ANALYSIS OF PROJECT-BASED TASKS TO IMPROVE LEARNING PERFORMANCE

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АНАЛИЗ НА ЗАДАЧИ, БАЗИРАНИ НА ПРОЕКТИ, ЗА ПОДОБРЯВАНЕ НА УЧЕБНИТЕ РЕЗУЛТАТИ

Abstract

Project-based learning is an approach to acquiring general or specific competencies from students through topic exploration and problem-solving. With the continuous development of artificial intelligence (AI) and its application in an educational context, new opportunities and challenges arise in the preparation and implementation of projects. The aim of the paper is to present a study, summarizing and analyzing the opinion and attitudes of school students with systems programming specialty whether project-based learning supports them to improve their learning efficiency and creativity. The possibilities of AI for supporting activities related to project development are examined. The findings show that project working facilitates students to acquire certain knowledge, improves their learning efficiency, and contributes to the successful completion of the course. Students admit that they use AI in the realization of their projects and that its utilization increases their efficiency. On the other hand, they comment that the communication with AI should be performed carefully and to rely more on credible sources such as learning resources recommended by a teacher and textbooks.

Keywords: *Project-based Learning; Learning Performance; Artificial Intelligence.*

INTRODUCTION

One of the approaches to increase students‘ motivation for learning in the subject under consideration in a particular curriculum discipline is related to their involvement in projects preparation [1]. Project-based learning includes separate steps aimed at choosing a specific topic for exploration, planning the implementation of the project, examining the issues and problems in accordance with the selected topic, realization of the project, presenting and evaluating the achieved results [2]. Projects can be accomplished individually or in collaboration with classmates, and regardless of the form of implementation, the goal is to improve certain knowledge and skills and/or acquire new ones. Zhao and Wang show in their study that project-based learning influences positively on students’ development as they achieve better understanding of the main topic ideas, their motivation to learn chemistry is increased and the competence to collaborate is improved [3]. Handoko et al. discuss the influence of project-based learning on creative thinking of students in the context of Green school considering saving nature and environment [4]. It is proved that this ability is improved in experimental class in comparison to students from the control class. Tain et al. explore the role of project-based learning on students at their physics study and conclude that it leads to development of competences like communication and socialization, research and problems solving [5]. Usmeldi and Amini present a study regarding the model of project-based learning to drive the students’ creativity in electric motor installation [6]. The findings show not only improved competence in subject matter, but also in creating creative products. Alice and Hesbon discuss the importance of project-based learning for students’ academic

performance and conclude that the project activities led to performance improvement [7]. Viruel et al. explore the teachers' opinion regarding the usage of artificial intelligence (AI) in project-based learning and outline its assistive role especially at artefacts production and evaluation [8]. Also, AI gives the possibility for realization of personalized and self-directed learning for obtaining common and specific skills. Tang et al. see the integration of AI in all stages at project-based learning in support of students' personalization, content delivery and evaluation of learning performance [9].

The aim of the paper is to outline and analyze the impact of project-based learning on school students' learning performance and a course accomplishment and to understand the role of AI in project doing activities through summarizing the opinion of surveyed school students.

SURVEY AND RESULTS

To investigate the school students' attitude towards the project-based learning and to understand whether it can support and improve their learning performance an online survey tool is created and distributed to students from a Bulgarian school. The respondents are 35 volunteers with specialty in System programming. The survey includes fifteen questions with closed options and one question with a free answer.

The first question aims to understand how independent the students are in choosing a project topic, how oriented they are in the set of topics and whether they are able to use the opportunity to work on topics that are interesting to them. The majority of students, 37.1%, prefer to choose their project topic independently (Fig. 1). Another large part, 28.6%, rely on the teacher to give a suitable topic. A relatively small percentage believe that through discussion with a teacher (14.3%), with a classmate (11.4%) or with a team of classmates (8.6%) they can reach a suitable choice of a project topic. The option of consulting with the AI was not selected. It can be seen that three large groups of students are forming, who prefer either to choose their topic themselves, the teacher to assign it, or to reach the most suitable topic through discussion. This shows that one group expresses an independent position and interests, while the other has no claims and relies on the teacher. The third group is currently not oriented and cannot choose a topic, but they believe that through analysis with a teacher or classmates they will reach the appropriate project topic for them.

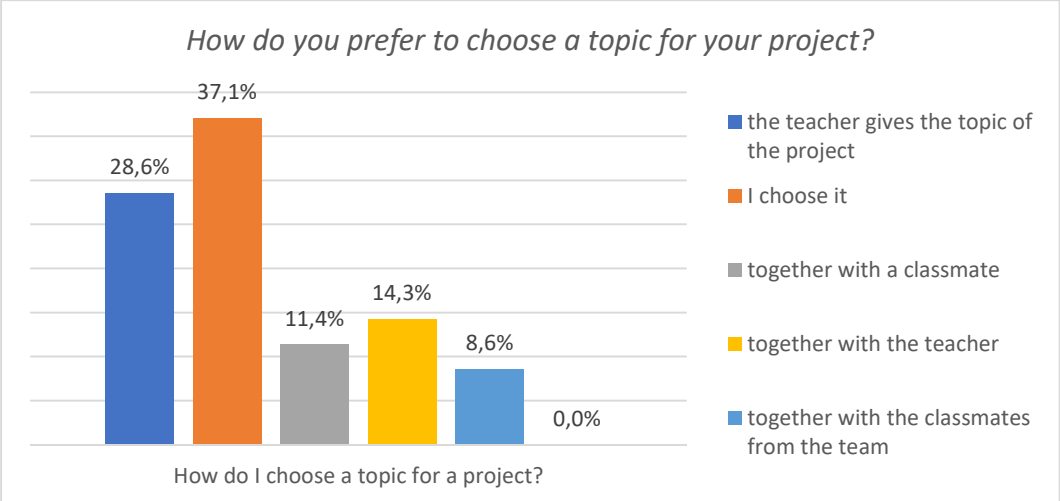

Fig. 1. Question related to students' preferences when choosing a project topic

The opinion of the students considering the question „*How do you prefer to complete the project?*" is divided into three parts as the largest of them 57.1% preferring to

independently handle the implementation of the project, the middle group 28.6% through work with a classmate and the small group 14.3% in cooperation with a team of classmates (Fig. 2). It can be seen that over half of the surveyed students show a clear tendency towards individual work, which indicates an expression of independence, the presence of self-control and initiative. On the other hand, their self-evaluation points out that they are not effective enough when working in a team.

