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Technological innovations and the transformation of Biology education technology - The Vision for the future of the Albanian educational system

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Abstract

The study is about how technological advances are being used to teach biology in the Albanian school system, and how it will change in the future. Technological advancement has the potential to considerably improve learning and teaching experiences as applied in education. The results were based on the 'National programme for the professional development of teachers', initiated by the quality assurance agency in pre-university education in Albania and the Ministry of Education and Sports. During a two-months period almost 140 teachers were trained. The study will also contain the final results and evaluations of the teachers, as well as parts from the worksheets and biology-related stimulations, that are becoming more and more important nowadays to create a better learning environment for students. It examines up-and-coming technologies such as interactive digital platforms, and advanced simulation tools that have impacted biology education. It also shows how these technologies can increase student involvement, make learning more immersive, and improve comprehension of intricate biological concepts. The research further looks into issues like limitations on infrastructure, teacher training and curriculum development. This study therefore should offer suggestions for aligning these advancements with the Albanian educational framework by proposing a strategic vision for the future. This vision aims to update biology instruction so that it becomes in-house with modern scientific achievements hence making students well prepared for tomorrow's science-based industries.

Keywords: technology, professional training, students, biology-related stimulations.

1. Introduction

In an ever-evolving education system, the role of teachers transcends traditional

boundaries. Today's teachers are tasked not only with imparting knowledge, but also with cultivating critical thinking in science and ICT. Embracing this dynamic challenge requires commitment towards lifelong learning, making continuing professional development a must for every teacher. STEM as an interdisciplinary educational approach integrates four fields: Science, Technology, Engineering and Mathematics. The goal of STEM education is to provide students with lasting knowledge and skills and integration in these areas, fostering critical thinking, problem-solving skills and creativity. STEM education also includes hands-on learning, real-world applications, and collaboration to prepare students for careers in fields that require skills in science, technology, engineering and mathematics. The digital revolution has reshaped the educational paradigm, making digital skills an aspect integral to contemporary teaching. Professional development in digital skills equips teachers with the tools to integrate technology by creating interactive learning environments and attractive. From coding to digital collaboration, teachers become proficient in preparing students for a future where digital education is a prerequisite.

Continuing professional development of teachers in the fields: 'Science and Technology, is not just a professional obligation, but a transformative journey. In this context, it is necessary to unite all institutional and human resources in order to ensure that teachers are equipped with the necessary knowledge and skills to cope challenges of the time and to provide a quality education for students. This can be achieved by means of the national program for the professional development of teachers, in which there are clearly defined objectives and expected results, all training needs are addressed and roles are assigned and responsibilities for each participating actor.

Through targeted initiatives in the national professional development program, not only improved teaching methodologies, but also a culture of lifelong learning inspired students, to shape a future where education is synonymous with innovation, curiosity and limitless possibilities.

As training the teachers in a more technologically-oriented way is considered one of the most important factors that will develop a better learning environment for the students, two modules were carried out in Albania, by qualified professors of different universities. Regarding the University of Shkodra: 'Luigj Gurakuqi', some of the most qualified professors carried out two modules. In biology a total of about 140 teachers from different regions of North of Albania were trained, specifically:

- 43 teachers were trained in Tropoje;
- 42 teachers were trained in Kukes;
- 32 teachers were trained in Lezhe;
- 23 teachers were trained in Shkoder;

The modules include:

- Module 1: „Using effective teaching-learning methods in Biology“;
- Module 2: „Improving the quality of teaching-learning with a focus on the implementation of biological knowledge in real-life situations“;

An example of the use of technology is the simulations through computer games,

where students play and through the internet navigation game they manage to understand many different and special topics in an easier and more appealing way. Thus, they will better develop critical thinking and problem solving skills. By using technology in the constructivist approach, teachers find it easier to engage students in the acquisition of knowledge.

Technology is more than another way of presenting information, it is the contemporary form of interpretation of knowledge. Technology, as part of the constructivist theory of teaching, is the framework of the teaching/learning methodology which ensures the interest of the students, their active involvement in the teaching-learning process and thus the increase in the effectiveness of this process.

