

# Relaunching Laboratories for Engineering Disciplines Using an Industry-Oriented Approach

Alexandru DINU<sup>1</sup>

Ștefania Cristina GHIOCANU<sup>2</sup>

Horia Alexandru MODRAN<sup>3\*</sup>

<sup>1</sup>Department of Electronics and Computers, Transilvania University, Brașov, Romania,

[alexandru.dinu@unitbv.ro](mailto:alexandru.dinu@unitbv.ro);

<sup>2</sup>Faculty of Business and Administration, University of Bucharest, Bucharest, Romania, [stefania.ghiocanu@yahoo.com](mailto:stefania.ghiocanu@yahoo.com)

<sup>3</sup>Department of Electronics and Computers, Transilvania University,

Brașov, Romania, [horia.modran@unitbv.ro](mailto:horia.modran@unitbv.ro)

\*Corresponding author

**Abstract:** *A pleasant working environment starts with a smooth adjustment of the graduate to the workplace. For this reason, preparing students in line with companies' work requirements must be in the focus during faculty. Since many of the subjects currently taught do not take this into account, this paper aims to contribute validated ideas and techniques to the creation of industry-oriented teaching activities. Therefore, this paper presents how practical work at a laboratory in an IT faculty has been adapted to accommodate some important aspects encountered in companies and required from future employees: teamwork where each member has well-defined tasks, creativity, taking on the task at hand, using cloud-hosted tools, tracking tasks within a team using dedicated platforms, and logging and solving a bug in a professional way. Actively helping the students in acquiring the necessary skills to design and verify a part of a chip, several didactic methods (e.g. brainstorming, explanation, discussion, "jigsaw" method) were also used to lead the students, step by step, to a good understanding of the working environment in a corporation. As results, it is shown that the students managed to learn how to approach the specific tools and methods of a company, and the good quality of the products obtained was confirmed by representatives of several companies in the field. The students' views on the teaching process, collected through an anonymous questionnaire, are also deeply analysed and discussed. Finally, the paper highlights the main aspects that positively influenced the students' professional development during teaching activities.*

**Keywords:** *collaborative learning; didactic methods; graduates adjustment to the workplace; industrial approaches in education; cloud-hosted tools.*

**How to cite:** Dinu, A., Ghiocanu, Ș. C., & Modran, H. A. (2024). Relaunching laboratories for engineering disciplines using an industry-oriented approach. *Revista Românească pentru Educație Multidimensională*, 16(2), 1-23. <https://doi.org/10.18662/rrem/16.2/843>

## Introduction

Technology is invading humanity. This phrase includes both opportunities and dangers. We believe that the boundary between the two is constantly changing, from individual to individual and from society to society. It is therefore particularly important that people learn to use technology for their own benefit, but without harming others. Some of the best-known benefits of technology include automating processes and replacing risky, time-consuming tasks once done by humans with highly sophisticated production lines (Helfgott, 1986). Although many voices (Bessen, 2018) claim that the automation of industry has resulted in job losses, the reality is that new jobs are being created even now (Rover et al., 2014), at the height of the fourth industrial revolution (Spertus, 2021). Although the time needed to produce an object has decreased, the demand for professional workers has increased (Vashisht, 2018) to coordinate the work of automated processes and to contribute by working with them. Considering these aspects, universities aim to prepare students to meet both the current demands and the challenges that will come in the next decades in this highly dynamic industry. Flexibility, adapting to the new, working in teams and planning activities are just some of the characteristics a student needs to learn from university, in order to successfully integrate into the labour market. Therefore, teaching activities must be designed taking into account the whole set of factors that propels a future worker in the labour market, and which are obviously not just about one person's knowledge at a given time. This paper presents the practical activities carried out at the "Integrated Circuit Verification" subject, which simulate the work on an industrial project. The teacher has adopted a modern way of working with students, using various online platforms. Modern methods of interaction between teacher and students, which have become increasingly common during the pandemic period (Barrot & Acomular, 2022), can be very effectively used to increase students' interest in the taught subject. However, face-to-face meetings in the university laboratory remain a key factor in ensuring that students have a good understanding of what they have to do.

The object of current study is to assess the appropriateness of introducing more industry-specific aspects of work into higher education classes. The subject of our study is to create a more efficient and pleasant working environment for students during Integrated Circuit Verification classes at an IT faculty.

The main objective of the current work is to evaluate the different effects of introducing some industry-related working methods in IT classes

considering several didactic aspects. This main objective can be split into the following sub-objectives, in order to better assess how the new learning process raised the quality of the didactic process:

- to find out if the evaluation method was considered fair by students.
- to assess the quality of information transmission process
- to evaluate the interest of the students regarding the taught object
- to assess how students have adapted to the modern working methods introduced in the teaching process.