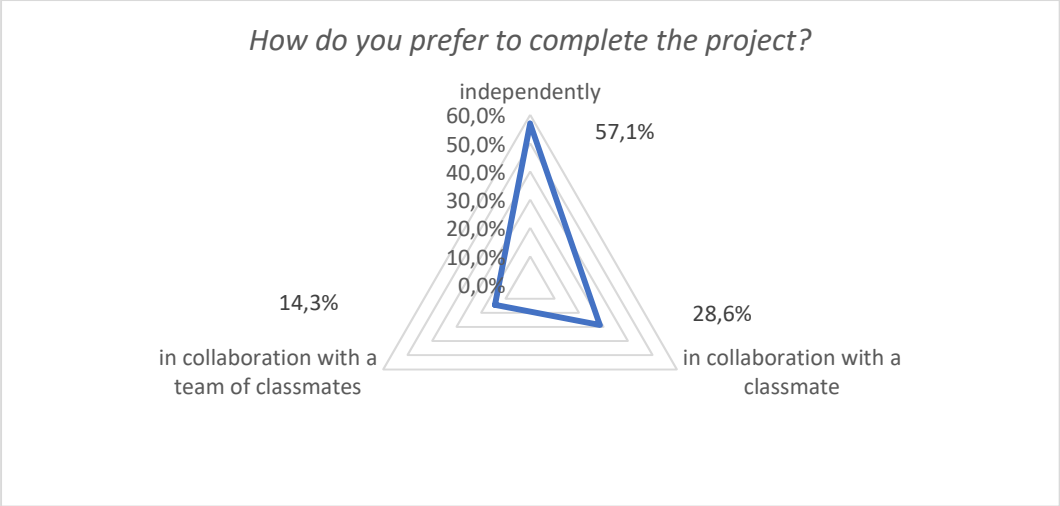

Fig. 2. The answers to the question "How do you prefer to complete the project?"

In order to understand how students solve the problem of needing assistance in completing the project, the question was asked: „*When you need help in completing the project, who do you ask?*". Most students seek help mainly from the leading teacher – almost three quarters of the respondents (74.3%) (Fig. 3). Over half rely on classmates (57.1%), which indicates a significant level of collaboration in the class. Consultations with students from higher grades are a relatively rare event (8.6%), and consultation with other teachers from the same specialty is indicated by nearly one third of the students (28.6%). This shows that the main channel for support is internal – within the own class and the lead teacher. It is also evident that many do not rely on just one source of help, often turning to both the leading teacher and their classmates.

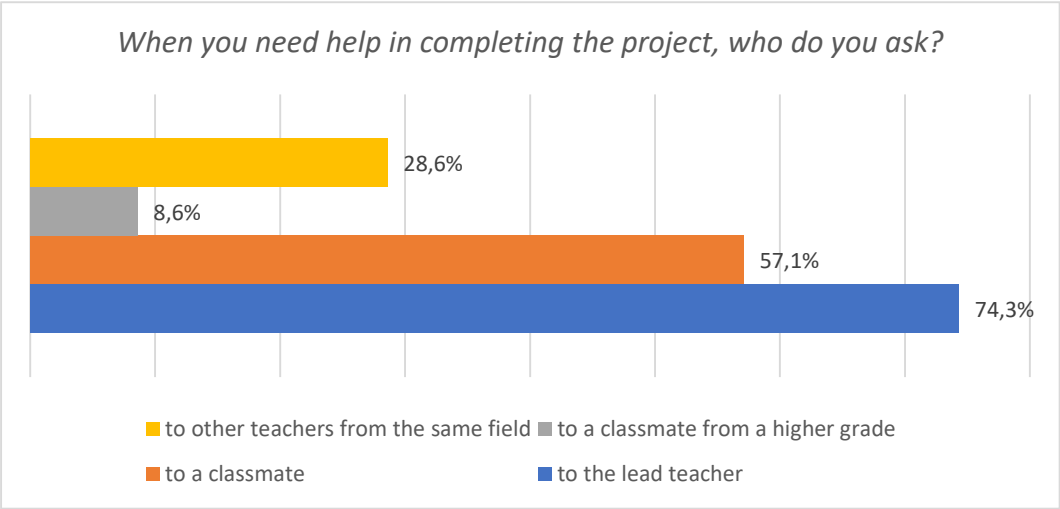

Fig. 3. Opinion of students regarding the question "When you need help in completing the project, who do you ask?"

In order to see where students get information when developing the project, the question was asked: "*What information sources do you use when implementing the project?*". The responses of the survey participants show that the most popular sources are tutorials on the Internet as 68.6% of respondents are voted for this option and artificial intelligence (AI) (e.g. ChatGPT) with a vote of 65.7% (Fig. 4). It is seen that over two-thirds of students take advantage of Internet-based learning sources and AI. This shows a strong orientation towards online resources and new technologies. YouTube lessons are also a preferred tool by 54.3% of respondents, used by over half of the students. Classic teaching materials provided within the discipline are also utilized, but by a smaller percentage of respondents (40%), which suggests that students are looking for technologically oriented, online-based and visually presented sources outside the standard textbook. It also becomes clear that students use several different information sources, which speaks of curiosity, creativity, and a desire for high-quality project implementation.

