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The Effect of Using Micro: bit on Lower Secondary School Student Critical Thinking

Kastriot Dermaku, Selami Klaiqi, Liridon Hoti, Hiflobina Dermaku

Abstract: *The concept of critical thinking dates back to the time of Socrates. According to research, most critical thinking programs have achieved modest results despite the importance of high-level thinking skills. It is essential to understand when to use critical thinking strategies and how to do this successfully [1, 2, 5, 8].*

This study included lower secondary schools in the Municipality of Kamenica in Kosovo, such as Rexhep Mala ShFMU, Fan S. Noli ShFMU and Abdulla Krashnica–Presheva ShFMU. It traced the impact of IT Teachers using micro:bit boards on the development of student critical thinking. Participants in the research were students, teachers and headmasters. The data providing the research results were obtained through questionnaires and interviews.

The study intentionally sampled grade 6–9 students from the schools mentioned above, including students who were involved in the micro:bit use project and those who have not had the opportunity to work with these boards.

The use of micro:bit boards in school increased the possibility of creating school programmer groups which in turn increased competition in programming and the level of student critical thinking. The research findings stressed the need to provide more favorable conditions for having special classes of young programmers in school.

The findings from the study also showed that the use of micro:bit in the process of education has a positive effect on the creativity of problem solving and critical thinking [7].

Keywords: *teachers; students; parents; micro:bit; critical thinking; problem solving.*

INTRODUCTION

Complex, higher-level thinking skills are directly related to critical thinking. This is the process of viewing ideas from many perspectives and from different aspects which includes objective analysis and evaluation of an issue in order to make a judgement, taking into account the influence of the processes developed. Critical thinking helps us come up with a creative solution to problems which may occur during various activities [4].

Critical thinking is also defined as critical reflection on learning experiences and processes and effective decision-making while avoiding common pitfalls, such as considering only one side of an issue, questioning evidence that is not in line with your ideas, passion-based reasoning, as well as illogical statements that are not supported by evidence [2].

We reason why we have chosen this research topic is that while dealing with traditional teaching and now the application of micro:bit in the teaching and learning process, we noticed an increased interest in students to contribute individually and in groups [12].

The use of micro:bit boards in Kosovo was initiated by the British Council's 21st Century Schools education programme. The first phase of training teachers to use them took place at the end of 2018. The second phase started in September 2019, initially with training headmasters and then teachers. It involved about 600 teachers from the central, eastern and southern part of Kosovo, and tended to include the rest of the country. Each school was equipped with micro:bit boards and was required to have at least a functional team of coders. Project competitions were held at national and regional level. Represented by Faik Konica ShFMU, Kosovo took second place in a competition held in Belgrade.

Micro:bit Structure

Micro:bit was developed as part of BBC's Make It Digital initiative (2015). It aims to boost young people's creativity in the digital world, to help them develop key skills and subsequently to create a new generation of inventors and creators. The two sides of a micro:bit plate can be seen in Figure 1.

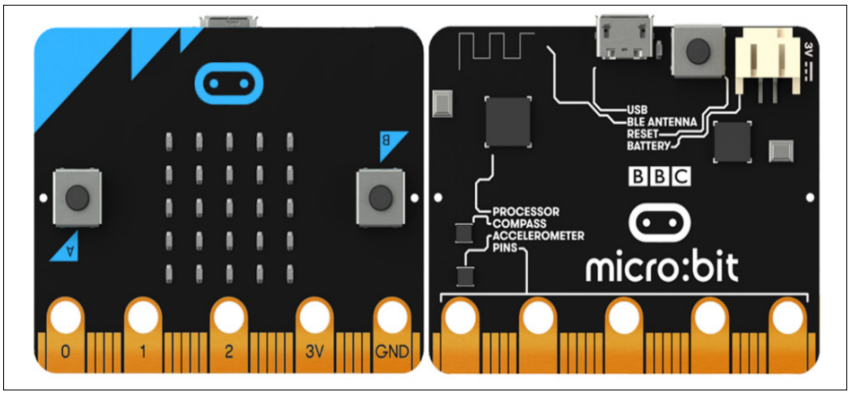

Figure 1. Micro:bit Board Sides [1, 11]

The BBC micro:bit is a handheld, programmable microcomputer that can be used for creating a wide variety of things – from musical instruments to robots. The possibilities are endless.

Micro:bit inspires children to acquire basic coding and programming skills, thereby preparing them for today's world where things change rapidly. Micro:bit can be coded, adapted and controlled to perform various tasks and bring ideas to life [3].

Micro:bit Features

- 5x5 LED matrix;
- Two programmable buttons;
- Accelerometer to detect motion;
- Compass to understand the direction;
- Ability to understand temperature and light levels;
- Bluetooth Smart Technology to interact with other micro:bits and mobile devices.
- Five Input and Output (I / O) rings to connect the micro:bit to devices or sensors, using e.g. grippers [16].

Table 1. Micro:bit Characteristics [9]

Group 1 – FEATURES	Group 2 – ALLOW YOU
LEDs **The LED abbreviation stands for Light Emitting Diode. The Microbit has 25 individually programmable LEDs.**	Display of text, numbers and images.
LIGHT SENSOR **By turning the LEDs into input, the LED display acts as a basic light sensor**	Detect ambient light
TEMPERATURE SENSOR **The microbe functions as a basic temperature sensor**	Detect the current temperature of the device
Accelerometer **The accelerometer measures the acceleration of your microbit; this component senses when the microbit moves**	Detect acceleration and other actions, e.g. vibration, slope and free fall.
Compass **The compass detects the Earth‘s magnetic field**	Detect in which direction the micro: bit is going
RADIO **The radio feature allows you to communicate wirelessly (wirelessly) between microphones**	Send micro messages to other bits, build multiplayer games, and more!
BLUETOOTH **The BLE (Bluetooth Low Energy) Antenna allows the microbit to send and receive Bluetooth signals.**	This enables the micro: bit to communicate wirelessly with personal computers, phones and tablets; so you can control your phone from your micro: bit and send codes to your device from your phone!
BUTTONS **On the front of the microbit are two buttons (button A and B)**	You can detect when these buttons are pressed, allowing you to activate the code on the device.
Pina **A total of 25 external connectors are on the microbit connector, which we refer to as ‚pins‘.**	Program motors, LEDs or other electrical components with pins or connect additional sensors to control your code!

