Is There a Link Between Creativity and Multiculturalism in Education?

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***Abstract* – This paper presents a few initiatives of developing Electronics engineering students' creativity and the achieved outcomes. After implementing these initiatives, a student group including students of different nationalities, distinguished themselves by their outstanding achievements in comparison with other three groups of students of identical nationalities. This paper emphasizes some aspects of intercultural cooperation and proposes the hypothesis of this cooperation as the driving force behind the development of student creativity.**

***Keywords* – engineering education, multicultural, creativity, gamification.**

1. Introduction

Banciu and Cordos [1] argue that globalization has made intercultural communication an inevitable reality, today's world being subjected to rapid changes where human interaction is gaining new dimensions, a world in which contact and communication with other cultures are dominant features of modern life. Situated in a central location in the Romania, very near to areas with a large percentage of Hungarian population, the "Transilvania" University of Braşov offers high quality engineering study programmes within a multicultural environment.

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In the academic year 2015-2016, the final year of the "Applied Electronics" study programme, a group of students, including students of both Romanian and Hungarian nationality, obtained outstanding academic achievements. The achievements of these students demonstrated creativity and a pleasant atmosphere of collaboration, which led to the initiative to identify possible generating factors. In this case, a possible source of motivation could be competition between different ethnic groups, based on cultural differences. However, this hypothesis is difficult to confirm or reject due to the interaction of a multitude of factors involved in the learning process. Creativity is an absolutely indispensable attribute for engineers which is formed throughout the study years. Engineering education develops creativity, and to this end, it must go beyond the level at which the student just listens to lectures and performs laboratory work, as instructed by the teacher. The gradual introduction of PBL (Problem Based Learning and Project Based Learning) is required at this level of education so that students can harmoniously integrate into the dynamics of IT (Information Technology).

This paper presents several methods of stimulating student creativity destined to better prepare them for the increasing job requirement in the IT industry. The academic results obtained are presented in the case of an academic year in which the number of students of Hungarian nationality was close to that of students of Romanian nationality in comparison with other three academic years with a smaller fraction of Hungarian ethnic students.

2. Multiculturalism and creativity in education

Most authors argue with optimism that multiculturalism provides important support in education. Grant and Sleeter believe that multicultural education of students from communities with diverse cultural backgrounds is, due to its qualities, a real springboard for learning (Multicultural education conceptualizes students, their diverse communities, their cultural backgrounds, mainly in terms of their strengths and their use as springboards for learning ") [2]. The same optimism is also embraced by Banks in

"Multicultural education: Issues and perspectives" [3]. Katai describes an education initiative that combines the art and computer science to overcome ethnic barriers, but also mentions certain difficulties [4]. A vast study of several authors [5], which contains data from eight countries in Europe and Asia, is less optimistic. It states that students taking part in the study speak positively of diversity, but they still have a number of prejudices. There are even very critical papers, such as Szakács' [6], which asserts that diversity is only discursively embraced by teachers and staff, practically failing to demonstrate an assimilation of diversity in schools, which remain marked by old structures centered on ethnicity, monoculturalism and self-victimization ("diversity is embraced discursively by teachers and staff, school practices fail to demonstrate an incorporation of diversity into the Romanian national narrative which remains marked by the old structures of ethnocentric monoculturalism and self-victimization"). Bernath and Hatos [7] demonstrate that "the multivariate analysis proves that the thesis of lower educational chances of Hungarians from Transylvania does not hold".

Creativity is defined according to Runco and Jaeger [8] by two necessary characteristics: originality and utility. In regard to utility in the engineering domain it is validated by the industry.

Kalinauskas' paper [9] focuses on the relationship between creativity learning through gamification. Focusing attention for creative purposes, diversity of perspectives on the problem, and student commitment are the most relevant advantages of game-based learning. According to Csikszentmihalyi (1996), creativity can be defined as "any act, idea, or product that changes an existing domain, or that transforms an existing domain into a new one" while gamification is defined by Deterding, Dixon, Khaled and Nacke (2011) as "use of game design elements in non-game context". The role of game-based learning is analyzed in a social context wherein the present-day generation of young people is stimulated, attracted through commitment and distractive activities.

