About the process to enhance the students' engagement: a practical experience

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***Abstract*—The interaction between professors and students in higher education represents one of the most stimulating challenges we are currently facing in our universities. Facing it implies the implementation of novel strategies, that may or may not involve new technologies. This paper aims to present a case study focused on an undergraduate course of fundamentals of power system within a Management Engineering bachelor program. The author, after being trained within the Mentoring Polito Project (M2P), introduced few adjustments in the teaching approach, by focusing on the professor/student relationship rather than introducing new technologies. The opinions of the students about the two innovations have been collected through a survey created *ad hoc*: the results are encouraging. In fact, these innovations have been welcomed by the students, proving that their implementation may help creating a more comfortable learning environment.**

***Index Terms*—student enagement, higher education, power systems, management engineering, intersubjectity, practical experience**

I. Introduction

The relationship between the students and professors is a fascinating topic, because of the potential implications that a good teaching approach may have on both sides. The impact of the teaching approaches has been investigated since long time, and the modern science permitted to highlight a number of consequences on the students [1]:

- the nonverbal behavior of the professors, namely their *immediacy*, beyond potentially reducing the distance with the students, was demonstrated to have consequences on the affect of the students on both the course instructor and the course itself [2];
- the absenteeism in higher education courses is somehow correlated to the type of student/professor relationship that has been established in the class [3], especially after the pandemic period that led to have a larger and larger number of freely recorded lectures offered by different universities;
- the type of "approach to learning", which differ by the "approach to study" [4]. In fact, the expression "approaches to learning" indicates the ways used by the student to *comply with the learning task*. Here, it is quite important the *intention* of the students, i.e., really understanding the topic or trying to take some information for being successful to the examination. When instead the *strategies* (i.e., the effort and the level of organization of the students in their learning process) are included, then we talk of "approaches to study" [5].

The last point of the above list raises an important aspects: the approaches used by the students to deal with a university course results strongly correlated with the established student/professor relationship [6]. According to the literature, two main basic approaches to learning have been recognized [5]: *surface learning* and the *deep learning*. When following the first one, the students are basically motivated by the *fear to fail*, and focus more on memorising the material rather than understanding the subjects themselves. In the latter case,

the students approach the learning process with an *intrinsic interest*; so they aim to find connection with the course material previous studies and real-world experiences [7].

Regarding the approaches to study, the literature indicated the existence of two different ways to handling with it: the *strategic approach* (aiming at reaching a high-level achievement) and the *instrumental approach* (aiming to cope with the examination barrier). When the students apply both a deep learning approach and a strategic study method, they aims to really understand the course content, by proving it through a high grade. As consequence, a high grade could be also reached trough a surface learning approach. This last possibility is, in my opinion, also strictly correlated to the (short) time the student can devote to understand the topic and assimilate it (often due to constraints imposed *only* to optimize the university organization), with consequent lower and lower possibility of appreciating and memorising the information presented during the lectures. This last point will be somehow debated in Section II, where I will briefly introduce the Italian system, as well as the Bachelor of Management Engineering and the course of fundamentals of power systems I am currently teaching. After that, Section III will present the introduction of the mentoring program at Politecnico di Torino, how being involved into this led me to introduce some innovations in the course, as well as the two innovations themselves. Then, Section IV will show the evaluation provided by the students on the course in general and on the two innovations. Finally, the concluding remarks will be shown in the last section.

II. Background

A. The university system in Italy

The university system was deeply modified through the university reform, based on the Ministerial Decree 509/1999 [8] and successively modified by the Ministerial Decree 270/2004 [9]. With reference to the engineering studies, the duration of the study was, before 1999, 5-year long. The reform changed this system by introducing the Bachelor degree (3-year long) and the Master degree (2-year long). This reform was the results of the so called "Bologna process", that aimed to create a more homogeneous system at European level [10].

