Project-Based Learning of Diffusion and Osmosis: Opinions of Students of Physics and Technology at University of Novi Sad

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Abstract
There are subjects which university students perceive as uninteresting and which they are reluctant to learn. The use of an appropriate approach to learning can contribute to the formation of positive students’ opinions on learning. Project-based learning (PjBL) is characterized by active research, problem-solving, and student-made projects which is nowadays usually facilitated by the use of computer and network technologies. The aim of this research is to assess opinions of students of physics and technology at University of Novi Sad, Republic of Serbia, on PjBL, as well as to analyze these opinions in connection to three different factors: gender, academic performance, and study program. The physics content Diffusion and Osmosis was realized using PjBL. This topic was chosen because of possible interdisciplinary concepts’ relations between physics, chemistry, and biology. After students’ group work on projects and their project reports, a survey was conducted. Research results showed that opinions of students participating in the research about PjBL were independent of their gender, academic performance, as well as whether they study physics or technology. All students had equally positive opinions on PjBL. Further implementation of PjBL is planned in the authors’ departments, along with the integrative implementation of PjBL in teaching science in collaboration with other departments at the university.

Keywords
faculty students, interdisciplinary concepts, PjBL, science, students’ projects

Introduction
Teaching and learning are very complex processes. They depend on many different factors, such as activities and experiences provided by the teachers and students. Teaching approaches can be defined as a complex combination of teaching intentions and strategies that teachers apply when they teach (Cao et al., 2019). There is a variety of approaches that teachers can choose from when designing their lesson, and it has been proven that teachers’ approaches to teaching influence students’ approaches to learning (Trigwell et al., 1999).

The teaching of the natural sciences is mainly affected by using different approaches to learning and teaching. It is noticeable that there is a general decline in students’ interest in science (van Griethuijsen et al., 2015). In this sense, it is essential to apply an adequate approach that would be effective in raising the students’ motivation for learning science (Heering & Höttecke, 2014).

Project-based learning (PjBL) is an approach which stems from certain progressive tendencies in education such as constructivist theories of learning, and it involves teaching in which the student is at the center of the education activity and is actively learning (Condliffe et al., 2017). It is characterized by active research and problem-solving. It can also be described as learning by doing, and it focuses on real-life problems that capture students’ attention (Bell, 2010). These problems are often complex and open-ended (Kahn & O’Rourke, 2004). Unlike problem-based learning (PBL), with which it has some common characteristics in terms of problem-solving, the outcome of PjBL is a student-made project (Ravitch, 2000), which is its basic specification (Savery, 2006). The teacher in this approach is not a mere distributor of knowledge, but someone who directs the whole

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Project-based learning involves defining driving questions to motivate learning (Larmer & Mergendoller, 2010) and target significant learning goals. Designing PjBL is a complex task that requires a substantial amount of time. An important aspect of PjBL is that it promotes the construction of knowledge. For this purpose, scaffolds could be used to guide student learning (Krajcik & Shin, 2014). According to Grant (2002), teachers should begin the PjBL approach by cultivating student engagement. They also have to encourage students to choose the activities by themselves, and to support collaborative learning among students (Krajcik & Shin, 2014). In terms of assessment, it is very important that the final product of the PjBL answers the driving question. Also, it is important to provide opportunities for student reflection and teacher feedback and to present products to authentic public audiences (Krajcik & Shin, 2014; Larmer & Mergendoller, 2010).

The end products of the projects may be different. These can be academic dissertations and presentations (Spronken-Smith & Kingham, 2009), reports (Nation, 2008), exhibitions, video materials, board games, etc. (Botha, 2010). According to Kolmos (1996), there is a classification of projects according to whether they are under the direction of the teacher or not and how much the problem itself directs the selection of methods. Thus, there are projects selected by the teacher in accordance with the program unit, subject projects for which students independently select methods, and problem projects, whose problem determines the choice of content and methods. Each of the types of projects mentioned above can be applied at different levels of education and can contribute to the realization of different learning outcomes and the development of numerous student skills (Kolmos, 1996). If group work is implemented, students develop skills such as communication, planning, and teamwork (Danford, 2006).

