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DAYBYDAY: A CONTINUOUS ENGAGEMENT FOR BETTER LEARNING IN A FIRST-YEAR MATHEMATICAL COURSE

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ABSTRACT

This study describes the DayByDay project that aims to support the students' understanding of a first-year mathematical course through a continuous engagement in large classes (250 students). Students are weekly suggested to do various activities throughout the semester, either alone or in a group.

Thanks to the DayByDay project, they receive support to structure their study to understand the lessons' content and self-evaluate their knowledge. The main activities proposed are individual multiple-choice tests and exercises to be solved and cross corrected in groups. Peer-to-peer support becomes even more critical in the pandemic condition in which distance learning changed traditional face-to-face interactions.

The experimentation has been randomly applied to 7 of the 20 parallel mathematical courses at Politecnico di Torino, Italy. Thanks to the randomized control group design, the project impact has been analyzed in terms of self-awareness of the student's preparation and the final grade.

The educational experience proposed to students improved technical competence and overall professional competence in problem-solving, collaborative work, time management and organization, creativity and critical thinking.

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1 INTRODUCTION

Arriving at the university, students perceive a big jump in the content and methodological approach compared to the high-school context [1]. This shift translates into a non-homogeneous class with some students who have difficulties remaining on track and decide not to face the exam right at the end of the course [2]. What can be done to support their technical competence and transversal skills with a reasonable effort for the lecturers?

2 CONTEXT

Politecnico di Torino (PoliTo) is an Italian technical university with Engineering and Architectural courses. Considering the engineering bachelor's degrees, the university enrols around 5000 students every year. During the first year, they are divided into 20 parallel classes of about 250 each. The subjects are not related to the degree chosen and cover all the basics science courses (Chemistry, Computer Science, Mathematical Analysis I, Linear Algebra and Geometry, Physics I and an elective one). The academic year (a.y.) is divided into two semesters of 14 weeks characterized, in the first year, by three subjects each. Although different lecturers teach them, all the parallel courses have a standard syllabus and the same assessment. Typically, the evaluation consists of an exam at the end of the course covering the entire program. Students can choose when to do the exam between four calls: two calls right after the classes end (called "first session"), one at the end of the other semester, and one in September. Students pass the exam if the score is higher than 18/30 and the maximum obtainable score is 30/30.

The role of the introductory science courses is not limited to a pure knowledge transfer but represent a preliminary approach to science. As a secondary goal, they have a reinforcement of many soft skills required by engineering studies. In particular, the Mathematical Analysis' course consists of 60 hours of lectures and 40 hours of exercise classes. Theoretical lessons are devoted to presenting the topics, with definitions, theorems, examples, properties and proofs, which are believed to facilitate the learning process and the students' metacognition. Every theoretical aspect is associated with introductory examples. The exercise hours aim to gain an adequate ability in computation.

Consistent with the literature, the shift between the high school teaching style and the university represents a first challenge for the students. Some of them find it hard to organize their time properly and to remain on track. The COVID-19 pandemic condition has even stressed these difficulties.

For all these reasons, the Mathematical Analysis' lecturers decided to apply a course revision through an ADDIE cycle [3]. The new strategy requires a revised assessment structure. Until a.y. 2019/20 consisted of a multiple-choice test with 20 questions followed by a written exam with two structured problems and a not mandatory oral exam. The test lasts one hour and takes place in a computer lab. Each correct answer is worth one point, and the wrong answers do not give any penalty. If the score is less than 12, then the exam is failed; otherwise, the student proceeds with the written exam.

The written part lasts 75 minutes, and the maximum achievable score is 13. If the score is less than 5, then the exam is failed; otherwise, the final score of the exam is obtained as the sum of the scores of the test and the written part, unless the teacher (or the student, provided that the final score is at least 18) requires an oral examination. The significant change in a.y. 2020/21 is the introduction of "ongoing activities". These require the active participation of the student during the semester. Each lecturer details the ongoing activities; they include, for example, answering self-assessment tests and solving exercises to be delivered according to methods and deadlines announced at the beginning of the course. The maximum score is 3. The test has been curtailed, and it consists of 15 multiple-choice quizzes in 45 minutes with a proctoring system (Respondus). Each question is worth one point, so that the maximum achievable score is 15. If the score is less than 8, the exam is failed; otherwise, the student proceeds with the written exam. The written exam still consists of 2 structured exercises, but the maximum achievable score is 15. If the score is less than 8, the exam is failed; otherwise, the final score of the exam is obtained as the sum of the scores of the ongoing activities, the test and the written part, unless an oral examination is required.

This study describes the ongoing activities methodology, called the "DayByDay project", adopted by a cluster of 7 of the 20 parallel mathematical courses. It aims to support the students' understanding of a first-year mathematical course through a continuous engagement in large classes (250 students).

3 METHODOLOGICAL APPROACH

Under the post-positivism quarry, this research evaluates the DayByDay project's methodology using a randomized control trial (RCT) design. The RCT suits this purpose perfectly as it allows us to study the impact of the intervention that is the newly adopted methodology on ongoing activities.