After the analysis regarding the outcome of the training, valuable information was achieved, where to mention some of the result with the highest importance would be: During the training, satisfactory results were achieved based on the improvement, which was obvious, as the teachers had the possibility also to discuss about the methods they actually use. At the end of the training, the teachers were tested and received a score for the completed test. All the teachers have been quite interested and followed closely sessions, worked with worksheets, discussed and gave examples of model lessons realized by them.

The discussions of the problems that they raised and the examples of the teaching hours that they completed, will encourage the participating teachers, increase the quality of teaching-students biology courses. After the training, a test of the students was carried out, regarding the effect of this study. The tested students were at the same progress level in the subject of biology, but of different classes from the point of view of the training of their teachers. The results showed an increase in the quality of teaching and students' interest in classes that had biology technology-trained teachers.

2. Material and methods

2.1 Materials

In order to carry out an effective training of teachers regarding the use of technology in improving the quality of teaching in biology, different materials were used that consist of:

- Materials of Training Modules;
- Technology and Didactic Tools;
- Examples of simulations that are suggested to be used in special topics, issues and concepts that are difficult for students to master;
- Examples of lessons realized by the teachers themselves that were demonstrated by the teachers, according to work groups;
- Sources and literature that demonstrate teaching practices through technology are used;

2.2 Organization of Trainings

The trainings were organized in four different cities in the north of Albania: Tropoja, Kukës, Lezhë and Shkodër. Each city had a group of teachers engaged in training, which included a total of about 140 biology teachers. Each training module was developed in two days of 4.5 hours. Each group participated in two training modules that included theory and practice related to the use of interactive methods in teaching biology.

2.3 Methods of Analysis of Test Results

Some methods of analyzing test results of teachers and students are:

- Quantitative Analysis: Statistical processing of teacher test results was done and this served to understand the value of training, in knowledge and skills.
- Analysis of the Success Rate: The percentage of teachers who achieved a satisfactory result in the training tests was calculated through different available methods.

3. Analysis of results

The results of the tests and the analysis of the discussions with the teachers served to evaluate the impact of the trainings not only in improving the quality of teaching, but also in the engagement of students in the acquisition of biology knowledge. The evaluation of teacher's training impact was based on a comparison test between the students results of different classes but with the same knowledge level. After the implementation, changes in the academic performance of students were measured. 43 teachers were trained in Tropoja. In Kukesi, 42 teachers were trained. 32 teachers were trained in Lezha and 23 in Shkodra.

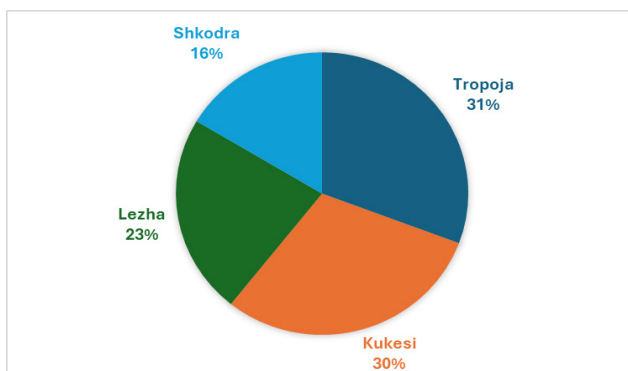


Figure 1: Graph presenting in percentage the number of teachers accepted in each of the regions in which the training took place.

The trained teachers at the end of the training were tested to notice the efficiency of the training, but also to understand if the final goal of the training was achieved. Thus, after testing the teachers, these results were reached:

- 107 teachers received very good results;
- 18 received good results;
- 9 teachers received satisfactory results;
- 6 teachers received sufficient results;

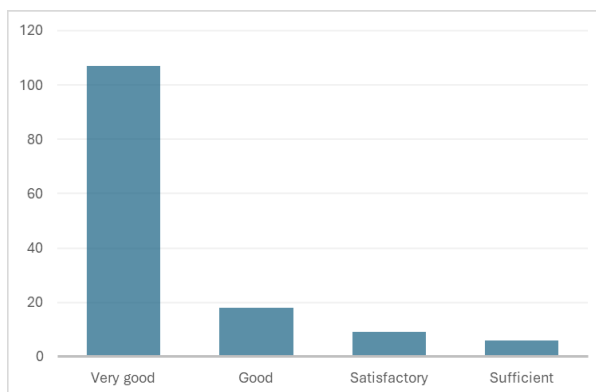


Figure 2: Graph showing the results of teacher testing and the comparison of the number of teachers who received a certain grade with another.

