such as students becoming disciplined

and responsible since by organizing their time, they do not leave their responsibilities to the end. These results will be reflected in professionals who optimize their time resulting in high quality work.

The reason why it is so difficult for human beings to abandon our habits is because we are beings that fear the unknown and this manifests itself as resistance to change. This justifies why it was expected to be difficult for instructors to plan their courses with this new modality. Instructors reported some resistance to change methods and as predicted, it happened.

Despite having some resistance to change, in this case the instructors were opened to learning about new teaching methods adapted to the reality and time at which the world is advancing.

Whenever a new educational framework is designed, there will always be a new challenge to meet, in this case how to adapt the laboratories to this modality. Today it is believed that the only way to teach the laboratory class is 100% face-to-face, but there will be a way to plan certain activities to be done synchronously and others asynchronously.

In closing, using the class as an example of the topic was pleasantly surprising. Since it was an experiential learning experience, the instructors experienced the position where their students will be and thus will be able to design their classes based on their experience. The training was very interesting for the instructors as they had ideas, examples, experiences and tools to design a course where their students will have a class that they will enjoy, learn the theory and be curious to learn more.

Conclusion

Guerra's BFL framework merges synchronous activities with asynchronous activities, and presential learning with online and distance learning where several benefits are obtained. Some of these benefits are the versatility, the responsibility that it generates to the students, the interest in the provoked subject and many more. Also, as it is a very versatile method, it can be successfully adapted to engineering courses.

A training was given to several instructors in North, Central and South America where this new framework was used to show them how it applies. The responses from the participants about their perception about the course indicated benefits but also challenges or places for improvement. Responses suggest that the success of the framework is to accompany the students but also give them freedom to generate interest in the subject. In addition, they were struck by the excellent results that can have without overloading them and having a flexible learning where they work at their own pace. Being a very versatile method, it can be successfully adapted to engineering courses. The responses also indicated challenges to overcome such as the difficulty in terms of time and efficacy to leave their current pedagogies to apply new ones; the higher

relevance of providing clear instructions and making sure students understand them. On the other hand, they were grateful that an experiential learning approach was used, since this way the training was much clearer, and it was recommended to give the training with a guide where there is a universal glossary to improve understanding.

Future research includes crating improvements to Guerra's framework approach, and to test different avenues of applicability in the engineering diversity of courses. In addition, it is hoped that in the future the author will be able to look for quantitative results that will allow compare the efficiency of pedagogy in the students learning. Furthermore, understanding the characteristics that influence the that right ratio between synchronic and asynchronous sessions, among other learning lessons that allow optimization of Guerra's framework.

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