The Efficiency of Teamwork in Medical Electronics Laboratories

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Abstract

With so many teaching strategies available today that enhance students' learning, it might be difficult to decide which one to implement in electronics laboratories at a faculty. Is the most effective method still the straightforward, traditional, team-based work, or are the new methods—flipped classroom, role play, gamification, etc.—suitable for students? Do students perform better working individually or in a team of people that share the same interests? The participants of this study are second-year students who worked either in free-chosen teams of two to three people or in pre

established teams of three to four people in the medical electronics laboratories of the Faculty of Medical Engineering over the course of a year. The goal of this paper is to answer these questions regarding the optimal teaching and learning strategy for university students by using a form with different questions about their perspective on teamwork.

Keywords: Teamwork, University students, Laboratory classes, Close-ended questions form

1. Introduction

These days, most universities emphasize that to fulfil the academic, professional, and personal requirements for a successful career, both hard and soft skills must be taught. Soft skills are interpersonal abilities, often known as an individual's set of social skills and personal features, whereas hard skills are the technical knowledge and abilities necessary for performing a job. Teamwork is one of the most valuable skills that employees can have because collaborative structures are becoming more prevalent in organisations (Rudawska, 2017). It has been shown that teamwork skills are great allies for academic as well as professional environments, helping students feel more balanced and confident (De prada et al., 2024). Since teamwork skills are seen as vital skills in a world that is becoming more dynamic, interconnected, and complex, they have been getting a lot of attention lately. New employees are questioned about their ability to work in a team, address certain problems at work, or possess the necessary abilities to deal with the new difficulties that come with modern society (Prada et al., 2022; Baneres & Conesa, 2017). Employers in Australia, for example, underline that graduates' capacity to work as a team is equally essential as having technical skills required for a specific job. This is why teamwork skills are appearing in a variety of fields in Australia, including engineering and health. According to employers, universities must do more to better train graduates for team-based work (Riebe et al., 2016, 2017).

A key pedagogical strategy that gives students the tools they need to learn and makes them better job candidates is teamwork (Omar & Plumb, 2023). Universities are increasingly incorporating teamwork skills and team-based learning as a teaching method in their curricula, as they are considered essential to success on all levels—personal, academic, and professional (Prada et al., 2022; Angu, 2019). In some fields, such as the healthcare sector, teamwork has emerged as the most effective work method for handling complex health problems and ensuring high-quality patient care (Angu, 2019). Moreover, a substantial connection between extracurricular activities and the development of essential teamwork skills has been demonstrated by studies such as the

one proposed by de Prada Creo et al. (2021), which examined if college students are effectively learning or improving teamwork skills through a range of extracurricular activities, including sports, music, volunteering, international group work experiences, and professional practices.

There are numerous advantages when using a teamwork-based approach with college students. It offers students the opportunity to explore new things and learn skills that they will need in their future careers, such as leadership, negotiation, teamwork, interpersonal communication, group problem-solving, and time management. Also, learning is more profound and relevant when teamwork is used in an active methodology environment. Positive impacts have also been proven on students' motivation, attitudes toward learning, and academic performance. Students have also highlighted some of these benefits, indicating that collaborative projects and active learning techniques are more stimulating, enjoyable, and favourable to learning than traditional teaching (Marin-Garcia & Lloret, 2008).

Even though teamwork has become a crucial skill, as previously noted, many students contest academic assignments that require collaboration. The need to be able to adapt to the many and different personalities of team members is one of these difficulties. It involves organising many activities through solid management and effective communication, as well as constructively responding to various learning attitudes and behaviours. Students who are not used to this method of working may be hesitant or confused in some situations, or they may believe that these activities require a significant amount of their time (Angu, 2019; Marin-Garcia & Lloret, 2008). Other participants may get unsatisfied if one person dominates the conversation because they feel excluded from the deliberations and choices. Other group members may end up performing as free riders and depending too much on the active members as a result, either of their own choice or insecurity in stepping forward (Omar & Plumb, 2023).