TABLE I
Student Workload: SEI Course vs Entire Semester Commitment

	SEI	**Entire semester**
Credits	8	30
Hours on-site activity	80	300
Hours individual activity	120	450
Total student workload	200	750

The students, for pursuing the Bachelor degree, must acquiring 180 credits in three years; the Master degree, instead, requires 120 credits in two years. This means an average commitment of the students of 30 credits per semester. Since 2009, all the universities belonging to the European Higher Education Area measure their programs through credits according to the European Credit Transfer System (ECTS) [11]. Each credit correspond to 25 hours of student workload: 10 hours of on-site activity and 15 hours of individual activities. For matter of comparison, at Eidgenössische Technische Hochschule Zürich (ETH) the average workload for the student is 30 hours per ECTS; the hours of on-site activities may reached also the value of 17.5 hours/ECTS (as proven by [12], a course of 4 ECTS with 5 hours per week of lecture for a 14-week semester). This last point represent, in my opinion, a good example of flexibility that may be followed and copied by the Italian university system.

B. Fundamentals of Power Systems within the Management Engineering at Politecnico di Torino

The Management Engineering at Politecnico di Torino was officially founded in 1994 [13]. At the Bachelor level, the students have the possibility to choose, during the second semester of the second year, a 8-credit course presenting the basic of power systems for industry applications entitled "Sistemi Elettrici Industriali" (in short SEI, translated in English as "Industrial Electrical Systems"), encompasses the basics of circuit theory, electrical lines, transformer, electricity production, electrical safety and electricity market [14].

The course is given in Italian and is taught in parallel to other three courses, for a total of 30 credits in that semester. The semester is composed of 14 weeks and, for a matter of clarity, the total workload required to the students is presented in Table I. Due to the unbalanced share between on-site and individual student workload, the student must invest more time for individual study. The relatively low number of hours

TABLE II
OVERVIEW OF THE STUDENTS' WORKLOAD

#weeks	#days	hours of workload per day				
		6	7	8	9	10
15	5	450	525	600	675	750
	6	540	630	720	810	900
16	5	480	560	640	720	800
	6	576	672	768	864	960

per credit for on-site activity introduces some constraints, both in terms of topics (some of them have been canceled by the course syllabus during the years, others have been strongly restructured and simplified) and in terms of potential teaching innovations (they require time for being effectively implemented, as well as non-negligible modifications at the course structure).

For understanding the (theoretical) workload of every student, Table II highlights that considering 5 days per week (i.e., the entire week end free), the students must dedicate at least 10 hours per day at university activities, if the period of time devoted to the courses is 15 weeks (14 weeks of semester plus 1 week); if the time period is 16 weeks, instead, something lying between 8 and 9 hours per day for 5 days per week is enough. Considering also the Saturday (i.e., 6 days per week), the student must devote to university activities more than 8 hours per day in case of 15-week period, and almost 8 hours per day with a 16-week period.

This small exercise aims to clarify (both at students and professors) how much is the effort required for handling with the courses attended in a semester. Regarding the SEI course, this course requires an effort that is more than 1/4 of the time students devote to university activities (i.e., about 26%). This information will be given to the next year students, and then its adherence to the student experience will be verified *ex-post*.

III. MENTORING AT POLITECNICO DI TORINO

A. The project "M2P"

The activity of mentoring between peers was introduced at Politecnico di Torino in 2021 and named as Mentoring Polito Project (M2P). Currently, after three years, the community of mentors counts about 60 components. The mentors may support the colleagues asking their intervention (called *mentee*) to recognize the area where some modifications in the teaching approach may be useful, as well as suggesting innovative methodologies to be applied in the class. However, above all, the community of mentors aims to offer an environment where it is possible to discuss about the teaching methods in engineering and architecture study courses. The M2P programme is organized, together with other activities devoted to the professional development of teaching skills, by the Teaching and Language Lab (TLlab) [15].

