DIFFERENCES IN STUDENT PERCEPTION IN HETEROGENEOUS LEARNING TEAMS

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Abstract

Two groups of engineering students of two different institutes participated in a collaborative virtual learning project. 145 students were enrolled in the 'master in engineering sciences' of the K.U.Leuven, 135 students were enrolled in the 'master in industrial sciences' at the Hogeschool voor Wetenschap en Kunst (De Nayer instituut) (Polytechnic Institute for Science and Arts).
Both disciplines have a different (complementary) profile, reflected in professional activities and careers later on. Professional duties frequently require that both disciplines work together on a regular basis. However, cooperation between the two disciplines is completely absent during their formal study time.

The project presented in this paper aims at filling this inconsistency. Small interdisciplinary (i.e. heterogeneous) collaborative virtual learning teams were formed by mixing students in both disciplines. The teams worked on a particular physics problem. The goal of the collaboration was for students to acknowledge and experience the complementary character of their respective study programmes.

The students were asked to indicate their appraisal of the collaboration project on a questionnaire. Results show that all participants were convinced of the benefits of collaboration, and appreciated the collaboration efforts. Contrary to expectations, however, they indicated they did not learn about the unique characteristics of both study programmes.

We conclude that the design of the assignments has to be improved. Indeed, the project might have hindered rather than facilitated cooperative interactions between the two disciplines later on, since the students did not experience the complementary character of both study programmes.

***Keywords*:** **computer supported collaborative learning, blended learning, interdisciplinary learning, student perception, physics teaching in engineering education.**

Introduction

In Belgium, students who want to become an engineer can opt for either a five-year university curriculum ("*master in engineering sciences*"), or follow a four-year engineering education at a college for higher professional education ("*master in industrial sciences*"). As an engineer, one of the major tasks is creating and developing new applications or to improve old ones. However, on the labour market both types of engineers have different, complementary profiles (see Figure 1) [CANNAERTS2005, WORDINGENIEUR].

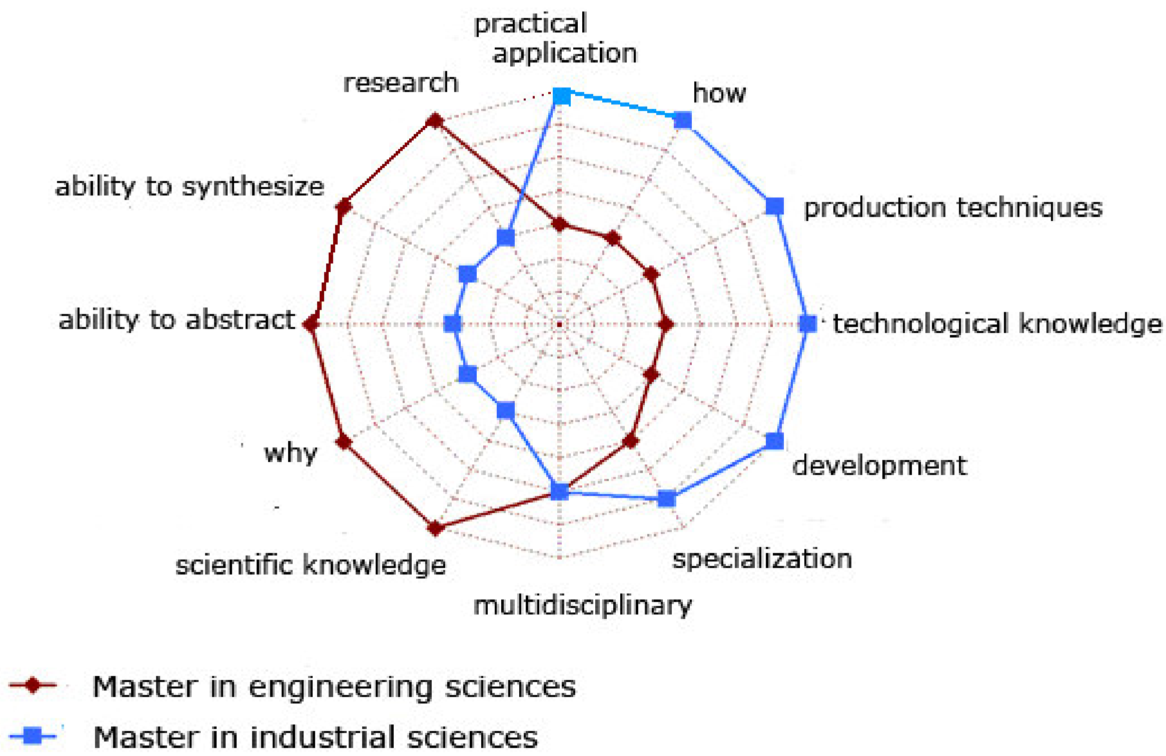

Figure 1. Main accents in the two engineering profiles (Source: www.wordingenieur.be).

