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Original Article

Modeling the Geography Class through Problem-Based Teaching: a Case Study from Novi Sad, Serbia

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Abstract

The idea of problem-based teaching, i.e. learning through solving problems, is not a new one, but has been fairly neglected in the teaching process. The aim of this research is to consider the possibility of applying this learning model in teaching geography in primary and grammar schools. This teaching model was proposed for the presentation of the teaching unit *Australia and Oceania*, in the framework of the thematic unit *Political/Geographic, Demographic and Economic/Geographic Features of Certain Parts of the World*. The model implies group work. The expected successful outcome of the applied teaching model has been verified by the results of a survey and the scores achieved in the knowledge test. The study contains the entire course of the experimental teaching of the unit *Australia and Oceania* by applying problem-based teaching, and presents and analyzes the results achieved. The classes were modelled by relying on Hill-Slater's model. A t-test was used for the statistical analysis of data in order to test the hypothesis on differences in the arithmetic mean. The choice and application of the statistical mathematical procedure are determined by the nature of the phenomenon which is the subject of this research. The software packages *Mathematica and Excel* were used in order to statistically analyze data and to draw tables and graphs.

Keywords*: teaching geography, group work, problem-based teaching, problem-based learning and educational technologies.*

Introduction

Problem-based teaching as a system of procedures and resources enables students' creative participation in the process of acquisition of new skills. Solving problems is an activity which contributes to forming creative thinking and cognitive interests important for the versatile development of personality. Problem-based teaching requires discovering new solutions through thinking activity organized in different combinations.

In solving problems, every student, or a group of students learning together, can choose their own method of working. In the process of solving problems, the most complex thinking activities emerge, because a problem situation requires a new reaction. Frequently asked questions concerning problem-based teaching are "What are the aims of this form of teaching?" and "What benefits does it offer to students?"

Another question is to what extent problem-based teaching has been accepted in ge-

ography, as a discipline which is not close to those in which this method of teaching first flourished, i.e. medicine and engineering.

In this study we have looked for and offered some answers to the above questions and considered the issues related to developing geography curricula, predominantly or exclusively based on problem-based learning.

Problem-based teaching stands out as a didactic system whose quality and efficiency contribute to the development of creative abilities, that is, students' capability of individual thinking. Thus, it responds to the more and more complex demands of modern society (Veinović, 2004). In the Gestalt theory of Max Wertheimer it is insisted that teaching should be organized in such a manner that the student is able to independently find his own way of solving a problem, seeing the relations among the elements of a problem-based situation. Gestaltists criticize mechanical learning; they have discovered that solving problems stimulates the development of productive thinking (Vilotijević, 2000, 191).

The American psychologist Robert Gagné points out to solving problems as the most effective way of developing creative thinking, and places it on the very top of the list of learning styles (Vilotijević, 2000, 241).

Pawson et al. (2006) state that problem-based teaching or problem-based learning are one of the clusters of the latest innovations in active learning, for which a wide spectrum of positive results for students has been established, while Agnew (2001) points out that the supporters of such innovations mainly declare that they are promoting profound learning through the better understanding of concepts and the development of skills, as well as through encouraging students' participation and motivation, and through organizing inspiring classes. They understand problem-based learning as a teaching method and strategy or as cultural philosophy (Mandsley, 1999).

Spronken-Smith et al. (2008) find that students can benefit greatly from IBL since they are active in the learning process, can have improved understanding, more enjoyable learning, develop valuable research skills, achieve higher-order learning outcomes and perform better academically. Teachers themselves can also benefit from strengthening teaching-research links through students' engagement. However, in order for IBL to be effective, teachers must be encouraged and supported to take on this facilitating role. When IBL elements are embedded in a more traditional curriculum, particular care needs to be taken so that students and teachers are carefully oriented to the expectations regarding the outcome of learning and teaching in this mode.

This assumes designing the curriculum around some key problems in the professional praxis. The louder advocates of PBL point out that it is not only a teaching method, but a more comprehensive approach to learning and teaching. Instead of putting emphasis on teaching, the process of learning itself is stressed. Problem-based learning has a long tradition in the field of geography (Solem, 2001; Jovanović & Živković, 2005). The model of learning, based on Slater′s (1982) idea of teaching geography, was developed by Hill (1990). This learning model uses questions as tools for planning lessons which bring about new analytical and geographical skills. Hill-Slater′s model was embedded in many curricula and served as a source for numerous institutes in the USA dealing with teaching geography. The Hill-Slater model is presented in Solem (2001).

Problem-based learning in practice

The foundation of problem-based learning is good preparation and an appropriate choice of "the right" problem. The problem should be interesting and should relate to the real world. The complexity of the problem is desirable, because in that way a situation is cre-

ated in which students can, by means of approximations (non-trivial simplifications), get to the problem which is not difficult to deal with.

The "right" problem should generate several hypotheses and should not have a unique solution; it should require group work and stimulate the development of cognitive abilities of higher order. Solving problems should rely on students' previous knowledge and experience.