The paper is further structured as follows: in the section “Literature Review” some modern teaching means and methods are presented. The section “Materials and Methods” introduces the didactic activities whose outcome is presented in this paper. The “Results” section covers the technological aspects, industry-specific tools and modern methods that have been used to increase students’ interest in the courses. The benefits of these methods are also described and are supported by student comments extracted from the questionnaire. The “Discussion” section shows how the objectives for improving the teaching process were achieved, taking into account how students benefited from them. The “Conclusions” section shows how the paper aim was met and summarizes how Functional Verification classes improvement objective was met.

## **Literature Review**

There are many attempts in our society for searching more efficient ways to transfer knowledge and create competences for the students in higher education. A large part of these initiatives involves a deep use of technology inside the learning process, provided by teachers who are IT qualified (Kaminskienė et al., 2022). For example, in Kertész (2015), a collaborative learning experience is presented, where students at a programming laboratory are requested to upload their work during semester on GitHub platform. In this way, the students can see and comment on each other’s projects, can get faster help when they encounter problems (from both the teacher and their colleagues) and can benefit from a professional coding system. One of the major benefits of using GitHub is the versioning system in place, which protects students from accidentally losing or damaging their work. Also, according to Kertész (2015) and many other studies, this platform makes teamwork more efficient during classes, the students being able to work in parallel on the same project. Kertész (2021) is another work where the educational process is powered up efficiently, using

technology. The author created a Wiring framework, which contains high-level functions pretty familiar to the students, thus easing their work with the microcontrollers. By creating this framework, the students can better focus on the laboratory theme (prototyping of different applications). Therefore, the work in Kertész (2021) can represent an example for adapting a working environment to make it more appropriate for the educational process. Searching for such examples of successful teaching methods, professors can make a fruitful analysis of their own didactic process, being able to find ways of improvement (Janson et al., 2022).

The software used for teaching highly contributes to the transmission of the information to the students, too. The tools used in classroom or for homework must stimulate the students' creativity and interest. The authors of Chamunorwa et al. (2022) used LabVIEW programming environment (Cotfas et al., 2014) in combination with SystemLink Cloud, aiming to create an ideal ecosystem for remote laboratories and IoT designs. The designed prototype circuit described in this paper combined with the NI myRIO provides a useful experimental platform for undergraduate electronics classes. It proves to provide versatility and flexibility because it allows connection of different sensors through the Pmod connectors. Also, the authors of Chamunorwa et al. (2022) claim that this ecosystem is useful for students with limited access to expensive lab equipment, and it is an excellent platform for remote laboratories.

Similarly, the authors of Samoila et al. (2022) focused on Virtual Organization of Remote Experiment Networks. The emergence of software that turns the computer into a device for measurement and control (LabVIEW, VEE Pro) cancelled limitations of the simulation and introduced the notion of remote experiment. The authors of Samoila et al. (2022) affirm that transformation of Remote Experiment network in Virtual Organizations changes the student's position towards Remote Experiment. From the consumer and memorizer of the information provided statically by the teacher, he can become a creator of knowledge. The fact that the creative teams of Remote Experiments are mostly from the university environment, makes graduates more easily fit into the advanced trends of the industry and especially those required by the development of IoT.

Also, the study in Auer (2022) outlines the initial and ongoing steps of the research work to design and implement a relatively inexpensive remote laboratory platform for electronics engineering students. The functionalities presented show that PSoC and LabVIEW ecosystems are suitable for use in Electronic engineering laboratories, as they can be adapted for various courses

and concepts. The courses include digital and analog electronics, the Internet of Things, and communication protocols concepts.

According to Ogrutan & Dinu (2021), the introduction of Arduino software and hardware in education of engineers increased the students' interest for electronics, too. By writing only a few lines of code, different projects consisting in one microcontroller and some peripherals can be setup, allowing students to practically test different interesting electronic systems.

## **Materials and Methods**

Over the course of a semester, which included ten weeks of work, students had to learn the basics of functional verification. The learning process was accompanied by the use of modern tools, which are commonly found in industrial environments.

### ***Context and participants***

The “Integrated Circuit Verification” laboratory presented in this paper has been designed to emulate working in a team that carries out its work in industry-like conditions. This was accomplished through the use of the Microsoft Azure DevOps platform, which allowed students to have a clear view of the work they needed to do, track both the progress of their work and the progress of their colleagues within the same team, have a technical communication with their colleagues and the teacher in order to solve problems encountered, and be able to alert their teammates responsible for errors discovered during verification.

The theme of the laboratory activities, in which 39 students from Transilvania University of Brasov (Romania) participated, was the creation, design and verification of a digital module which forms an electronic system. The subject of the laboratory activities is very topical, given the huge demand for devices incorporating integrated circuits (Constantin et al., 2021) present in all domains (Dinu & Ogrutan, 2019).

In this perspective, students were taught the verification language SystemVerilog (Mehta, 2021), the most widely used verification language in the industry (Foster, 2020). Students were given a set of minimum requirements as to what the project to be designed should contain:

- Implementation of a communication protocol for at least one module interface.
- The design logic should comprise a machine that has a minimum of four states.
- The project also implements mathematical operations.

