From Flipped to Remote to Hybrid: Transformation of a Game-Based Flipped Classroom During the Covid-19 Pandemic

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Abstract: Purpose – This research examines how students' learning was affected by the transition from a flipped classroom model to remote learning during the Covid19 lockdown and hybrid learning after return to class. Methodology – This study features quantitative analysis of undergraduate students' online interactions with the course material over two semesters with the same instructor, one completely online, the other in the form of hybrid learning imposed by Covid19 restrictions. Participation in the game-based quizzes before class, in-class multiplayer game sessions, and presence in the classroom or online during the lectures were measured, as well as the students' score to the final exam. Students also took a survey at the end of each semester to provide feedback on the course. Finally, interviews were made with some of the students to document their detailed impression of the learning challenges of the period. Findings – Results from this study identified four groups of students with different attitudes regarding learning and challenges during and after Covid19 restrictions. Some came back immediately in the physical class while others remained online or did both. Average scores correlate increased face-to-face time and regular online preparation before class with better results in the final exam. Qualitative data from students' interviews confirm these changing attitudes to learning due to Covid19. Practical implication – This study allows us to reflect on best practices for hybrid learning and opportunities to improve on the flipped classroom model under changing modes of delivery. Furthermore, it underlines strategic importance to engage different profiles and challenges for students with less time and opportunity to engage in face-to-face learning. Interest – While research on flipped and hybrid classrooms is prevalent, little has been done in comparing the two models and their impact on students' learning attitudes Furthermore, research on classroom adaption and adjustment during Covid19 is still at early stages. This study presents opportunities and challenges for the hybrid classroom moving forward.

Keywords: flipped learning, hybrid learning, emergency remote teaching, game-based learning, COVID-19

1. Introduction

The coronavirus (COVID-19) was declared a global pandemic on 12 March 2020. The virus spread rapidly worldwide, and prevention of contamination quickly became a global issue. The WHO recommended several public health and social measures (PHSMs) to suppress SARS-CoV-2 including but not limited to personal protective measures (e.g., physical distancing, hand hygiene, mask-wearing); environmental measures (e.g., cleaning, disinfection, ventilation); and physical distancing measures (WHO, 2021). High Education Institutions (HEI) were largely affected by the social distancing measures, with many schools and universities having to move their teaching online (Triyason, Tassanaviboon, and Kanthamanon, 2020). While online education had been used before and widely tested for its flexibility and convenience, this sudden shift was dubbed Emergency Remote Teaching (ERT) owing to the specific time and resources constraints that triggered its use during COVID-19 (Hodges et al., 2020). Institutions adapted to the new context, but rapid changes and uncertainty had a huge impact on both educators and students, who frequently reported increased stress, risk of depression, lack of motivation and difficulty focusing (Birmingham et al., 2021). As restrictions were lifted, the possibility of returning to campus was seen as desirable both for social interactions and improvement in education quality.

In the Aalborg University (AAU) department of Medialogy, the adaption came quickly since some classes had already adopted a flipped classroom (FC) model (Triantafyllou, 2015), with extensive use of Moodle as a Learning Management System (LMS) for online delivery of content and tests. Courses moved fully online over Fall 2020 and Spring 2021, and presence on campus started again in Fall 2021. During that time, we endeavoured to gamify our FC with the introduction of games to support the students' learning experience (Algayres and Triantafyllou, 2019). The gamified learning experience was moved fully online during the Spring semester and to hybrid form in the Fall semester of 2021, with the introduction of a collaborative game for students in the physical classroom. Both online and hybrid models were made necessary by the physical distancing mandate, and the necessity to maintain isolation for symptomatic or contact cases. During that time, the introduction of Game-Based Learning (GBL) elements allowed us to have a specific window into the students' online habits and learning challenges.

With this sudden influx of data and quick adaption to different learning circumstances, we started investigating the process of returning on campus with the hybrid classroom format, and asked ourselves the following research questions:

- RQ1: was the implantation of a hybrid classroom beneficial to the students' learning?
- RQ2: did the students' learning habits change after COVID-19 and during the implementation of the hybrid format?

The structure of the article is as follows: we present the literature background, the methodology for the implementation of the gamified classes, the results of the experiment, and discuss the potential and limitations of hybrid learning with GBL elements.

