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Paper 4: Inclusion: a new reverse perspective

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ABSTRACT

Reverse inclusion has been recently proposed as a powerful tool to pursue many relevant goals at the same time, precisely to assure deserving students higher educational standards and stimuli, to strengthen the initiatives for supporting and including protégé students, to assess new pedagogical methods and teaching contents for the benefit of the whole students' community.

This paper is aimed at presenting and discussing an on-going project carried out at an Italian technical University, the Politecnico of Torino, suffering from a high student to teacher ratio. This problem is mostly imputable to the increasing enrolment of freshmen coming from many different regions and countries, who show varied cultural background and abilities. In the present project, therefore, the concept of reverse inclusion was adopted as the cornerstone of the activities conceived and performed, in order to assure the larger number of students as possible a tailored range of flanking measures. The preliminary results of this experience may represent an empirical demonstrator of the effectiveness of reverse inclusion in the field of Engineering education, as well as a sound tool for mapping the impact and the overall benefits of such approach.

The project has been developed starting from the academic year 2014/15, and it was firstly aimed for talented students, that is to enrich the curricula of the top 4% freshmen, on the about 4500 enrolled each year, with hybrid activities. This was quite easy to do, since all the Engineering Bachelor's degree programmes of our University share a first-year path equal for all the different majors, and the curriculum differentiation progressively occurs during the second year.

However, keeping in mind the objective to develop the project in a real reverse inclusion perspective, the selected deserving students are asked to follow the standard lessons together with all the other students, whereas they were grouped in homogeneous classes only for specific supplementary lectures and laboratories, with the aim of deepening their scientific background, fostering critical thinking, and stimulating interdisciplinary approaches.

Besides the benefits for the deserving students deriving by these talent-oriented activities, two other relevant results were achieved. The inclusion of the motivated talented students for the majority of the regular lectures and inside the standard classes ensured a driving force for the protégé students, who were involved in mixed groups for discussing and studying. This spontaneous inclusion assures them a support in improving their performances, as traceable throughout the analysis of their career. In addition, as the group of talented students alone constitutes a separate class only for additional teaching activities, innovative educational contents and pedagogical methods, as well as reviewed courses were proposed them inside the project. This was used to set up and optimize these experiences before extending them to the whole students' audience.

Preliminary positive achievements are here discussed, based on one complete cohort of students, the first ones include in the project, and partially on the second one.

INTRODUCTION

During the recent past, a growth on the student to teacher ratio has been registered at the Italian Technical Universities, generating a prolongation of the mean graduation time. For example, at the Politecnico di Torino this ratio is 40:1. (Ballatore, et al., 2018). To face this problem the University is strengthening a policy of inclusion towards protégé students in order to guarantee all students to reach an adequate level of knowledge and complete their studies in the due time.

Starting from an analysis of the concept of teaching inclusion in the university, one can see how its recent reversal, which means inclusion and support to the most capable and deserving students for a renewal of teaching methods and contents leads notably advantages to the entire university community and in particular to 'weak' students.

The present paper is aimed to describe the new concept of reverse inclusion and provides some application examples and results. This will be achieved by looking at the impact that the project 'Research among Quality - Young Talent track' ("La Ricerca della Qualità - Percorso per i Giovani Talenti" in Italian; https://didattica.polito.it/Percorso_per_i_giovani_talenti_en.html) has on the overall community. The project is open to both Engineering and Architecture students, but the

reverse inclusion approach was tested only in the case of the Engineering programmes, for many reasons (the number of students involved, the need of experimenting new pedagogical methods for fostering experiential learning, interdisciplinary topics, renewing of course contents, etc.).

In the following section, the research context is described in order to introduce the research question in the next section. The other sections show the results of this first experience and the consequent discussion with a view to a possible implementation of the tool.