Then, given some brief examples, they took part at a brainstorming session in which they were asked to conceive the operation of a simple digital project. This brainstorming session and the discussions between students and teacher which followed this aimed to develop students' creativity and technical logic.

Students used the EDAplayground platform, which is also used at other universities (Spertus, 2021), to write code and simulate the project during the laboratory activities. In this way, they had access to commercial simulators that are also used by companies in the field. Also, using this platform, students in each were able to work on the same project provided they did not write code simultaneously. This was a great advantage as students were not dependent on any laboratory infrastructure, but were also able to work for the project from the comfort of their own homes, completing the remaining tasks for the physically held laboratory at the university.

### ***Instrument and data collection***

In order to objectively analyse the outcome of the activities carried out, the opinions of people from three areas that influence and are influenced by the teaching process were collected: students, teachers from the same department in the faculty and representatives of companies recruiting future employees in the field of IC verification.

Student opinion was obtained by asking students to complete a voluntary anonymous 14-question survey that was developed using Google Forms. The survey was submitted for completion after grades had already been recorded in the grade book. The welcome opinions of teachers and representatives of companies in the field came after they had participated in the presentation of the students' projects. They appreciated the teaching activities and their outcome and, based on their experience, provided feedback (mostly via email messages) to help further improve the performance in the functional verification classes.

### ***Data analysis***

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## **Results**

The outcome of introducing more industry-related working methods in didactic activities from "Integrated Circuits Verification" classes can be evaluated by consulting the direct and indirect feedback received from both students and other advised persons that were able to understand the students' activities. The specific characteristics introduced during didactic activities in focus are further analysed one by one, and their effect over the educational process is evaluated.

### ***Working in teams***

The benefits of teamwork are highlighted by numerous studies in both academia and industry (e.g. (Bamber et al., 2003; Marin-Garcia & Lloret, 2008)). Teamwork entails a dynamic Project Based Learning (PBL) approach (Ogrutan, 2014) that involves students in investigating real-world problems (Blumenfeld et al., 1991). On the other hand, teamwork is empowering: if someone falls behind on what they have to do, it pulls the whole team back. However, if the team's organization is flawed, even good students will be demotivated in carrying out a task. It is therefore the responsibility of teachers who organize their practical activities in this way to ensure that student teams are functional, do not inhibit the personality and mode of expression of individual students, and that team members are able to communicate when they need to with each other effectively.

We believe that an important factor in the cohesion and success of the teams participating in the practical activities presented in this paper was the freedom to choose teammates. Thus, students being closer friends were able to associate, and thus group communication went more smoothly. The advantage of forming teams without the intervention of the teacher was mentioned by the students when they were asked, through a questionnaire, after the end of the didactic activities if teamwork was advantageous: "Teamwork was very welcome, especially because we could choose our teammates", "It was good to choose to work in teams and choose our own teams".

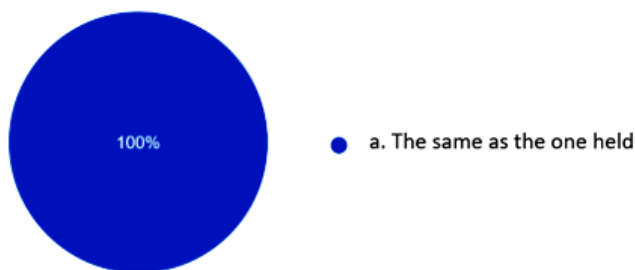
On the same question, out of 21 answers, 19 students appreciated working in teams and 2 students gave neutral answers (e.g. “It depends. In some cases, some members work more than others, tasks should be shared equally. But it was good that we could help each other”).

Each team was characterized by the clear definition of its members’ roles. At the beginning of the teaching activities, the available roles in each team were presented: an architect, who has the tasks of producing the project documentation and the files for the interfaces; a designer, who has the tasks of implementing the electronic circuit in Verilog language and solving the problems found by the other team members during the verification; and three verification engineers, who have the tasks of developing the verification environment and implementing the verification scenarios described in the documentation. We believe that being able to choose their roles also made students more responsible for their work during the semester. The tasks for each student were written on the online platform used to manage the project, so that both the team members and the teacher knew from whom they could get relevant information on a particular aspect of the project. At this point, the application of “jigsaw” didactic method can be recognized: the students are split in several teams, each member in team has one of the three possible roles, in which the participant becomes expert during the semester. Three groups of experts can be further created (one for architects, one for designers and one for the verification engineers) in which their members collaborate and exchange information in order to be able to solve the challenges they meet within their initial teams.

The assessment took into account teams and the role each student played. The fact that the practical activities carried out in teams replaced theory in the assessment was one of the things unanimously appreciated by the students, as can be understood both from Figure 1 (the students had the possibility to write a custom answer, too), and from the comment of one student’s response: “I liked the project-based final assessment method, it seems to me the most appropriate in engineering”.

