




© 2023 Jashari. This article follows the  Open Access policy of CC BY NC under Creative Commons attribution license v 4.0.



Submitted: 09/07/2023 - Accepted: 09/08/2023 - Published: 29/09/2023

## **Some practices from STEM education and the incorporation of some SDG goals in the educational process in the Republic of North Macedonia**

**Hasime Jashari**

Primary School Simche Nastovski, Tetovo, the Republic of North Macedonia, Institute of Biology, Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius

Email: jasharihasime@gmail.com

### **Abstract**

Interdisciplinary integration as a form of STEM (Science, technology, engineering, mathematics) education including the combined learning of natural sciences, technology, engineering and mathematics has recently evoked interest in the involvement of this type of education to a greater extent in the educational process. STEM education still does not have the right approach in primary and secondary schools in the Republic of North Macedonia, so we will try to share some practices from working with our students. STEM education has developed with more intensity in our school since the implementation of the project '21st century Schools' supported by the British Council. During this study, the activities were carried out during the academic year 2022/2023 in two primary schools in two different municipalities, namely in Ismail Qemali primary school in Nerasht village, Tearca municipality and in Simçe Nastovski primary school in Vratnica, Jegunovci municipality. As a result of the application of integrated methods in the educational process, students have shown the highest results in terms of the level of knowledge and skills obtained. In the application of the integrated methods, 250 students from two primary schools were involved, where 50 of them were active participants of the Ismail Qemali Coding Club.

**Keywords:** STEM, coding, outdoor learning, SDG(Sustainable Development Goals) goals, Republic of North Macedonia

## Introduction

Interdisciplinary integration as a form of STEM education including the combined learning of natural sciences, technology, engineering and mathematics has recently evoked interest in the involvement of this type of education to a greater extent in the educational process. STEM education unquestionably increases the creativity of students, the deepening of ideas in solving problems in everyday life, in this way developing the critical thinking of students, students feel more free in expressing their ideas as well as feel more important during the realization of learning process, considering the fact that this type of education places the student at the center of the educational process.

STEM education still does not have the right access in primary and secondary schools in the Republic of North Macedonia, so we will try to share some practices from working with our students. STEM education has developed with more intensity in our school since the implementation of the project '21st century Schools' supported by the British Council.

The rapid development of the technology has also brought changes in the educational process. With MOOC(Massive Open Online Courses), learning has been transferred from traditional learning where the teacher was the distributor of information in the classroom, to the inverted classroom model where the student has other access to information and resources before coming to the classroom (Brahimi & Saritete, 2015).

After completing their studies, students should possess digital skills to land a good vacancy; however, traditional learning combined with activities during the lesson or watching videos in the lesson will continuously increase interest about the digital world. (Jarosievitz, 2017)

Creating a student activity from the beginning to the end makes students feel ownership of a knowledge (Kafai, 1995), while hands-on work facilitates to the students technical learning (Kolodner et al., 2003). Besides, micro:bit device is a good opportunity to encourage students in their involvement in computer science and to create their digital projects, (Teiermayer, 2019) on the other hand, this device can be used in other subjects such as Physics, Chemistry, Biology, Mathematics, etc. Taking into account that this device has different components in its composition, including here the sensors of light, temperature, humidity, etc. <https://microbit.org/code/>

In addition to interdisciplinary integration, the practice of SDG goals (Boeren E., 2019) is inalienable, therefore the acknowledgment of these goals by students plays an important role so that in the future they can focus on these goals.

The purpose of this research is:

Increasing the quality in the learning process (SDG 4) by motivating students for learning and a deeper understanding of problems and the practical possibility of solving them.

Placing the student at the center of the learning process.

Increasing the digital skills and creativity of students, increasing the passion about nature and taking care for it.

Development of students' ideas for future professions

## **Material and Method**

During this study, the activities were carried out during the academic year 2022/2023 in two primary schools in two different municipalities, namely in Ismail Qemali primary school in Nerash village, Tearca municipality and in Simçe Nastovski primary school in Vratnica, Jegunovci municipality. There were involved students of different ages, 8-14 years old. The activities were carried out in nature, on the schools' areas, as well as through visits to state institutions, in this way, the students had the opportunity at a closer look to get to know the problems that nature is endangered, as well as with the development of ideas for the protection of the environment from the dangers that threaten it.

### **The application of coding in the educational process**

Coding has been a constant part of the activities carried out in the regular headway of the educational process and in the framework of extracurricular activities. During the regular classes, coding activities were linked to the curriculum, where students, depending on the topics created different codes using the Let's code microbit program, in this case, depending on the age group of the students, there was also the formulation of codes, from more basic to more complicated ones.