BACKGROUND/CONTEXT

The term 'inclusion', in educational, refers to the idea that everyone should be able to use the same facilities, take part in the same activities, and enjoy the same experiences, including people who have a disability or other disadvantage. More in detail, for the US National Centre on Educational Restructuring and Inclusion, it is the provision of services to students with disabilities, including those with severe impairments, in the neighbourhood school in age-appropriate general education classes, with the necessary support services and supplementary aids (for the child and the teacher) both to ensure the child's academic, behavioural and social success and to prepare the child to participate as a full and contributing member of society (Frederickson & Cline, 2006; Jamison, et al., 2014).

In literature, recent experimentations of the transformation from the traditional teaching to a student-centred one in higher education are reported (Catalano & Catalano, 2013; Ross & Judson, 2018; Leshner, 2018). In particular, the group learning is been implemented in technical courses, such as the electrical field, with a significative result in terms of the generation of long-term knowledge (Marth & Bogner, 2017; Chance, et al., 2013).

In the Italian panorama, there are numerous and differentiated attempts of inclusion and support in favor of the students with greater difficulty. However, it is not usual to stimulate the personal skills of each student in a differentiated and targeted manner by creating varied parallel paths with different levels of study on the same topic. Historically, the course of study is structured with a unique curriculum depending on the chosen major of interest.

Recently, in Engineering Education (EE), a huge effort is been invested on the protégé students' inclusion. Therefore, due to the limited resources, the attention on the deserving students is been mostly neglected. This choice, however, had negatively affected the overall quality because the Talented Students (TS) lose their stimulus. The direct negative feedback was a prolongation of the graduation time. Thanks to an experimentation called "Research among Quality - Young Talent track", started in a.y. 2014/15 at Politecnico of Torino (PoliTo), the empirical definition of a reverse inclusive process is been attempted and its positive overall impacts have been recorded (Ballatore, et al., s.d.).

The PoliTo, with 4500 freshmen every year, is organized with a first-year path equal for all the different majors. The curriculum differentiation starts in the second year. During the first year, students study Mathematical Analysis I, Chemistry, Physics I, Linear Algebra and Geometry, and Computer Science and are divided into 20 parallel classes (two of them taught in English).

AIMS, RESEARCH QUESTIONS, AND METHODOLOGY

The aim of this research is to discover which are the advantages of a reverse inclusive process inside a Technical University. To do this, the following questions were considered as guidelines of the educational research activities performed:

- Which is the empirical definition of reverse inclusion in EE?
- Which are the overall impacts and benefits of this process?

In order to address this questions, the TS's program was used as a reference. In fact, this partially funded project has given the possibility to enrich the Bachelor's degree curricula of the top 4% of freshmen with Hybrid Activities (HA) (Jamison, et al., 2014) and courses reinforcements. Considering the overall 4500 engineering freshmen, the students selected for this project are around 200. The selection is firstly based on the enrollment test; then, the students' performances are checked at the end of each semester in term of number of ECTS and average exams score. As a consequence, an incoming and outcoming flux of participants to the project is in place until the first semester of the second year.

By looking at the gender (male to female) ratio, although at the PoliTo it is about 3:1, inside the project it is higher, since the male students are around 85% of the participants. The reason why the females are present in a more limited amount on the top fraction of students is currently under investigation.

Having in mind the pedagogical benefits of inhomogeneous class and our research objectives, the TS are following the standard lessons with all the other students. At PoliTo thanks to the first common year for all the majors, students are grouped in classes of about 250 students based on an alphabetic order. The project structure and methodology are been built with a high degree of inclusion between the different groups of students, in particular either between TS and all the other students, that inside the program itself.

The TS's supplementary activities can be distinguished between those devoted to the implementation of the standard curricula and the hybrid activities. The first ones includes the offer, to small groups of about 60 students, of additional scientific and technical contents: two curricular courses of Mathematical Analysis I, and Chemistry during the first semester, and the complete in-depth teaching of Mathematical Analysis II, at the first

semester of the second year, and of Physics II, during the first semester of the second year, that are taught to the TS homogeneous class. The aim of this competence reinforcement is to provide a more organic, practical approach to the laboratory sections and an 'in-depth' view of the topics covered, above all by stimulating a more autonomous study and enhancing willingness to an interdisciplinary approach. The hybrid activities instead have the aim of training TS in non-technical areas, such as soft-skills, critical thinking, humanities, and creativity. These activities have been gradually increased during the academic years. The students were involved in few daily or weekend sessions during the first year. The activities lasted several weeks during the second year, and finally they covered a full semester in the third one.