3/14 How would you organise the exam in this subject?

21 responses



**Figure 1.** Students' opinion about the assessment of the subject "Integrated Circuits Verification"

(Source: Authors' own creation, resulting from data analysis).

However, to be successful in teamwork, team members need to aim for good results. Half of the teams formed in the laboratory activities described in this paper (four teams out of eight) performed well and were also nominated by company representatives in the presentation session. The other four teams, although benefiting from the same supportive laboratory conditions, did not perform particularly well. Therefore, we cannot say that working in teams increases the performance of all team members, but we can strongly affirm that this approach to supporting practical activities in engineering can enhance and amplify the efforts of students who want to learn, more than if they worked on their own.

### ***Using online project management platform***

A newly introduced aspect of the laboratory activities compared to the previous year was the use of Microsoft's Azure DevOps platform. It allowed the planning of activities to be carried out within team, facilitates communication between team members, integrates the use of the Git versioning system and provides valuable statistics about the progress of a project.

The tasks were defined in front of the students of each team and put in the *New* column. Then, when the students started working on a task, they would move its corresponding window to the Active column, and when it was finished, they would move it to the Resolved section.

Then the teacher, would check the correctness of the completion of the task, initiating discussions with the team members, and if it was correctly solved, moved them to the Closed column. Otherwise, he moved it to the Active column, and let the student know what they should insist on. However, there were very rare cases when assignments ended up back in the Active column.

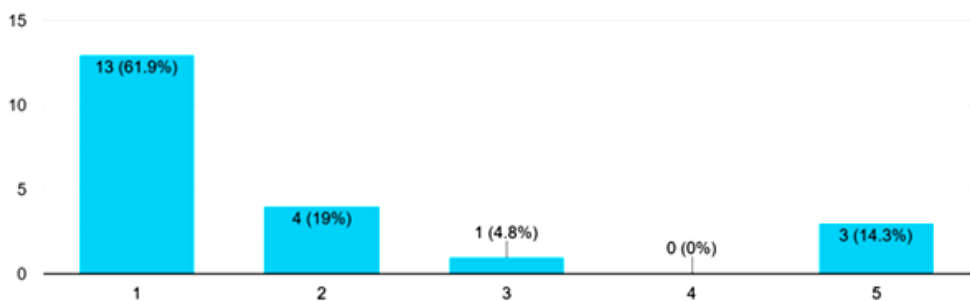
By running the same simulation environment, the students' work was interlinked, and therefore they were able to discover errors even in their peers' code. According to common industry practice, errors found are reported on the platform. The report for each problem contains a brief description of the error, the steps that must be taken for the error to be reproduced, and a screenshot of the waveforms at the time the error occurred.

The Azure DevOps platform can also provide statistics on project progress throughout the project.

The Azure DevOps platform, as well as other platforms produced by other companies that operate on a similar principle, is a particularly valuable aid in organizing projects within institutions. The fact that students have become familiar with how it works gives them a greater familiarity with the environment they will enter by working as programmers, designers or in other fields. Last but not least, when you enjoy what you do you have more fun. The use of this platform was highly appreciated by the students as they themselves confessed at the end of the semester: "Working in a team using a special tool was very beneficial", "By using Azure we could work anytime, we were not limited with a time slot at the faculty or lab", "I really liked the fact that we worked on something like we will do at work, that the professor somehow introduced us to team workflow, that we used Azure, it was something cool". The flexibility of their thinking, which is typical of young people, made it easy for students to adopt it, as can be seen in Likert scale from Figure 2 (Choice "1" represents "Strongly disagree" and choice "5" represents "Strongly agree").

**9/14 It was difficult to use the Microsoft Azure DevOps platform.**

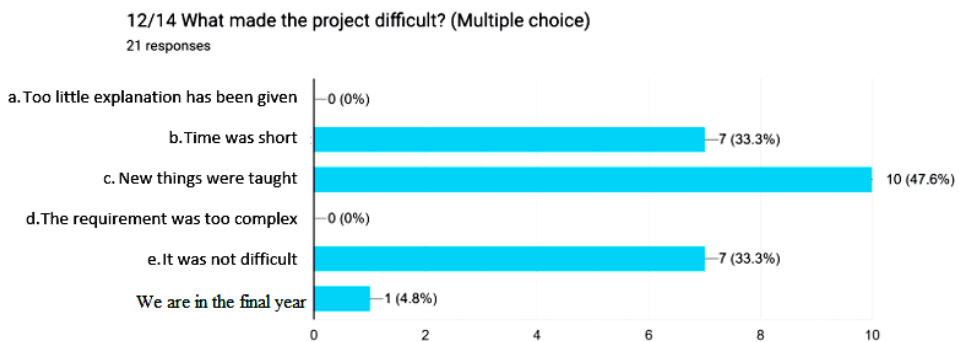
21 responses



**Figure 2.** Student responses on the difficulty of using the Azure DevOps platform.  
(Source: Authors' own creation, resulting from data analysis).