Defining the Problem

We assume that lower secondary education has significant problems based on internal and mostly external evaluations that are constantly carried out. Internal evaluations yield very high results, while external ones yield very low results.

The lack of encouragement of student critical thinking has always been an essential issue. Many factors affect it, some of which include teacher access, improper teacher qualification and ineffective parent–student–teacher triangle [10].

Research Purpose

Micro:bit boards have been used in lower secondary schools over the recent months and weeks. The project is funded and implemented by the British Council in Kosovo in order to encourage student critical thinking. but normally this has also affected teachers.

The purpose of this study is to determine the effect of micro:bit on students’ critical thinking, creative skills, intelligence development, and their preparation for studies and the job market.

Research Questions and Hypothesis

Research Questions:

- What impact does the use of micro:bit have on student critical thinking development?
- What are the prerequisites for students to use micro:bit boards?
- How prepared is the teaching staff for implementing creative projects by means of micro:bit?
- How has the introduction of new programmer classes in schools affected the quality of education?

Research Hypothesis:

The use of micro:bit boards in lower secondary schools has a positive effect on the development of critical thinking.

Research Methodology

The methodology of this study is based on research of literature by local and foreign authors and experts, collection and analysis of the data related to the influence of micro:bit on the development of student critical thinking. The study adopted a quantitative approach where data from teachers and students were obtained through questionnaires, while data from principals through interviews [6].

The data were analysed according to the methods of theoretical, comparative, descriptive and statistical analysis.

- The method of theoretical analysis was adopted to browse and analyze scientific and professional articles, related in one way or another to the research problem on the use of micro:bit, but in western country schools, especially in the UK.
- The comparative method allowed us to clarify the existing differences between students who are using micro:bit today and those who are not.
- The descriptive method ensured the description of the research data.
- The statistical method enabled the collected data to be processed, analyzed and interpreted through the SPSS Statistics software.

Research Population and Samples

This research was conducted in the Municipality of Kamenica, particularly in three lower secondary schools: Rexhep Mala in Topanica, Fan S. Noli in Kamenica, and Abdulla Krashnica–Presheva in Koret. It sampled students between grades 6 and 9 from each of these schools.

The study also included teachers at the same schools who were either trained to use micro:bit boards or not. The headmasters of the respective educational institutions were interviewed in order to ensure a greater involvement of stakeholders who could influence the research.

Prior to conducting the interviews and questionnaires for the purposes of our study, we had a meeting with officials from Kosovo's Ministry of Educational Development (MED) to obtain permission to carry out the study. We explained the importance thereof and the need to conduct further research in the field.

The successful negotiations with the MED were followed by the distribution of questionnaires to students and teachers, and the conduction of interviews with the headmasters in order to collect the necessary data for the study.

The final phase of the research included the processing of the collected data. This was carried out by means of the SPSS Statistics software.

It should be noted that the data collected and processed has been used only for the needs of the Master thesis, and that we are able to cooperate with the MED in the future if the latter deems it necessary.

Research Findings

The research conducted in the already mentioned municipality and schools traced the impact of IT Teachers using micro: bit boards together with students on the development of the latter's critical thinking. The findings are based on the questionnaire results provided by students and teachers, and on the interviews with the principals.

The student questionnaire contained 11 questions. They were answered by 130 respondents from grades 6–9 who have made use of micro:bit boards.

The teacher questionnaire consisted of 10 questions. A total of 30 teachers from the three schools filled it in, regardless of whether they were trained to use micro:bit or not. Both students and teachers were deliberately selected.

During the interviews, the headmasters were asked five questions regarding the number of teachers who have attended the training on the use of micro:bit boards, the effect of using them in teaching and learning, and how things were going with the school programming groups and the training of teachers to implement these boards in the teaching process.

Student Questionnaire Results

As mentioned above, the questionnaire was answered by 130 students from three lower secondary schools in the Municipality of Kamenica in Kosovo.

The first question was "What is your gender?". 59 (45%) of them were male and 71 (55%) were female, as shown in Figure 8.

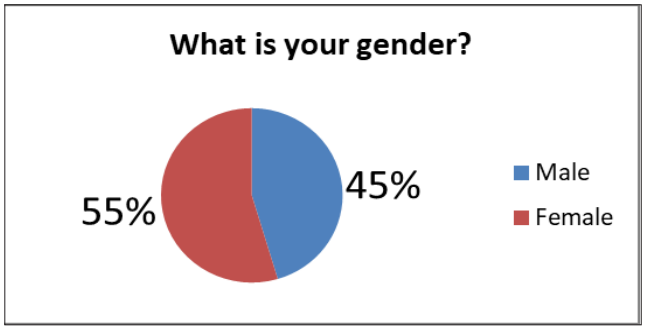

Figure 8. What is your gender?

The second question was "In which school are you attending classes?". The chart in Figure 9 indicates that most of the respondents were from Fan S. Noli ShFMU (52 or 40%), followed by Abdulla Krashnica–Presheva ShFMU (47 or 36%) and Rexhep Mala ShFMU (31 or 24%). We attempted to make the number of students at the school level in proportion to the number of students at the respective schools.

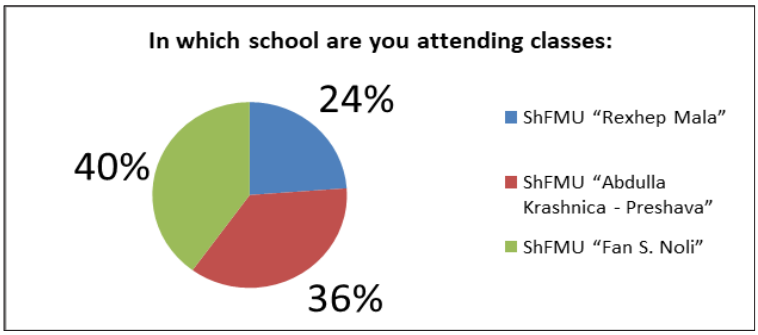

Figure 9. In which school are you attending classes?

The answers to the third question provided the number of students from each grade. Out of 130 students, 14 (11%) were from Grade 6, 33 (25%) from Grade 7, 32 (25%) from Grade 8 and 51 (39%) from Grade 9. These results are presented in Figure 10.