This study is based on one complete cohort of students, the first one included in the project, and partially the second one, since for this cohort of students the graduation period is not still ended. The authors ensure that all relevancies are confirmed by the following cohort and then this simplification is reasonable.

FINDINGS

The presence of motivated and reactive TS inside the regular classes naturally ensures a strong peer to peer learning. Indirectly, the protégé students receive a nudge that helps them keep up the lessons time. Spontaneously TS and protégé study together in groups. This allows students to share views, review the notes and solve problems together. It also makes the workload lighter and helps them stay on track with their study commitments.

This is been registered with a reduction in the graduation time with a higher score degree average, despite the already mentioned increase of freshmen (Table 1). This reduction is clearly stated by the comparison with the values presented by the cohort of students matriculated before the beginning of the project (a.y. 2013/14). A net positive trend is also observable comparing the first and second cohorts involved in the project.

An observation of the phenomenon is been performed in order to better understand what was occurring. It is firstly necessary to remember that no changes were been made on the traditional support for protégé students, namely (i) the available online materials and courses on background knowledge in order to help students recover lacks before the first year beginning, (ii) the video recorded lessons and tutoring during the first year and the first semester of the second year, and (iii) the supplementary course for those who failed exams during the first semester of the first year.

Table 1 - Number of students graduated in 3 years with the related average degree score, the percentage of drop-out during the first year and the % of students that fail the first-year minimum requirements (*not including the whole graduation period). The green backdrop characterises the two cohorts considered in this study.)

a.y.	Matriculated	Graduated in 3 years	Average degree score (3 years)	Drop out during the first year	Minimum requirements not satisfied during the first year
2013/14	4168	893	100,9/110	13,9%	23,8%
2014/15	4432	980	101,2/110	11,2%	21,0%
2015/16	4518	1136*	/	10,9%	16,3%

Having a group of stimulated students across all different engineering courses gives also the possibility of a direct feedback on the curricula. Then, in case a review of contents or of course organization is needed the TS can be actively involved in testing the new design. This can be done because the size of this group is perfectly reflecting a standard PoliTo class (around 200 students). Thanks to their feedback and reactions, collected in a yearly survey, the new or renewed course could then be proposed, after optimisation, to all the students starting from the following academic year.

Some concrete examples of this “managerial” application are first-year workload, the content review of the Geometry course, and the benefits expansion.

CRITICAL DISCUSSION

Speaking about ‘reverse inclusion’ can seem a paradox, however, the empirical definition can be stated as the process that, by stimulating the TS, indirectly includes and supports the protégé students. This has a double advantage because both protégé and talented students receive special training that ensures increasing overall quality.

As already said, the project for TS foresees the common attendance with all the other students of most of the subjects. This creates a proactive environment during standard lessons: deserved students break the ice, asking questions, exchanging views and generally this taking part involves the students with more difficulties that are free to be proactive in

turn. In this way the entire class of 250/300 students is participating and expressing doubts, recognizing that being in class can also be an active exercise and a chance to study.

This peer-to-peer interaction, in particular, affects the quality of each student's study that is summarized by the reduction of drop-out, of fail in the achievement of the first-year minimum requirements (28 ETCS) and of the graduation time.

In Table 1 the growth of the number of matriculated students is clearly mapped. Usually, this increase has a negative impact on the overall quality of the enrolled students. This is due to the fact that the additional students generally are coming from the protégé area. Thanks to the reverse process the drop-out during the first-year decreases of 3%. Reaching almost a 10% of deflection is a very good achievement if the overall number of students is considered. Similarly, the number of students failing the first-year minimum requirements of 28 ECTS over the 60 achievable is visibly reduced. This means that more students are able to access to the second-year courses in time, and consequently to have the possibility to graduate in time. In fact, this effect is reflected also on the number of students which graduated in time (3 years) and on the increase of the average score, too. Therefore, these results clearly state that this program helped and stimulated the overall students community and not only the TS involved.