B. My experience as mentee

I had the opportunity to participate at the first edition of M2P, developed in the a.y. 2021/2022. After an initial training (about 20h), we were divided in small groups composed of few collegues (generally four). Each member of the group was both mentee and mentor: in this way, in this "beta" version of the mentoring activity every member can live both roles. The mentorship activities was organized as follows:

- first meeting: the mentee explaines which course he/she was teaching and which were, in his/her opinion, the areas where he/she taught would improve;
- the mentors participated at two lecture sessions, to see how the mentee faced the teaching activity;
- during the second session, the students were interviewed by the mentors (without the presence of the mentee in the lecture room). This session aimed to collect the feedbacks by the students, as well as to present at the students their observations;
- after those two sessions, the mentors had a meeting to synthesise their observations and the students' feedback;
- finally, a second in-person mentee/mentors meeting was done. In that occasion, the mentee, thanks to the information provided, could delineate some actions to be implemented in the following academic year.

The role of mentee was particularly important for me, due to the fact that academic year was the first in which I taught the SEI course; hence, every suggestion for improving the quality of the teaching was more than welcome.

My mentors put in evidence some positive aspects:

- overall, the students appreciated the willingness to clarify their doubts and answer to their questions;
- the students appreciated the way I handle with their questions sent by email (i.e., I used to upload my answer into the material folder, so that all the students can take advantage from them);

However, some negative aspects were also risen:

- the students found *non-sufficient* their knowledge to face the course content;
- the students were disappointed by the update of the slides after the lectures (modifications made to correct some mistakes existing into the text).

By the way, for matter of completeness, I must say that the same pros and cons were also reported in the opinions that the students gave at the end of the course as free comments (as part of the form provided by Politecnico di Torino to all the students and for all the courses).

C. Which innovations can be introduced?

Once I read the feedbacks, I thought that was necessary a *support* during the lectures: after some discussions with the mentors, the entire group agrees that the students felt them *alone* when facing the SEI course. This was (maybe) due to the fact that the course was not part of the set of *major* courses; moreover, it required the resolution of several exercises, mostly developed at home. Say differently, I felt a *lack of community*, and all the mentors agreed about it.

On this basis, due to the time constraints, I thought was possible only to introduce innovations at (almost) zero impact on the lecture schedule.

In particular, I proposed two potential improvements for the SEI course:

- *innovation #1*: the support given by a former student during the lecture hours (for both theoretical part and practical exercises);
- *innovation #2*: the introduction of the so-called "5-minute of thinking"

The first innovation (i.e., the support given by a former student) was thought to:

- provide (hopefully positive) feedbacks to the current students about the course and the teacher: sometimes, it is sufficient to have reassurances about the teaching approach, for empowering the reciprocal trusting between professors and students. Who better that a former students (that passed the exam with a relatively high mark) can make it?
- give an additional source of information, partially enabling the *peer learning* [16]. In particular, within the course was implemented a particular type of peer learning, called *peer tutoring*, where the senior student has the role of tutor, while the juniors are the tutees [17].
- create an *indirect* communication channel between the professor and the students. In fact, the support student may got some rumors/suggestions/complaints and report them to give a feedback to the professor (who may introduce the proper corrective actions).

The second innovation (namely, the "5-minute of thinking") aimed to:

- create a *collaborative environment*, in which the students may compare their thoughts and doubts about the lectures, by creating a *shared understanding of the learning activity*. In literature, this is known as *intersubjectivity* [18];
- create a (further) direct communication channel between the professor and the students. In fact, during the "5-minute of thinking" (that sometimes was even longer...) I was walking in the lecture room, by encouraging the students to interact, as well as trying to directly interact with them asking question so that I could understand their doubts (especially with students that were particularly shy, who usually did not intervene during the lecture).

IV. Feedback from the students

The aim of this section is twofold:

- presenting the evaluations given by the students at the end of the course (Section IV-A) ;
- showing the results of a dedicated survey in Section IV-B, to highlight how much the student appreciated (or not appreciated) the two innovations.