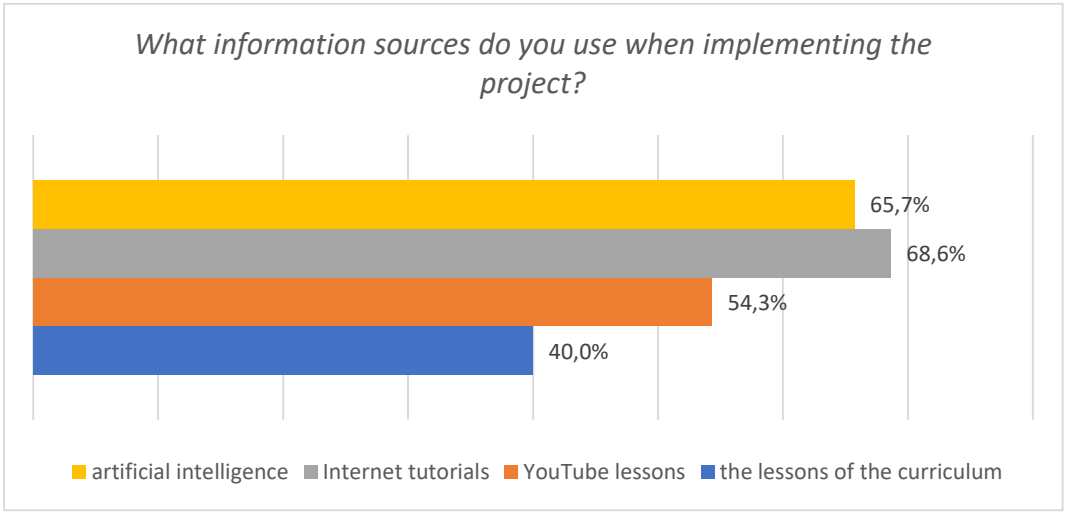

Fig. 4. Answers of the question "What information sources do you use when implementing the project?"

The answers to the next question reveal how much students use and rely on AI when creating their projects: „*To what extent do you rely on AI when creating a project?*". The majority of students (77.1% of them) indicated that they use the general or specific information received from AI when asked questions (Fig. 5). 45.7% of them said that they use the instructions received as answers from AI. 31.4% of respondents said that they use the literature sources recommended by AI. Only 20% of respondents used the step-by-step tutorials provided by AI. It can be seen that AI is utilized for different purposes by students as more often are followed instructions, general information and recommended literature sources, while step-by-step tutorials being less often used.

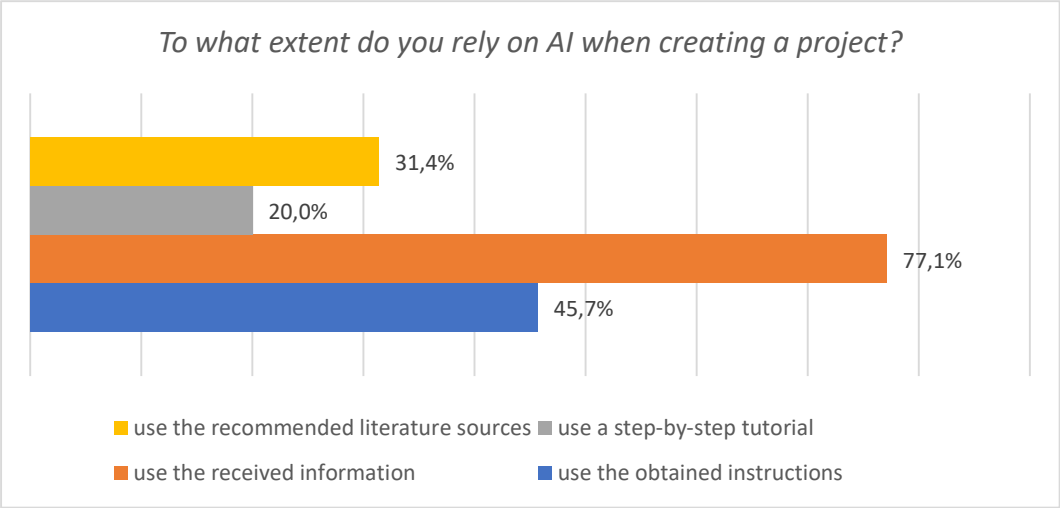

Fig. 5. The students' opinion regarding the question „To what extent do you rely on AI when creating a project?"

The next question explores students' preferences and attitudes regarding the duration of the project. Over half of them (57.1%) prefer medium-term projects with a completion time of 1 month. Another large part of the students (34.3%) indicated as an answer: short-term with a completion time of 1 week. A small part of the respondents answered with long-term, e.g. with a completion time of 1 school term. From the answers it is clear that the preferred duration of a project is 1 week or 1 month, when students feel effective and focus their efforts and attention on developing their project.