2. Background literature

2.1 Remote, flipped, hybrid: different modes of online delivery

Online teaching and research in eLearning have been increasingly developing fields. Traditional teaching is still conceptualized as face-to-face, "seat time" in person with the instructor, but forms of online delivery have become extremely diverse. Technology-enhanced learning incorporates IT tools to traditional delivery (e.g., a LMS to access learning material and computerized homework), blended models mix face-to-face time with online learning time, whereas in fully online course students never meet physically (Van Wart et al., 2019).

The FC is a model of blended delivery that use online resources to flip traditional concepts of class work and homework. It divides instruction in two parts, "interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom" (Bishop and Verleger, 2013). On a practical level, FC move most lecture time out of class, use class time for active and social learning activities and require students to complete pre- and/or post-class activities with online support to fully benefit from in-class work (Abeysekera and Dawson, 2015).

Hybrid learning aims at adapting to the need for more flexibility by enabling synchronous virtual classrooms to connect both onsite students and remote students during teaching time. Research in hybrid learning appears still in early stages although interest in this form has expanded in the wake of the COVID-19 crisis (Raes et al., 2019).

Finally, ERT borrows tools and techniques from online learning but is different in that it constitutes a "temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances" (Hodges et al., 2020). It involves fully remote teaching solutions but with the aim to provide instructional continuity for the limited crisis time, not fully incorporate online instruction.

The advantages of various forms of online delivery have been extensively researched in the decades following their introduction. Van Mart et al. (2019) showed that online learning allowed to provide education with reduced expenses for students and faculty, gave flexibility for the students who need asynchronous learning to fit their schedule, and could improve their digital skills. Similarly, studies have shown that the FC presents many advantages such as students learning at their own pace, teachers being able to better support their students, more classroom time for hands-on and collective activities, and students gaining more autonomy in the learning process (Herreid and Schiller, 2013). Abeysekera and Dawson (2015) propose that due to the active participation of students, "[learning] environments created by the FC approach are likely to satisfy student needs for competence, autonomy and relatedness and, thus, entice greater levels of intrinsic motivation". Finally, early research into the hybrid format points to similar benefits. Hybrid learning has two main advantages in organization and pedagogy. It can reach a greater base of students who are working or ill, and can interact with the teacher synchronously, benefiting from direct interaction (Raes et al., 2020).

There are however challenges with online learning. Motivation in students can be harder to sustain without presence time with the instructor and the fellow students, also called social presence (Van Mart et al., 2019). Raes et al., 2020 qualified this phenomenon of 'ambiguity' regarding group membership. The FC model is extremely dependent on student coming prepared to the class, and lacking preparation time the pedagogy is less efficient. (Herreid and Schiller, 2013). Similarly, in hybrid learning students can feel disconnected and experience less relatedness compared to their in-class peers, and technical requirements must be solid to

guarantee audio quality for all (Raes et al., 2020). Finally, Smith (2021) showed that reduced face time in a hybrid configuration did not worsen students' perception of their education quality and that they appreciated its flexibility, but that their test performances were negatively impacted.

2.2 Game-based learning

GBL is similarly a well-established field in educational research. Game-based learning (GBL) can be defined as an environment where game content and game play enhance knowledge and skills acquisition, with challenges that provide playing students with a sense of achievement (Qian and Clark, 2016). Gaming elements have been introduced in the classroom in a variety of forms: serious games (Michael and Chen, 2005), Digital Game-Based Learning (Prensky, 2003), and gamification, i.e., inclusion of gaming mechanics such as scores and levels to improve experience and engagement (Muntean, 2011).

Research into GBL has focused both on the challenges of evaluating the impact and benefits of GBL and the best practices to implement them in the classroom. Although some studies underline the difficulties of proving an educational benefit from GBL (Young et al., 2012), others insist that it has positive outcomes. Abdul Jabbar et Felicia (2015), in an extensive review, show that gaming provides opportunities for players to gain from the gameplay, and that GBL helps students to develop skills and knowledge and strengthens their ability to handle their learning experience. They also defend the efficiency of games that combine both a competitive element for engagement and a collaborative aspect since socializing is a driving factor in the efficiency of GBL. De Freitas (2006) argues that games can be extremely immersive and collaborative environments but necessitate sustained motivation and clear learning outcomes for the participating students. They also underline the fact that GBL is often experience-based or exploratory, and therefore a good support for experiential, problem-based learning approaches. Similarly, Young et al. (2012) defend the idea that digital-learning games target the acquisition of knowledge as its own end and foster mind and understanding habits that are generally useful within an academic context. Finally, Qian and Clark (2016) researched the capacity of GBL to improve 21st century skills (i.e., critical thinking, creativity, collaboration, and communication) and showed that GBL brought both improved attitudes to learning and cognitive gains.