**Teacher availability. Monitoring of student progress throughout the semester**

In the subject “Integrated Circuits Verification” students encountered a number of new things: IC verification and UVM verification methodology, SystemVerilog verification language, documentation of problems encountered during the project and task planning using an online platform. The course materials were also prepared in such a way as to theoretically support the students in what they had to do. Also, throughout the semester, the lecturer sat down with each team individually to explain what needed to be done and answered questions they received both by email and via the Azure DevOps platform (the cumulative total exceeded 400 messages received by the lecturer directly from students or via the platform). This required a lot of time, which would not normally be available for a teacher who supports activities in many subjects each semester. However, it was noted that the constant help provided throughout the semester resulted in students’ increased confidence that they could complete the project, even though it was such new ground for them. This was appreciated by them, as they said in the questionnaire, they completed at the end of the teaching activities: “The teacher’s involvement through the communication with him, through the explanations and suggestions given, through the problems raised that we, the students, most probably would not have discovered was appreciated”, “Teacher gave us a lot of free time, and we had sessions even outside the classes to clarify our terms... he was so open with us and willing to help us so much that he even worked 12h a day for a week”, “The teacher is very involved and always helps us, even outside the classes, with the problems we have”.



**Figure 3.** Student response to the question “What made the project difficult to carry out?” asked in the questionnaire at the end of the semester.  
(Source: Authors' own creation, resulting from data analysis).

Considering both the graph generated from student responses in Figure 3 and the difference between the students' perception of the material in week 3 of teaching activities and their opinion at the end of the semester (Figure 4) it can be said that during classes teacher was able to answer students' main concerns satisfactorily.

Question: how does this subject seem to you in the landscape of the subjects you have this semester?

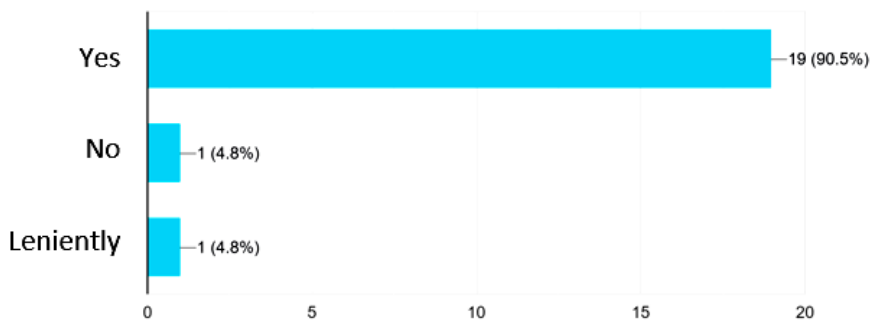
1/14 Looking at the other subjects this semester, Integrated Circuit Verification object ranked:



**Figure 4.** Students' opinion about the difficulty of the subject in the third week of school (a) and after the end of teaching activities (b).  
(Source: Authors' own creation, resulting from data analysis).

The fact that the teacher closely monitored the students' progress throughout the semester was reflected in the fairness of the marks awarded, as shown in Figure 5. Even though the students worked in teams, the teacher knew what tasks each student had to do and was able to assess their effort easier.

2/14 Did the grade you received reflect the effort you put into this project?  
21 responses



**Figure 5.** Students' answers to the question about the correctness of marking during the semester.  
(Source: Authors' own creation, resulting from data analysis).

The students' comments are relevant in this respect: "congratulations for the way the material was graded (although it was a project carried out in teams of students, the grading was done very fairly from my point of view, with each student being rewarded according to the work done)". On the other hand, opinions that show that there is always room for improvement are also particularly valuable, and the organization of the activities themselves influences the quality of the marking: "I have a suggestion related to the project, in the evaluation there was a certain difference between the engineers, some had to work less, others more, and in the evaluation those who had to work more also had a higher degree of difficulty in the questions. A balance should be found...".

### ***Rewarding student effort with more than a grade***

Another factor that contributed to the students' involvement in the didactic activities and, therefore, to their desire to learn more in the subject "Integrated Circuits Verification", was the organization of a presentation session on the next day after the exam, where they presented their projects to representatives of companies in the field. The participation of students was voluntary (for this reason only seven of the eight teams that went through the laboratory participated in the session) and was rewarded with an extra point on the final grade obtained. Seven companies from Brasov and two companies from Bucharest were invited to the project presentation session. The company representatives listened to the students' presentations, asked questions, and formed a common ranking to nominate the best works.

Company representatives gave positive feedback on the organization of this event, which showed that this meeting also helped companies looking for capable graduates to integrate them into the workforce.