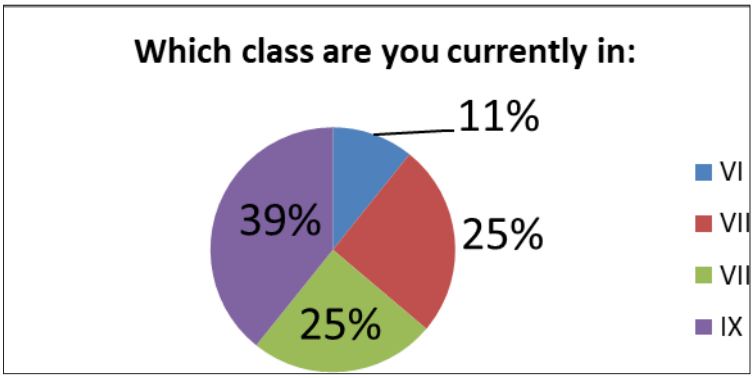

Figure 10. Which grade are you currently in?

Question 4 was: "Did you have the opportunity to use micro:bit boards during the learning process?". We assumed that this question would help us gain insight into how many students in general have had such an opportunity. Figure 11 shows that 105 or 81% of the students have provided a positive answer, while with 25 or 19% this was not the case.

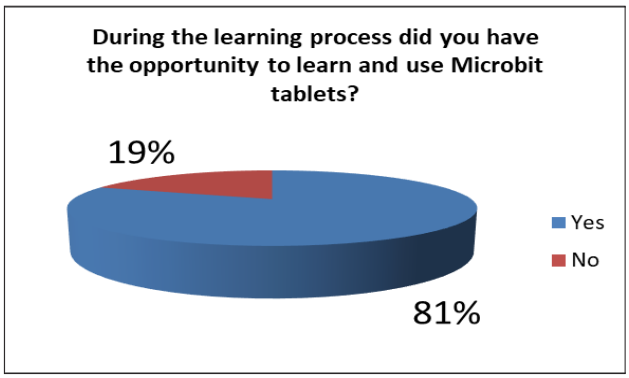

Figure 11. Did you have the opportunity to use micro:bit boards during the learning process?

One of the most important questions in the questionnaire was "Do you think that the use of micro:bit has encouraged your critical thinking?" as its answers could help us draw a conclusion in terms of our research hypothesis. The results are illustrated in the bar chart in Figure 12.

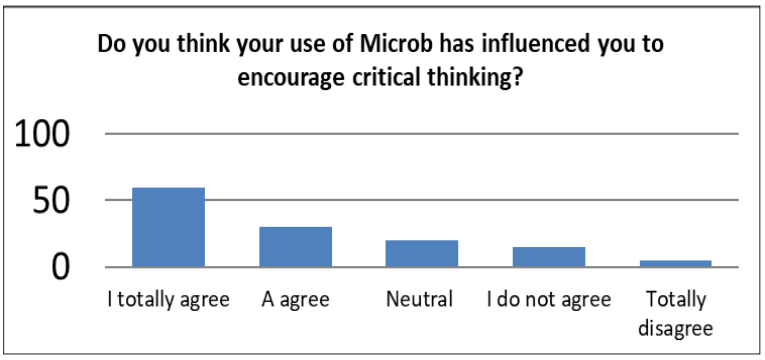

Figure 12. Do you think that the use of micro:bit has encouraged your critical thinking?

As we can see, 60 (46%) of the total number of students completely agreed that micro:bit boards stimulate their critical thinking. 30 students (23%) responded positively to the question, whereas 20 (15%) remained neutral. Students who took the opposite view were 20 in total, where 15 (11%) did not agree and 5 (4%) totally disagreed. To sum up, 70% of the surveyed students confirmed that the use of micro:bit has contributed to their critical thinking.

Developing critical thinking and problem-solving skills requires highly agile teachers and a safe learning environment in which students would feel free and encouraged to think, ask questions, explore and work in groups without fear of making mistakes.

The sixth question was whether the application of micro:bit helps in solving problems. The answers thereto can be seen in Figure 13. We think that problem solving is closely related to critical thinking on the part of students.

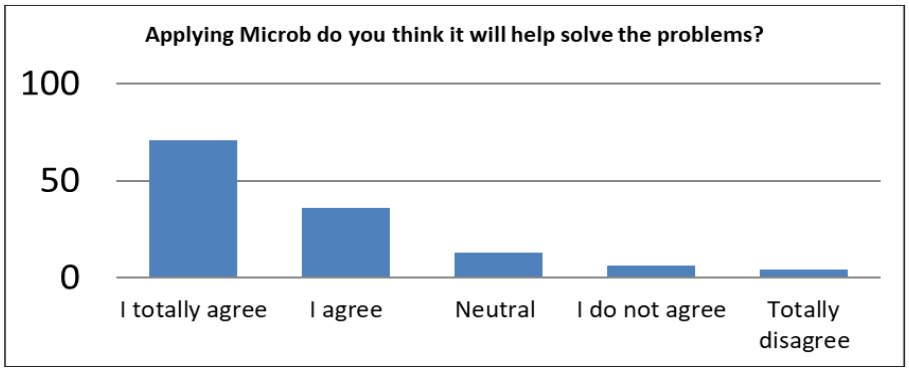

Figure 13. Do you think that the application of micro:bit helps in solving problems?

Out of 130 participants in the questionnaire, 73 (56%) totally agreed that this was the case. 34 (26%) agreed less confidently while 13 (10%) could not decide. Only six students (5%) provided a negative answer. The remaining four students (3%) fully disagreed with the statement. Without taking the students who answered neutrally to the question into account, approximately 82% of the respondents responded positively more or less. This is a good indication that micro:bit boards have had a positive impact on students.

The chart in Figure 14 shows the results from the next question: “Do you think that the application of micro:bit has boosted your creative skills and intelligence development?”

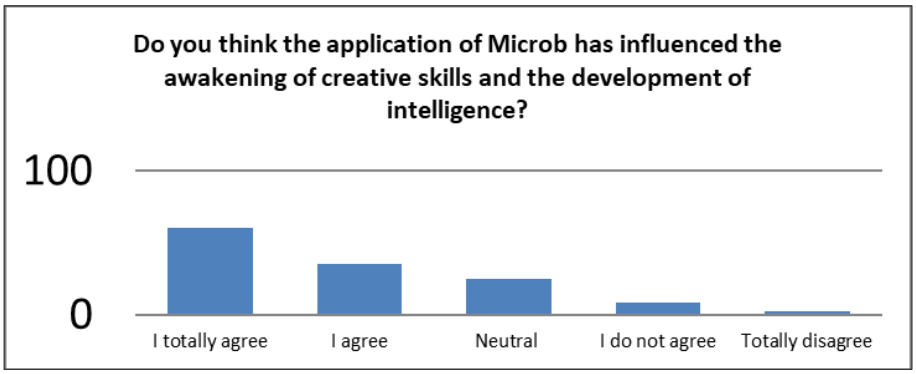

Figure 14. Do you think that the application of micro:bit has boosted your creative skills and intelligence development?