The aim of this study is to investigate the importance of teamwork in medical electronics laboratories of the Faculty of Medical Engineering, National University of Science and Technology POLITEHNICA Bucharest in Bucharest, Romania. The main purpose of these

laboratories is for students to improve their practical skills in the field of electronics with medical applications. The focus is on creating and developing circuits, powering them, performing measurements, commanding them through code, etc., with first having a base of theoretical knowledge. In order to be able to find out the answer, we used a form to collect responses from the participants (our second-year students) after one year of medical electronics laboratories, where they work in various team configurations (free-chosen or pre-established teams with two to four members). Besides the scientific and statistical purposes, the outcomes of this study can also help us to better organise the laboratories in the future.

2. Literature Review

Universities all around the world have embraced teamwork as a teaching strategy. According to the Randstad Workmonitor, which examines 34 countries worldwide, Romanian workers, regardless of their generation, are the most capable of interacting with their coworkers (Marica, 2018). Lincă et al. (2023) investigated, using a questionnaire, how Romanian students' demographic characteristics, such as age and education, varied depending on the level of development of their teamwork skills, concluding that as students' chronological age and level of education increased, so did their teamwork skills.

In her study, Rudawska (2017) determined how the teamwork experiences of some Polish master's students have influenced their attitudes toward collaborative work, using questionnaires. It concludes that to promote a positive attitude regarding teamwork, teachers should encourage teamwork projects, and the university should cultivate a collaborative environment. Contrary to the general opinion that Iranians are not particularly interested in teamwork, the results of a survey about teamwork that was given to students in three large Iranian universities showed that Iranian students have moderately positive attitudes toward teamwork, being more concerned with how teamwork is evaluated (Beigi & Shirmohammadi, 2012). According to Angu (2019), the Health Professions Council of South Africa identifies

teamwork as one of the fundamental skills for being prepared for the workforce, and university students, particularly those studying the health sciences, must demonstrate this ability.

The study conducted by Huang (2022), which was based on quantitative survey data obtained from a general chemistry laboratory course, assessed how students' attitudes toward teamwork, willingness to try new things, and problem-solving and collaboration skills changed. By the end of the course, more experienced students had formed negative attitudes toward problem-solving and teamwork, while novice students with a lower starting point for team-based problem-solving reported more learning achievements than more experienced students. Furthermore, it was determined that both novice and experienced learners' team-based problem-solving skills improved with deeper study. Omar & Plumb (2023) focused on teamwork in practical sessions, investigating how teamwork helps students learn, factors which promote student engagement, and the optimal group size. After a teamworking laboratory, students were asked to complete a questionnaire, and after an analysis of the responses, it was determined that the most important aspect of improving team engagement and performance was communication. Student involvement was also found to be greatly influenced by the members' cooperation, communication, and interaction. The activity's complexity and nature decided the optimal group size, as it is also mentioned by Beck et al. (2025). It was concluded that successful teamwork greatly improves student learning and helps them acquire essential skills for employment (Omar & Plumb, 2023).

Ionescu (2007) describes how the teamwork component of the laboratory classes in a third-year unit of the civil engineering degree contributed to the improvement of soft skills. According to the students' survey conducted over a three year period, the practical sessions and teamwork helped them to increase their technical knowledge, and they enhanced their interpersonal and communication skills and became more conscious of their own strengths and weaknesses when working in teams. The method of organized pairing for forming student teams in engineering laboratories for first-year electrical and computer engineering students is explained by Fila &

Loui (2014). This method is adapted from pair programming, which has been shown to increase computer science students' self-confidence, satisfaction, and retention. As a more intriguing and motivating alternative to conventional laboratory teaming techniques, this structured pairing reported noticeably greater confidence in laboratory activities as well as satisfaction with the course and collaborative activities.

3. Materials and Methods

Based on the studies in the literature, we decided to use a form to collect responses from the participants after one year of medical electronics laboratories, where they work in various team configurations.

3.1. Participants

In this study, there were 46 participants; their participation was optional and anonymous. Moreover, there is no other detail about them but the fact that they are second-year students who worked, over a year, either in free-chosen or in pre established teams in the electronics laboratories at the Faculty of Medical Engineering, National University of Science and Technology POLITEHNICA Bucharest, Bucharest, Romania.

3.2. Form

The form consisted of 12 close-ended questions, as is presented in **Table 1**. The close-ended questions were selected because they are brief, require minimal time (Sanchez, 2024), and enable the development of statistics based on the responses received. Two of the questions (Q5 and Q6) had the *Other* option field, where they can freely complete an answer. Moreover, these questions accepted multiple answers, compared to the others that accept only one. For each participant, only one submission was accepted. The form was anonymous, and there was no question regarding personal details about the respondents. No personal data that could identify the respondent was required or saved. There was no time limit for completing the form, and it

was open for several days.