The development of these skills is facilitated by the use of computer and network technologies. By Chang and Lee (2010) the use of technology to facilitate PjBL implementation can be categorized as technology-supported or as multimedia technology-assisted. In technology-supported PjBL, the technologies can be used as tools for communication, research, scaffolding, or project management. In multimedia technology-assisted PjBL research, technologies serve as tools that enable students to create, organize and present their research work using multimedia. A technology-integrated PjBL provides learning environment that helps to overcome difficulties in conducting the cooperative learning activities (Bottino & Robotti, 2007) and it is also effective in enhancing students’ motivation in learning science, their capability in problem solving and their learning achievement (Hung et al., 2012).

One of the most important features of PjBL is its interdisciplinarity (Hanney & Savin-Baden, 2013). This approach may cover different disciplines within both natural and social sciences (Lehmann et al., 2008). This encourages students to take a holistic approach to problem-solving and adapt to different content, regardless of cross-curricular, and cross-disciplinary differences (Harmer & Stokes, 2014).

Solving real-life problems in PjBL increases student motivation (Lockrey & Bissett-Johnson, 2013). It has been shown that by considering problems of interest to students and problems with which they have already had an experience, the students’ motivation in the PjBL approach is increased (Harmer & Stokes, 2014). Moreover, group work has been shown to be a factor that increases students’ motivation in PjBL (Frank et al., 2003). According to Darling-Hammond (2008), PjBL approach enhances students’ motivation, deeper learning, conceptual knowledge, and development of different skills. Besides, this approach is positively correlated with students’ skills development (Botha, 2010) and has a positive effect on their creativity and innovativeness (Joyce et al., 2013). Interviewing students and their educators showed that the students made more effort in project activities than in other types of teaching (Van Den Bergh et al., 2006). Project-based physics learning is one of the most effective didactic models for understanding science (Holubova, 2008).

Research Problem, Research Aim, and Research Questions

Students, although most of them have chosen the study program according to their interests, come across courses that they find difficult or less interesting and that they are reluctant to study. When a student finds him/herself in that situation, he/she should be ready to devote him/herself to master the course, that is, learn the content. When learning physics content, an individual encounters difficulty because of the complexity and abstractness of this content (O’Keefe, 1997). In order to be successful in mastering it, students must have adequate knowledge of mathematics and language, as well as the skills needed to solve problems and perform experiments (Lacambra, 2016).

The use of an appropriate approach to learning is useful for forming positive students’ opinions on the learning of physics contents. Integrated approach and PjBL can help students change their opinion on learning, even when they learn physics contents that they find difficult or uninteresting.

This research aims to assess the differences according to gender, study program and academic performance which may exist in opinions of students of Physics and Technology at University of Novi Sad, Republic of Serbia, on PjBL of
physics content, particular Diffusion, and Osmosis. Based on the set research aim, the research questions arise. Thus, the research questions are:

- Do students of physics and technology at University of Novi Sad have a positive opinion on the implementation of projects in physics learning, particularly learning of Diffusion and Osmosis?
- Is students’ opinion on the implementation of projects in physics learning related to their (1) gender, (2) study program, and (3) academic performance?

Methods
General Background and Design

Cross-sectional research was used to examine students’ opinions on PjBL and how differences in gender, academic performance, and study program might correlate with students’ opinions. In order to determine students’ opinions on PjBL, the students were engaged in projects. Afterward, the survey constructed for this research was distributed to students. In Figure 1, the research design is shown.

The research was carried out in the academic year 2018 to 2019, and it lasted for six school weeks (May and June). The physics teaching content studied using the PjBL approach during the research was Diffusion and Osmosis. This topic was chosen because of possible interdisciplinary concepts’ relations between physics, chemistry, and biology. The PjBL can help in delivering integrated content, as well as in widening physics contents and indicating existing correlations.