In a.y. 2019/20, a pilot qualitative study was run to support the development of the project. This study involved only one of the twenty parallel courses with about 60 over 250 students. Participation was voluntary, and students did not receive any additional points for the final exam. Those who joined received a detailed study program and the opportunity to take an online quiz weekly. If the quiz was not completed within a week, the student received an email reminder. At the end of the semester, we analyzed the data relating to the weekly quizzes and the exam outcome. We observed how the majority of the voluntary students got hooked by passing the exam in the winter session with this pilot.

Thanks to this experience, the structured DayByDay project has been designed as a possible way to include the "ongoing activities" inside the newly revised course in a.y. 2020/21. Seven out of twenty courses decided to adopt it. The other courses, chosen as a control group for this study, adopted more straightforward actions either alone or in smaller clusters. For example, some lecturers decided to have a couple of oral discussions with each student; others organized a monthly quiz while other lecturers had two sets of exercises to solve individually. The most remarkable difference

between the experimental and the control group is that, in the first one, the weekly activities required an ongoing study. On the contrary, in the second one, they were typically individual and monthly; therefore, the students' effort was more discontinuous.

Three tutors were available to support the extra load related to the ongoing activities organization and implementation. One of them was dedicated to the experimental group, the others to the control group.

The main activities proposed by the DayByDay project are:

1. individual activities: multiple-choice tests (T)
2. group activities: a set of exercises to be solved (E) and peer corrected (EC).

An activity is proposed weekly, repeating the pattern T, E, EC. Students can choose when to fulfil it inside the week starting from the fourth week. All the activities replicate the exam environment: the tests use the same structure and platform, while the exercises are structured like the written part.

The individual activities consist of carrying out four sets of 15 multiple-choice tests to be performed via the Moodle platform. Each test has only one attempt and lasts one hour. At the same time, groups activities consist of carrying out, in collaboration with teammates, three sets of 12 structured exercises and uploading the solution in Moodle. The following week, each team receives another group's solution on the platform and is asked to evaluate it, correct the mistakes, and upload the revised document on Moodle. Students receive a structured layout in which they need to fill the list of people that took part in E and EC and a grid for the exercises' solution. This latter one includes a space for the solution, the peer-to-peer score (zero, one or two points), a space for the peer-to-peer corrections, and the lecturer's grades. The lecturer can confirm or modify the peer-to-peer score associated with the exercise solution and gives one point to the correction if it was acceptable or zero if something was missing or incorrect. Therefore, each group activity receives a score up to 36 (24 for the solution and 12 for the correction).

At the beginning of the course, the teacher organized homogeneous groups of about ten people based on the admission test. That is, we tried to maintain the same average of the entrance test between groups with similar score variance within each group. Each team autonomously choose a spokesman that is responsible for the files upload. In addition, s/he must communicate to the lecturer when they plan to meet for the E and EC activities. Students could decide where to meet, but all meetings were held online due to the pandemic condition. The lecturer could join these meetings to check who participated in these activities and how the load is distributed inside the team. The lecturer played an auditor role and did not intervene in any way in the discussion.

Considering that the total weight of the ongoing activities is a maximum of 3 points of the final exam, the individual activity will count one point. The group activities will count two points as follows.

Individual activities:

- 1 point = four tests performed with score >= 8/15, of which at least two tests with score >= 12/15
- 0.5 points = at least three tests performed with score >= 8/15

Group activities:

- 2 points = three sets of exercises delivered with score > = 20/24, at least two with an overall score, following the correction phase, > = 32/36
- 1.5 points = three sets of exercises delivered with score > = 20/24, at least one with an overall score, following the correction phase,> = 32/36
- 1 point = at least two sets of exercises delivered with score > = 20/24
- 0.5 points = at least one set of exercises delivered with score> = 20/24

To evaluate this DaybyDay project, this study considers two directions: (i) horizontally, comparing the students' results of the intervention group against the control group in a.y. 2020/21; (ii) vertically, comparing the results of both groups between a.y. 2019/20 and 2020/21. The sample includes only students enrolled for the first time.

The study considers the number of students taking the exam during the first session and the score obtained at the test part. The ongoing activities and written part's results have a subjective bias due to the lecturer's correction style. For this reason, they are not used.

4 RESULTS AND DISCUSSION

The first element to consider evaluating the impact of the DaybyDay project is the number of students that decide to take the exam in January. Applying to the first call available at the end of the course implies that one could follow the course and remain on track with the study. There was no difference between the course taught by the lecturer of the experimental and the control group in the past. In a.y. 2020/21, the experimental group has a +2,34% of students who sit at the test compared to the control group (Table 1). However, for both groups, the overall number of examinees is decreased. This change can be linked to the pandemic condition and the related shift to online courses. Looking at the number of students that pass the test part, in a.y. 2019/20, the two groups are comparable. While in a.y. 2020/21, the experimental group has a +5,74% of passed students compared to the control group. Considering the score distribution (Figure 1(b)), the experimental group has a higher average (9,51/15 points vs 9,05/15 points) with a lower standard deviation (3,37 vs 3,53). Also in this case, as shown in Figure 1(a), in a.y. 2019/20, there was no significant difference between the scoring average (12,12/20 vs 12,22/20) and standard deviation (4,02 vs 4,03).