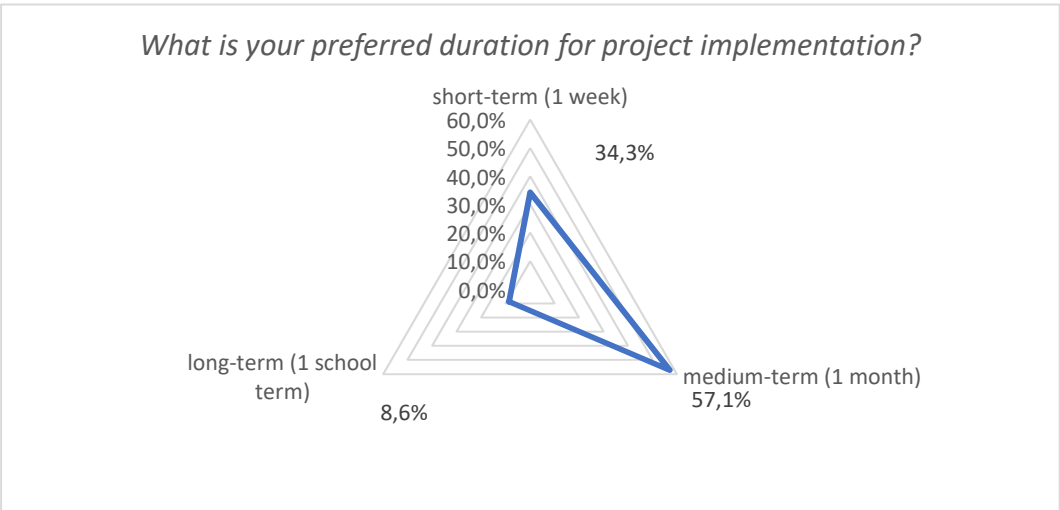

Fig. 6. The answers to the question "What is your preferred duration for project implementation?"

When students asked "*How do you plan to implement your project?*", a large majority of respondents (57.1%) are in favor of evenly distributing the steps in the implementation of the project, 31.4% say that they need more time for the exploration part, while only 11.4% say that the research step is shorter than the implementation itself. There are no students who chose the option "I am usually late with the implementation of the project".

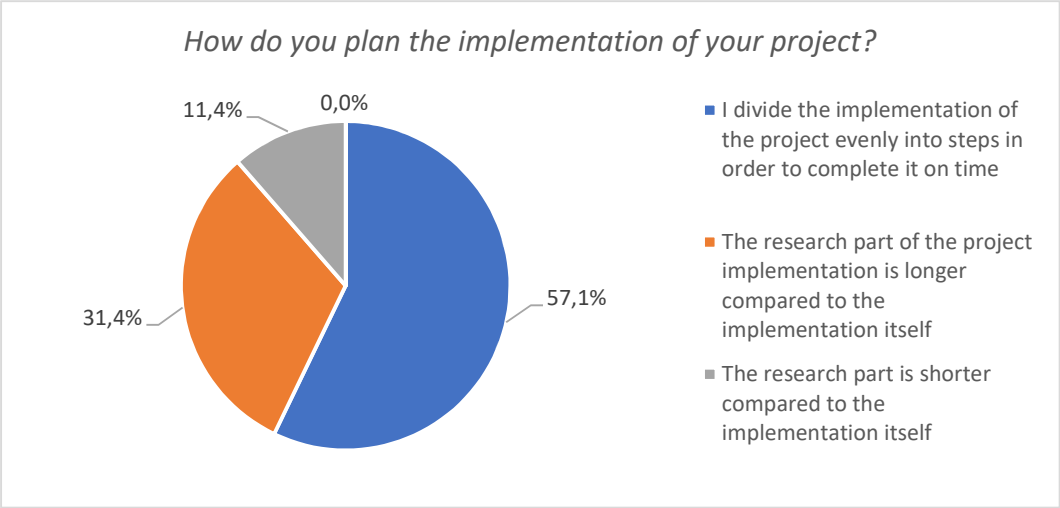

Fig. 7. The answers to the question "How do you plan the implementation of your project?"

Considering the question "*How do you prefer to present your project?*", the majority of students prefer to defend the project in front of the teacher (71.4%) and a small part of them in front of their classmates (14.3%) or a wider audience (14.3%). This can be explained by the fact that students highly value the teacher's competence in the topic under consideration and prefer his/her opinion to be listened to and evaluated by the leading teacher.

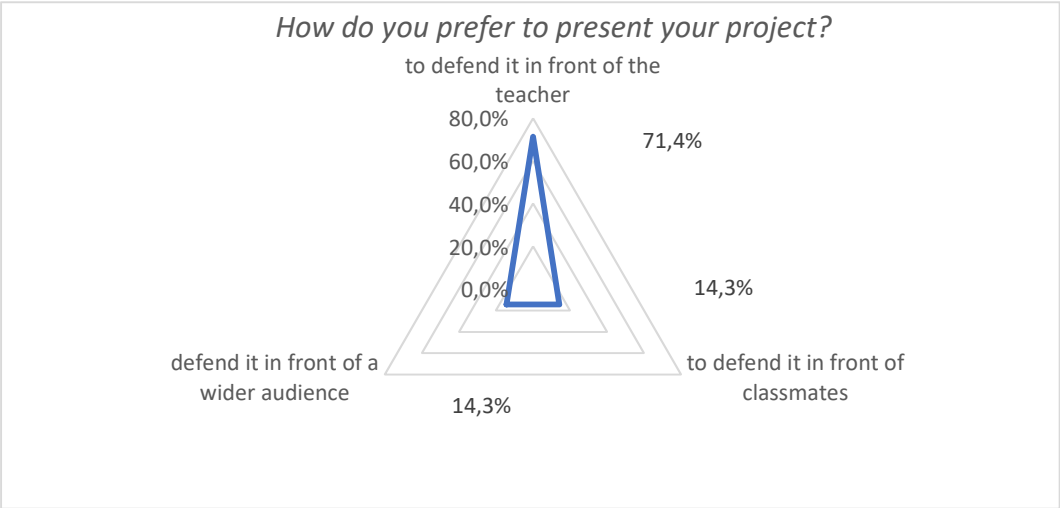

Fig. 8. The answers considering the question "How do you prefer to present your project?"

When asked in what form the project should be implemented ("*What is your preferred form of project?*"), the students' opinion is divided into almost three equal parts: the project should be practically oriented (e.g. program code), should be a theoretical analysis (e.g. essay), and should combine theory and practical implementation. It can be said that the vote of the students that is practically oriented is slightly higher (37.1%), followed by theorists (34.3%) and students, who prefer to combine theoretical with practical parts at their project realization (28.6%) (Fig. 9).