The concept of collective creativity which is intended to be developed through education is the group-creativity. Collective creativity presupposes cooperation among individuals and is an important quality required in the process of innovation [10]. Games are helpful in amplifying participation, commitment, and passion to pursue new ideas. Development of competitive spirit is required, despite the fact that group activities are based on cooperation. Group activity requires a game philosophy based on software applications intended for a well-configured collaborative environment, to allow the development of creativity. These principles were used to foster the efforts made for modernizing the educational process at the Faculty of Electrical Engineering and Computer Science, Braşov Romania.

3. Teaching initiatives for the development of creativity

The Faculty of Electrical Engineering and Computer Science in Brasov (FEECS), Transylvania University of Brasov is conducting a project on improving the learning process including initiatives based on PBL methods. The results are encouraging, showing an increase in the interest and responsibility of the students involved. Some of these initiatives, which have been applied on a larger scale, are:

1. Proposing optional homework assignments to develop creativity;
2. Introduction of the gamification concept;
3. Reshaping laboratory activities to enable students to configure their own lab projects [11].

One of the initiatives, applied to several disciplines that do not include the project-type activity, was the students' proposal to develop a homework assignment, in form of a mini-project. For this home assignment a bonus point scheme for students was established. The homework was proposed to be introduced as teaching activity in Computer Interfacing. This subject is taught, with a similar structure, both to Applied Electronics, and to Telecommunications and Computers.

The homework is optional and consists of conceiving a microcontroller application and interfacing a wireless module for data transmission. The application, the microcontroller type and the wireless module type are at the students' choice. The homework does not imply mandatory practical realization, the final accepted result being the electrical diagram, the software for the microcontroller, tested in a development environment, and the achievement's documentation. If the homework is practically implemented, additional bonus points are provided for the students. Ideas about this activity were inspired from [12].

The main goal of this homework is to stimulate the ability to work independently, to increase responsibility and initiative, to prepare for e-design jobs. Since all elements can be freely chosen, students must make serious efforts to document the application. After completion, a PowerPoint presentation is delivered to the fellow students, which is regarded as an important training element. The mini-project provides many choices of theme and components, which stimulate student creativity. Further ideas for stimulating student creativity

applied to homework development were inspired by Fonseca [13].

In addition to the optional mini-project that is not required to be practically implemented, it is important for students to develop their practical skills [14]. The emergence of the Arduino development systems on the market has simplified practical realization, but has also lowered the student's interest in microcontroller architectures. The Department of Electronics and Computers is looking for solutions to compensate this trend. One of the solutions consisted in setting up lab projects that allow students the use of Arduino systems to develop their own applications. In the first part of the lab session each student conceives an application and after a competition of ideas the most interesting ones are selected. This phase of competition is followed by the collaborative phase of the project. In this second phase the student whose ideas were chosen becomes team leader, builds a team and implements the proposed application. In all applications, students are required to write the specific software without using the Arduino open source libraries. The students' propensity for automobiles and "gadgets" can be used for didactic purposes to stimulate creativity and to imagine interesting applications [15]. However, in addition to the positive aspects of gamification methods, the increase in student engagement and involvement in activity also has negative aspects. These aspects depend on the specific work context and the group of students involved [15].

Homework accomplishment, student laboratory activity, and gamification-based work motivate students to elaborate on these topics by increasing their complexity and including them into their final engineering project in attractive forms.

One important occasion for students to present and promote their ideas is the Student paper competition, an annual event that takes place every spring. In general, this event enjoys large student participation, with a particularly high proportion of final year students involved in preparing their final engineering project. Another reason why students are attracted by this activity is the fact that many companies participate in the event and often award prizes. Student presentations provide valuable training in support of the engineering disertation and the questions asked by company representatives highlight possible weak points in the papers and help to correct them.