Sample

The total sample size was 89 first-year university students enrolled at the Faculty of Technology and Faculty of Sciences (Department of Physics) at University of Novi Sad, Republic of Serbia. These are students studying one of the next study programs: food engineering, pharmaceutical engineering, materials engineering, and biotechnology at the Faculty of Technology and students of physics teaching and general physics at the Department of Physics. The sample was formed in such a way as to include all students with whom the researcher could implement project teaching as an interdisciplinary approach in the realization of the selected physics content (these are almost all students enrolled in the first year of study at Department of Physics and Faculty of Technology at University of Novi Sad). Because of incomplete surveys or unfinished projects, the analysis was carried out on 73 students. The students were voluntarily participating in the research, and informed consent to participate in the research was obtained from each participant.

Research Instrument and Procedure

A survey, used as a research instrument, was created by the researchers. This survey consisted of two parts. In the first part, the information on students’ gender, study program, and academic performance (the average grade in studies) was collected. The second part was used for collecting data about students’ opinions on PjBL; this part consisted of statements about PjBL, and the students were supposed to evaluate each statement using five-point Likert-type scale responses (from “strongly disagree”—1 to “strongly agree”—5). The second part of the survey consisted of 17 items about using PjBL and working on students’ projects. The researchers have estimated the reliability and validity of the survey and these estimations will be presented within Results.

In order to answer research questions, a procedure designed specially for that purpose was followed. One of the researchers introduced PjBL to students, outside the scope of regular classes. Students were already acquainted with the cooperative way of learning within laboratory exercises, which are designed so that two to four students work together on an experimental task. They did laboratory exercises at least once a week during the semester. This situation was a good basis for presenting PjBL and its features such as group work when assigning the project. After PjBL is introduced to
students (in the next teaching term), driving questions and target significant learning goals for topic *Diffusion and Osmosis* were defined. Afterward, projects were assigned to students according to their interests and experience.

Students were assembled into three- or four-person groups, based on their common interests. The project goal was to design a video material containing an explanation of the phenomenon of diffusion and osmosis, as well as its demonstration through experiment and analysis of interdisciplinary relations concerning it. The project consisted of students’ study of YouTube videos on the selected topic and the creation of their own videos.

While working on projects, students could get help from the researcher. What followed the work on the projects was the process of students’ reflection, as well as teachers’ feedback. When the projects were finalized, each group prepared presentations for the project report and afterwards they presented their projects to other students and the researcher and each project was discussed and assessed. When all projects presentations were finished, the survey was administered to students; the time assigned for completing the survey was 35 minutes. The survey was anonymous and since students’ privacy was respected during the research and there was no influence on students regarding their answers, they were able to express their opinions freely.

Each group realized one project, and within the entire research, 18 different projects were done, and each of them contained video material. Some projects were designed to look like an episode of a documentary series where one of the students was the narrator in the video, some were scientists performing an experiment, and so on. Other projects resembled a lecture in which the video material that completes the lesson was an integral part of it. One group of students made several short videos in which they presented simple home experiments—one video for each experiment. An example of one group’s project is given below.

During the project design period, physics students would contact the instructors, asking them to provide them with additional literature (mainly related to biology), so that they could complement their work with examples of this phenomenon from the point of view of other disciplines. Also, they would come looking for recommendations for computer programs that could help them design the video and ask for an opinion on the concept and content of the video they designed. The students presented the project in the form of a lecture, through which they presented the video material they had made.