Finally, recent reviews present two different trends: the first one leaning into more complex and fully integrated learning environments (De Freitas, 2006), the second towards more simple approaches like puzzle based and simple game mechanics, allowing quick engagement, easily understood educational relevance, and short efficient duration of play (Abdul Jabbar and Felicia, 2015). In an extensive literature review, Kay and LeSage (2009) showed that quizzes and polls have proven to be an effective educational tool as students attended more classes, paid more attention, and were more engaged. Similarly, Raes et al. (2020) found that their students' intrinsic motivation was higher during quiz times than during other moments of the lecture. Therefore, the overall tendency points to the benefits of using GBL especially in the context of active learning or problem-based learning, with the main limitation that GBL needs to be supported by clear learning objectives, sustained student engagement, and reliable technological support.

2.3 Emergency remote teaching during COVID-19

Framing and analysing the students' learning experience during and after COVID-19 remains complex. Studies emphasize the challenge of adapting quickly to the online format and unique temporary nature of ERT (Hodges et al., 2020) According to a survey conducted by Marinoni, Van't Land and Jensen (2020), two thirds of HEI respondents implemented distance teaching and learning, experimenting challenges technical infrastructure, skills, and pedagogies, but also opportunities to explore blended and hybrid learning. Recommendations to adjust to the COVID-19 crisis included development of reliable network infrastructure, investment in more affordable technological devices, training initiatives, and diverse modalities in delivering flexible learning experiences (Ferri, Grifoni, and Guzzo, 2020).

Other studies underlined that teachers' presence and quality of content were the major factors that influence student engagement online during lockdown (Khlaif, Salha, and Kouraichi, 2021), as well as strong and timely communication, clear organizational structure and expectations, and accommodation of multiple learning styles (Wiltse et al., 2020).

Finally, tentative studies into the hybrid mode of delivery showed its potential. Reas et al. (2020) in their review state the potential of synchronous hybrid learning, which creates a more flexible, engaging learning environment. To improve the model, they also recommend clear communication, an active lecturer that frequently ask oral questions, and cognitively activating activities such as polls and quizzes presented in an active and amusing manner.

3. Methodology

3.1 The structure of the course

This study covers the two semesters of the year 2021, the Spring semester (Semester 1) and Fall semester (Semester 2). This study followed the same group of students engaged in a Medialogy bachelor course, representing the second and third semester of their ten-semester study program. The courses evaluated were programming courses followed by the same group of students (n=47). The methodology for this study is presented in figure 1.

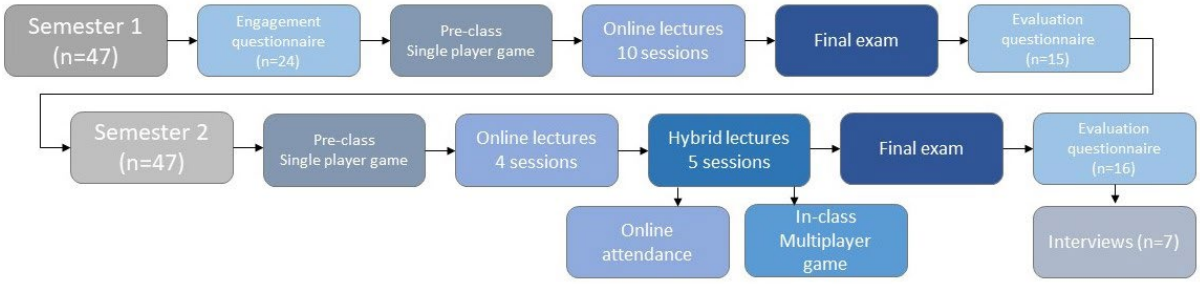

Figure 1: Methodology for the implementation and evaluation of the Medialogy 2021 programming courses

The lectures for Semester 1 took place online. The students had to prepare before each lecture, access the learning material and play the pre-class quiz game. During Semester 2, the requirements for pre-class preparation and single player quiz game remained the same. However, the nine lectures were split: the first four lectures were delivered online, the last five were delivered in hybrid format. The students that were physically present started class with a multiplayer quiz game session, other students followed the lecture online.

