

## Guided Learning Sequences as an e-Learning Enhancer During COVID-19 Emergency Conditions

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# **Guided learning sequences as an e-learning enhancer during COVID-19 self-isolation**

## **Abstract**

During 2020, COVID-19 dramatically changed the way in which students receive and analyze information from their teachers, classes have moved from face-to-face sessions into synchronous virtual meetings and asynchronous homework, increasing stress levels in students. This Evidence-based Practice paper explores Guided Learning Sequences as a content delivery strategy which allows the student to receive information, think about its meaning, put it into practice, and receive instantaneous feedback in order to reinforce their learning process. Empirical evidence from 108 students in a Business Mathematics course shows a statistically significant decrease of students' stress level when exposed to the proposed methodology. As well, a pre-test post-test analysis of a sample of 45 of those students shows evidence of positive impact in student's performance.

## **Introduction**

At the early start of COVID-19 pandemic in Mexico, Tecnológico de Monterrey quickly moved into an on-line environment to recover continuity of operations: in less than one week, more than one hundred classes were completely redesigned for the virtual environment. This redesign brought up new challenges to deliver learning contents to the students, who were exposed to synchronous and asynchronous learning moments. On one hand, synchronous classes were held through virtual meetings, where the teacher had face to face interaction with the students to discuss theoretical topics and provide practical demonstrations, both within the time constraint implied by the lesson's schedule. On the other hand, the students had the opportunity to get a better insight of the theoretical - practical issues of their courses by means of asynchronous materials available 24/7.

On March 13<sup>th</sup> of 2020, Mexico's government took several countermeasures to reduce the speed of COVID-19's spread. As part of those actions, population was asked to remain at home in self-isolation [1]. This situation significantly raised stress levels of students, which hinders the learning process of students due to depression and anxiety [2]. Moreover, this phenomenon gives the asynchronous materials a more relevant role in the learning process while providing flexibility and less constraining technological limitations, such as Internet speed and signal quality [3].

This Evidence-based Practice paper explores a novel method to approach these asynchronous materials using Guided Learning Sequences, a method based on the guided learning approach that considers different kind of stimuli to provide an enriched learning experience to the students.

## Literature review

Asynchronous e-learning refers to interaction teacher-learner and can be delivered in both directions at any time and place [4], unlike synchronous methods where interactions are developed in regular schedules, either in a physical or in a virtual classroom [5], [6]. Several studies have demonstrated the efficiency of e-learning asynchronous methodologies for academic content delivery, such as offline video repositories [7], social network interaction [8], and mastery learning interfaces [9]. However, although literature shows that students still prefer the traditional class with synchronous methodologies, it has been observed that they also like the integration of technology and new strategies in their courses [10]. Moreover, some studies have also shown the advantage of mobile devices in asynchronous learning [11], such as the improvement of technological skills in students [12].

On the other hand, synchronous and asynchronous e-learning performance varies according to the type of student [13]. Given that some students in asynchronous online courses may complete the learning contents earlier than others [14], it is a necessity to track the progress and to maintain the motivation in each student. Guided learning methodologies allow the teacher to engage the learner in different ways, from behavioral, affective, and cognitive engagement, improving the achievement of students [15]. However, in such interactive learning environments, teachers need supporting tools to analyze the students' performance [16] and to provide pedagogical interventions as needed [17]. In addition, these virtual environments must provide confidence to the student that their participation will be taken in account, instead of just posting information without any feedback [18].

Asynchronous and guided e-learning can be considered as opportunities for building healthy interpersonal relationships and seeking the co-construction of knowledge [18], [19]. Nevertheless, a possible issue is to provide exclusively task-oriented contents, as it potentially inhibits the effect on some specific communication skills, and in the application of new acquired knowledge [20]. In order to avoid this, researchers remark the importance of including a variety of techniques and strategies in the learning methodologies [21], [22], and the benefit of having an instructor to stimulate engagement [19].