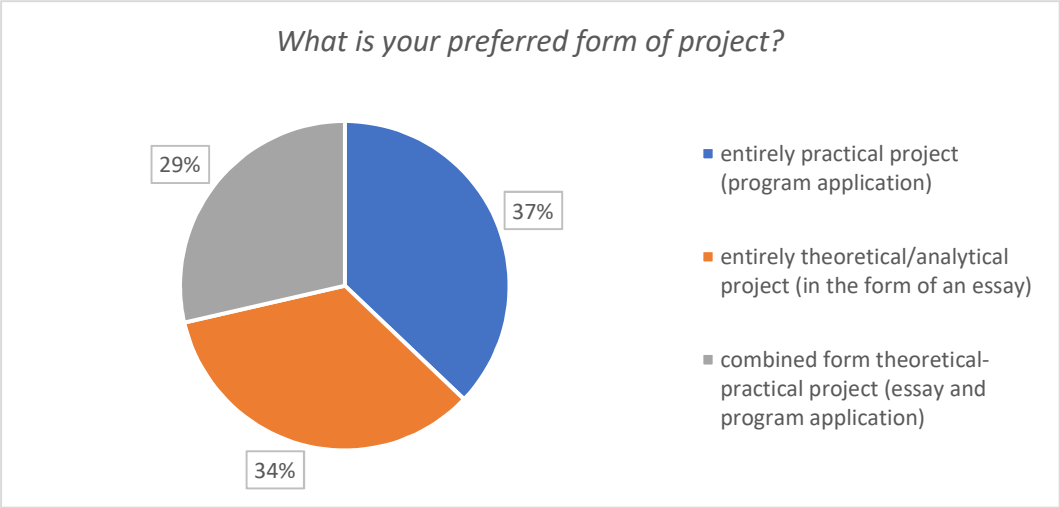

Fig. 9. The answers to the question "What is your preferred form of project?"

The next question ("*How do you prefer the project to be assessed?*") aims to understand the students' moods and attitudes regarding how the process of assessing their projects should best proceed. The majority of the respondents believe that the teacher with his/her competences in the field will objectively assess them according to the results obtained (54.3%) (Fig. 10). A smaller part believe that an objective evaluation can be achieved through self-assessment (17.1%) or by combining self-assessment with the assessment of the teacher and their classmates (25.7%). A very small part share that classmates are the ones who can give an objective assessment of the implementation of their project (2.9%). It can be summarized that students believe that teacher assessment or self-assessment are appropriate approaches for evaluating the results of project implementation.

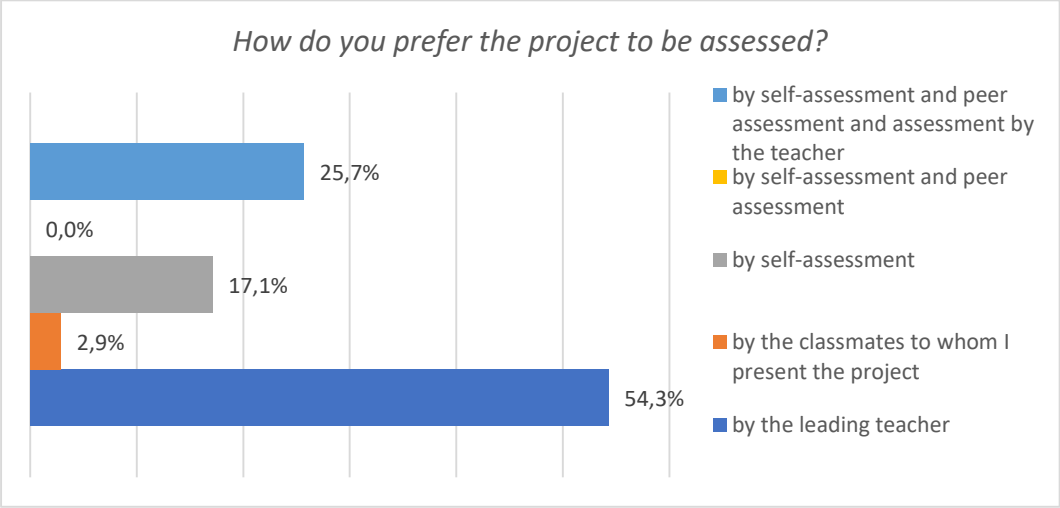

Fig. 10. The answers considering the question "How do you prefer the project to be assessed?"

The answers to the question "*Do you think that AI helps your learning efficiency*" (to complete the project qualitatively and on time, according to the previously set requirements and to have a high final grade)? are as follows: a big part of the students (71.4%) vote with "yes, I think", 17.1% "I cannot judge" and 11.4% "I do not think" (Fig. 11). It seems that many students use AI at project working and appreciate its support to be more effective at different tasks at project preparation.