3.2 The game implementation

Both courses exploited a game to enhance the learning experience: a game quiz like popular application Quizlet, for facility of implementation and easy to understand learning objectives. The game has two modes: single player (SP) and multiplayer (MP). Figure 2 presents a capture from the SP game screen, figure 3 a capture from both MP game screens, and a picture of the game being played in class.

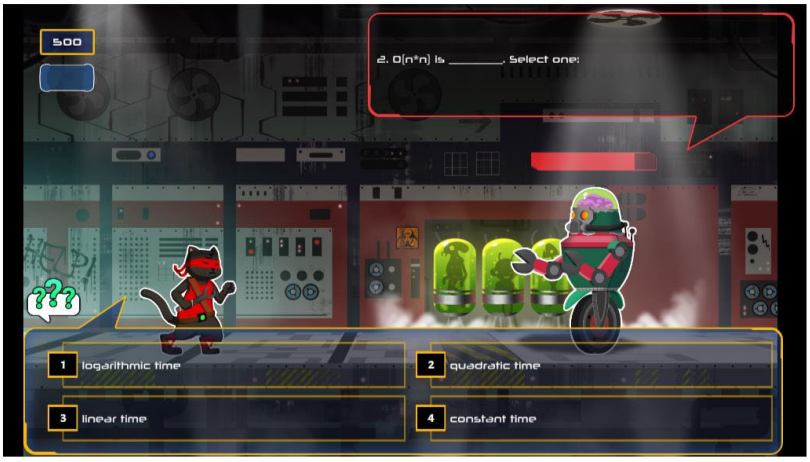

Figure 2: Screen capture of the SP game

Figure 3: Screen capture of the MP game and game activity in class (October 2021)

Semester 1 had 11 SP game sessions for a total of 106 questions. Semester 2 had eight SP game sessions for a total of 53 questions, and five MP game sessions. Due to the differences in structure for both iterations of the SP games, to compare them we included in the output the scores per game session and per question.

The games were implanted on a dedicated platform. This gave us information about the students' activity (engagement time, scores, number of right and wrong answers, MP participation), allowed adjustment of the quizzes to each lesson, as well as targeted interventions towards the lesser-engaged students. Due to COVID-19 constraints, the MP game was only implemented during Semester 2, allowing us to map the number and activity of the students who returned physically on campus.

3.3 The evaluation tools

We decided to use mixed methods for the study to cover the diversity of students' experiences through various data. Our primary source was quantitative indicators from the gaming platform and LMS: number of quiz sessions completed, score per session, engagement time, MP participation, online attendance, and final assessment score. This hard data allowed us to track the regularity and performance of the students. We also decided to use a questionnaire and interviews to record the students' perception of their learning experience: out of 47 students who completed the engagement questionnaire, 15 filled the feedback for Semester 1 and 16 for Semester 2. Students were selected for interviews on a voluntary basis among the respondents.

Our focus determined the choice of methodology. For RQ1 (benefits to students' learning), we could exploit data from the students' performance both summative and formative, as well as their self-reported perception of the class efficiency. Similarly, for RQ2 (students' learning habits) we used both hard data from their online behaviour as well as their subjective, but also relevant, perception of the learning process.

4. Results

Table 1 presents an overview of the results for both semesters. The final exam result average was better in Semester 2 by ten points on a maximum of 100. The game scores are expressed in points, each correct answer valued at 500 points. The average score for the SP was higher during Semester 1 but the average score relative to the number of questions was higher during Semester 2 by more than 100 points. Similarly, the engagement rate (time spent on the game expressed in seconds), was significantly higher during Semester 2, with students spending an average of three minutes by game session time. The MP game score, available only for Semester 2, is rather weak with an average of 1456 points, which is explained by the fact that only a minority of students took part in all the game sessions.

We then studied attendance during the time in Semester 2 when the course format turned hybrid. We listed the students who participated in the MP game, those who attended physically without playing the game (usually due to arriving late and missing out the game session), those who attended online synchronously and those who did not attend at all. We also looked at the students who completed the SP game to prepare for the

classes before the end of the lectures, and those who took the SP game quiz after the course was ended. Figure 4 presents the conclusions of these observations.