No.	*Question*	*Possible answers (A/B/C/D/E)*
Q1	Do you think that teamwork in practical laboratories, such as electronics, is more effective than individual work?	Yes / No
Q2	Do you prefer to work in free-chosen or pre-established teams?	Free-chosen / Pre-established
Q3	How many people are necessary on a team in an electronics laboratory?	2 / 3 / >3
Q4	Do you constantly change teams or keep the same teammate(s) for the whole year?	Change / Keep
Q5	What criteria do you apply when choosing your teammate(s)?	Friendship / Knowledge / Common interests / Other
Q6	What factors, in your opinion, help a team in an electronics laboratory develop an effective collaboration?	Friendship / Interest in the subject / Good communication / Equal effort / Other
Q7	Does a conflict that takes place outside of the faculty affect the laboratory team's work?	Yes / No
Q8	Do you prepare for exams individually or in a team?	Individually / In a team / It depends on the exam
Q9	Do you think you learnt something from your teammate(s) as a result of working together?	Yes / No
Q10	When you were required to work in a certain team, did you get along with your teammate(s) and adapt to the team?	Yes / No
Q11	When you were required to work in a certain team, did you build a friendship with your teammate(s)?	Yes / No
Q12	Do you consider keeping the teams that have been formed in the electronics laboratories for the upcoming laboratories?	Yes / No

Table 1. Questions and possible answers that have been used in the form

4. Results

The form was completed by 46 participants (all of them being second-year students from the same faculty, as mentioned above); the mean submitting time was 2:29 min. The results are centralised in **Table 2**. For questions that accept multiple answers (Q5 and Q6), the percentages expressed represent the total number of choices of that answer.

No.	Possible answers				
	A	B	C	D	E
Q1	87%	13%	-	-	-
Q2	98%	2%	-	-	-
Q3	48%	48%	4%	-	-
Q4	2%	98%	-	-	-
Q5	83%	57%	54%	2%	-
Q6	57%	59%	96%	87%	0%
Q7	46%	54%	-	-	-
Q8	33%	15%	52%	-	-
Q9	89%	11%	-	-	-
Q10	74%	26%	-	-	-
Q11	57%	43%	-	-	-
Q12	83%	17%	-	-	-

Table 2. Results after completing the form

For better visualization and interpretation, the results are graphically displayed in **Figure 1**. As it can be seen, in some cases most of the participants chose the same answers. This control of the outcomes and the possibility of performing statistical tests and graphics represent advantages of

using close-ended questions in the form given to the participants.