The microbit device has provoked a special interest among the students who have shown utterly curious to get to know the composition of this device as well as the possibilities that this device offers for implication in the learning process and solving problems. This device has enabled the students to develop their coding skills whilst having fun which means that this method has been entertaining for them all along.

In the framework of the coding club, 50 students from the Ismail Qemali elementary school were involved; the activity was carried out in the school premises as well as in nature. Students were first introduced to coding method by using the Let's code microbit program, then putting their codes into operation by transferring them to the micro:bit device.

The codes created by the students have started from more plain/ basic to the realization of projects done by the students from where the students have developed many ideas on how they can create their own projects.

In addition to the development of students' digital skills, their creative skills are also increasingly developed.

The use of micro:bit was often used during lessons in the subject of Natural Sciences as well as in the Subject of Biology, so that the students depending on the topic of the lesson created codes which they used afterwards for their research within the framework of the lessons. Using the micro:bit device, the students measured the temperature of the environment, the intensity of the light, have created different melodies, which they afterwards placed in models of musical instruments made by the students themselves using recyclable materials. The setting up of different games has always been part of the students' work.

Using the device micro:bit, the students have created different models, giving different examples of how the electric circuit works, the hydropower plant, the windmill, measuring the speed of vehicles, compass construction, building an automatic parking lot, automatic lighting of the environments, different ways of tracking the conditions for plant growth, automatic operation of the drip irrigation system; as well as many other examples where by putting it into practice of what was taught to the students was very easy to understand and to make the students more creative, more skilled for practical work, as well as the students' examples were also related to ways of protecting natural resources, saving renewable energy sources, preparing models of how we can use wind energy and water energy.



Fig 1. Creating codes in the Let's code micro:bit application; Fig 2. The model prepared from the students; Fig 3. Presentation of projects created by Ismail Qemali Coding Club students

### Outdoor Education

Going out into nature with an educational purpose is a key method for the learning process, moreover for natural sciences. During outdoors learning, students quickly create a connection with nature for a deeper knowledge of it, as well as the increase of the responsibility for the protection of nature (Charles et.al.,2008; Carleton et al.,2010). During this study, numerous of activities were carried out outside of the

school where all the research was carried out in nature or a combination of nature-classroom, where the students processed the results of their research.

During the direct approach to the problem where the students were confronted with the ecological problems in nature and were themselves witnesses of the negative interventions made to nature by people, and the students immediately developed different ideas on how to offer solutions to these problems.

As for water management is concerned, in order to improve the situation related to water pollution in the area where they live, the students have created the Eco Club of the school, where they continuously measure the physical-chemical parameters of the water and present the obtained results in front of other students of the school, other schools as well as partner schools during the realization of the projects, in this way this method has had a positive impact on raising the awareness of the students, for water protection (SDG 6) and on the residents it has had a positive impact because they are involved in such activities.

In the activities carried out outside, the students have also researched the biodiversity of their area, thus getting to know the living world around them, therefore the material collected in the operating environment, they have prepared it afterwards in the form of herbariums, insectariums.

The explorations with plants have increased the students' interest on how to cultivate and use of medicinal plants, as well as the students during outdoors researches have become familiar with the variety of plants of this category in their surroundings.

Part of learning outside the classroom has also been learning through games, where the teacher has offered different ideas on how the students can develop their educational games, then this has had an impact on the students to give their ideas on how they themselves can create such games, and this method has shown quite successful because students on the one way have understood how ecosystems work, the consequences of damage to the food chain as a result of climate change on planet Earth from negative human interaction.

The games that the students have created during the cooperation between themselves in pairs or in groups, in addition to increasing the creativity of the students, has also influenced the development of the critical thinking of the students, where after using the outdoors learning method, the students have understood much more clearly the topics represented by the curriculum as well as the expression of the students has been more notably because they have already created many ideas on how they can bring positive changes in the future.