Even asynchronous and synchronous strategies have been thoroughly researched for different learning environments, such as distance learning, virtual learning and e-learning; the COVID-19 pandemic highlighted that stress is a very important factor in distance learning. Commonly, stress of learners is caused by frustration, lack of feedback and poor motivation [21], [23], [24], however, this pandemic has increased stress factors generated by lack of socialization and by educational, economic, environmental, psychological, and socioeconomic situations that are affecting the well-being of students [25]. Furthermore, students were forced to change from physical classrooms to virtual lessons, causing their anxiety and burnout to increase, decreasing engagement of the students. These conditions have been found to impact negatively on the perception of e-learning, and some students have even become reluctant to virtual learning over the face-to-face classes during the lock down situation [22].

Mathematics courses have an aggregate factor of stress because they are perceived as challenging and students are often reluctant to take these courses, focusing on the results of tests instead of the whole learning process [26]. Nevertheless, practice has shown that asynchronous learning in virtual environments, when reinforced with the guidance of the instructor, can improve mental health of students by providing motivational feedback, tracking the stress level, and, if necessary, making e-health interventions [27].

## **Purpose of the study**

The education model of Tecnológico de Monterrey is based in four pillars [28]: Challenge Based Learning, Flexibility, Memorable University Life, and Inspiring Teachers. Class redesign resulting from the On-Line environment conversion has opened a wide variety of learning methodologies that support the aforementioned pillars. Moreover, in Tecnológico de Monterrey, math courses are managed and imparted by the School of Engineering, whereas students belong to this school or any other, such as Business, Architecture, or Social Studies. Historically, we have found that students not belonging to the School of Engineering are deeply concerned about their performance in math classes [29], and additional stress factors induced by self - isolation have triggered countermeasure actions such as the proposed methodology.

This study contributes to the Flexibility element of our education model, by exploring and evaluating the impact of Guided Learning Sequences in the learning process of business students in a mathematics course of Tecnológico de Monterrey. The analysis of our results will enable us to generate better asynchronous materials and enhance the understanding of mathematics' topics that can be used in On-Line courses.

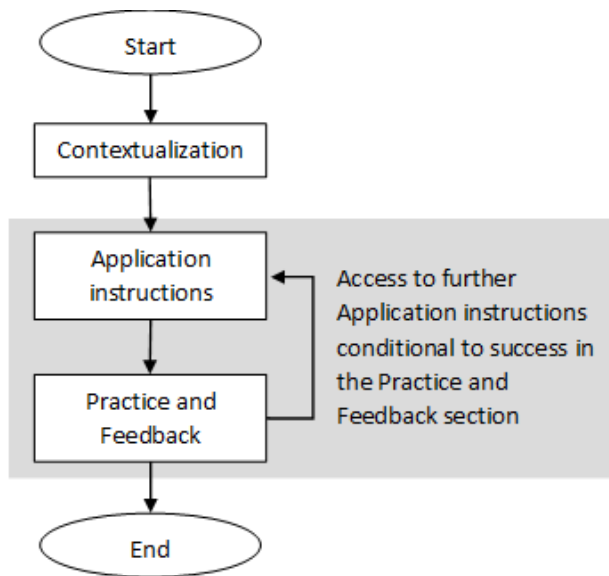
It is of our interest to evaluate the positive impact of Guided Learning Sequences in the students' performance, as well as the stress level caused by its application. The first one is important due to its implications of effective delivery content with flexible, asynchronous, and self-paced content. The second one is particularly relevant during COVID-19 pandemic due to current situation of our students and the high levels of stress that they may be exposed to. Therefore, we focus our results on two key indicators: Pre-Post performance and Academic stress.

## **Methodology and implementation**

During the redesign of the Mathematics course for Business Students, five Guided Learning Sequences were introduced into the course's Learning Management System (LMS): Straight line, Linear regression, Logarithmic and exponential functions, Differential calculus, and Integral Calculus. Each of the Guided Learning Sequences had a three elements structure, as depicted in Fig. 1.

- Contextualization: Each of the five sequences were oriented into the solution of a simulated real-life problem. In this phase, the student received information about the problem to be solved and the available data to analyze.

