

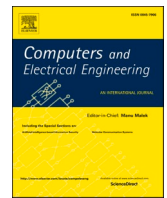


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Using a digital whiteboard for student engagement in distance education

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ABSTRACT

The COVID-19 pandemic transformed educational processes across different educational levels. As institutions and faculty members effort focused on guaranteeing academic continuity, the challenge was how to translate the learning methodologies applied in the classroom to virtual settings. A digital whiteboard was integrated to synchronous class sessions to complement the educational experience. During these sessions, students and teachers interacted to co-construct ideas and socialize learning. The objective of this study was to assess the impact of introducing a digital whiteboard in student engagement. The quantitative approach integrated student's perception through an online survey with 12 items. The results show that the students enjoyed the dynamic(4.56), students believe that the incorporation of digital whiteboard contributed to understanding abstract concepts(4.83), and perceived the resource contributed for class engagement (4.72). The design of educational projects that incorporate these resources translate to active learning dynamics which foster student engagement.

1. Introduction

By March 2020, SARS-CoV19, a novel Coronavirus first described on december 2019 in the Chinese province of Wuhan was declared as a pandemic. The global impact of this virus was unimaginable as global economic and social activity stopped, carrying out a radical change on the dynamics of daily life. Education of course was not an exception. Courses in different educational levels, from elementary to higher education had to be rapidly migrated to digital platforms, and teachers were forced to innovate and find new digital alternatives for educational dynamics. [1]. Particularly in higher education settings, the main challenge was to successfully provide the curricular content, skill development and a comparable educational experience for learners.

By April 2020, the Digital Flexible Model (MFD, by its initials in spanish), a proposal for distance education by Tecnológico de Monterrey University was developed. This model described the incorporation of digital tools such as Zoom for synchronous sessions and some educational technologies that allowed to recreate a similar learning experience for students during the pandemic [2]. The beginning of the MFD model constituted a challenge for the educational community, which quickly innovated with dynamic and alternatives for student engagement.

The first section of the paper describes the impact of innovation for teaching and learning, and its determining role for the challenge of the COVID-19 pandemic. The following section describes the introduction of the digital whiteboard to spark student engagement in

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distance education, and presents a method to assess its effects. Then the results section presents findings and analysis of students' perception of the educational experience. The discussion section presents arguments and views of the different factors that impact on student engagement. Finally, the conclusion section presents alternatives to incorporate educational innovation strategies to improve classroom dynamics besides the distance or remote format for learning.

1.1. Innovation in teaching and learning

Educational innovation is the application of an idea, methodology or process to produce a change in the educational experience [3]. These planned changes surpass the achievement of educational goals, and strive to integrate novel proposals to nurture learning environments [4]. In higher education, models are transitioning away from the massive lecture halls where the students are passive subjects who receive the knowledge of the expert [5]. Educational institutions are focusing on active learning methodologies and innovations that prepare graduates for an uncertain future [6]. But it has also been adjusted to teaching a new generation of students, the Generation Z (Gen Z), which through a generational lens can be described as a generation that values diversity, are optimistic about their future and are highly persistent [7].

As educational technologies reach new disciplines and develop new applications, these trends have gained acceptance and credibility, as well as an impact on the training process [5]. As new generations arrive into the university, there is a need to update and redesign course materials and methodologies, as well as to assess the contributions of traditional strategies [8]. This has encouraged educators to implement educational innovation projects that integrate technology; however, the question is the extent in which institutions, teachers and students are prepared to implement them [9].

In medicine, although the prevailing way of teaching has been the *see one, do one, teach one* for surgical and clinical skills [10], the educational processes have evolved to incorporate new strategies where the educator guides, facilitates and accompanies the teaching-learning process and students take their role as active learners [11]. Some trends in educational technology that have been incorporated are the use of augmented and virtual reality for teaching anatomy, online evaluation supported by feedback [12] and the use of mobile devices to trigger interaction and discussion.