After the testing, it was necessary to understand if all this, had an impact on the students, who are the most affected by this training. For this reason, the students of a school in which their teachers were not trained were tested with a school in which the teachers were trained. The data were then compared, as can be seen in the graphs below. The results of the students in school in which the teachers were trained are as follows: 423 students took part in the test. 57 students were evaluated as very good, 120 were evaluated with good, 179 as satisfactory and only 67 as sufficient.

In the school where the teachers were untrained, a number of 386 students were tested, from which the following results were achieved: 36-very good, 74-good, 188-satisfactory and 78-sufficient

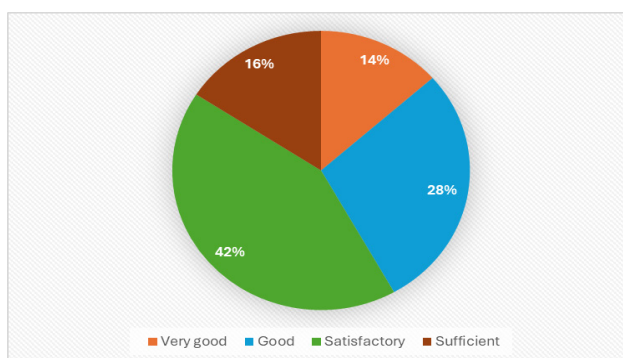


Figure 3: Graph showing the percentages of each assessment for students who had teachers who were previously trained.

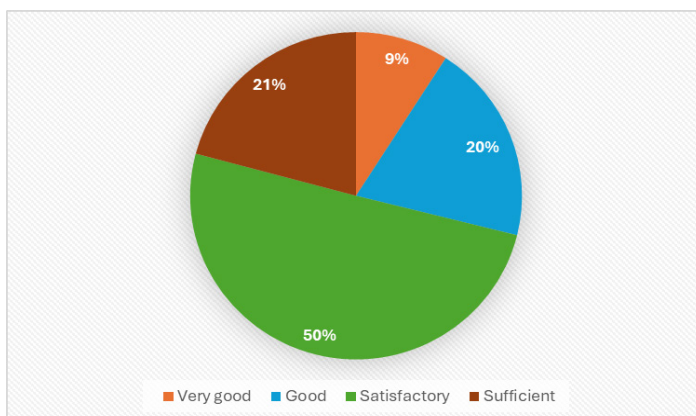


Figure 4: Graph showing the percentages of each assessment for students who had teachers who were not previously trained.

4. Conclusion

This study highlights the important role played by technological advances and the professional training of teachers in the growth of education in Albania and that of biology in particular. The integration of digital platforms and simulation tools in the classroom has opened up new opportunities for student engagement, fostering a more inclusive and interactive learning environment. As reflected in the data, students whose teachers received technology-focused professional development performed better in biology compared to students taught by teachers without such training. Improvement was noted in all performance categories, from “very good” to “sufficient”, demonstrating the effectiveness of these educational reforms. The training of 140 teachers in different regions of northern Albania is at the center of this positive impact. Post-training evaluations of teachers showed tremendous engagement, with 107 teachers rated as “very good” and 18 as “good,” indicating that the majority understood the new methodologies effectively. More importantly, these teacher assessments corresponded with improved student outcomes.

In schools with trained teachers, 57 pupils achieved a ‘very good’ grade in biology, compared to just 36 in schools with untrained teachers. This suggests that technology integration not only improves the quality of teaching but also increases student performance. The use of technology in biology education has proven transformative by making complex biological concepts more accessible. Digital simulations, interactive platforms and hands-on tools allowed students to understand challenging topics more effectively. This shift also encourages the development of critical thinking, problem-solving skills, and creativity—key components of STEM education. Furthermore, using real-life applications through simulations increased student engagement, helping them better understand the importance of biology in everyday life and future careers in science and technology. The challenges indicated by the study are mainly seen because of the limitations in infrastructure and the need for

continuous curriculum development to accommodate technological advances. While the initial training was successful, maintaining this momentum requires continued support for teachers and investment in educational technologies. Furthermore, the curriculum must be developed to integrate new tools and techniques that match the rapid pace of scientific progress.

Acknowledgment

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