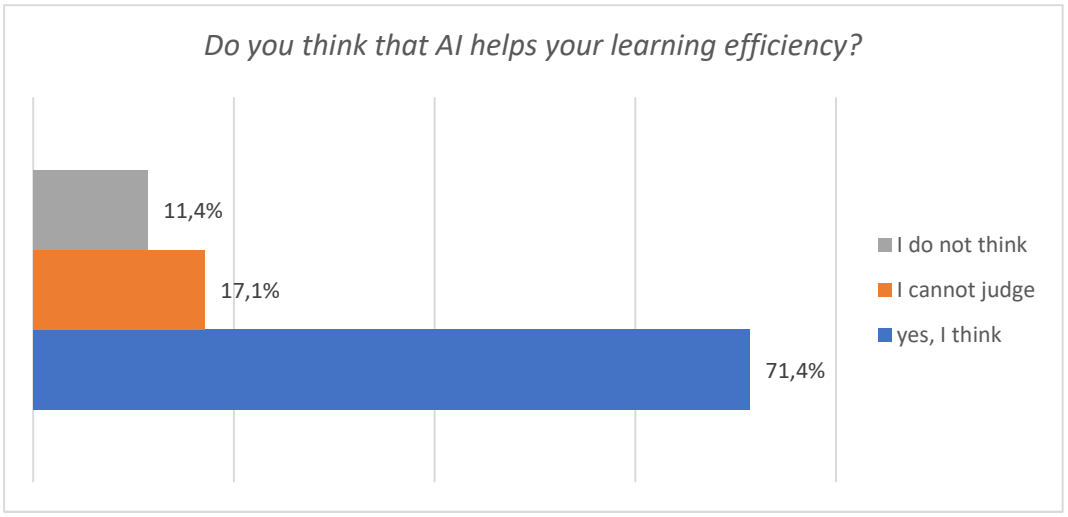

Fig. 11. Responses to the question "Do you think that AI helps your learning efficiency?"

To the question "*How often do you use AI in project implementation?*", the biggest part of students (71.4%) share that they apply AI in the research part of their project, 17.1% at each step of implementation and 11.4% during project implementation (Fig. 12). It seems that students very often rely on AI at the research phase of project doing to collect information regarding a topic, relevant information sources or possible tools for its implementation.

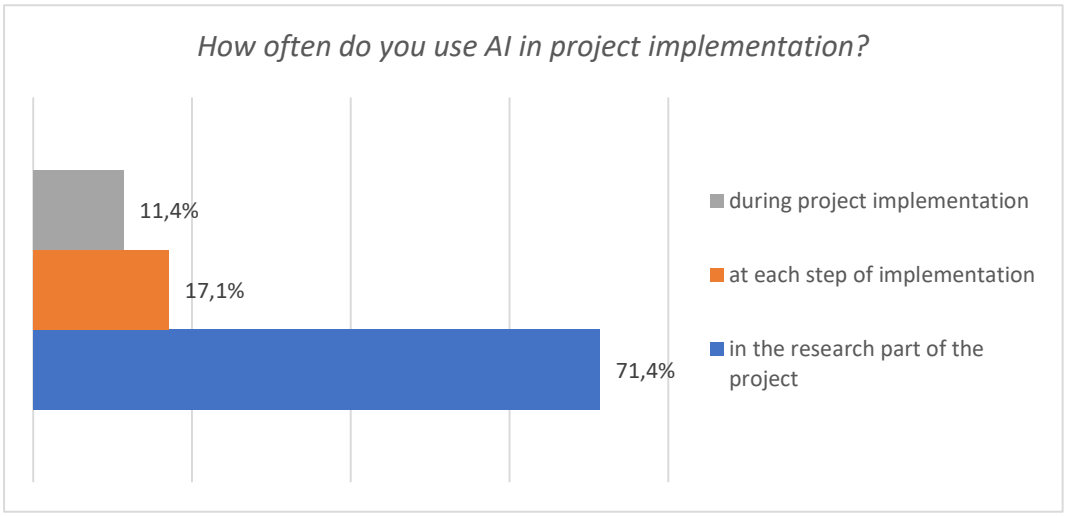

Fig. 12. The answers to the question "How often do you use AI in project implementation?"

To understand the ability of students to be creative at project preparation, the following question is asked: "*Do you consider yourself creative when implementing a project?*". The students show creativity in one or another form as it is seen from their answers. The bigger part of respondents (almost a half - 48.6%) said that they use existing solutions and adapt them to the project requirements (Fig. 13). The rest of the students are divided in two equal groups as the first group includes students who create a completely new solution to a problem (25.7%) and the second group consists of students who combine several existing solutions to obtain a new approach (25.7%).

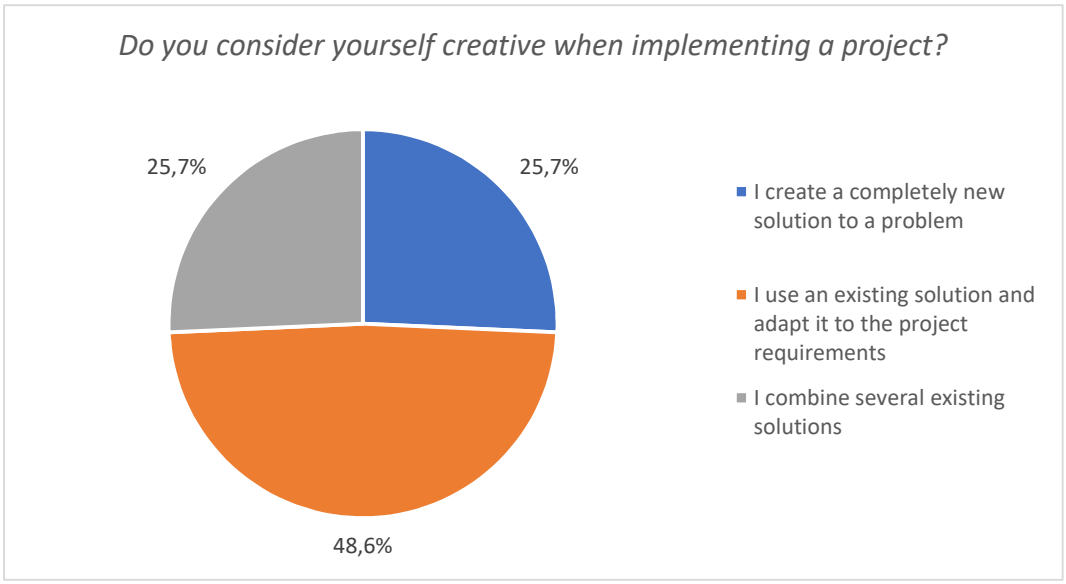

Fig. 13. The answers to the question "Do you consider yourself creative when implementing a project?"