Figure 1. shows a number of passionately developed accomplishments of the students who have embraced the concept of gamification. Their achievements were highly regarded by company representatives, some of them being awarded. The upper left of the figure shows a drum with a stick actuated by a motor, the time and force of each strike being governed by a microcontroller system; the upper right image shows a stringless harp which can be played by moving the fingers thus blocking the infrared light beam between IR emitter and photo sensor. The central left figure displays a remote controlled mobile unit for measuring the electric field in areas that are hazardous for humans, where the field strength exceeds 2kV / m. The model car is equipped with a video camera and a traffic sign recognition system. In the lower left is another model car equipped with sensors, capable to avoid obstacles, and on the right is a photo from the Arduino system lab showing the interfacing process of an analogue joystick.

Figure 1. Practical achievements of the optional homework assignment

Four of the presented achievements were developed by students of Romanian nationality and two by students of Hungarian nationality (the electronic harp and the electric field measuring mobile).

4. Comparison of academic performance and student attitude towards intercultural collaboration

The academic year 2015-2016, the final year of the Applied Electronics (AE) study programme included a total of 23 students, of which 16 Romanians and 7 Hungarians, in contrast with the two previous years with one and, respectively, two students of Hungarian nationality. The subsequent academic year did not include students of Hungarian nationality. The performance of the aforementioned group of

students was remarkably good compared to the previous and the subsequent academic years. Figure 2. presents the results obtained by the 4th year AE students in the academic years 2013-2014, 2014-2015, 2015-2016, and 2016-2017 in Interfaces and Peripheral Equipment. The grades were divided into 4 categories in order to make the graph more suggestive, as follows: category 1- 9 and 10, category 2- 7 and 8, category 3- 5 and 6 and category 4 absents (grade 0) or unpromoted (grade 4). The results are given for the first exam session, since after the backlog sessions the results are naturally much better. As can be seen, grades 9 and 10 show a higher peak in 2015-2016 compared with other academic years. Also, the number of backlogs and students who failed exams in 2015-2016 is lower than in the other academic years.

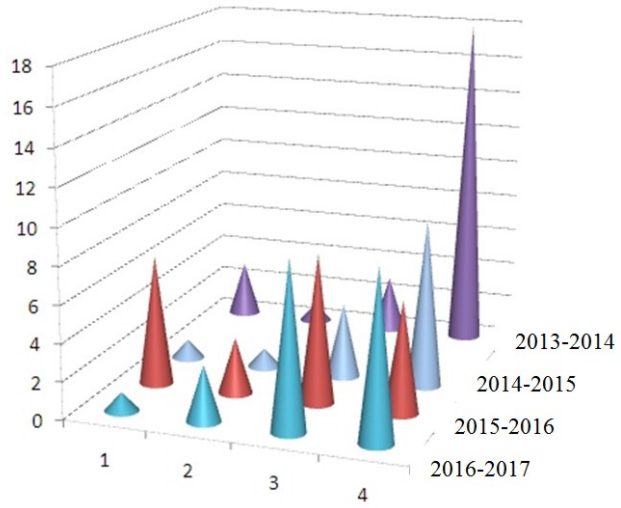

Figure 2. Distribution of grades in the academic years 2013-2014, 2014-2015, 2015-2016 (in red) and 2016-2017.

The average of grades obtained by students in the 2013-2014, 2014-2015, 2015-2016 and 2016-2017 academic years in Interfaces and Peripheral Equipment in the first exam session is presented in Table 1. and shows good student performance in the year 2015-2016 (on gray background). The averages are poor, because in the first session many students missed the exam, to which the score in this statistic is 0. The averages which include the grades of the students who failed or missed the exams, reflect both school performance and the degree of interest of the students.

Student creativity can be best appreciated at the Student paper competition. Table 2. shows the number of prizes received by Applied Electronics students in the academic years 2013-2014, 2014-2015, 2015-2016, and 2016-2017.

Table 1. Good student performance in 2015-2016.