1.2. Teaching in the COVID-19 pandemic

The challenges of teaching amid the pandemic have emphasized the importance of building on the lessons learned from the previous implementations of innovation projects, as well as in the creativity from teachers for a successful transition. Some of the dynamics that were threatened in educational virtual settings is the *interactions of learning with peers and the experiences with faculty* [13]. Enablers to foster these interactions are video conferencing tools such as Zoom, Google Meet, Youtube Live, Facebook Messenger, and Whatsapp Rooms. However there must be an intentional incorporation and design to leverage these advantages. These *structural elements* recreate the campus environment for content delivery; some designs have relied on Learning management systems (LMS) such as Canvas, Google Classroom, Blackboard, Edmodo, Moodle, to name a few. If the structure of these learning environments is well defined, it can favor engagement of the students through challenging tasks and clear guidelines for learning [14]. However, a poor instructional design can become an impeding or maladaptive cognition for engagement [15].

At first, the temptation was transferring face-to-face classes to short online conferences where teachers would present a monologue of each topic, but it became a setback on the actual model in which students are actors responsible for their own learning process. The face-to-face interactions are a factor for nostalgia in many cases, a constant threat for learning amid the pandemic is behavioral disaffection [16]. Thus, courses sessions benefit for activities that target skill development and interactions between the members of the learning community designed [17]. The redesign underwent needed to create scenarios for active and collaborative learning, where students could experience the *emotional and behavioral engagement* to manage their own learning [5].

Providing a comparable experience than the one received face-to-face requires the integration of resources which recreate powerful dynamics of students' active role. Although the teaching-learning process has been challenging for teachers and students alike, it has also contributed to visualize elements that under normal conditions would go unnoticed, such as building community and a safe-space for students to interact.

For the Immunology course, the usual dynamics consisted in developing diagrams to explain interactions between concepts and processes. The building process is guided by thought-provoking questions to engage in discussion and to help students to identify key concepts, the conclusions and synthesis, as well as these key points are represented on the whiteboard. This is one of the best valued formats by students that have previously participated in class, as they highlight the opportunity to co-construct ideas and socialize learning. To recreate this dynamic when migrating to the distance education model, an innovation was developed to address two elements: 1) the use of connectivity and distance education platforms to promote a dynamic and active class, and 2) promote collaboration between students and teachers. To do so a virtual whiteboard application was integrated to synchronous class sessions. During these sessions, students and teachers participated and discussed specific topics of the program. The objective of this study was to assess the impact of introducing a digital whiteboard in student engagement on a distance learning experience..

2. Methods

2.1. Methods

In order to assess this implementation, a quantitative approach was implemented [18]. The methodology described by the first

level of Kirkpatrick model was incorporated as it focuses on the assessment of student satisfaction and reaction to innovation [19]. A 12-item questionnaire was used to assess different factors that impact student engagement: 1) interaction with peers and faculty [13], 2) structure and educational environment [14], 3) emotion and behavior [16]. Each factor explored different elements for engagements described in table 1. The instrument incorporates 10 items using a five-point Likert scale where 1 corresponds to total disagreement, and 5 total agreement, and 2 additional open-ended questions to understand the engagement factors that students considered the most important in a face-to-face format, and in distance settings.

The sample strategy was a convenience sample, since participants were volunteers [18]. It consisted of 39 fourth-semester medical students from the Immunology course which gave consent for the results to be used for educational research purposes.

This distance education model started implementation in early April 2020. In order to achieve an active class, the implementation required prior planning work in which the topics were agreed to be discussed in each session, clear rules of etiquette were established for interaction in the virtual course, as well as materials to be completed before class.