It is obvious that the majority of students have given an affirmative answer. In particular, 60 students (46%) totally agreed and 35 (27%) agreed to a lower extent. 25 (20%) remained neutral. Eight students (6%) did not agree and two (1.5%) completely disagreed with the statement.

Question 8 was the following one: "Do you think that the use of micro:bit boards along with the instructions of the teachers have influenced your career orientation?". We can see how it has been answered by the participants in the questionnaire in Figure 15.

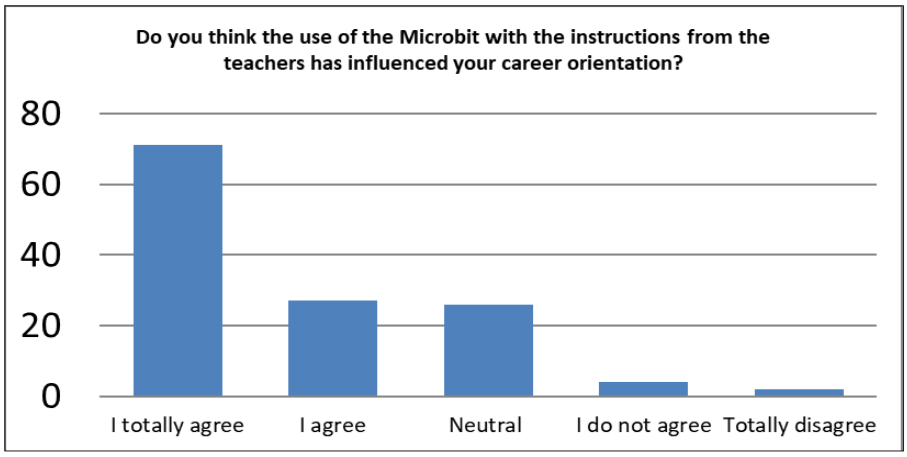

Figure 15. Do you think that the use of micro:bit along with the instructions of the teachers have influenced your career orientation?

The results are as follows: 71 (55%) of 130 students declared that they completely agree with the statement, 27 (21%) agreed, 26 (20%) were neutral, four (3%) disagreed and two (1%) were absolutely certain that this was not the case with them.

In addition to finding widespread use in lower secondary schools across six countries in Southeast Europe, it is very important to note that micro:bit boards are used not only in ICT, but also in other subjects. They facilitate the process of teaching the material provided by the curriculum. Familiarization of other teachers with these gadgets became even easier.

Figure 16 illustrates the responses to the following question in the questionnaire: "Do you think that micro:bit boards can be used in other subjects besides ICT?"

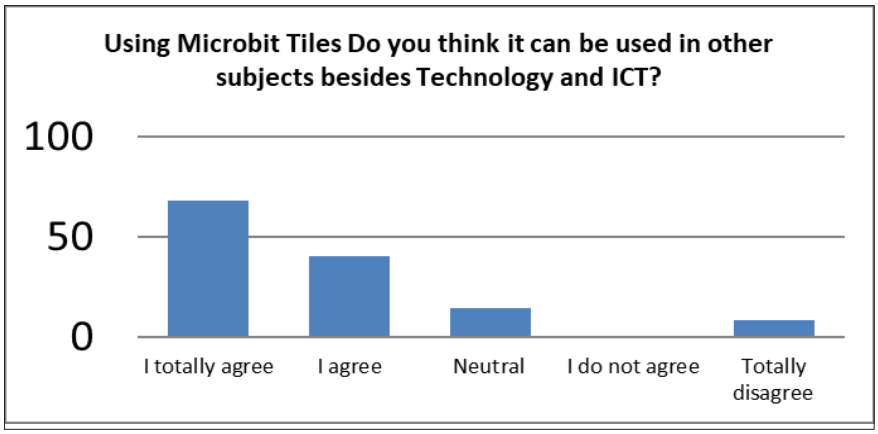

Figure 16. Do you think that micro:bit boards can be used in other subjects besides ICT?

The answers are as follows: 68 of 130 respondents (52%) completely agreed, 40 (31%) agreed and 14 (11%) were neutral. Eight of them (6%) did not agree with at all. No student stated "I do not agree". Hence, the use of micro:bit boards in subjects different from ICT is welcomed by students as a whole.

The umpteenth question had to do with the programming or coding groups set up in the surveyed schools, namely: "Are you part of a school-level programming team?". The students' answers to this question are presented in Figure 17.

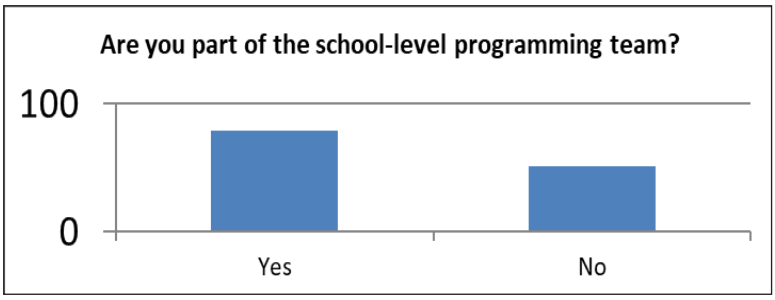

Figure 17. Are you part of a school-level programming team?

Out of the 130 respondents, a total of 79 students or 60% answered affirmatively, while the other 51 students (40%) were not members of such a team.

The last question in the student questionnaire was the following one: “Are teachers prepared to carry out exercises by means of micro:bit boards?” The answers to this question are shown in the bar chart in Figure 18.