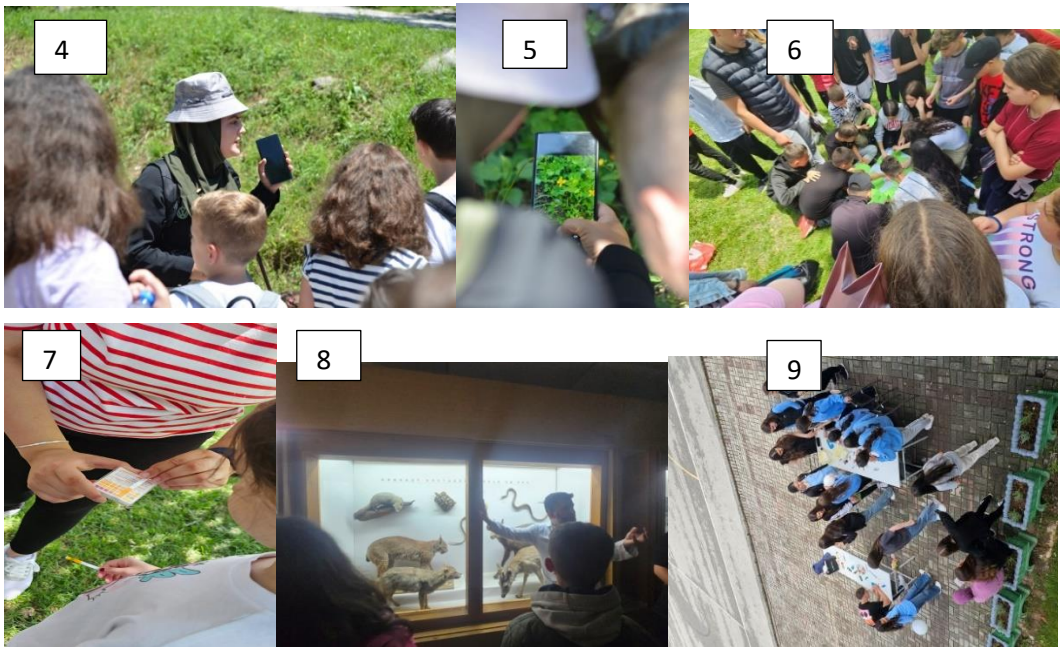


Fig. 4;5;6;7;8;9. These photographs show some of the activities during learning outside the classroom

## Results and discussion

As a result of the application of integrated methods in the educational process, students have shown the highest results in terms of the level of knowledge and skills obtained. In the application of the integrated methods, 250 students from two primary schools were involved, where 50 of them were active participants of the Ismail Qemali Coding Club.

The students whom voluntarily participated in the Code Club have shown satisfactory results as well as increased interest in coding, Natural Sciences, showing different ideas for ways of solving problems in everyday life.

92% of participating students managed to create their own projects independently

8% of students provided with the help have created projects using the micro:bit device

100% of students, however, were actively involved in the learning process.

During the use of integrated methods in the lessons, an increase in interest for the lesson was observed even among students who were not active during the traditional lessons. The students were showing satisfaction when they created codes with Let's code micro:bit and have created models which they put into operation afterwards, therefore they voluntarily asked to carry out additional activities.

89% of the students have communicated that their participation in the Coding Club, as well as the integrated learning, has helped them to understand more clearly the lessons in science subjects and to be able to choose their future professions.

95% of the students announced that during the activities in the Coding Club they felt freer and were able to express their ideas better

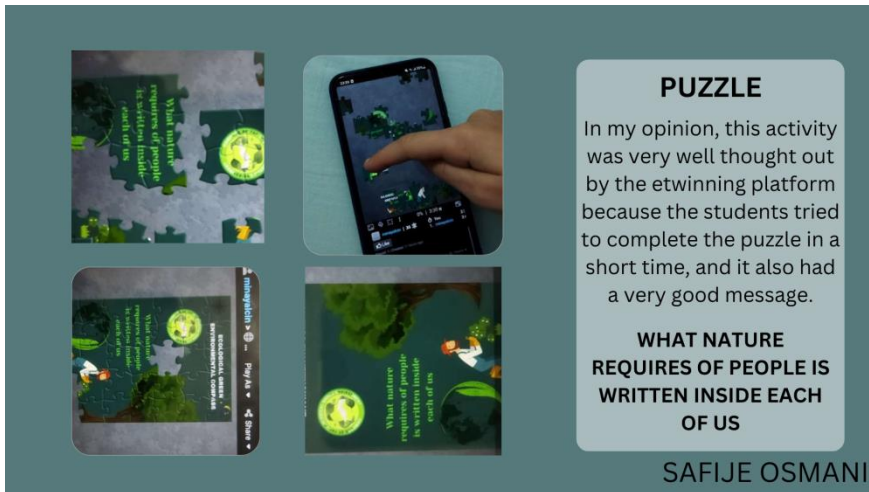
75% of the students expressed that the presentation of the activities in front of their parents encouraged them, 20% of the students felt more stressed to present in front of their parents.

85% of students initially expressed that they feel uncomfortable when presenting in front of the public, but this opinion has changed in 50% of students after their participation in several presentations.

20 of the students with their projects have also participated in Code Week 2022, and more are preparing for participation in Code Week 2023.