The organization of this project presentation session motivated and empowered the students who worked harder, wanting to present quality work, as can be seen in the following text sent by a student to the teacher: "Good evening! I am I. T. from the team with the Numerical Converter and I would like to ask you: Could we have an on-line meeting in order to solve some remaining issues related to the project? We would like to solve them before the exam and to nicely present the project to companies. We are available tomorrow around 3.00 p.m. o'clock. Are you also available at that time? Thank you!". Some students also saw the organization of this event as an opportunity to get a job or a scholarship.

Equally important, fellow professors in the department which also participated at the event appreciated and encouraged the conduct of such activities: "It was a real event. You motivated the students, set up teams and

roles, and achieved what we as teachers have always found difficult: to assess individually those working on a group project”.

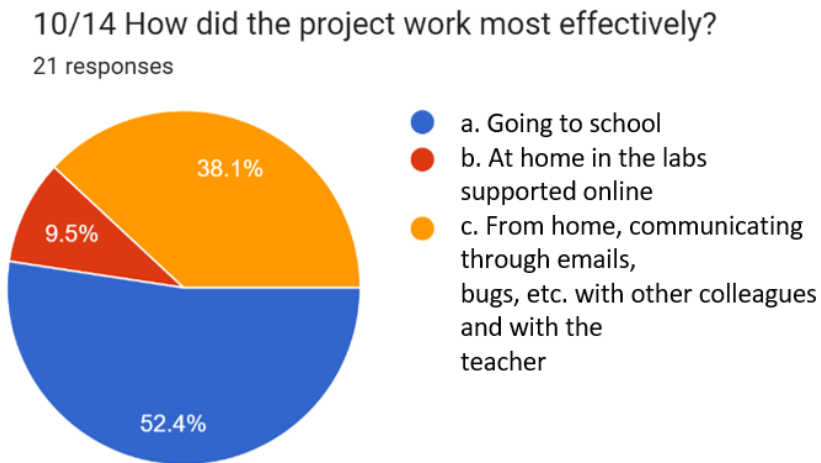
Thus, the students’ work was rewarded with more than a grade. Following the event, students who were interested in a fellowship or a job in the field were invited to provide their contact details to be contacted. Out of the 39 students who attended the lab, 10 expressed their desire to be contacted by companies. Of these, at least two students have started a work placement with one of the companies present at the project presentation session: “after the subject I had with you this semester and after getting an internship in this field I started to be more attracted to the field of verification, Verilog”. Although they put in extra effort, done in parallel with working on their diploma project, the students appreciated the initiative to hold such a session to present the lab’s work in front of company representatives and encouraged the continuation of such events for their peers in younger years: “Keep holding such sessions with companies”, “Professor has done for us ... from taking care of us to trying to give us a start in our testing careers to those of us who want it by meeting with companies that deal with it. BIG THANK YOU!!!”.

### ***Hybrid support for practical activities***

In view of the restrictions adopted during the pandemic, Transylvania University has decided that in semester 2 of the academic year 2020/2021 that theoretical activities will be held online, and practical activities will be held in physical format.

In case of the activities presented in the current paper, the practical activities were held in physical format. However, at the end of the semester, using some lecture hours as well as at the request of the students, practical activities were also supported online. In addition to the in-class work, students were able to work on projects outside of class, communicating easily via the Azure DevOps platform.

Thus, they were able to evaluate which of all the approaches tested gave the best results. As expected, and as shown in Figure 6, only a symbiotic relationship of several methods of delivering learning activities can successfully meet the students’ knowledge accumulation needs.



**Figure 6.** Students' views on supporting teaching activities in different ways.  
(Source: Authors' own creation, resulting from data analysis).

### ***Improving didactic activities based on feedback received***

Although some of the student comments so far have been laudatory about the work in the subject “Integrated Circuits Verification”, it is also worth mentioning the role of the comments of those who had some dissatisfaction with the laboratory. These are of great importance for the continuous improvement of teaching activities.

For example, in the comment “I have a suggestion related to the project, there was some difference between the checking engineers, some had to work less, some had to work more, and in the evaluation those who had to work more also had a higher degree of difficulty of the questions. If a balance can be found...” shows that more care needs to be taken in the distribution of project tasks so that no one feels overloaded or discriminated against in the assessment process.

On the other hand, there are also suggestions that do not necessarily call for a change but show that some students do not fully understand the decisions made regarding the teaching activities they have been involved in. One student wrote in a questionnaire that he wished “Each team was given a minimum set of project specifications”. This is just one example that highlights the need to better explain the intention behind certain decisions in the future.

## Discussion

The teaching activities carried out for the subject “Integrated Circuits Verification” had several objectives.

Obviously, the aim was to teach students the notions of functional verification, to understand the usefulness of data transmission protocols and to refamiliarize them with general notions of digital electronics. This objective was achieved by a significant proportion of the students, as evidenced by their ability to present their projects and answer questions from representatives of companies in the field.