- Application instructions: The student received guidelines of how to approach the problem using the class contents. These guidelines contained both, theoretical and procedural content to allow the student to master the several aspects of the studied topic.
- Practice and Feedback: After receiving instructions, the student was exposed to a sequence of questions that implied both, algorithmics and interpretation of results within the context of the problem. Each question, either correctly or incorrectly answered by the student, presented an instantaneous feedback designed to reinforce learning and understand the mistakes of the student.



*Fig. 1 Elements of a Guided Learning Sequence*

The Guided Learning Sequences were assigned to 108 students, divided in 5 groups, during the second semester of 2020. Classes were held as virtual meetings due to pandemic self-isolation, but the sequences were solved as asynchronous activities, assigned by the teacher at specific moments of the course. During the learning period and at the end of it we collected information to analyze the performance of students and the stress perceived during the course.

In order to measure the Pre-Post performance of students, a sample of 45 students were exposed to a pre-post test experiment, where the individuals were asked to solve a mathematical problem without any procedural guidance. Later, these same students were exposed to a Guided Learning Sequence about the topic, with no further explanation or assistance from the teacher. And finally, the students were asked to solve again a similar exercise. The performance of the students, as well as their opinion about the proposed methodology was recorded and analyzed using a difference of proportions statistical test.

Similarly, in order to analyze Academic stress, we asked all the students to answer a modified version of the Medical Student's Stressor Questionnaire (MSSQ). This questionnaire was developed in Malaysia and validated in several countries such as the Netherlands, Romania,

Nepal, and India [30]. The MSSQ contains 40 items divided in 5 stressor groups: Academic, Staff and Students, Intrapersonal and Expectations, Teacher and Learning, and Patients. This study focuses exclusively in the first group, Academic related stressor, which includes items that directly involve the content delivery strategies and we consider are not exclusively intended for the medical students. The questionnaire was applied to students that were currently coursing classes with and without using Guided Learning Sequences, hence, each student was asked to compare the experience with and without the methodology for each of the MSSQ items.

### Findings and discussion

This study establishes two research hypotheses to be discussed and analyzed. On one hand, that Guided Learning Sequences can positively impact in the student’s learning. On the other hand, that academic stress can be significantly reduced by use of the methodology. In both hypotheses we present evidence at a 95% confidence level.

During the pre-post test experiment, it was found that 46% of students were able to solve the exercise before being exposed to the methodology. However, after using the Guided Learning Sequence about the corresponding topic and asked again to solve a similar exercise, that percentage raised to 71%. Table 1 shows the distribution of students according to their performance in the pre - post experiment. After exposure to just one sequence, a 95% confidence interval for the difference in proportions of students able to solve the exercise shows an increase of 5% to 45%. As well, a 95% confidence interval for the rate at which students with incorrect answers improved their results after exposure to the methodology was of 30% to 70%. These results provide significant statistical evidence that support the hypothesis of Guided Learning Sequences to positively impact the academic performance of students.

*Table 1 Distribution of students in pre-post test experiment*

		Post-test	
		Incorrect	Correct
Pre-test	Incorrect	27%	27%
	Correct	2%	44%

Moreover, an analysis of student’s comments towards the Guided Learning Sequence shows an interesting distribution when classified according to the pre - post test experiment. It was found that 83% of the students in the incorrect-correct quadrant of the previous table, and 71% in the correct-correct quadrant, had positive opinions about the methodology. Most of the opinions were related with the practice provided by the Guided Learning Sequences, the practical orientation, and the instantaneous feedback available after each practice section.

As well, the results of the modified MSSQ show a positive impact of Guided Learning Sequences towards mitigation of Academic Stress, in comparison with traditional assignments performed by the students during the same period of analysis. Table 2 shows the results of the difference of means statistical tests, where the null hypothesis is that the stress level in both, the

suggested methodology and the traditional homework, is similar; the alternative hypothesis stands for a decrease in the academic stress level when exposed to Guided Learning Sequences.