Considering now the managerial advantage of having a small group of talented students, some concrete examples of how reverse inclusion have positively affected the curricula review and the students' benefit are now critically discussed.

a. First-year workload

Considering the yearly survey results, the TS reported that the work-load was not well balanced between the two semesters of the first year. For this reason, considering the background requirement, the Computer Science course was the best candidate to be anticipated from the second to the first semester. Starting from a.y. 2015/16 this course anticipation is been implemented for all students.

During the survey of a.y. 2016/17 the deserved students highlight a better workload balance between the two semesters without reporting any missing course requirements.

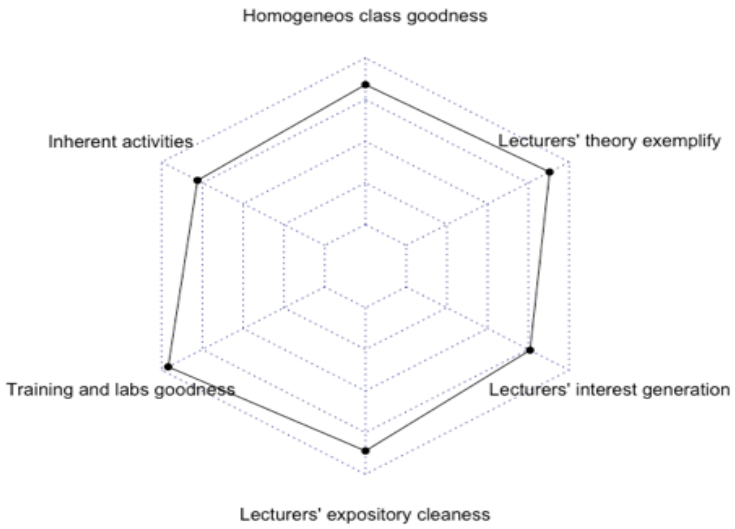
b. Geometry course content review

Similarly, the standard Geometry class needed a review in term of contents with a reinforcement of the Linear Algebra part and the introduction of MatLab software. A new course of Linear Algebra and Geometry has been planned. The new syllabus has two main goals. The former is to introduce the main topics of these subjects, training the student to follow logical deductive arguments and to use the proper formal language. The latter is to give students the main concepts of some basic numerical methods of linear algebra and of the implementation in MatLab.

As the TS can perfectly simulate the numerosity of a standard class and can help lecturers judge the goodness of the new syllabus, the reviewed course has been proposed inside the program.

The students have been given a very positive feedback about this new course (Figure 1). Thanks to this trial, the contents among Mathematical Analysis I and II, Physics and Geometry courses have been synchronized. Starting from a.y. 2016/17, the new 'Linear Algebra and Geometry' course has been suggested to all students on the traditional path instead of the previous Geometry one.

Figure 1 - Radar plot with the results of the survey on the Linear Algebra and Geometry course



c. Benefits expansion

As a part of the program, TS receive some benefits such as a card for free access to many regional museums and public transportation subscription. Looking at the survey data collection, the services were frequently used with a positive impact in term of interest. For

this reason, starting from a.y. 2017/18, these tools have been offered to all the students enrolled just with few limitations related to family income and academic results.

CONCLUSIONS AND RECOMMENDATIONS

By considering the results achieved, the empirical definition of a reverse inclusive process can be stated as all those activities that, thanks to the mixed class formation, indirectly include the protégé students by stimulating and motivating the talented ones.

The peer learning, for example, is automatically activated and reinforced increasing the overall knowledge level and reducing the career duration. In addition, this awareness on the presence of stimulated TS allowed to test improvements of the course contents or their modifications on such a small and well-responding TS class. Such monitored and balanced test of a curriculum review is a great advantage to the entire students' community.

In order to guarantee the spontaneous activation of the reverse inclusive process, the TS program must be designed to be strongly inclusive, that is aimed to facilitate the interactions both inside the TS group that between TS and standard classmates.

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