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Promotion of STEM education through STEM clubs in Georgia

Medea Abramishvili
National center for teacher professional development, Georgia

Abstract

Applying STEM teaching principles to schools is not an easy process due to the traditional characteristics of today's education system. One thing is undoubtful, working on an interesting project requires appropriate skills, space, and time. Unfortunately, it is not common for teachers of different subjects to collaborate at the level of a joint curriculum. STEM projects do not recognize "subject boundaries", children use their versatile knowledge and experience while finding ways to solve life problems. Based on these factors, we at the National Center for Teacher Professional Development believe that the first step for STEM teaching promotion in a Georgian school is non-formal education. That is why STEM club, named "Chkhirkedela" club was established. The goals of the club are: to strengthen such a strong form of non-formal education on a school basis, such as club work, and to connect it with the teaching process, increase the professionalism of teachers in STEM approaches in the learning process, increase students' motivation and involvement in the teaching of science subjects. The concept of our program and club work is based on the involvement of children in the teacher professional development system. During meetings, the student gets the first experience of working with electronic components, working with microcontroller Arduino and its programming, gets acknowledged with the project ideas and their connection to solving important life problems – such as traffic in cities, environmental pollution, health and safety, poverty and hunger control and other issues. We talk about the problems of the world and the sustainable development of our country.

Two years of work with public school principals and teachers has shown that principals financially support STEM activities in their schools, as creating such activities require far less financial support than buying one whole Physics, Chemistry and other labs, and they see the main benefit - all students in the class can participate in such activities at the same time. Also, teachers who started their STEM activities with club work have developed the skills needed for such activities and are now incorporating STEM activities into their formal education.

Keywords: *STEM, club working, non-formal education, teacher professional development*

1. Introduction

The world continues to change. If in previous centuries a person needed to have traditional literacies (reading, writing, speaking, calculating skills), in the XXI century, a human of the technological era needs to have more technical skills to be fully adapted to everyday life [3]. On the other hand, it is crucial for the country to build a strong economy, and nowadays it is generally recognized that for economical well-being the STEM education must be the decisive topic [1].

STEM education is an approach that can equip modern humans with the appropriate skills. However, when it comes to its implementation into practice, it often causes some misunderstandings because there are many beliefs and attitudes of what STEM education is and how it should be taught [6]. Another issue is the way how to implement STEM approaches into formal education.

2. Challenges of STEM education in Georgia

To successfully implement STEM activities into formal education, teachers' motivation must be considered in the first place. "Taking teachers' motivating style into account in the future educational initiatives regarding STEM, is highly relevant as

a way of stimulating students' motivation and engagement“ [4]. Students' attitudes towards STEM subjects are entirely depended on what the teacher's viewpoint is. That is why the National Center for Teacher Professional Development (Teacher's house) in Georgia aimed to train teachers in this field.

Every new initiative in a Teacher's house begins with the research of the study. Research has also been conducted on STEM education and several issues have been identified in relation to the introduction of this approach. Among the reasons given by public school principals and teachers, the following are common: The school does not have a proper laboratory or has one, and it is in a bad condition; Such an approach takes extra time and the school does not have a person to lead the STEM projects; teachers themselves do not have the extra time for that [7]. Also conducted trainings showed us that from STEM subjects teachers need the most help in the field of technology. For many teachers, the word "technology" is connected just with a computer and that is why they feel uncomfortable and try to get rid of it [6].