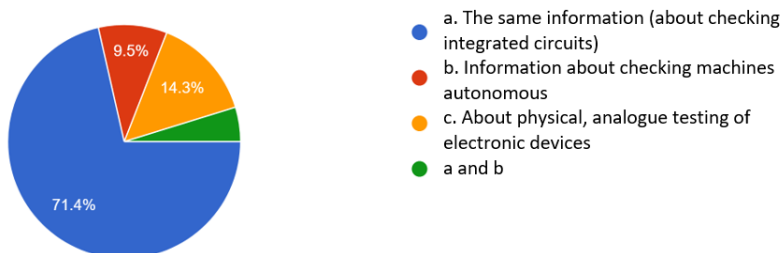
The students’ work has also generated eight verification projects which, after being adjusted, will be published in a public database. Although there are many databases of digital projects, it is rare to find projects where these are also integrated into a verification environment and where the code contains the necessary comments to be easily understood. Thus, the work of the students in this lab will be usable by others who are eager to learn verification or to test some automation attempts in functional verification environments.

First actor which validates the quality of the didactic process in the student-centered learning environment is, without any doubt, the student. Therefore, an anonymous questionnaire, where the participation of the students was optional, was used to collect the opinions of the students. From the point of view of research ethics, this study (in which students had the possibility to complete the questionnaire, to withdraw from completing it without consequences on their status and in which the completion was anonymous) complied with all the rigors, this being also certified by the University Ethics Committee of Transilvania University of Brasov, Romania.

While the very uptake of information by students and its application in projects is an important achievement the students enjoyed working on what they had to do. This important result is also revealed by Figure 7, in which it can be seen that the majority of students would not like to change the notions that were taught in the subject “Integrated Circuits Verification”.

7/14 If you were now at the beginning of the semester, what information would you prefer to receive at this object (multiple choice)?

21 responses



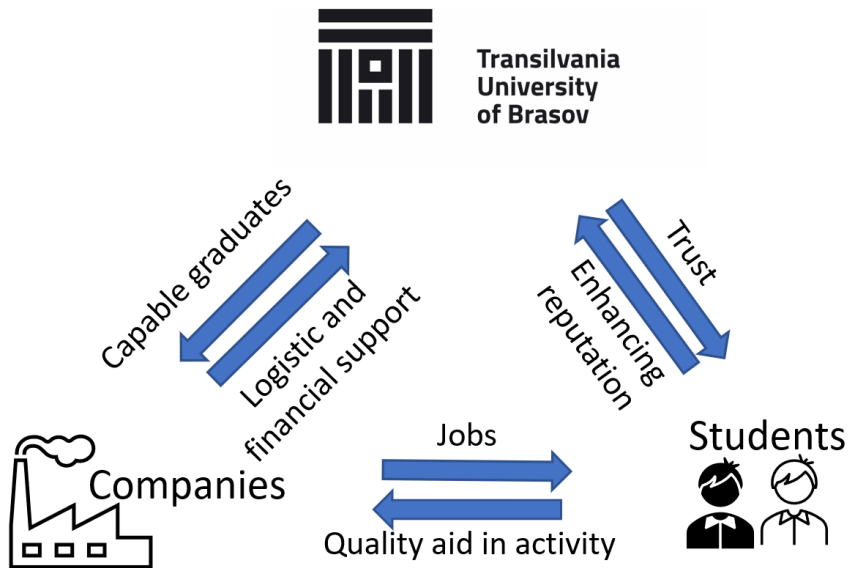
**Figure 7.** Graph of students' opinions on the appropriateness of the concepts taught.  
(Source: Authors' own creation, resulting from data analysis).

Another aspect of the teaching activities is that they were intended to give students an enjoyable experience of teamwork, to understand the advantages of this very common approach in industry and to get used to it with a view to employment.

We believe that this objective was also successfully achieved, both from the point of view of the teaching staff and from the point of view of the students, the vast majority of whom appreciated this way of working. The brief comment of one student is relevant for this matter: "Teamwork was the best".

Furthermore, the requirement for students to document what they have worked on and to present their project in a technical manner has been helpful both in the short term (for writing and presenting their diploma project) and in the medium term (in order to accommodate industry requirements to document for clients or other purposes how they have developed various software or hardware systems).

Moreover, by supporting teaching activities and carrying out the project presentation session, the relationship of the University with companies, of students with companies and implicitly of students with the University could benefit, as represented in Figure 8.