Table 1 Test results related to January call

	January call 2020		January call 2021	
	Experimental group	Control group	Experimental group	Control group
Test passed	730 (47,04%)	1560 (48,84%)	839 (56,38%)	1587 (50,64%)
Test not passed	548 (35,31%)	1121 (35,10%)	313 (21,04%)	766 (24,44%)
No showed up	274 (17,65%)	513 (16,06%)	336 (22,58%)	781 (24,92%)
Total	1552	3194	1488	3134

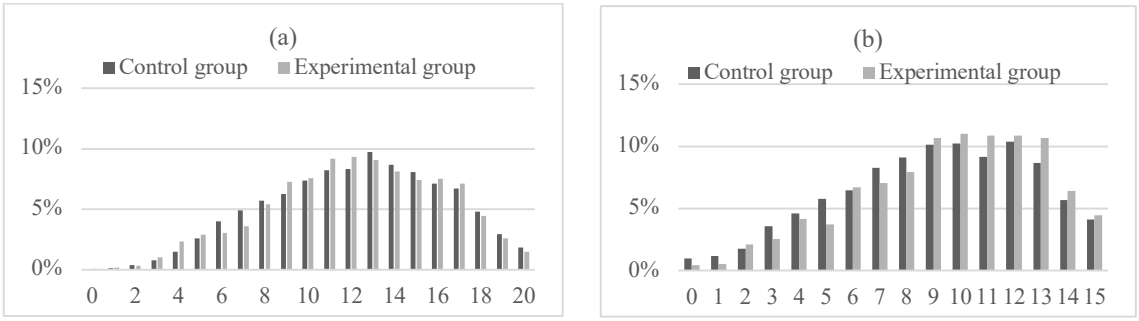


Figure 1 Test score distribution in (a) January call 2020 and (b) January call 2021

Considering the entire first session (Table 2), the number of students that did not show up is comparable between the groups. Moreover, the experimental group has a better rate of success in the overall exam.

Table 2 Exam results related to the first session

	First session 2020		First session 2021	
	Experimental group	Control group	Experimental group	Control group
Exam passed	851 (54,84%)	1662 (52,03%)	823 (55,31%)	1441 (45,98%)
Exam not passed	486 (31,31%)	1135 (35,54%)	431 (28,96%)	1168 (37,27%)
No showed up	215 (13,85%)	397 (12,43%)	234 (15,73%)	525 (16,75%)
Total	1552	3194	1488	3134

This analysis highlights that the DayByDay project satisfies its initial objective of supporting the daily student's organization to improve mathematical analysis. Students who took part in the project were prepared immediately at the end of the course with a better understanding of the subject. Despite the pandemic condition, the experimental group maintain a success rate in line with the previous year, while the control group significantly worsen.

5 CONCLUSION

Thanks to the DayByDay project, students receive support to structure their study to understand the lessons' content and self-evaluate their knowledge.

It is essential to underline that some limitations may have undermined some partial results analyzed in this paper. Firstly, the COVID impact; not only on teaching and learning but also on the students' daily life. Our habits changed a lot due to the pandemic situation, which also impacted the learning performance. Another aspect is the difference in the structure of the assessment between the two academic years under study. All the significant findings come from comparing the control and experimental group in the a.y. 2020/2021 to reduce this bias. Moreover, only objective evaluations such as test results have been considered to avoid the possible bias introduced by the writing exam assessed by different professors.

The individual activities help to keep the preparation in line with the lesson contents. Whilst, the group activities become crucial for peer-to-peer support, a critical element in the pandemic condition in which distance learning changed traditional face-to-face interactions. The educational experience proposed enhances students' learning to

acquire technical competence and various team-based skills such as communication skills, presentation, time management, and problem-solving [4,5,6]. This secondary learning knowledge and skills gained by the regular ongoing process and team activities will be further analyzed in the next academic year.

REFERENCES

[1] Costabile, A., Cornoldi, C., De Beni, R., Manfredi, P. (2013), Metacognitive Components of Student's Difficulties in the First Year of University, *International Journal of Higher Education*, Vol. 2, No. 4, pp. 165-171. http://dx.doi.org/10.5430/ijhe.v2n4p165

[2] Ellen P.W.A. Jansen & Cor J.M. Suhre (2010) The effect of secondary school study skills preparation on first-year university achievement, *Educational Studies*, 36:5, 569-580.

[3] Branch, R. M. (2009). Instructional design: The A.D.D.I.E. approach. Springer Science & Business Media. https://doi.org/10.1007/978-0-387-09506-6

[4] Chan, C., Pearson, C., & Entrekin, L. (2003). Examing the effect of internal and external team learning on team performance. Team Performance Management: an international journal, 9(7/8), 174-181.

[5] Julie Yazici, H. (2005). A study of collaborative learning style and team learning performance. Education + Training, 47(3), 216-229.

[6] Quitadamo, I., Brahler, C., & Crouch, G. (2009). Peer-Led Team Learning: A Prospective Method for Increasing Critical Thinking in Undergraduate Science Courses. Science Educator, 18(1), 29-39.