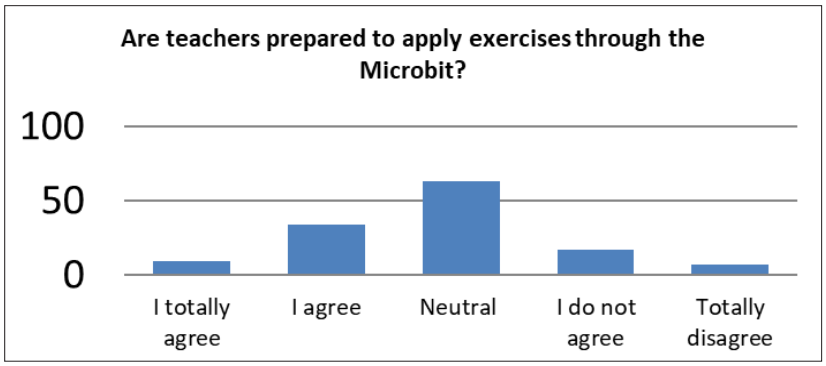

Figure 18. Are teachers prepared to carry out exercises by means of micro:bit boards?

Nine students (7%) totally agreed with the statement, 34 (26%) agreed, 64 (49%) were neutral, 17 (13%) did not agree, and 6 (5%) totally disagreed. The results lead to the conclusion that a considerable number of students were neutral, but approximately 26% of the respondents shared the view that teachers are unprepared to conduct exercises with the use of micro:bit tiles.

In Table 2 we can see the processing of the results obtained from the student questionnaire in addition to the values for each answer. In the second part of the table, we have the percentage of the result for each question as well as the average and standard deviation.

We notice that the average deviation for each question varies from 1.19 in the question “Did you have the opportunity to use micro:bit boards during the learning process?” to 2.92 in the same question.

The standard deviation is 0.4 in the question: “Do you think that the use of micro:bit has encouraged your critical thinking?”. It varies as the maximum value increases to 1.04 in the question: “Did you have the opportunity to use micro:bit boards during the learning process?”

Teacher Questionnaire Results

The teacher questionnaire was answered by 30 teachers of different subjects from the already mentioned three lower secondary schools in the Municipality of Kamenica: Rexhep Mala ShFMU, Fan S. Noli ShFMU and Abdulla Krashnica–Presheva ShFMU.

Identically to the student questionnaire, the first question here concerned the gender of the respective respondent. 17 or 57% of the teachers were male and 13 or 43% were female. Figure 19 illustrates this proportion.

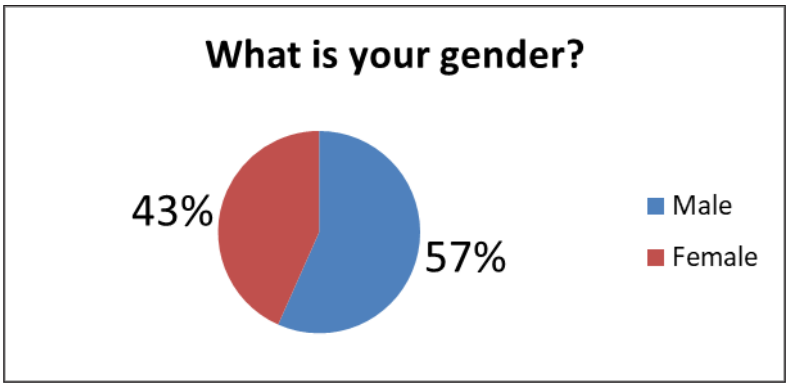

Figure 19. What is your gender?

The second question was: "Which school are you working at?". The chart in Figure 20 indicates that most of the respondents were employed at Fan S. Noli ShFMU (15 or 50%), followed by Abdulla Krashnica–Presheva ShFMU (10 or 33%) and Rexhep Mala ShFMU (5 or 17%).

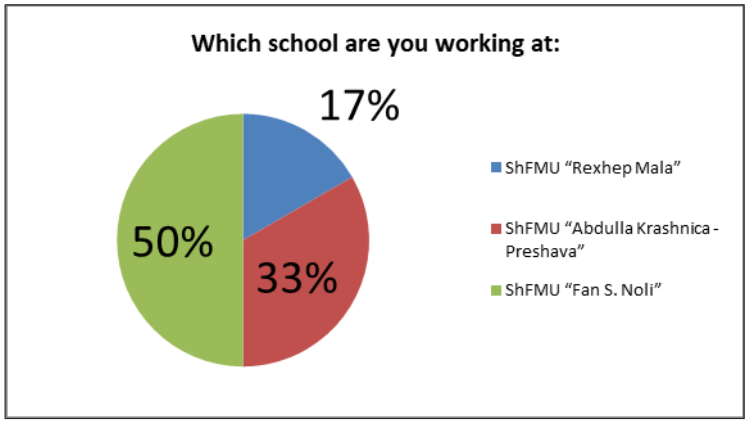

Figure 20. Which school are you working at?

With a view to the use of micro:bit boards, we considered it essential to know which subject each of the participants in the questionnaire taught. For this reason, the next question was: "Which subject do you teach?", the answers to which are presented in the pie chart in Figure 21.

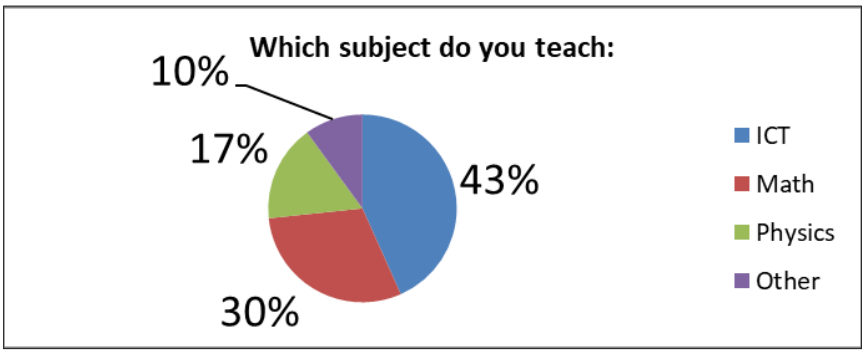

Figure 21. Which subject do you teach?

As we can see, ICT teachers make up the largest number of participants in the questionnaire (13 or 43%). They are followed by teachers of Mathematics (9 or 30%) and Physics (5 or 17%). The other three respondents (10%) taught other subjects.

Not only the qualification and professional development of the teachers, but also their experience has an impact on the level of critical thinking of students. So, the next question was “How many years of experience do you have in education?”. Figure 22 indicates how it has been answered.