To the question "Is the knowledge acquired in the subject area in which the project is set sufficient?", 57.1% share that use knowledge from different subjects and 42.9% said that the obtained knowledge is sufficient for the project implementation (Fig. 14).

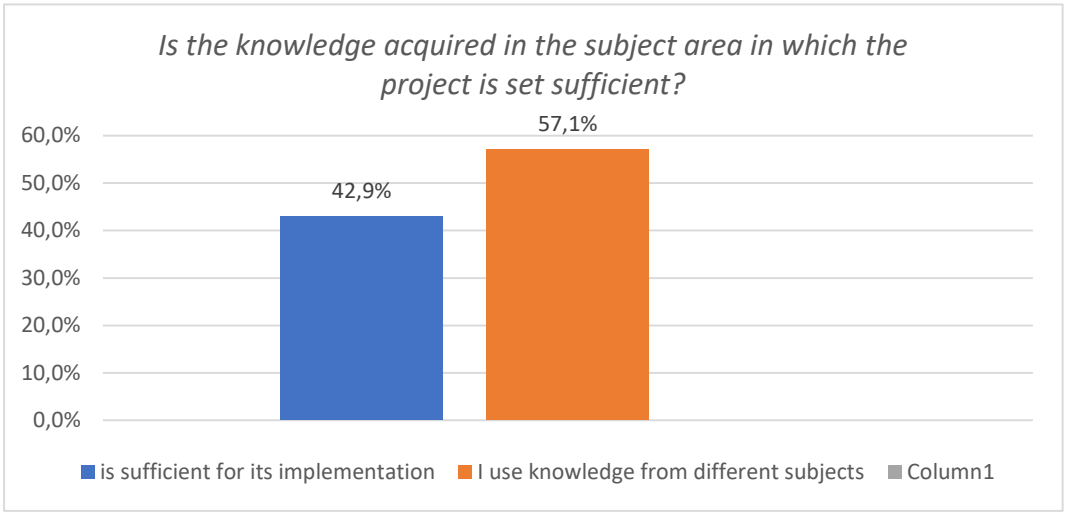

Fig. 14. The answers to the question "Is the knowledge acquired in the subject area in which the project is set sufficient?"

To the question "*Does working on a project help you acquire the planned knowledge for successful completion of the course?*", the biggest part of students (77.1%) votes with "yes", 2.9% with "no" and 20% with "I can't decide" (Fig. 15).

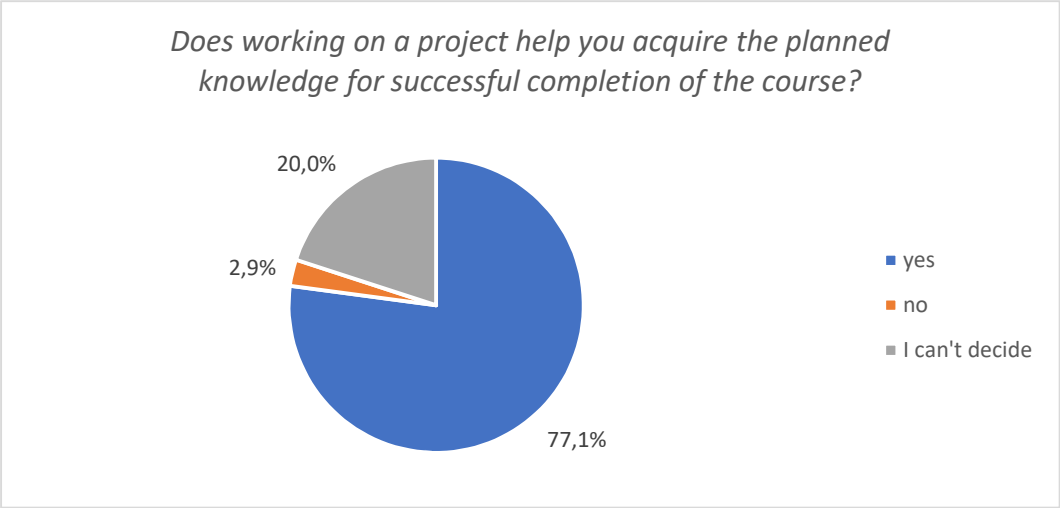

Fig. 15. The vote considering the question "Does working on a project help you acquire the planned knowledge for successful completion of the course?"

The answers to the question "*How do you plan to improve your learning efficiency when implementing projects?*" can be summarized as follows. Students believe that they will be more effective when implementing projects by:

1) setting clear learning goals,
2) better planning the time for implementation, as well as setting specific deadlines,
3) better planning and dividing tasks into stages for implementation,
4) using different sources of information and applying the learned theory in practice,
5) seeking feedback from the teacher and classmates when necessary to supplement knowledge,
6) when possible, practicing teamwork for analysis and exchange of ideas, for motivation and learning new approaches,
7) using various digital tools for organizing and presenting the project,
8) analyzing mistakes made after each task and looking for ways to improve.

Regarding the application of AI, students say they use it, but rely more on credible sources such as learning resources recommended by a teacher and textbooks. Do not overuse AI in order to stimulate their own creativity and analytical thinking when implementing projects.

DISCUSION

In this section is proposed a model for learning performance improvement considering the school students point of view (Fig. 16). The project work has to begin with formulation of clear learning goals (e.g. to improve or obtain general or specific knowledge and skills). Planning is an important step related to understanding the project stages and tasks that should be conducted in each stage and setting the deadlines for project stages and tasks to implement the project in time. Searching and using suitable literature sources in the form of online information resources as well as utilization of tutorials and textbooks recommended by teachers. Contemporary students communicate with AI most often at the research stage of their projects, but share that it should be applied in projects with attention considering the provided information, instructions or programming code. The survey shows that students almost equally prefer to carry out practical, theoretical or combined (with theoretical and practical parts) projects. Depending on the nature of the projects, they should choose appropriate digital tools and software for implementation. When necessary, they receive

feedback from a teacher or classmates. To exchange ideas and better analyze the topic, they can participate in teams and work collaboratively. For the successful implementation of the project it is necessary conductance of self-control and self-evaluation whether the formulated learning goals have been achieved. Students' learning performance at project working could be improved if it is necessary considering the analysis of the included in the model elements.