Academic year	2016-2017	2015-2016	2014-2015	2013-2014
Number of Romanian/ Hungarian students	23 / 0	16 / 7	14 / 2	27 / 1
Average of grades	4.04	6.48	3.13	2.72

Table 2. Number of prizes received by Applied Electronics students

Academic year	2016-2017	2015-2016	2014-2015	2013-2014
Number of prizes	3	9	1	1
Number of Romanian/ Hungarian students awarded	3 / 0	5 / 4	1 / 0	1 / 0

It can be noted that in the academic year 2015/2016 the number of prizes was higher and that the numbers of Romanian and Hungarian students awarded were close.

The methods used to identify students' attitudes towards the homework and the multicultural working environment consisted of discussions with students and completing a questionnaire. Discussions with the students took place both with the whole group and individually, depending on the subjects chosen. At the end of the semester, students were asked to complete an anonymous questionnaire in which they did not declare their name or nationality. Completing the questionnaire was not mandatory.

Part of the questionnaire was aimed at identifying the students' opinion about the atmosphere created by multicultural collaboration. The questions were:

1. Use a scale of to 1 to 5 describe the atmosphere created by the fellow students of the other nationality, where 1 means a very unpleasant atmosphere and 5 a very pleasant atmosphere;
2. What are the most important 3 aspects you liked in the collaboration with fellow students of the other nationality?
3. What are the three most important issues you did not like in collaboration with fellow students of the other nationality?
4. Please mention personal opinions, or what do you think the teachers could do to improve collaboration with students of the other nationality.

A number of 20 students of a total of 23 provided answers to the questions in the questionnaire. The results, presented in Figure 3., confirmed the atmosphere of collaboration between students. The

average rating for the atmosphere of the other nationality is 4.75, which is a very good appreciation of the multicultural collaboration.

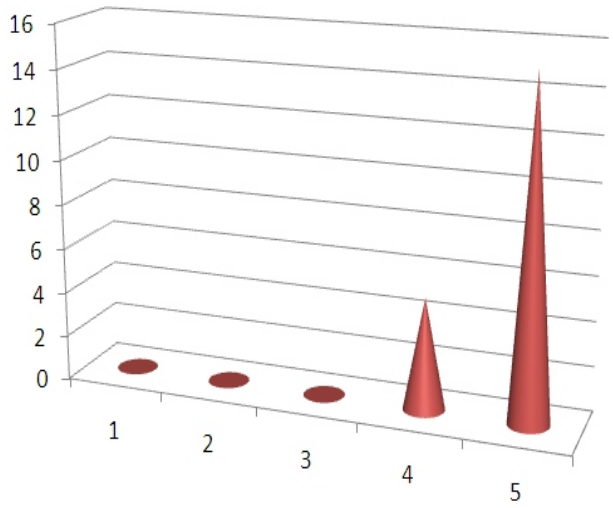

Figure 3. Ratings made by students describing the communication level with the other nationality, where 5 is the highest rating (the best atmosphere) and 1 the lowest rating

To the first question in the questionnaire, the most frequent answers (12 students) indicate professional collaboration between different nationalities as the most important positive aspect, and that there was no difference between relations among conationals and with the other nationality (11 students).

To the second question, the most frequent answer was that there were no negative aspects (10 students) while the second most frequent answer indicates the use of native language in the common discussions of the two nationalities as the most important negative aspect (9 students).

Regarding the third question, 8 students considered that teachers can't do anything to improve collaboration, 5 students believed that the creation of mixed lab teams would improve collaboration, and 5 students believed that teachers should treat students equally, regardless of nationality.

The results obtained by the students, in the academic year 2015-2016, in Interfaces and Peripheral Equipment, were analyzed separately, for students of Romanian and Hungarian nationality. As relevant criteria were considered the grades obtained in the first exam session and class attendance (attendance is not mandatory). The results are comparatively presented in Table 3:

Table 3. Results obtained by the students

Result	Romanian Students	Hungarian Students
Average	6.35	6.83
Average attendance	45%	39%

This comparison shows that there are no major differences between the academic performance of the two groups of students.