Table 1: Overview of the study's quantitative indicators

	Semester1	Semester 2
Final score (average/100)	74,36	84,13
Average score MP game (points)	NC	1456
Average score SP game (points)	48659	30590
Sum Average Engagement (seconds)	151	1482
Average score by session (points)	4423	3824
Average score by question (points)	459	578
Sum average engagement by session (seconds)	14	185
Sum average engagement by question (seconds)	1,42	27

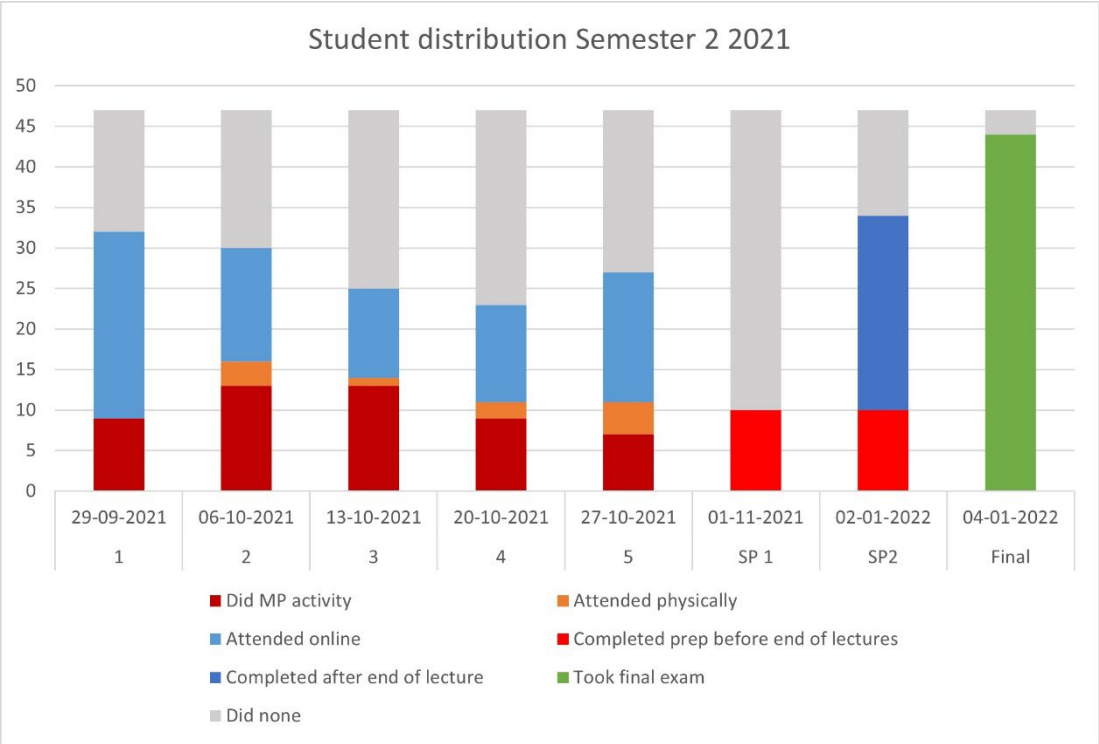

Figure 4: Student distribution and participation during Semester 2

We can observe that most students struggled to reconnect with the classroom, whether online or in person. We can also observe that a very small minority, ten students, did the activity to prepare for the class as intended. A significant part of the students completed the quizzes, but towards the end of the semester as preparation for the exam. Finally, most students took and completed the exam.

Looking closely at those results we sorted the students in six different groups. The groups were based on the following characteristics:

- Group A: the present and active. Participated to at least three MP sessions
- Group A': the well-prepared. Completed the pre-class preparation before the end of the lectures. This group comprises 5 students of group A, 3 students of group B and 2 students of group C
- Group B: the connected active. Attended most hybrid classes online.
- Group C: the irregulars. Attended less than two classes (physically or online).
- Group D: the "last minute" students. Completed quizzes or final examination after the end of the lectures.
- Group E: the dropouts. A minority of students did not take the final examination at all.

Table 2 presents the quantitative indicators for each of these groups. This distribution shows us that the students who were consistent with pre-class preparation as well as the students who were active physically in class got a slight advantage in their final examination results compared to the other groups. We can also underline that the students who followed the courses synchronously online do not present significant different results from the last-minute student group. This can be explained by the fact that some of the last-minute students are high performing students who do not feel the need to work regularly and can succeed by mobilizing at the very end of the semester.