Master in engineering sciences students go trough a five year study programme, developing their concept and design abilities, ideas and processes. Additionally, their training prepares them for a research and development job. During their professional life, they typically plan, design and supervise all kind of projects.
The study programme of students at the polytechnic institutes is focussed on the acquisition of polyvalent, technical skills and a fundamental knowledge of the basic sciences in a multidisciplinary context. Graduates are referred to as 'industrial engineers'. During their professional life, they often work in close collaboration with masters in engineering sciences.

In brief, in an industrial engineering sciences profile the focus is on *applications* and *development*, and on the *transfer of knowledge*, while master in engineering sciences students have a broader (theoretical) foundation focusing on *"why*", *research*, the *ability to abstract and synthesize* and the *build up of knowledge.*

Those two types of engineers work together frequently and intensively during their professional careers. Industrial engineers will often be the connection between the masters in engineering sciences of the R&D (research & development) department and the workforce with specific technical jobs. Therefore, a fluent communication and the ability to cooperate with each other are fundamental.

However, during their education there is no formal collaboration or training in interdisciplinary work. This lack of experience might hinder constructive interactions during professional life later on. The project as presented in this paper aims at filling this gap.

Method

145 first-year engineering students from K.U.Leuven (university) and 135 first-year industrial engineering students from 'De Nayer'- institution (college for higher professional education) participated in this collaboration project.

To realise this collaboration we combined conventional face-to-face lecturing and computer-mediated instruction [LANGIE2005].

First of all, students were expected to go through a *self-study module*, distributed by way of a Digital Learning Environment. Before studying the theoretical part, students' prior knowledge was assessed.. In this particular project, the students focused on 'polarization of light'. Since one of the underlying intentions is to (partly) reduce differences in the prior knowledge of this heterogeneous group of students, elementary feedback and links to extra study material are provided when necessary. This pre-test is followed by four modules wherein the theoretical background is discussed. To give students the opportunity to test whether they obtained a sufficient understanding of the theoretical background, the self-study module is concluded with a post-test.

Next, a *face-to-face lecture* was organised. The lecture focuses on practical applications and demonstrations. A teacher-exchange program – university professors teach the industrial engineers and vice versa – gives the students the opportunity to experience another teaching approach and makes a first attempt to bring master in engineering students and industrial engineering students closer towards each other.

Finally, students of both disciplines work together on a particular problem by means of an online discussion forum in small mixed groups of typically four students. In every group, we assigned one particular student with a 'leading' role. He or she was responsible for the arrangement of work and was obliged to start the discussion. The intensive collaboration efforts finally resulted in a short scientific paper.

At the end of the collaboration period, students were asked to fill out an online questionnaire to give their appraisal of the project. The questionnaire contained 63 items, constructed on a 5-point-scale (1=complete disagree, 5= complete agree).

Analysis - Principal Component Analysis, scale construction and ANOVA

A varimax-rotated Principal Component Analysis (PCA) on the above items and subsequent scale constructions were executed. Only components with an eigenvalue higher than 1 were retained. As a result, three different scales were constructed. Differences between both student groups were analysed by a MANOVA and subsequent ANOVA-analysis.

Benefit of collaboration

The first rotated component had an eigenvalue of 5.57 and accounted for 20% of the total variance in the students responses. Eight items loaded high (i.e., $>.40$) on this component and were found to constitute a reliable scale (Cronbach Alpha = 0.87). Since most of these items probe the advantages of this kind of collaboration projects for the learner, we will refer to this scale as *benefit of collaboration*. The overall mean for this scale amounts 3.34 (see Figure 2), which is significantly above the mid-point of the 5-point scale (i.e., 3.00), $p<.001$, but a lot lower than we might have expected. Industrial engineers and master in engineering sciences students do not differ significantly in their appraisal of the project ($p=.102$).

Collaboration within own group

The second rotated component had an eigenvalue of 2.23 and explains 11.89% of the total variance. Four items probe to what extent the workload was evenly shared and whether the contribution of all group members was equal, and constituted a reliable scale (Cronbach Alpha = 0,75). We computed the respondents' mean on these four items as a measure of their appraisal of the *collaboration within own group*. Industrial engineering students are significantly more positive about the proceeding of the collaboration than the university students (*M* = 3.25 vs. *M* = 2.89, see Figure 2).

Different profile

Finally, the third rotated component had an eigenvalue of 2.19. Five items concerning the different profiles loaded high on this component. Although the reliability is rather low (Cronbach Alpha = 0,61) we retained the *different profile*-scale because of its high-interpretable character and the fact that this component still explains 9.60% of the total observed variance in the students' responses. Both groups of engineering students do not agree when it comes to their postulated *different profiles* (see Introduction and Different profiles) (*M* = 2.69 vs. M = 3.07). The university students indicate that they did not experience a difference between the two types of students at all. Industrial engineering students, on the other hand, are more convinced about this distinction, although their responses are mainly situated around the mean value (*M* = 3.07, p = .26).