A big part of the students think that project-based learning is an important supportive approach for successful accomplishment of the course at whole. Based on all the survey data, models were prepared to predict successful completion of the course considering the successful implementation of the project. The data set is divided to 70% for learning and 30% for testing in RapidMiner Studio. The used algorithms are from supervised machine learning with focus on these based on creation of three structures: ID3, Decision Tree, AdaBoost, Bagging and Stacking. The models were evaluated and the obtained accuracy is 80% that could be explained with no so big number of surveyed participants. The main predictors in each predictive model are presented in Table 1. It is seen that different models are characterized with different predictors as exception is observed to Decision Tree and Stacking models, which has one predictor that is the same.

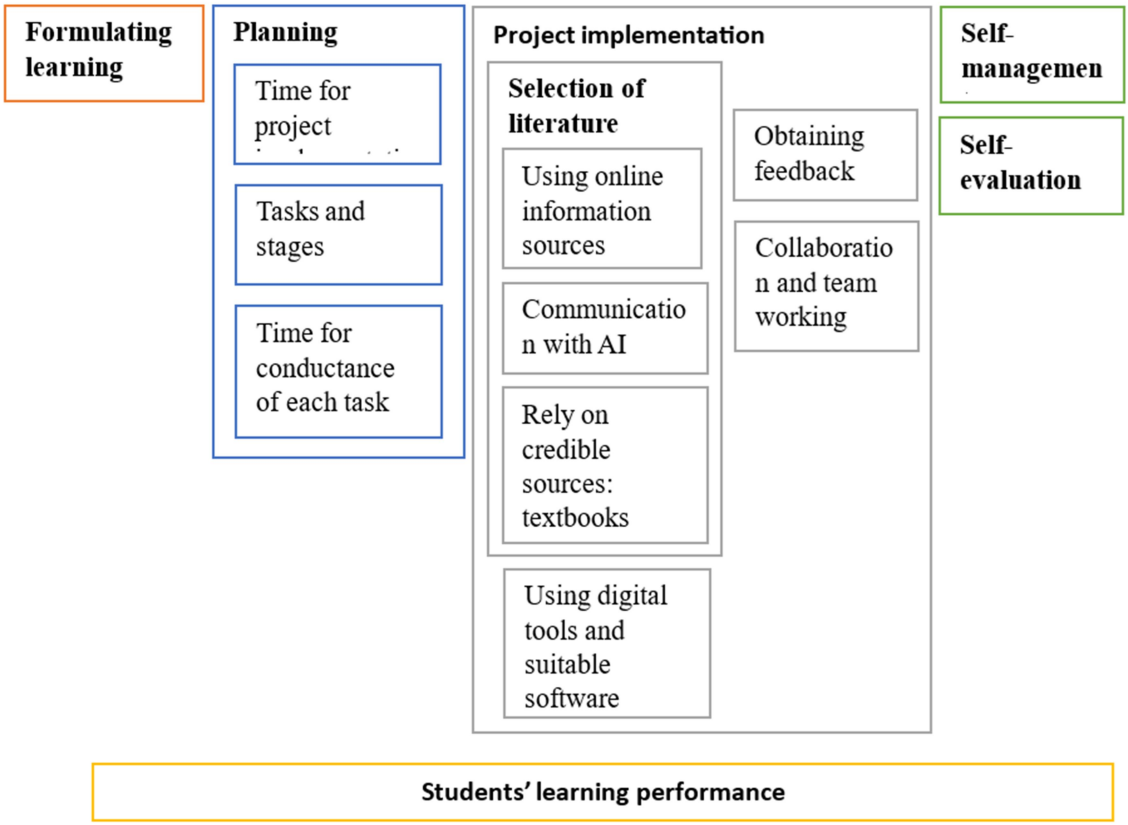

Fig. 16. Conceptual model for improvement of students' learning performance

Table 1. Machine learning algorithms and found predictors

Algorithm	Predictors
ID3	1st level: Who do students turn to when they need help? 2nd level: How do the students prefer to choose their topic? 3rd level: How they prefer to conduct their projects? 4th level: What information sources do they use when implementing the project?
Decision Tree	1st level: How students prefer to conduct their projects?

Algorithm	Predictors
AdaBoost (Decision Tree)	1st level: How often do you use AI in project implementation? 2nd level: How would you prefer the project assessment to be conducted? 3rd level: How do you prefer to submit and defend your project? 4th level: Do you think you are creative when implementing a project?
Bagging (Decision Tree)	1st level: How students prefer to conduct their projects? 2nd level: What should be the format of the project (theoretical, practical, combined)? 3rd level: What is the preferred duration of the project?
Stacking (Decision Tree, ID3)	1st level: How students prefer to conduct their projects?

CONCLUSION

The paper examines the impact of project-based learning on students' learning efficiency and successful completion of the course. Based on a developed survey instrument, the opinions of secondary school students were collected in order to understand their views and attitudes regarding the importance of project work on their learning performance. The analysis shows that contemporary students realize the importance of clearly set goals, task planning, selection of learning resources, as well as careful communication with the AI. Self-control and self-evaluation are important parts of the success of the project, which is completed in time. Students' views on the main elements for the successful implementation of a project and for improving their learning efficiency are presented through the created conceptual model. Predictive models have also been developed to predict the success of students in completing a course in which projects are implemented as the main predictors for each model are also presented.

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