Protecting the environment through coding was the project through which the students participated in the STEM DISCOVERY CAMPAIGN 2023 with continuance from 1<sup>st</sup> of February – April 30, 2023(<http://www.eun.org/stem-discovery-campaign-2023>)

Students have increased self-confidence about their work, increased creativity and abilities. The forming of new friendships inside and outside the school during online meetings with other partner schools from different countries such as Turkey, Poland, Greece, Georgia as part of the joint project with the theme ECOLOGICAL GREEN ENVIRONMENTAL COMPASS (SDG 4;5;6;13) . During this period, the students have been quite active using various technological applications which have greatly increased their digital skills. Using the Canva application, students have created Posters to present their city, the extinction of materials on the earth, self-presentation with an avatar, Online creation of a Puzzle game themed for the protection of the living environment. The students have given various ideas on how we can prepare food using as little oil as possible in order to protect water from pollution, the use of means of transport that do not pollute the environment, at the same time the students together with the teachers marched on the streets with bicycles carrying out messages about ways we can change our transportation without harming the environment. Part of the project was watching the educational film “25 liters” ([www.youtube.com](http://www.youtube.com) › watch), which was very impressive to the students and very effective in raising awareness about water conservation.



**Graf.10. Puzzle game created by students**

### **Conclusion**

STEM education has had a positive impact on the improvement of the educational process. Innovative approaches have been very well accepted from the students when we consider the fact that they already belong to the digitalization era.

The students expressed their satisfaction, they felt free and independent, and the cooperation between the students has influenced them to develop better socialization, as well as the idea that together they can solve the problems faster.

Students have felt important because they have always seen results of their work.

Students are liberated from paradoxes and have improved their difficulties in presenting to others.

The challenge for the realization of the activities has been the lack of sufficient conditions, therefore the models have been completed with a bit expensive means.

The voluntary participation of students in the Coding Club expresses a positive result for the students' interest in the digital world.

Activities outside the classroom have been really effective compared to those explained in the classroom about nature and the students have been quite curious to know the world around them, the changes it has undergone as well as the ways to improve the created situation.

The changes in the way of learning have been very well received by the students at both primary schools where the innovative approaches have been put into practice, so the satisfactory results encourage us to share our practices with other schools in our district as well as beyond through joint projects with partner schools which are always welcome so that we can exchange our ideas.



While learning through games, the students have communicated that this method for them has been entertaining and the students have not felt at all psychologically burdened when they have learned through games, and this method has helped them in while having the problems more clear to develop ideas on how to solve the same ones.

## Literature

- [1] Austin J., Baker H., Ball T., Devine J., Finney J., P De Halleux, Hodges S., Moskal M. Communications of the ACM, 2020 • dl.acm.org
- [2] Brahimi T., Sarirete A. 2015. Learning outside the classroom through MOOCs. Elsevier. Computers in Human Behavior. Volume 51, Part B, October 2015, Pages 604-609
- [3] Boeren, E. Understanding Sustainable Development Goal (SDG) 4 on “quality education” from micro, meso and macro perspectives. Int Rev Educ 65, 277–294 (2019). <https://doi.org/10.1007/s11159-019-09772-7>
- [4] Carleton-Hug, A., & Hug, J. W. (2010). Challenges and opportunities for evaluating environmental education programs. Evaluation and program planning, 33(2), 159-164. <https://doi.org/10.1016/j.evalprogplan.2009.07.005>
- [5] Charles, C., Louv, R., Bodner, L., & Guns, B. (2008). Children and nature 2008. A Report on the Movement to Reconnect Children to the Natural World. Santa Fe: Children and Nature Network, 9(11).
- [6] <https://microbit.org/code/>
- [7] <http://www.eun.org/stem-discovery-campaign-2023>
- [8] Jarosievitz, B. PHYSICS TEACHING ACTIVITIES AND RESOURCES USED INNOVATIVELY IN HIGHER EDUCATION. 2017. informatika.gdf.hu
- [9] Kafai, Y. B. (1995). Minds in play: Computer game design as a context for children’s learning. Routledge.
- [10] Kolodner, J., Camp, P., Crismond, D., Fasse, B., Gray, J., Holbrook, J., Ryan, M. (2003). Problem-Based Learning Meets Case-Based Reasoning in the Middle-School Science Classroom: Putting Learning by Design(tm) Into Practice. Journal of the Learning Sciences, 12(4), 495-547.
- [11] Teiermayer, A. Improving students' skills in physics and computer science using BBC Micro: bit Physics Education, 2019 • iopscience.iop.org
- [12] The BBC %ro: bit: from the UK to the world
- [13] ([www.microbit.co.uk](http://www.microbit.co.uk))