Regarding technical preparations, the teacher logged into the Zoom video conferencing tool on two different devices: computer and tablet. The purpose of the computer session is for the teacher to periodically review the Zoom chat with questions or comments that the students may have, to have an extra screen to corroborate the transmission of the class and to manage the waiting room of the Zoom session. The tablet was used to share the screen where the diagrams were being worked using the *Goodnotes* app. As the session progressed, the teacher used questions to guide the students' discussion. Together they built the graphic representation that included drawings or annotations. Sometimes screenshots of figures from a book, paper or videos were overlapped into the diagram in Goodnotes to complement the explanation. Altogether, this ensured the class remained interactive, favoring student's engagement and this digital whiteboard was the keystone on achieving it.

In this app, the key concepts and arrows that demonstrate the interaction between the various immunological or hematological processes are integrated. Fig. 1 presents an example of these sessions, it particularly depicts a sequence of events on the platelet activation process. First a table was made (upper left corner) comparing the main glycoproteins on the platelet's surface and their ligands. The bottom right corner showcases a diagram showing step by step platelet activation and involvement of these glycoproteins from adhesion to agregation.

The construction of the diagram starts from the top left corner, continues towards the right side, and finishes at the bottom of the board. Colors complement the presentation of information in an organized way, helping students to achieve knowledge organisation. Students can take screenshots as the class progresses, but they can also access the diagrams through an online shared-folder where each class is documented.

3. Results

The items that received the most favorable responses were: "10. I think my teacher showed great commitment making the transition to the distance education model", "4. The use of graphic resources (whiteboard, drawings, mental maps, integration of text figures) helped me to understand abstract concepts that I find difficult to understand in books", and "1. I enjoyed the methodology in which my class was taught in the face-to-face format", with mean of 4.94, 4.83 and 4.8, and variances of 0.053, 0.31 and 0.33 respectively.

The items that received a less favorable evaluation correspond to the items of "7. Switching from the face-to-face diagram construction to a digital version of the whiteboard made it difficult for me to follow the course content.", "8. I felt more involved with the course in the distance course", and "10. I was more motivated to participate in the course in person", with a mean of 2.3, 3 and 3.63, and variances of 2.22, 1.77 and 1.55 respectively. Table 2 presents the results obtained by each engagement factor.

In the open-ended questions, students identified that in *face-to-face settings* the most relevant engagement factors were 51.2% interaction with peers and faculty, 41.4% structure and educational environment factors, and 7.4% referred to emotion and behavior factors. In *distance education settings*, students described that the most relevant engagement factors were 0% interaction with peers and faculty, 78.1% structure and educational environment factors, and 21.9% declared emotion and behavior factors. Exemplary quotes of students reflections in open-ended questions are presented in Table 3.

4. Discussion

The innovations implemented in the course were focused in fostering *interaction with peers and faculty*. These adaptations presented a challenge because some of the strategies were not the best to promote interaction and engage students. Tools such as the digital

Table 1
Instrument design for student engagement

Factors	Theoretical elements of engagement
Interaction with peers and faculty	Learning with peers (McCormick, Gonyea & Kinzie, 2013) Experiences with faculty (McCormick, Gonyea & Kinzie, 2013)
Structure and educational environment	Campus environment (McCormick, Gonyea & Kinzie, 2013) Structure-dependent engagement (Bangert-Drowns & Pyke, 2001) Adaptive cognition (Martin, 2007) Impeding/maladaptive cognition (Martin, 2007)
Emotion and behavior	Emotional (Skinner et al., 2009) Behavioral Disaffection (Skinner et al., 2009)