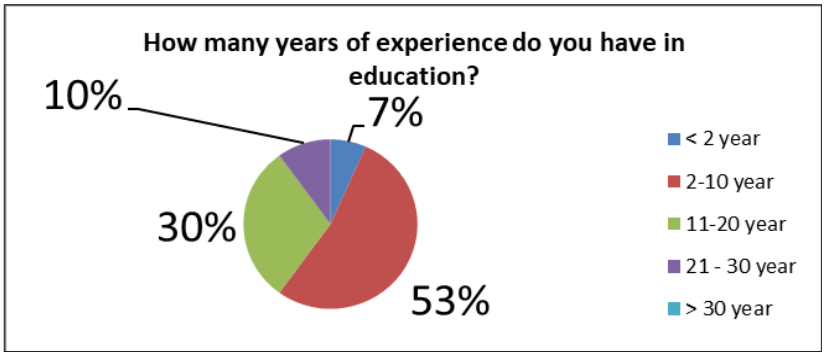

Figure 22. How many years of experience do you have in education?

The work experience of the majority of the participants in the questionnaire (16 or 53%) ranges between two and ten years. Nine teachers or 30% of the total number is between 11 and 20 years. Three teachers (10%) have been in the education sector between 21 and 30 years, while two (7%) have been working for less than two years. There are no respondents whose work experience exceeds 30 years.

The project on the use of micro:bit boards was organized and funded by the British Council in Kosovo. It was implemented in six countries in the region. This inevitably led to the fourth question in the teacher questionnaire of whether the respondent has attended the 21st Century Schools training on the use of micro:bit in the education process. The answers thereto, which we regarded as very important in terms of critical thinking, can be seen in the pie chart in Figure 23.

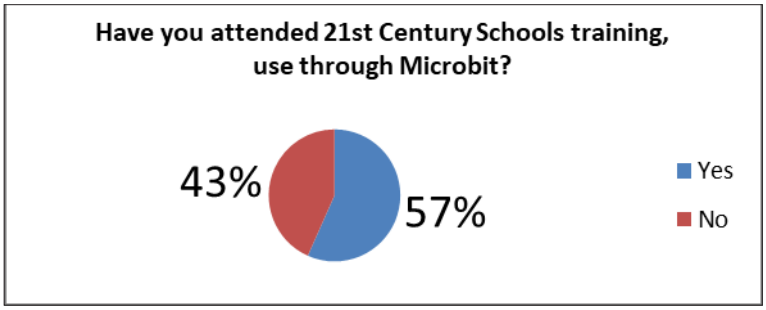

Figure 23. Have you attended the 21st Century Schools training on the use of micro:bit?

Most of the respondents (17 or 57%) provided a positive answer to the question, while the others (13 or 43%) stated that they have not taken part in the training.

The next question was: “Do you think that the use of micro:bit by your students has stimulated their critical thinking?” Figure 24 indicates how the 30 sampled teachers have responded.

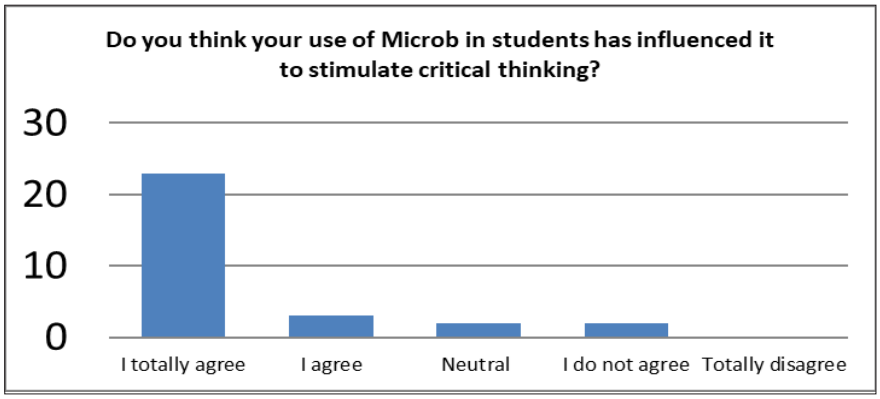

Figure 24. Do you think that the use of micro:bit by your students has stimulated their critical thinking?

It is evident from the chart that the major part of the participants in the questionnaire (23 or 77%) totally agreed with this statement. Three teachers (10%) declared that they agree, two (7%) were neutral and two (7%) did not agree. None of the respondents disagreed with absolute certainty. Therefore, we can conclude that a considerable number of teachers think that they encourage the critical thinking of their students by using micro:bit boards in the education process.

Practically speaking, most trainings can have problems in terms of their implementation as they do not match the curriculum. I myself was a participant in the 21st Century Schools training which was focused on critical thinking and problem solving. The implementation of creative projects with the help of micro:bit boards is well received by teachers and students, as well as the school management staff. However, one of the main challenges in this respect continues to be the fact that the part of the procedural programming or between blocks is not included in the official curriculum in Kosovo. This means that school exercises and projects have been carried out as extracurricular activities or within the programming groups from the very beginning.

Therefore, it was a must to include a question in the questionnaire related to this issue. It was formulated as follows: "Do you think that the use of micro:bit should be included in the basic curriculum?". The answers of the 30 respondents can be seen in Figure 25.

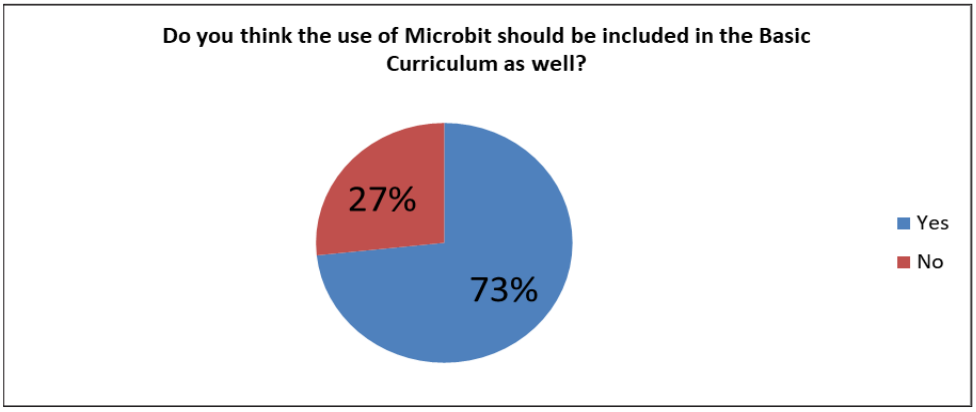

Figure 25. Do you think that the use of micro:bit should be included in the basic curriculum?