First, diffusion and osmosis were explained from the point of view of physics, referring to these phenomena as the consequences of the Brown movement. The students introduced certain terms, such as chemical potential and concentration gradient, in order to explain Fick’s laws for diffusion. Afterward, they presented some examples of the occurrence of osmosis in the living beings (e.g., what happens to a cell in a hypertonic and in a hypotonic solution). They then presented how to perform an experiment in order to observe plasmolysis in onion leaves put in aqueous sodium chloride solution. The students then performed some simple experiments to demonstrate the occurrence of diffusion (an experiment in which candies dissolve their color in warm water) and osmosis (an experiment in which potatoes serve as a semipermeable membrane). In the end, they showed a video in which they performed and explained an experiment with gummy candies that are put into different liquids or solutions to see how they can swell or shrink as a consequence of the osmosis.

**Data Analysis**

The scores on students’ opinion surveys were statistically analyzed within this research, and the variables were described using descriptive statistics. An individual’s opinions on PjBL were assessed by summing the responses (range 1–5) to all the statements. A negatively formulated statement (“Project-based learning is difficult”) was scored in reverse order with an aim of maintaining a unidirectional scale. A high score indicated a positive student’s opinion on PjBL, while a low score indicated a contrary opinion. The possible interval for the score was between 17 and 85 points. A separate analysis was performed for the variable of gender, enrolled study program, and for students with different academic performance. Normality was tested using a Shapiro–Wilk normality test. An independent-samples *t*-test was conducted to compare the survey scores for different groups of students. The data were treated statistically using the IBM SPSS Statistics 20.

**Results**

In order to estimate the reliability of the survey, the Cronbach’s alpha coefficient was calculated. The gained value of this coefficient is .901, which indicates that the survey has good reliability. Further, as proposed by Segedinac et al. (2011), the expert team was formed in order to estimate the validity of the applied tests. Three university professors constituted the expert team which estimated that the survey items were appropriate for university students since all formulations were precise and easy to understand.

Basic descriptive statistics related to scores on the Students’ opinion survey are presented in Table 1.

According to results (Table 1), it can be suggested that students’ opinions on PjBL are positive.

Additionally, the average value was calculated for each item separately. The items which the students agreed with the most were:

- PjBL encourages the development of skills for independent planning of learning (with average value 4.23).
- Students’ projects are interesting (with average value 4.19).
Students’ projects are significant in the learning process (with average value 4.05).

PjBL is intellectually stimulating (with average value 4.05).

On the other hand, the students agreed the least with the following items:

- I am satisfied with my engagement during the project realization (with average value 3.69).
- I have acquired knowledge of project planning (with average value 3.69).
- PjBL encourages the development of analytical skills (with average value 3.86).
- Work on the project has aroused my interest in a given topic (with average value 3.90).

Each student could write an additional comment on PjBL. It was surprising that, although this was an optional field, 44 comments were written. Most comments could be paraphrased as “PjBL is an excellent way of learning,” and “PjBL is useful.”

There is no deviation from normality within the selected groups, according to the Shapiro–Wilk test: for all students ($W[73] = .98, p = .42$); for the females ($W[56] = .97, p = .13$); and for the males ($W[17] = .94, p = .11$).

An independent-samples $t$-test was performed to compare the survey scores between the physics students and the technology students. There was no significant difference between the survey scores of the physics students ($M=70.5, SD=11.2$) and the technology students ($M=67.3, SD=8.4$); $t(71) = 1.31, p = .20$.

In order to compare the survey scores between the students with different performance, the students were grouped, regarding the number of exams that they passed and their average mark, in three groups: (1) students with high performance, (2) students with average performance and (3) students with low performance (Table 3).

There was no deviation from the normality of data within any group, according to the Shapiro–Wilk test: for the students with high performance ($W[27] = .97, p = .61$); for the students with average performance ($W[29] = .95, p = .18$); and for the students with low performance ($W[14] = .97, p = .91$).