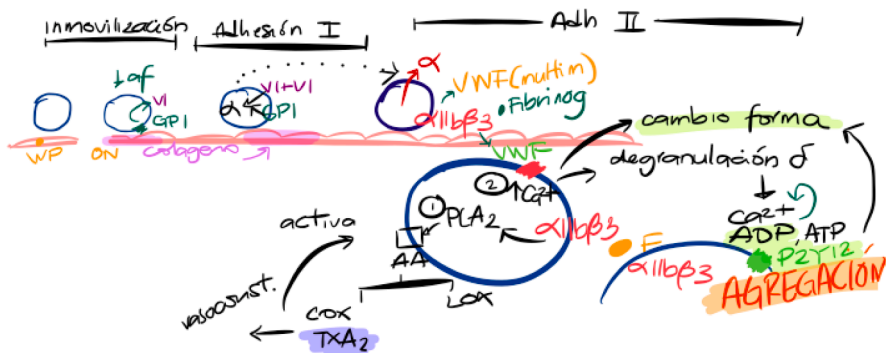
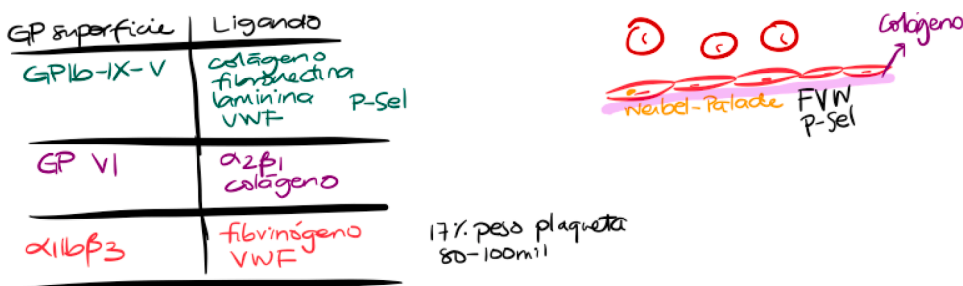


Fig. 1. Platelet activation

Table 2
Student engagement assessment in the implemented innovation

Factors	Theoretical elements of engagement	Item	Mean	Variance
Interaction with peers and faculty	Learning with peers and faculty	1. I enjoyed the dynamics and interaction of developing diagrams in which my class was taught.	4.81	0.33
	Experiences with faculty	2. The format and dynamics of the favored interaction with the teacher.	3.75	1.11
Structure and educational environment	Campus environment	3. I think my teacher showed great commitment making the transition of class to this distance model	4.94	0.05
	Structure-dependent engagement	4. The inclusion of multiple resources and stimuli in the classes, kept my interest.	4.72	0.38
	Structure-dependent engagement	5. I would recommend my friends participating in courses that use a similar format.	4.56	0.83
	Adaptive cognition	6. The digital whiteboard helped me to understand abstract concepts.	4.83	0.31
	Impeding/maladaptive cognition	7. Switching from the face-to-face diagram construction to a digital version of the whiteboard made it difficult for me to follow the course. *	2.31	2.22
	Emotion and behavior	Emotional	8. I felt more involved with the course in the distance course.	3.00
Emotion and behavior	Behavioral Disaffection	9. The educational experience I received in the face-to-face format was better than the one I have remotely.*	3.64	1.32
	Behavioral Disaffection	10. I was more motivated to participate in the course in person.	3.64	1.55

*Reverse scored items

whiteboard were considered useful because they helped to preserve some of the usual conditions and class dynamics. The results of this study show that students felt the class as if nothing had changed from the presence based interactions. That perception of quality was deeply valued since the migration to remote learning was done fast and efficiently given the short-time there was to plan and adapt contents to strategies that were already designed. However, it posed the question to consider if some of the *teaching rituals* are strictly necessary. Practices such as delivering paper-based assignments, organizing synchronous team-discussions, and long lectures, are to be replaced by the incorporation of some technologies. These additions could contribute to protecting class time for the important elements described above: describing examples of specific processes, discussion with peers, posing questions, and overall constructing knowledge with previous conceptions as learning takes place.