A total of 22 (73%) teachers answered with a "Yes", while the other eight (27%) with a "No". This proves that the British Council's project is well received, meaning that the use of micro:bit will be incorporated in the high school level curriculum as soon as possible.

Since the impact of micro:bit on the development of student critical thinking is the focus of our study, the next question was whether the application of these boards has boosted the development of students' creative skills and intelligence. Figure 26 shows the respondents' opinion in this regard.

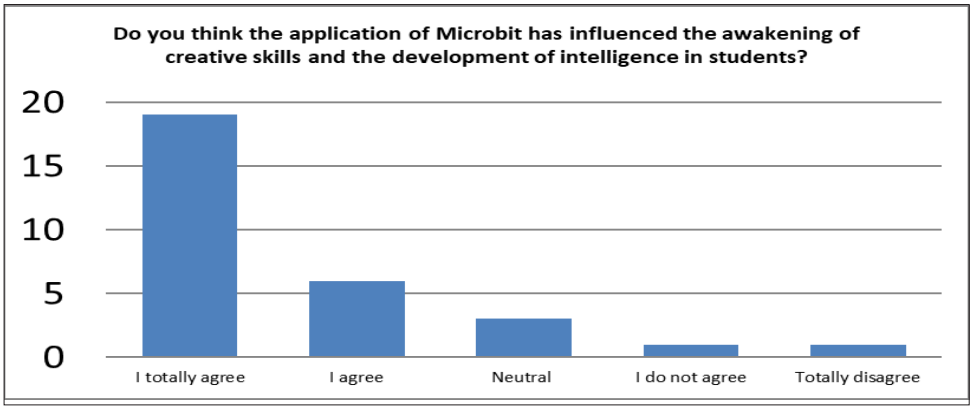

Figure 26. Do you think that the application of micro:bit has boosted the development of students' creative skills and intelligence?

Out of the 30 participants in the questionnaire, 19 (63%) completely agreed that this was the case, six (20%) agreed with a lower degree of certainty and three (10%) provided a neutral answer. Three teachers (10%) did not agree and the same number (10%) totally disagreed.

Since problem solving and critical thinking are not limited only to the subject of ICT, the questionnaire also contained the following question: "Do you think that micro:bit boards can be used in other subjects besides ICT?". The answers are presented in the pie chart in Figure 27.

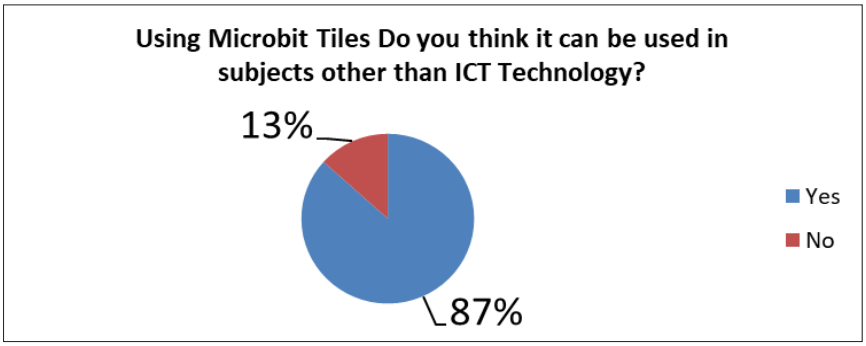

Figure 27. Do you think that micro:bit boards can be used in other subjects besides ICT?

The chart clearly indicates that the vast majority of respondents (26 or 87%) provided an affirmative answer. while the remaining four teachers (13%) answered negatively.

In order to obtain even more accurate results, we decided the last question in the teacher questionnaire to be the following one: "Do you think that the introduction of programming classes has increased the level of student–teacher cooperation at the school level?". The answers to this question are shown in Figure 28.

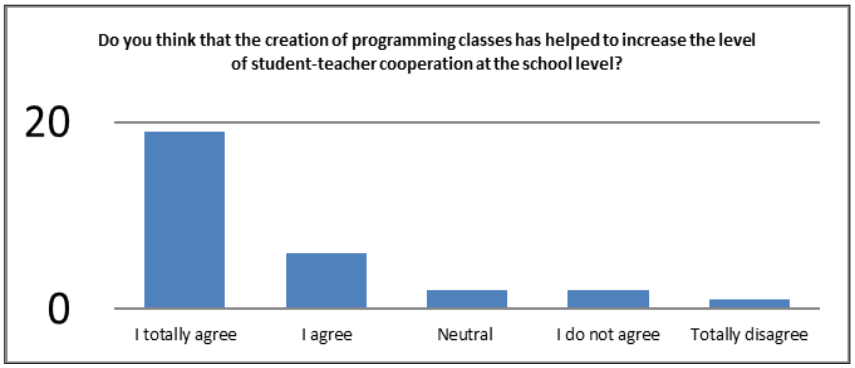

Figure 28. Do you think that the introduction of programming classes has increased the level of student–teacher cooperation at the school level?

We have the following results: 19 teachers (63%) completely agreed with the statement, six agreed to a lower extent (20%) and two (7%) answered neutrally. Another two teachers (7%) did not agree, while only one strongly disagreed (3%).

The processing and identification of the teacher questionnaire results seems simpler due to the smaller number of respondents. Table 3 presents these results in detail.

Research Results

Since the research we have conducted concerns a relatively new event in Kosovo and neighboring countries, there were challenges during the research in the respective schools.

The research questions were the following ones:

- What impact does the use of micro:bit have on student critical thinking development?
- What are the prerequisites for students to use micro:bit boards?
- How prepared is the teaching staff for the realization of creative projects through micro:bit?
- How has the introduction of new programmer classes in schools affected the quality?

The results from the student and teacher questionnaires and the daily work with students show that the use of micro:bit has had a positive impact on students by increasing their creativity and level of critical thinking.

As we already mentioned that the project is relatively new in Kosovo, the preconditions for the use of micro:bit boards include the need to provide schools with ICT equipment and for schools to invest in additional equipment in combination with micro:bit in order to create projects that are in favor of the school and the community [13].