That is why the STEM club was formed on the basis of the Teacher's House “Chkhirkedela” (translation of "chkhirkedela" in English is Tinkering), as an example of how one can take the first steps in introducing STEM education so that neither the teacher is discouraged from learning the new things and students' desire to master the STEM subjects is increased. The goal of the club is: to strengthen such a strong form of non-formal education on a school basis, such as club work, and to connect it with the teaching process, increase the professionalism of teachers in STEM approaches in the learning process, increase students' motivation and involvement in the teaching of science subjects. Another important fact that the work of the club helps to improve is the increase of the cooperation between the teacher and the student. STEM clubs are a "safe" space for students to explore, fail, and persevere while gaining confidence in STEM fields because there are no tests and grades as well. Teachers are free to be more creative and have the opportunity to struggle in solving the problem by helping students and even feel the failure [8]. The fact is that modern students are much better at mastering the technical means and therefore can more easily catch the basics of coding or electrical engineering than the middle-aged or elderly ones, in this case, teachers. This is why the educational system had to face the fact it has become necessary to have a teacher as a facilitator who uses a creative approach in the teaching and seeks to demonstrate students' skills through accumulated experience. STEM teaching requires a fundamental shift away from teacher-focused education to student-focused education [2]. Moreover, nowadays students go to school with knowledge of programming (and not only), and their involvement as "colleagues" in the teaching process will also be another successful step in the educational space. This does not mean that the teacher's reputation is anyhow damaged. This shows the change of the era and if we want to keep pace with the changes we have to change the teaching process so that both the teacher and the student are driven by the same goal. This goal is to develop a full-fledged person who, after graduating from school, will be prepared for life and will be able to meet life challenges.

3. Working style of STEM club “Chkhirkedela”

At “Chkhirkedela” club we pay special attention to the visits of groups of school teachers and students. During these meetings, a student gets the first experience of working with electronic components, with microcontroller Arduino and its programming, gets acknowledged with the project ideas and their connection to

solving important life problems such as traffic in cities, environmental pollution, health and safety, poverty and hunger control and other issues. We talk about the problems of the world and the sustainable development of our country. The first step club members took was the introduction of microcontroller Arduino to teachers and students. We have short-term and long-term STEM trainings for them. The Arduino is chosen, because it is made for educational purposes, gives the opportunity to make wealthy products on the basis of school. Our trainings are divided into parts. The first part is about getting to know what STEM is itself, how to make it a part of school life. The second part is about the description of Arduino and electronic components. Teachers and students make easy projects to understand how to use them. The third step is about getting to know how to code Arduino and make automatic projects. The last step is about how to make STEM projects. Participants of the training have to make a plan of the automatic project, write its purpose and connect to everyday life. As it was mentioned harder parts for teachers are electronic engineering and coding, however, their strong point is that they have knowledge of science and can describe scientific phenomena from Physics, Biology, Chemistry, etc. On the other hand, modern students have the skills to study coding and electronic engineering faster. That's why collaborating between teachers and students is crucial for the contemporary studying process.

4. The influence of competitions on students' interest in STEM subjects

There is a lot of research on the fact that STEM competitions and science exhibitions have a positive effect on students' attitudes towards STEM subjects and increase their career connection with STEM fields. STEM competitions and science exhibitions give students an opportunity to share their work with one another. Especially when students see the innovative work of their peers, they get motivated to become more familiar with STEM subjects and realize that they also can create something new, that innovation is not rocket science and that it is based on the basics of the STEM subjects taught as a subject in school. Gomez discovered that science fairs give an opportunity to students to gain more information about their spheres of interest and found out how to organize, analyze, display data, and develop presentation skills [2].

That is why Teacher's House, organizes competitions, exhibitions and also groups working in the club take part in various competitions. One such finalist project was the automatic hydroponics system assembled by the teacher and her students at the club which was controlled completely remotely, with an app created by the students. While working on a project students learned several phenomena from different subjects: plants life processes from Biology, they assembled automatic water and fertilizer delivery system using different sensors, where they used their knowledge from Physics, they found out information from Chemistry while were searching which microelements were needed for the plant they wanted to rise, students used Math skills while creating a drawing for a 3D printer and calculating the price of prospective production, finally, ICT skills were needed for programming Arduino. It was interesting how the teachers and students had responsibilities assigned to their own strong "points".

5. Conclusion

The work of the club "Chkhirkedela" established at the National Center for Teacher Professional Development for two years showed that club headteachers, trained by club staff are doing more STEM projects in schools than ever before. Teachers

themselves are no longer "afraid of " technology, in addition to increasing acceptance to learn and introduce technologies in the teaching process, they also wish their students, who have better knowledge in coding, to assist in the teaching process and create STEM projects with joint efforts. Principals, on the other hand, see what the positive side of STEM teaching is, and try to carry out different activities at the school, considering the school budget. Two years of intensive work has shown us that promoting STEM teaching through clubs was the right decision and the fact is that Georgian teachers are more confident thanks to this approach and more students are interested in STEM subjects.

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