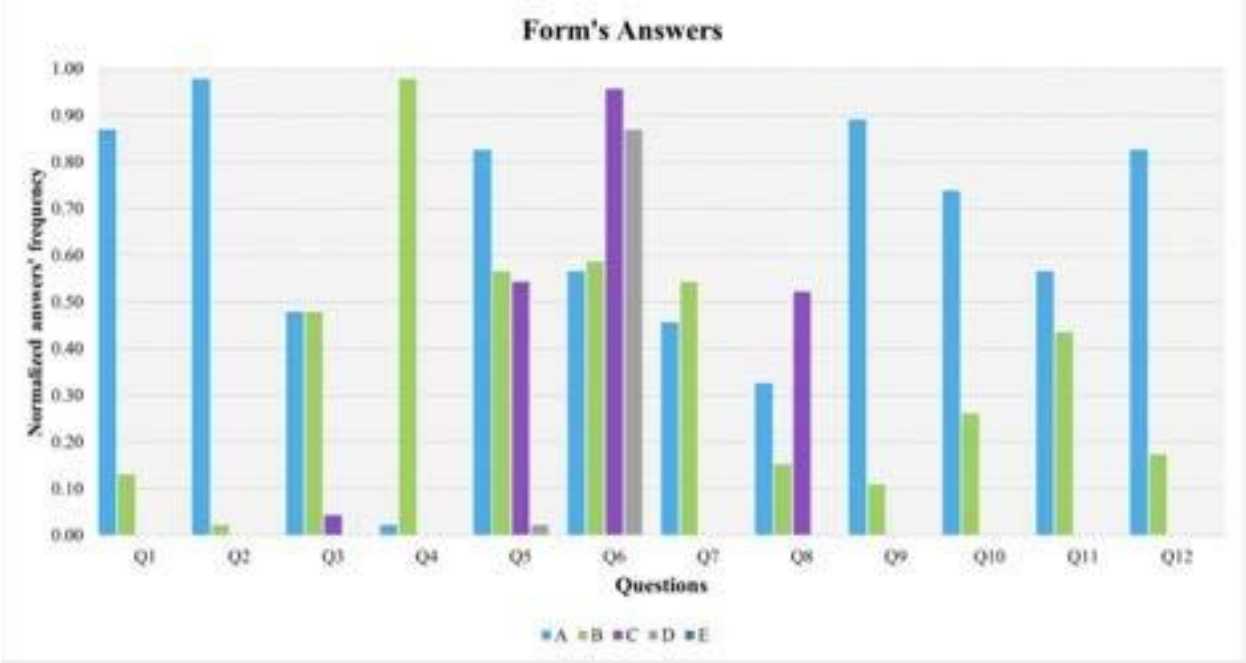

Figure 1. The graphical display of the form's answers

Most of the participants (87%) consider that teamwork in practical laboratories, such as electronics, is more efficient than individual work, and 84% of them want to keep the same teams as in the medical electronics laboratories. Only 2% of the participants prefer to work in a pre-established team rather than in a free-chosen one and consider they got along with their partners and adapted to the team, even built a friendship, and they had something to learn from their partners. However, they do not consider keeping the teams that have been formed in the electronics laboratory for the upcoming ones. Most of the participants (98%) confirm that, in general, they prefer to keep their teams rather than constantly changing them, but only 87% of them want to keep these particular teams. The opinions are equally divided when it comes to the optimal number of teammates (two or three); only 4% of the participants have chosen more than

three people in a group.

The most important criterion applied when choosing a teammate is friendship (83%), followed, almost equally, by knowledge (57%) and common interests (54%); 1% chose "Other". Moreover, friendship was the only criterion for approximately 20% of the participants. However, the factors that help a team in an electronics laboratory to develop an effective collaboration are good communication (96%) and equal effort (87%), then followed by interest in the subject (59%) and friendship (57%). A conflict that takes place outside of the faculty might almost equally affect the laboratory team's work (46%) or not (54%). More than half of the participants (52%) say that, when it comes to preparing for an exam, it depends on the exam if they choose to learn individually or in a team, while 33% of them prefer to learn individually no matter the exam, and only 15% choose to learn in groups.

As a result of working together, 89% of the participants agree they had something to learn from their teammate(s). When they were required to work in a pre-established team, 74% of them managed to get along with their teammates and adapted to the teams, but only 57% managed to build a friendship.

5. Conclusions

Based on these results, we can conclude that teamwork is more efficient than individual work when it comes to medical electronics laboratories. For a good, long-term collaboration, the students should be able to decide their own team members and also the number of members (which came to be two or three). Even though friendship is the most common criterion applied when forming a team, the factors that help a team to develop an effective collaboration are good communication and equal effort. A conflict that takes place outside of the faculty is likely to affect the team. However, when talking about an exam, 15% choose to learn in groups, and half of them say that it depends on the exam. Since 89% of the participants agree they had something to learn from their teammate(s), the teamwork has proven to be beneficial. Even though most of

the participants preferred to work in free-chosen groups, 74% of them managed to get along with their teammates and adapted to the pre-established teams, and 57% of them even managed to build a friendship.

Due to the database's reduced dimensions, this study also had a few limitations. In order to determine if teamwork can represent a general solution for university laboratories or if there are distinct criteria and outcomes in other laboratories, we intend on including more participants in our future research, as well as students from various laboratories. Analysing an entire generation of students from their first to their last year to determine if their skills have improved over the four years of faculty is another future objective.

The main benefit of this type of study is that the outcomes can help us, and teachers in general, to better organise the laboratories, based on students' opinions. We consider that these kinds of surveys should be constantly conducted during an academic year or after a semester because this way, the teaching methods could be improved or modified in real-time according to that generation's opinions and preferences.

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