Some of the most interesting views of the students were:

- "I came to school with prejudices, but here I realized that relationships between nationalities can be beautiful";
- "I greatly appreciate the moments when I joined a group of another nationality and they changed the language so that I could understand";
- "Collaboration with fellow students of the other nationality depends on where they come from and how they have been involved in different multicultural environments in the past";
- "We understood each other so well that we could make jokes about nationality."

These personal views of the students have confirmed an atmosphere of mutual understanding and collaboration.

Acknowledgement of successful student creativity initiatives was provided by the students' good performance at the creativity contest organized by an electronics company. The team of AE students won the first place of all 8 participating teams in the competition on hardware and software development of an automotive interface. A photo from the creativity contest is shown in Figure 4.

Figure 4. A picture taken during the creativity contest.

Once more, student performance was certified at the Student paper competition organized by the University in 2016 with the participation of 6 AE students with papers, 3 Hungarians and 3 Romanians. Student papers were appreciated by the jury of the competition and one paper won the section's prize. Figure 5. shows a photo of the students, grouped by nationality, the three on the left being of Hungarian nationality and the others of Romanian nationality. Organizing student groups by nationality shows that there is still much to be done to improve relations between students of different nationalities.

Figure 5. Students at the Graduates in Business Conference, 2016

5. Conclusions

The idea of this paper emerged when, during project activity, a female student of Romanian nationality addressed a fellow student of Hungarian nationality using Hungarian language. Obviously, the student addressed only a few words, and these were extremely poorly pronounced. Nevertheless, the student's effort was considered to be a noteworthy event. Also, the outstanding school achievements of the "Applied Electronics" final year were compared to the students' results of the previous years. In this study, which aimed at analyzing the correlation between the multicultural composition of the student group and the academic performance, the collaboration between students, regardless of nationality, was noted. This favorable environment was confirmed by an anonymous questionnaire, wherein the students expressed positive opinions about the relationships among them (with emphasis on collegiality and collaboration), a fact also backed up by very high grade averages. In this questionnaire, the students highlighted the most important advantages as well as the negative aspects of multicultural collaboration.

The suggestion that students should be organized into groups including both nationalities could be considered by the teachers. In "Interfacing" students organized into groups, according to their own preferences and, as a rule, groups are formed by national criteria, to facilitate communication in their national language. Mixed groups could facilitate dialogue between nationalities, but could equally lead to tensions among group members.

Solving the homework assignment was optional and individual. Discussions between students of different nationalities were frequent in the process of collaboration for finding ideas to implement and select microcontrollers and wireless modules. Within these mixed groups, ideas could be discussed from a multicultural perspective. From this point of view, multiple application options, more information sources and a broader choice of hardware suppliers have been identified. Unfortunately, only a few students managed to complete their homework because of the tight time limit.

According to teachers' opinions, dialogue and intercultural collaboration contributed to improved performance and creativity. The data in Tables 1. and 2. confirm teachers' views, considering that the study was conducted over four academic years with a total of 90 student participants, so the collected data was sufficiently relevant. In regard to academic results, the average of the multicultural group scores is more than 2 points higher than the average in the other 3 years of comparison. In terms of creativity, the multicultural group received 9 awards (Table 2.) compared to 5 awards in total, over the 3 years of comparison. However, the teachers' impression and statistical results are not sufficiently relevant to constitute an indisputable proof of the link between creativity and the multicultural structure of the group of students. Even if the performance in 2015-2016 was better than in the previous years, there may be other reasons apart from multiculturalism behind this outcome. Unfortunately, it is quite difficult to continue this research because an increasing proportion of students chose to study abroad.

An incontestable conclusion, proven by the students' answer to the questionnaires, is that the students have been treated with the same respect regardless of their nationality or the nationality of the teaching staff. This positive attitude adopted by the teachers has helped intercultural collaboration between students by establishing a pleasant and relaxed work environment. The home assignment, the lab work where the students developed their own projects, and the introduction of gamification elements played a major role in encouraging student creativity.

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