In both cases, the evaluation is provided with a scale composed of integers lying in the range 1 to 4, with the following meaning:

- #1: absolutely no;
- #2: more no than yes;
- #3: more yes than no;
- #4: absolutely yes

A. Some indications from the final survey about the course

The survey filled by the students at the end of the course presents some opinions referring to the workload of the semester (whose theoretical values are shown in Table II). The

TABLE III
STUDENTS' OPINION ABOUT THE TOTAL WORKLOAD

Academic year	Is the workload of the semester acceptable
2021/2022	2.60
2022/2023	2.77
2023/2024	3.00

students' opinion is shown, for the last three academic years, in Table III.

As shown in Table III, during the years the students found the total workload more acceptable. This is due to some changes happening in the years in the Bachelor organization. In fact, since the academic year (a.y.) 2022/2023, the SEI course was not mandatory anymore (so, only the most engaged students chose it). Moreover, since the a.y. 2023/2024 the opinion about the acceptability of the semester workload was obtained by considering all the students of Management Engineering (i.e., also the students attending other alternative courses). In any case, the enhancement in this indicator leads to think that the variations introduced so far in the study programme resulted suitable to make the total workload more acceptable by the students.

Then, the students gave their opinion about:

1) the SEI course in terms of organization and material provided;
2) the effectiveness of the teaching approach;
3) their interest with respect to the topics of the course.

The values shown in Table IV highlight an improvement in all the indicators. For the a.y. 2023/2024, Politecnico di Torino provides a comparison between the courses offered within the same Bachelor. The SEI course got a total score of 89.22% of satisfaction, as shown by the red dot in Figure 1.

Moreover, Table IV shows that the largest improvement

TABLE IV
STUDENTS' OPINION ABOUT THE SEI COURSE

Academic year	Are you satisfy of the SEI course?	Do you think that the professor is effective?	Are you interested to the topics of the course?
2021/2022	2.69	2.89	2.58
2022/2023	3.19	3.40	2.90
2023/2024	3.20	3.57	3.02

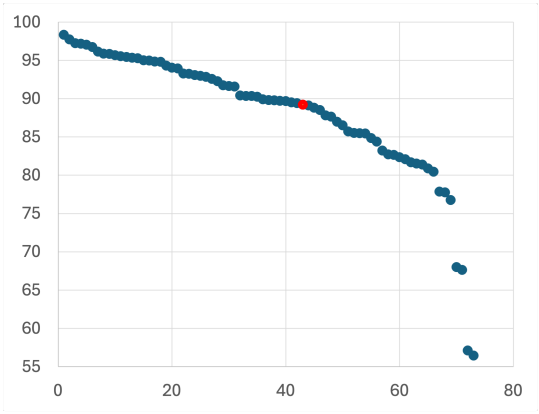

Fig. 1. Ranking of the Courses in Management Engineering (in red the position of the SEI course)

happened in the a.y. 2022/2023: most of the merit, in my understanding, was due to the *study material* (composed essentially of slides), that in that a.y. was fully ready. However, according to the free comments of the students in the course final survey, the introduction of the two innovations were appreciated.

For having a clear idea about the students' opinion about the introduced innovations, I created a survey, as explained in Section IV-B.

B. About the survey to the student

Thanks to the communication system of the university, I was able to send a message to all the students attending the SEI course in the last two academic years, i.e., 2022/2023 and 2023/2024. I sent an email to the student by asking their collaboration in providing their judgement about the *effectiveness* and *usefulness* of the two introduced innovations. The two terms were clearly defined in the email:

- *effectiveness*: one innovation is effective if its implementation enables reaching the predefined goals;
- *usefulness*: one innovation is useful if its implementation provide some advantages/benefits to the student.

I also specified that for the innovation#1, the usefulness should be evaluated by considering the instilled calmness and wellness given by the awareness that, if needed, the students may found a "friendly" support.

The number of students who responded to my invitation was 20 for the a.y. 2022/2023 (a small percentage of the total attendee, i.e., about 200) and 40 for the a.y. 2023/2024 (more than half of attendee, i.e., about 75). Unfortunately, the

TABLE V
WAS THE INNOVATION #1 EFFECTIVE?