There was no significant difference between any pair of groups in the independent-samples $t$-tests: for survey scores of students with high performance ($M=66.4, SD=9.58$) and group of students with average performance ($M=69.2, SD=9.28$); $t(57) = -1.15, p = .25$; for survey scores of students with average performance ($M=69.2, SD=9.28$) and group of students with low performance ($M=68.7, SD=8.80$); $t(44) = .18, p = .86$; for survey scores of students with high performance ($M=66.4, SD=9.58$) and group of students with low performance ($M=68.7, SD=8.80$); $t(39) = -.75, p = .46$.

**Discussion**

Based on a large number of positive students’ comments (Table 1), it can be suggested that the students’ opinions on PjBL were positive. Many students pointed out in the comments that they like teamwork and collaborative learning, and as one of the most common reasons they state that through interaction with colleagues they often find themselves in a situation to check their knowledge. There were
often comments in which students referred to the aspect of interdisciplinarity and point out how this way of mastering the material helped them to acquire some new knowledge from other areas. The students found PjBL interesting and encouraging for the development of skills for independent planning of learning. For all students, no item had an average value below 3.69 (out of maximum 5), indicating that the projects were very well accepted. This result is in line with findings of various studies. For instance, Bilgin et al. (2015) showed that PjBL positively influenced undergraduate students’ self-efficiency beliefs about science learning and teaching and that these students had positive opinions on the application of the PjBL. Besides, undergraduate Physics students in “Fundamental Physics” section at the University of Paris-Sud, who attended the PjBL course, stated that they had one very enjoyable course (Bobroff & Bouquet, 2016). Similarly, university students (from five institutes of technology in Taiwan) had a positive attitude toward the application of PjBL within the interdisciplinary curriculum of Science, Technology, Engineering and Mathematics education—STEM (Tseng et al., 2013).

Chang and Lee (2010) showed that students who have been taught using the PjBL favored this approach, and that they felt good about their work and their involvement in this type of teaching. University students at Technical University of Denmark-DTU who have implemented PjBL have expressed readiness for teamwork and defined PjBL as a motivating factor (Zhang et al., 2016). Several studies have analyzed students’ attitudes toward PjBL, especially in the sense of its impact on their motivation. Observation and analysis of semi-structured interviews with students and student reports showed that they enjoyed designing the project and that it increased their motivation for learning (Frank et al., 2003). Students (from Beijing) stated that the PjBL approach is much more motivating and effective compared to lecture-based teaching (Du et al., 2013). Positive student-teacher feedback after implementation of PjBL was recorded by Graham (2010) in an engineering program. Students felt satisfied and enjoyed the realization of the project (Joyce et al., 2013; Spronken-Smith & Kingham, 2009) and also showed a positive attitude toward project work (Meehan & Thomas, 2006).

In the authors’ opinion all students have the benefit of introducing PjBL, but when students are future teachers, introducing PjBL to them is beneficial also because they can implement PjBL when they start teaching. Notwithstanding, only one group of students of physics studied a program related to physics education (physics teaching), a large number of both physics students and technology students, after graduating opt to gain additional qualifications to become teachers. That is an additional reason why one can find a particularly significant introduction of the PjBL approach to students included in this research sample. Various studies can be cited to confirm this claim since many researchers focused on the implementation of PjBL in pre-service teachers’ education in order to contribute to the introduction of PjBL into schools (Tsymbulsky & Muchnik-Rozanov, 2019). Holubova (2008) found that it is necessary to educate pre-service teachers in order for them to become competent to create interdisciplinary projects. Goldstein (2016) found that not one student expressed a negative attitude regarding learning physics when introduced to the PjBL approach to teaching physics for pre-service elementary school teacher education students.

The items that students least agreed with indicate that students are slightly less satisfied with the realization of the project and their participation in the project, as well as how much they have mastered PjBL. It is also worth pointing out that one of the items that showed a relatively low average value (3.90) is the statement about working on the project to arouse students’ interest in a given topic. Based on that, it can be suggested that although students’ interest in a specific topic may be only slightly changed, PjBL can make the learning of that content more interesting. Related to this finding, a study in the field of applied physics disciplines should be mentioned since it showed that students had a very positive view of topics Power supplies and Photovoltaic electricity when they were presented with PjBL (Martinez et al., 2011). Besides, student survey analysis showed that the project-based lab teaching was more attractive than routine lab work in engineering subjects such as Power Electronics and Drives.