The *structure and educational environment* elements are shown in the results obtained demonstrate an adequate transition from the face-to-face model. One of the main strengths of this innovation refers to the successful migration to the digital model where the

Table 3
Students reflections in open-ended questions

Factors	Face-to-face	Distance education
Interaction with peers and faculty	<p>“Communicating with other classmates inspires me to ask questions during class”. (participant 5)</p> <p>“The interpersonal experience, even just seeing other people makes me more aware in a session”. (participant 9)</p> <p>“Interacting with the teacher allowed us to solve doubts as they emerged”. (participant 18)</p>	(no mentions were given to this factor)
Structure and educational environment	<p>“I enjoyed that the class was very visual and it was easy to follow”. (participant 21)</p> <p>“In the course there was bibliography, I knew that if I read it I at least knew the minimum. After that, it was up to me to find out more. Also the teacher guided the session with what we had read, using the diagrams allowed me to integrate the concepts”. (participant 26)</p>	<p>“Classes were recorded and I was able to watch them over again”. (participant 15)</p> <p>“The teacher adapted to an online format very fast, and she seemed interested to make the explanation of the content crystal clear”. (participant 7)</p> <p>“I enjoyed that we translated the diagrams and dynamic explanations that we had in class to keep some kind of normal in the distance setting”. (participant 13)</p>
Emotion and behavior	<p>“I felt that I was involved in the session, and it made me want to participate”. (participant 27)</p> <p>“It made me relax, and I wanted to be ready for class because it was an unrepeatable moment that I needed to take advantage of”. (participant 31)</p>	<p>“I was studying at my bed”. (participant 11)</p> <p>“I felt I got to know more of the teacher and talk about life”. (participant 21)</p> <p>“I felt that the teacher was doing her best. I really liked that and motivated me to put all my effort in and learn more, not by memorizing but learning”. (participant 22)</p>

students expressed that the quality was comparable to the one they had in the face-to-face model. A lesson learned in this implementation was to assess the project by the students' voices, not as customers that needed to be satisfied but rather as partners that have to be interested in their learning process in order to succeed. For instance, the first configuration performed by the teacher received feedback from students which ended providing alternatives to make the setting up of the session easier. To achieve this, it is crucial that the teacher has presented clear objectives for the class, as these are discussed and clarified with the student there is an alignment of expectations on both stakeholders. One strategy is to ask students to read the course materials, before each class since it is key for students to have that previous knowledge to be able to interact. Although remote sessions were guided by the teacher with directed questions during this process, student preparation is important to the dynamic in a remote model.

A result of the assessment that was quickly recognized was the *emotional and behavioral* impact that the implementation was fulfilling. The COVID-19 pandemic has demanded an extra effort from teachers to deliver not only the excellence students are used to, but also to provide a bit of normality amid uncertainty and stress. To foster these learning environments educators need to continually assess their own performance to recognize the contribution of their teaching efforts, a skill that needs to be nurtured by faculty development programs even after the pandemic crisis has passed.

5. Conclusions

Students seem to respond well to active learning dynamics besides the distance. Some elements still require a continuous effort to impact on student engagement, for example in the resistance of participants towards opening their microphone to ask questions or share a comment, they still perceive that by making an oral contribution, it's an interruption of the teacher's explanation. There is a need to develop alternatives where all students can participate and engage in the most natural and effective way. This could be achieved by holding dedicated times for discussion, scheduling online forums or by making students work in small groups where they interact with their peers. Unfortunately, there is still not a way to emulate the totality of a face-to-face classroom and the live interaction within. However, these types of dynamics provide a sense of activeness and normality of the classes before the pandemic, with the elements that now make us nostalgic.

Traditionally, a large portion of teachers still limit themselves to conduct lecture-based sessions that are supported with Powerpoint presentations. This strategy is time consuming and could become tedious for Gen-Z students, who are used to receiving multiple stimuli and have shorter attention spans [7]. Implementing educational innovations allows that students stay engaged and active by collaborating in the sessions. Surely, this strategy requires that the teacher performs some additional work, due to the setup, planning and implementation. However, the results obtained make it worthwhile.

Author contributions CRediT roles

Aniela Mendez-Reguera: Investigation, Methodology, Writing – original draft, review & editing.

Mildred Lopez: Methodology; Formal analysis; Resources; Project administration; Roles/Writing - original draft, review and editing

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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