Table 2: Quantitative indicators for each group based on class attendance and online interactions

Group denomination	Number of students	SP average score (pts)	SP average engagement (s)	MP average score (pts)	Examination average final score (pts/100)
Group A	10	44806,2	1655,8	5300	91,2
Group A'	10	44968,7	1552,2	3300	92,7
Group B	13	33802,85	291,67	1766,77	90,69
Group C	10	26024,9	1150,2	1050	90,6
Group D	11	24784,09	1487,36	0	87
Group E	03	5791,66	753,66	0	0

The quantitative indicators argue in favour of the benefits of returning to campus for students and more personal interactions. Qualitative comments from the feedback questionnaires and interviews seem to support this observation. Figure 5 presents the word cloud of these interviews.

Figure 5: Interviews word cloud by frequency of mentions

First, the students were mostly positive about returning to campus. Several answers mentioned the challenge of interacting online, and that being present physically allowed them to ask questions and seek the teachers' help more easily. Quote: *"I feel like it's more intimidating to answer questions on Teams rather than in real life. I prefer asking questions in real life because it feels more natural and less intimidating."* (Questionnaire, Semester 1), *"So, I thought it was a bit harder whenever I was online. But as soon as we had [teacher] in a classroom, it was a much nicer experience because everyone was present and there was a bit more social norm to be quiet during the lectures."* (Student F)

Some students expressed difficulties adjusting. Quote: "*There's kind of this vibe that's been changed in a way. There's (…) habits that are hard to break, (…) going to the place and being in the seminar room when you had to get used to do it from home*." (Student A)

Students finally mentioned continued use of online tools, and especially appreciated being able to access the lectures online. Quote: *"One thing I really like now that even if we're back physically, is that we still are using the online space, such as teams, to have the availability of the online classes."* (Student F) "*I think it's awesome to always record the lectures because I often I download them to my cloud, and I listen to them on my way to school.*" (Student A)

5. Discussion

- RQ1: was the implantation of a hybrid classroom beneficial to the students' learning?

Our study show that students benefited from the implantation of the hybrid format. The students who took full advantage of the tools at their disposal got better average results than students who worked fully online. The students' survey responses show general satisfaction with the conduct of the courses.

This study aligns with conclusions of previous works regarding the potential of hybrid learning as a sustainable and valid mode of blended learning delivery. The best features of hybrid learning remain organisational flexibility and pedagogical. The current political and environmental trends remain uncertain: it is very probable that modern societies will face other epidemic spikes and climatic crisis. In this context, building robust infrastructures and educational model to support hybrid learning and quick adaption to changing circumstances appear of paramount importance.

- RQ2: did the students' learning habits change after COVID-19 and during the implementation of the hybrid format?

The students' learning habits do not appear to have changed in depth, although some students reported struggles to get back to physical learning. The hybrid format however has the potential to reinforce digital usages that were in place before. In that regard, there is potential in investigating how to adapt the best practices of the FC to the hybrid format. This aligns with previous research showing that with the right tools, solid technological backup, and emphasis on interesting and playful activities, hybrid learning can deliver a motivating learning experience. In the future, we may see more adaption of students and educators to changing circumstances of classroom delivery, and consolidation of digital habits that support this kind of flexibility.

There are however limitations to this study: we only followed a single class, and the multiplicity of concurrent parameters (including ERT, hybrid learning and GBL) does not permit to determine precisely which practices supported the better learning outcomes in our students. While our research seems to confirm the benefits of hybrid learning, it is still a relatively new field, and more research is needed to understand the long-term impact of COVID-19 on education.

6. Conclusion

This paper presents data from two semesters of teaching with the same students, with ERT during lockdown and hybrid classes after reopening, while introducing a GBL approach. Students had better results during Semester 2, with better learning outcomes for students who were more physically present and active, and consistent in working regularly. Students were positive with being able to both return in class while being able to follow the lectures online when necessary and have easy access to the learning materials. This aligns with current research in the potential of hybrid learning, especially in conjunction with active learning activities and pedagogy.

More research will be needed to fully assess the potential of hybrid classes and the impact of COVID-19, but facing this crisis also allowed us a new insight in our teaching practices and our students experience, and a better understanding that will be useful to adjust to future crises should they arise.

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