Further, this research results show that, as far as the particular research sample is concerned, the university students’ opinion on PjBL of physics contents was independent of gender, average students’ performance, as well as to the study program they are enrolled in. Namely, based on the results presented above, male and female students, as well as Physics

| Average mark | Number of successfully passed exams in relation to the number of courses taken |
|--------------|---------------------------------------------------------------------------|
|              | Less than half | More than half | All                      |
| Below 7      | low performance| low performance| no students              |
| 7–8          | low performance| average performance| average performance |
| 8–9          | average performance| average performance| high performance |
| 9–10         | no students    | high performance| high performance |
### Conclusions

The research aim has been achieved. Based on the research results, it can be concluded that students of physics and technology at University of Novi Sad, Republic of Serbia, have positive opinions about PjBL while using this approach in learning particular physics contents (*Diffusion and Osmosis*). Further, gained results show that both male and female students have equally positive opinions on PjBL; the same applies for students with high and low performance, as well as for Physics and Technology students. That is, within the research sample, the university students’ opinion on learning physics contents with the use of PjBL was independent of gender, average student’s performance, and whether the student is enrolled in the study program Physics or Technology. Based on that, it can be suggested that the implementation of PjBL of physics content can induce students’ positive opinions on physics learning; related to above stated suggestions one must be aware of research limitations, particularly the specificity of the sample.

A main limitation of this research is related to the research sample; that is, this research is related to a particular case. The survey was not conducted on a random sample. The research included only students enrolled at Faculty of Technology and Faculty of Sciences (Department of Physics) at University of Novi Sad, Republic of Serbia and just physics content *Diffusion and Osmosis* was realized using PjBL. Accordingly, it is necessary to emphasize that based on the research results it is not possible to make general conclusions in regard to differently constructed courses, differently organized faculties and universities or other educational levels. Moreover, there is a possibility that students expressed positive opinions about PjBL because for the time while the research was conducted the proposed PjBL approach was new (and because of that interesting) to them. Besides, the research limitations related to collecting data should be noted. The data about sample characteristics and students’ opinions were recorded using the survey and the collected data enabled a very limited analysis of students’ opinions about PjBL. The analysis could give more interesting insights about the implementation of PjBL if the survey included items related to other variables (for instance, students’ knowledge, motivation, metacognition, cognitive load, or similar). Carried out analysis of gained data did not provide insight into the efficacy of knowledge acquisition when PjBL is implemented and although students’ opinions were shown to be positive, one should be careful when implementing PjBL in order not to have a negative impact on students’ performance. Further, the survey recorded self-reported data which cannot be verified and students could try to attribute positive outcomes to their opinions.

Based on the results of this study and the observed limitations, further development of the PjBL approach is planned, which would reduce the limitations and other parasitic factors that primarily affect the opinions and learning outcomes. Besides, the next studies that are planned will include analysis of several factors in relation to the effectiveness of PjBL.

The implications for the practice and further research derive from the results of this research. It can be suggested that the implementation of the PjBL approach in learning physics content can be beneficial in particular case since it can develop positive students’ opinions on learning process. The teachers can be successful in using PjBL only if they receive the necessary material and training about this approach. Therefore, it is necessary to carry out additional teachers’ professional development in order to enrich university teaching with the implementation of PjBL.