**Figure 8.** Types of relationships that can be improved by supporting students' projects with companies in the field.

According to Figure 8, we consider that three types of links can benefit from scientific communications, such as student scientific communications sessions and events dedicated to a particular technical aspect. Thus, in relation to companies, the University can testify to the preparation of graduates who are capable and up to date with both new technologies and industry requirements. In relation to students, the University is the institution that promotes them as future technical specialists, giving them confidence that what they have learned is applicable in industry. Companies are encouraged to provide both logistical and financial support to the University, knowing that the performance of the educational act will be faithfully reflected in the performance of future employees recruited from among the graduates. In this case, following the project session, one of the companies offered to pay for student access to a more powerful commercial simulator needed to check integrated circuits, another company offered to help at installation of the infrastructure needed to use the simulator, and representatives of two other companies offered to help practically improve the theoretical and practical activities of the subject "Integrated Circuits Verification". Also, as was the case here, companies offered students the opportunity to apply for a training or fellowship position which could then lead to contractual relationships. The students created a good business card for the University by participating in the project presentation session, demonstrating to companies that they are

capable of tackling technical tasks with seriousness. In this way, they showed to company representatives that they are keen to continue their scientific development, using the technical foundations obtained at the faculty. Summarizing the above, it can be said that all parties participating in the project presentation session benefited, improving the cohesion between these interdependent fora.

Also, soliciting students' opinions on aspects of the conduct of teaching activities, proved to be beneficial. For example, students were asked their opinion on whether to organize the project presentation session, and the answer was in the affirmative. Gaining students' "complicity" in certain issues improves the degree of teacher-student collaboration and therefore leads young people to speak their mind in other situations.

Although the methods used to create an industry-oriented teaching activity achieved their purpose, the limitations of this study should also be pointed out: the proposed methods were validated for only one semester, on 4th year Applied Electronics students in one university, and all students belonged to an IT faculty. For this reason, a question arises: can the results be representative for a larger number of students from universities in different countries and for graduates from different engineering and non-engineering fields? Given the success and enthusiasm of the students after they participated in this experiment, the authors intend to repeat this type of activity organisation to cover a larger number of students and to validate the proposed methods in different learning contexts.

## **Conclusions**

This study has shown how the use of several means of enhancing the learning process (e.g. using online tools for writing code and running simulations, using a dedicated platform for task management and error tracking, creating teams where students have well-defined roles and a good overview of their tasks and the errors found) can lead to the creation of successful industry-like experiences for students at university, which will make graduates have an easier adaptation to the workplace in their field. The proposed activities, which combine the benefits of technology with good organisation within the companies, provided the students with an appropriate and enjoyable learning environment in which eight interesting and comprehensive projects were developed. The feedback received from students, teachers and industry representatives who evaluated the students' projects shows that the approach presented in this paper has great potential in effectively conveying information and building skills for the new generation, while helping graduates to adapt more easily to jobs in their field.

The didactic activities in the subject “Testing of electronic equipment” aim at enriching students with some of the skills needed by employees in the field. Using state-of-the-art technologies, the practical activities developed functional verification projects that the students, having acquired the necessary basic knowledge, had the confidence and desire to present to representatives of companies in the field. The organization of the work in teams, the focus on the practical implementation of the theoretical notions learned, the management of the whole project using the Azure DevOps platform forged by Microsoft are just some of the things that attracted the attention and involvement of the students, making their work more exciting. It has been demonstrated that during the teaching activities, students have mastered key elements of academic communication, demonstrated that they can participate in technical projects successfully if they are given the right support and can positively represent the group they are part of.

Finally, it can be said that the success of a teaching activity is a symbiosis between the students’ desire and effort to learn, the helpfulness of the teaching staff who should be a reliable support available whenever needed, the availability of state-of-the-art technologies in the industry and the solid infrastructure through which they are accessed, and the creation of healthy links with the business environment.

Under these conditions, one of the driving forces of change for the better in teaching activities will increasingly be on students’ lips: their satisfaction expressed as in the sentence: “Honestly, they were my favourite course and laboratory” (extracted from the questionnaire filled in by the students at the end of the teaching activities).

**Acknowledgement.** The authors thank Professor Petre Lucian Ogruțan for his valuable insights into the teaching process.

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**Alexandru DINU** – Lecturer at Department of Electronics and Computers at Transilvania University of Braşov, Romania. Teaching about communication protocols and computer interfaces and peripherals, he is mostly interested in digital design and embedded programming. He is the co-author of two books and several research articles with technical and higher education topics.

**Ştefania Cristina GHIOCANU** – University Assistant at Faculty of Sociology and Social Work at University of Bucharest, Romania. She is interested in demonstrating that eastern orthodoxy is a resource of ethics and social sustainability for the challenges faced by the digital transformation of society and in developing policies aiming to combat youth unemployment.

**Horia Alexandru MODRAN** - PhD in Electronics, Telecommunications and Information Technologies and associate lecturer at Transilvania University of Brasov. He holds a BSc and a MSc degree in Computer Science from the Transilvania University of Brasov, Romania, obtained in 2014 and 2017, respectively. Horia Modran also works as a software developer, with 7 years of experience in this area. His research interests are artificial intelligence, bioinformatics, cloud computing, and remote-controlled systems. He is the author or co-author of several papers published in international journals or international conferences proceedings.