Table 2 Difference of means for items of Academic Stress questionnaire

*Null Hypothesis: Stress in Guided Learning Sequences - Stress in Traditional homework = 0*

*Alternative Hypothesis: Stress in Guided Learning Sequences - Stress in Traditional homework < 0*

Question	p value
If I do not obtain a good grade i get frustrated	0.076
The time spent is excessive	0.000
I do not practice enough, and I don't understand the topics	0.818
The activities do not allow me to spend time with my family and friends	0.001
It is difficult to understand and follow the instructions	0.914
I feel worried of obtaining a low grade	0.110
The number of topics involved is excessive	0.005
I am concerned the grade won't be fair	0.005

Students perception of academic stress improved in four main aspects: time spent in the activities, time spent with family and friends, number of topics that must be mastered, and unfair grades. This change in perception can be explain due to Guided Learning Sequences structure, which focuses in providing the required aid to understand and apply a topic within the time actually needed by the student. Nevertheless, the student perception in the amount of practice required, understanding of topics, and frustration towards low grades did not change. Fig. 2 shows the distribution of the academic stress questionnaire answers, as it can be seen, the implied distribution in these aspects is similar for traditional homework and Guided Learning Sequences.

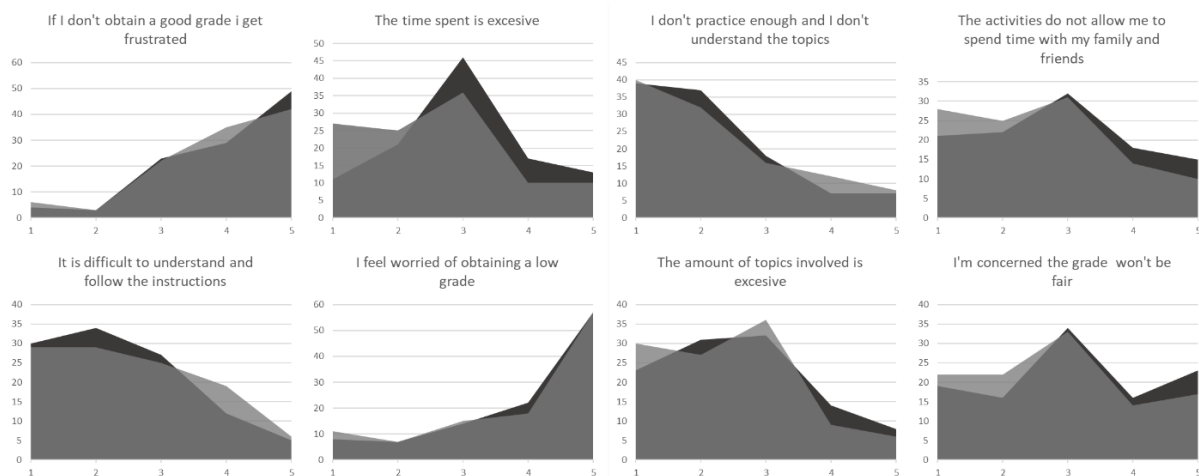


Fig. 2 Distribution of Academic Stress questionnaire answers. Traditional assignments in dark gray and Guided Learning Sequences in light gray.

## Conclusion

An important concern of Tecnológico de Monterrey during self-isolation conditions, and in general within a virtual learning environment, is the ability to deliver contents without generating additional anxiety to students. We believe that our proposed methodology can positively contribute to this goal by allowing the student to contextualize theoretical contents and to receive immediate feedback without time stressing constraints.

This study provides empirical evidence of Guided Learning Sequences to be a methodology that positively impacts student's learning while reducing the academic stress. Within self-isolation conditions and a virtual learning environment, students demonstrated a significant increase in performance after being exposed to the proposed methodology. As well, the stress level, measured by the modified MSSQ questionnaire, showed a significant decrease in stress levels related to factors of time, scope of the activities, and fairness of the grading system.

However, the methodology does not mitigate the student's frustration when underperforming in the activities, or the requirement of further practicing to reinforce knowledge. In further research, we are planning to experiment with multiple Guided Learning Sequences for a single topic, and the use of a control group to compare the improvement in students' performance with respect to other learning methodologies. We believe that future studies can provide us information to continue improving the proposed methodology as a better content delivery strategy to be used in virtual environments.

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