Evaluation	a.y. 2022/2023	a.y. 2023/2024
# answer	20	40
1	0	0
2	4	1
3	10	15
4	6	24
average	3.10	3.58

TABLE VI
WAS THE INNOVATION #2 EFFECTIVE?

Evaluation	a.y. 2022/2023	a.y. 2023/2024
# answer	20	40
1	0	0
2	4	4
3	12	16
4	4	20
average	3.00	3.40

engagement of the students in activities not directly correlated with the examination resulted more difficult than how much expected.

The results about the effectiveness are shown in Table V and Table VI for innovation #1 and innovation #2, respectively.

The results show that no students consider the two innovation totally uneffective. In general, the students attending the a.y. 2023/2024 found the two innovation more effective than the students attending in 2022/2023. In any case, the results are extremely positive, and the improvement obtained in only one year is really encouraging.

TABLE VII
WAS THE INNOVATION #1 USEFUL?

Evaluation	a.y. 2022/2023	a.y. 2023/2024
# answer	20	40
1	0	0
2	4	1
3	9	15
4	7	24
average	3.15	3.58

TABLE VIII
WAS THE INNOVATION #2 USEFUL?

Evaluation	a.y. 2022/2023	a.y. 2023/2024
# answer	20	40
1	0	0
2	5	3
3	7	14
4	8	23
average	3.15	3.50

The students' opinion about the usefulness of the two innovations are instead shown in Table VII and Table VIII. Also in this case, there is a non-negligible difference between the average opinion about the two innovations between the two academic years: the students attending during the a.y. 2023/2024 gave more positive judgements about the usefulness of both the innovations. Even considering this, the results reached are, also in this case, really encouraging.

C. Final comments

The differences between the two academic years, highlighted in Section IV-B, may be due to a number of reasons:

- from my side, I think I exploited in more effective way these two innovations during the a.y. 2023/2024. In fact, I had already in mind some dynamics in the people interaction (thanks to experience got from the first-time implementation of the two innovations in the a.y. 2022/2023), and I tried to remove some barriers that could appear (in all the interactions: student-professor, students-students, juniors-senior).
- the opinions of the students attending the SEI course in the a.y. 2022/2023 were collected one year after the end of the course. This could have introduced bias/false memory/different feeling regarding these two innovations. Moreover, the number of students answering to the survey was really small with respect to the total number of attendee in the a.y. 2022/2023.

V. CONCLUDING REMARKS

This paper presents my experience with the introduction of some innovative elements into the course "Sistemi Elettrici Industriali". This journey started basically thanks to the Mentoring Polito Project, which recalled the concepts about the innovative teaching methods studied in one training module I attended in 2017 (i.e., "Teaching in Higher Education") and made possible to perform both the mentee and the mentor role.

The rigidity of the university system, always between a rock (i.e., the necessity and wishing to innovate the teaching approaches) and a hard place (i.e., the rigidity in terms of time and programmes) led me to introduced two relatively easy-to-implement teaching innovations, by avoiding more

sophisticated and time-consuming methods (e.g., team-based learning [19]).

Both the innovations have as aim to create an environment that fosters the deep learning and the strategic study method. This is extremely important when the taught course is not part of the majors of the attendees (as it is in the analysed case).

The students' opinion are in general positive and this encourages to continue use these methods in the teaching activities. The methods are easily implementable also in other courses, maybe with slight modifications.

In the future, for further enhancing the teaching activities, I would like to introduced a further innovation. In particular, I would like to update some *ad hoc* recordings I did in the a.y. 2021/2022, to facilitate the student learning: these recordings were much more shorter than a usual lecture, e.g., 30 minutes to cover topics that required 1.5 h of lecture. Furthermore, I would like to introduce also some *ad hoc* registrations of the exercises. The recordings of both the theoretical parts and the exercise will enable the implementation of the *flipped classroom* [20] approach.

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