The results from the student and teacher questionnaires and the interviews with the headmasters of the surveyed schools indicate that one of the main challenges to achieving success in students using micro:bit boards is the preparation of teachers to implement creative ideas easily, which would increase the quality of school education. Their training could be carried out by including a larger number of them without diving them in terms of the subjects they teach, i.e. to be inclusive. If the training courses held by the British Council in Kosovo cannot involve everyone, then school–based training could be conducted where certified teachers share their knowledge with colleagues in the respective school.

The establishment of clubs for young programmers in public schools in Kosovo is a new activity that has come with the micro:bit implementation project. Not only the lower secondary schools under review, but also those in the regions involved in the project have at least one programmer club. These clubs have proven beneficial to the quality of school education, increasing teacher–student cooperation and outdoor activities.

We remind that the hypothesis we raised in this paper is that the use of micro:bit boards in lower secondary schools has a positive effect on the development of critical thinking.

If we take the statement that the use of micro:bit boards in lower secondary schools has not influenced the development of critical thinking in a positive way as Hypothesis 0 (H0), and the opposite statement as Hypothesis 1 (H1), we may assume that the average value of the answers in the student questionnaire is $\mu = 1.1$. The calculations for each answer in Table 2 indicate that the values vary from 1.19 to 2.92. The question with the lowest average value is “Did you have the opportunity to use micro:bit boards during the learning process?” where 81% of the respondents provided a positive answer. From two alternatives, we have a standard deviation of 0.4. The question with the highest average value is “Which grade are you currently in?” where 50% of the respondents were in grades 7 and 8. From four alternatives, we have a standard deviation of 1.04 [14, 15, 16].

Considering the results from the teacher questionnaire and the interviews with the headmasters, we can freely say that $H0 \leq H1$ which proves the hypothesis that the use of micro:bit boards in high schools influences the development of critical thinking in a positive way.

Discussions, Conclusions and Recommendations

This research aims to confirm the hypothesis raised from the findings from the student and teacher questionnaires and the interviews with the headmasters that the use of micro:bit boards in lower secondary schools has a positive effect on the development of critical thinking.

The results we have received show that the use of micro:bit boards has had a positive impact on student critical thinking, creativity and the cooperation between students and teachers and not only.

The project of equipping schools with micro:bit boards and the organization of trainings and support in the field are carried out by the British Council in Prishtina. However, the results from the interviews with the headmasters of the surveyed schools indicate that the main challenge in implementing projects and using micro:bit boards in schools is the lack of suitable conditions and preparation of the educational staff.

The preparation of the teaching staff is one of the main challenges to a successful development of student critical thinking and problem-solving skills not only in ICT, but also in other school subjects.

In each school where the 21st Century Schools project for using micro:bit boards to help students develop critical thinking and problem-solving skills is implemented, there is at least one coding group consisting of students between grades 6 and 9. This is beneficial to the development of creative projects in the interests of the respective school and the community.

In conclusion, the study we have conducted in three lower secondary schools in the Municipality of Kamenica in Kosovo (Rexhep Mala ShFMU, Fan S. Noli ShFMU and Abdulla Krashnica–Presheva ShFMU) confirms our hypothesis that the use of micro:bit in lower secondary schools has a positive impact on the development of critical thinking.

REFERENCES

[1] **Austin, J., Devine, J. et al.** (2020). *The BBC Micro:bit – from the UK to the World*.

[2] **Carlborg, N. and M. Tyren** (2017). *Introducing Micro:bit in Swedish Primary Schools*. Department of Applied IT, Sweden, Gothenburg.

[3] **Czekman, B. and J. Kiss**. “Coding without (Age) Limits? Experiences with BBC Micro:bit in Primary School.” HERJ Hungarian Educational Research Journal, vol. 8, no. 4, 2018. pp. 112–115.

[4] **Edmondson, J.** (2018). 10 Activities for BBC Micro:bit. CAS National Conference Workshop.

[5] **Instituti i Zhvillimit të Arsimit** (2015), *Të nxënit me situata, konstruktivizmi dhe teknologjia*, Tiranë, Republika e Shqipërisë, Ministria e Arsimit dhe Sportit.

[6] **Matthews, B. and L. Ross** (2010). *Metodat e hulumtimit, udhëzues praktik për shkencat sociale dhe humane.* Tiranë: Qendra për Arsim Demokratik (CDE).

[7] **Milić, M., Kukuljan D. and E. Krelja Kurelović**. “Micro:bit Implementation in ICT Education.” The Eurasia Proceedings of Educational & Social Sciences (EPESS), vol. 11, 2018, pp. 128–133. International Conference on Science and Education.

[8] **Musai, B.** (2005), Strategji të mësimdhënies dhe të të nxënit për klasat mendimtare, Tiranë, Qendra për Arsim Demokratik (CDE).

[9] **Perry, J**. micro:bit Challenge. Canada Learning Code.

[10] **Sentance, S., Hodges, S. et al**. "Creating Cool Stuff": Pupils Experience of the BBC Micro:bit. Conference Paper – March 2017

[11] https://makecode.microbit.org/ (accessed in October 2019)

[12] https://www.computingatschool.org.uk/custom_pages/84-microbit (accessed in October 2019)

[13] https://ieeexplore.ieee.org/document/8424786 (accessed in October 2019)

[14] https://www.cna.al/2015/06/04/karakteristikat-e-te-menduarit-kritik/ (accessed in November 2019)

[15] http://pendulumscimag.weebly.com/pedagogji/te-menduarit-kritik-dicka-qe-u-duhet-mesuar-femijeve-patjeter (accessed in November 2019)

[16] https://learn.sparkfun.com/tutorials/how-to-load-micropython-on-a-microcontroller-board/microbit (accessed in March 2020)

ABOUT THE AUTHORS

Kastriot Dermaku – Assistant Professor in Computer Science, PhD, Faculty of Computer Science, Kadri Zeka Public University, Gjilan, Kosovo, E-mail: kastriot.dermaku@uni-gjilan.net

Selami Klaiqi – PhD Student in Informatics, Faculty of Mathematics and Informatics, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria, E-mail: selami.klaiqi@uni-gjilan.net

Liridon Hoti – PhD Student, University of Library Studies and Information Technologies, Sofia, Bulgaria, E-mail: liridon.hoti@uni-gjilan.net

Hiflobina Dermaku – PhD Student, University of Library Studies and Information Technologies, Sofia, Bulgaria, E-mail: hiflobina.obertinca@gmail.com