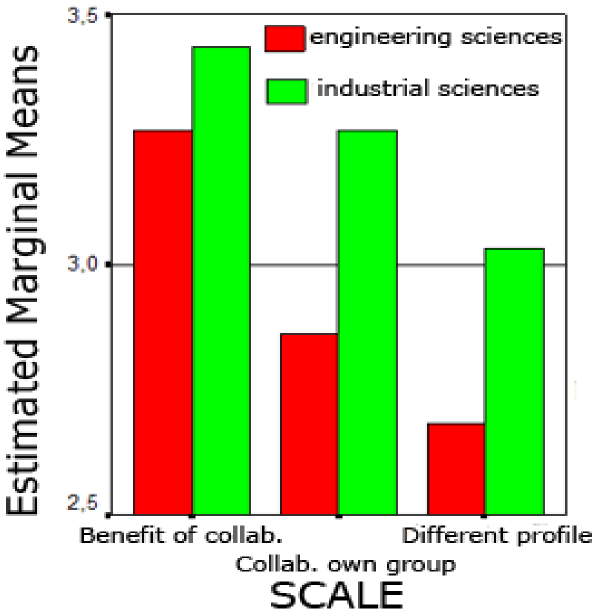

Figure 2. Estimated means on the three different scales for master in engineering sciences and for master in industrial sciences students.

Discussion

Collaboration

First of all, respondents are positive about collaboration. Both groups of engineering students perceive the potential benefits of cooperation, indicating that there is a need to take a look beyond the strict boundaries of their own institution or discipline. Students are clearly aware of the fact that in their professional career they will have to cooperate frequently and intensively, and they acknowledge the advantages of interdisciplinary collaboration projects during their formal education.

On the "*collaboration within own group*"-scale, students were less positive. The students' opinion about collaboration in general is contradicted by their appreciation of the specific project described in this paper. At least one hypothesis can be put forward to account for this apparent inconsistency.

Although both scales involve the evaluation of the collaboration experienced, a distinction can be made between cooperation on a small, specific level and cooperation in a more abstract, general sense. Despite the fact that working together with another discipline did not proceed as smoothly as they may have expected (*collaboration within own group*), students are still convinced of the potential surplus value of collaboration as such (*benefits of collaboration*). Indeed, the students indicated – when given the opportunity - they would participate again in similar collaboration projects. Students might have appreciated both the variation in the classic lecture-pattern and the attention that came along with the project in general. However, working together on a paper was presumably the hardest part in the collaboration, causing a lot of troubles and obstacles, reflected in the questionnaire-data.

Master in engineering sciences students and master in industrial sciences students differ significantly on the *collaboration within own group*-scale. Industrial engineers are consistently more positive about the specific cooperation than their university peers (although still below our initial expectations). This difference can not be ascribed to the composition of the groups, since all groups were composed interdisciplinary. This difference can also not be accounted for by the specific topic of the paper, since the difference was observed in all teams.

We attribute this reduced enthusiasm of the university students to the following two reasons.

First of all, in every team, we assigned one particular student with a 'leading' role. He or she had to take care for the division of tasks and was obliged tot start the discussion. It seems plausible that students with a leading role perceive this as a burden and hold themselves more responsible for the proceeding of the collaboration than other group members. Maybe the idea of being an involuntary 'leader' could give the impression that the workload was not evenly shared and that they had more work because of this extra task. Because of practical arrangements during group-composition, significantly more university students were – undeliberately – assigned this leading role. This unfortunate practical issue could explain their reaction when asked about the division of tasks in the interdisciplinary groups.

A second reason for the different ratings on the *collaboration within own group* scale, can be of a more fundamental nature. Indeed, there are clear differences in independency between both groups of students. Traditionally, at universities, a strong appeal is made to the independence and self-activation of the learners. At institutions for higher education, students find themselves in a more protected environment, where their progress is followed more closely and intensively [CANNAERTS2002]. These students are used to more instruction and guidance, in comparison with university students. It seems plausible that this explains why the university students have the perception that they participated more intensively in the collaboration.

Different profiles

Another remarkable observation concerns the results on the *different profile* scale. Despite the initial intention to create a situation in which students have the opportunity to be introduced to each others' engineering profile, none of both student groups indicate they experienced those 'typical' profiles. Even more, university students clearly 'deny' those differences.

In the Introduction we described the complementary profiles of both engineering types. However, the generic view of the master in engineers sciences curriculum seems questionable for the first year university students. They seem to have the impression that they have both theoretical and practical experience, reflected in their view towards the interdisciplinary collaboration project.

Another explanation for the results on the *different profile* scale, and possibly the most important one, can be attributed to the particular nature of the task the students had to fulfil. In none of the polarization-problems, the different engineering profiles and their complementary accents were explicitly anticipated and taken into account. We assumed that the complementary profiles would evolve spontaneously during the project, e.g. that the theoretically inclined university students would focus on the theoretical background of the problem, and the industrial engineering students would focus on the practical applications. Unfortunately, such an seemingly obvious division of the tasks between both groups of students did not occur spontaneously. This clouded the student perception of the collaboration effort, since they were not specifically required to use their unique skills.

In order to optimize future projects, it is recommended to revise the nature of the tasks. Assignments will focus more on the complementary profiles, increasing the effectiveness. For example, the students will not merely be asked to give a solution to a practical problem, but also to include sufficient theoretical aspects in their final paper.

Finally, we wonder whether it is opportune to work with first-year students on similar collaboration projects, since they might not have had the opportunity to experience their unique profiles.

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