Taking into consideration the findings of this research and its limitations, the recommendation for future research can

| Students            | N    | M     | SD    | Min  | Max   | Std. Skew | Std. Kurt. |
|---------------------|------|-------|-------|------|-------|-----------|------------|
| with high performance | 27   | 66.4  | 9.58  | 43.0 | 85.0  | -1.16     | 0.22       |
| with average performance | 32   | 69.5  | 9.47  | 46.0 | 84.0  | -1.63     | 0.11       |
| with low performance  | 14   | 68.7  | 8.80  | 53.0 | 83.0  | -0.33     | -0.45      |
be given. Further research on the use of PjBL in other topics, other faculties or study programs (for instance, Department of Biology or Faculty of Technical Sciences) can be conducted, as well as at different educational levels. Besides, different research designs (experimental design with control and experimental groups), different sampling methods, and different data collection instruments could be used in order to examine different effects of PjBL approach.

The results of this study will impact the development of PjBL, and other approaches of learning, especially from the aspect of the application of different teaching aids, within a larger sample of students. Based on the above considerations and conclusions, further implementation of PjBL is planned in the authors department. Particular subjects will be enriched with this teaching approach. For this purpose, adequate material resources and training for teachers and students should be provided. Also, integrative implementation of PjBL in teaching science in collaboration with other departments at the university is planned.

Appendix

Survey on Students’ Opinions About Project-Based Learning

This survey is part of the research carried out as part of the work on the doctoral dissertation. The survey is anonymous and your answers will not be seen by anyone but the person conducting the research. By answering the questions honestly, you will help achieve the goal of the research.

A - The first part of the questionnaire consists of questions on the basis of which the analysis of the structure of the research sample will be performed.

Answer the questions by circling the letters in front of the corresponding answer.

1. Sex:  
   (a) male  
   (b) female

2. Number of exams passed so far (refers to exams from completed courses, NOT including courses taken this semester)  
   (a) less than half of the total number of attended courses  
   (b) more than half of the total number of completed courses  
   (c) all courses taken

3. Average grade:  
   (a) below 7  
   (b) between 7 and 8  
   (c) between 8 and 9  
   (d) between 9 and 10

B – The second part of the questionnaire contains statements about your views on project-based learning.

For each of the following statements, indicate how much it corresponds to your opinion by circling the appropriate number according to the offered scale:

1 = Strongly disagree,  
2 = Disagree,  
3 = Neutral,  
4 = Agree,  
5 = Strongly agree.

1. Project-based learning is useful for learning physics content. 1 2 3 4 5
2. Student projects are important in the teaching process. 1 2 3 4 5
3. Student projects are interesting. 1 2 3 4 5
4. I liked the teamwork. 1 2 3 4 5
5. I liked the public presentation of the project. 1 2 3 4 5
6. I gained knowledge about project planning. 1 2 3 4 5
7. I am satisfied with my personal engagement during the project implementation. 1 2 3 4 5
8. The realization of the project was difficult for me. 1 2 3 4 5
9. Teaching projects encourage the development of analytical skills. 1 2 3 4 5
10. The realization of projects in teaching encourages self-confidence in dealing with problems. 1 2 3 4 5
11. Teaching projects encourage the development of independent learning planning skills. 1 2 3 4 5
12. Teaching projects encourage the development of problem-solving skills. 1 2 3 4 5
13. Teaching projects encourage enthusiasm for learning. 1 2 3 4 5
14. It is necessary to implement projects to a greater extent. 1 2 3 4 5
15. Working on the project aroused my interest in the given topic. 1 2 3 4 5
16. Project-based learning is intellectually stimulating. 1 2 3 4 5
17. Project-based learning encourages motivation. 1 2 3 4 5
What do you think about project-based learning? (Write your answer.)

Thank you for taking the time to complete this questionnaire.

Availability of Data and Material
Raw data supporting the findings of this study were generated at the University of Novi Sad, Faculty of Science. Data are available from the corresponding author on reasonable request.

Declaration of Conflicting Interests
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Ethics Statement
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The students were voluntarily participating in the research, and informed consent to participate in the research was obtained from each participant. Since students’ privacy was respected during the research, and since there was no influence on students regarding the questionnaire, they were able to express their opinions freely.

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