When creating a problem, it is important to save the fundamental concept, which is a constituent part of the educational unit. In order to solve the problem successfully, it is necessary to divide it into smaller units (phases or stages). It is desirable to prepare a short guide to solving problems and helping students to identify the source of data.

The most important elements of the problem are: the hook (bait), trigger, scenario, problem display and problem documentation. The hook can be newspaper news, an event, an article, a photograph, etc. The trigger is most often some text which suggests how the problem could be solved. The scenario represents the frame for solving the problem. The problem display and documentation contain the material which is given to students at the beginning of the process. This is where the problem is implied explicitly or implicitly. The problem display is given in such a way that it is a good combination of materials which make up the hook, the trigger and the scenario.

The basic characteristic of problem-based teaching manifests itself in the fact that solving problems is aimed at acquiring new knowledge, linking that new knowledge with different kinds of previous knowledge, and at verification through finding solutions (Havelka, 2000). In this case the student is the one who possesses some "knowledge" of his own. Such "knowledge" of the student and his perceptions of the phenomenon observed are placed in the focus of teaching, determining the guidelines according to which an active process of knowledge mediation between a teacher and a student begins. With carefully designed improvisations, the teacher offers a series of problem situations, which place students in the state of wonderment, provoke their curiosity, so much needed for launching all the thinking processes and the processes of learning and comprehension. Not one part of teaching a class (from the beginning, through the presentation- till the end) can be achieved without a high level of students' activity, in the form of a discussion about the observed problem. This also provides feedback information about the level of comprehension of a specific part of the curriculum. Problem-based learning and teaching cannot in any part function without active students' participation. With their ideas, observations and, above all, with their interesting conclusions, they create the teaching process.

Problem-based teaching is suitable for team or group work based on a social situation. A problem-based situation entails joint work and engagement. In a social situation, even the psychic functions which have just started to develop can be engaged. Without social support, a student is functioning only to the limits of his current development; however, through cooperation, his functioning goes beyond those limits, to the subsequent levels of development.

In problem-based teaching, the teacher plays a special role. First of all, the teacher should prepare a good problem. Problem-based teaching and learning do not focus on the teacher and his/ her knowledge, which can be found in textbooks anyway. The role of the teacher is to steer the learning process, to be the creator of the procedures, to indicate the sources of knowledge, provide additional information and materials and communicate with students. Instead of teaching, the teacher should encourage students to study independently. It is important to ask metacognitive questions such as: "How did

you reach this conclusion?"; "Do you know anything else on that matter?"; "Do you have any assumptions?".

The concept of PBL is present in many scientific disciplines, and the primary objective of PBL is to create an environment that allows students to become life-long learners. PBL has been integrated into numerous areas of study, including dentistry, pharmacy, optometry, nursing, law, environment, business and education. PBL involves confronting students with a problem related to the class material, as opposed to traditional didactic approaches to education. The problems that students face in these classroom simulations are loosely-structured situations designed to create an environment that create an opportunity for students to explore and learn (Ahlfeldt, Mehta, Sellnow, 2005; Williams, 1999).

Geography as a science is rich with different contents. It is advisable to choose such contents which boost creativity in students, improve thinking, and develop the ability of solving practical tasks and self-education (Ivkov, 2003). In geography there are many problem situations, and, as a result, problem-based learning can be successfully applied in this area. These problem situations arise from the logical structure of geography teaching and endless possibilities of observing, monitoring and discerning geographical phenomena. Solving problems in geography teaching has a series of didactic advantages. In this way, educational performance in respect of the level of knowledge, the acquisition of facts and the understanding of geographical concepts and rules can be increased (Gavrilović & Gavrilović 2009).

Class model

The idea of this study was to start PBL-based teaching by representing a specific problem, unlike the traditional approach, where teaching starts with representing the fundamental theoretical knowledge. In this way, students are encouraged to continually move in the direction of acquiring knowledge and skills, according to the levels and sequences of the problem being presented in a specific context. In that process, students are simultaneously using the corresponding learning material and receiving continuous expert support by their teachers.

In this process, teachers play the part of facilitators, rather than being the primary source of expert knowledge. As the key element in PBL is using the materials based on which students are faced with problems in the situations which are very close to professional reality, the intention was to realize classes in that way. Students most frequently jointly work and cooperate in small groups or teams in order to clarify and define the nature of the problem and to try to establish the procedure of solving it.

Slater-Hill′s model consists of several distinctive segments: targets, questions, geographical questions, data (presentation methods and practicing skills), outcome and evaluation. The target is the same as that set in the curriculum for the teaching unit which is being presented. The bait could be questions with which we want to provoke curiosity and inquisitiveness in students. After the student is "drawn into" the situation, geographical questions follow. These questions should direct students towards the teaching matter at hand. Jovanović & Živković (2005) point out that asking questions which provoke thinking is an excellent technique for creative problem situations. Geographical questions play the role of a trigger. That is why in addition to "clean questions", students are given texts which suggest how the problem could be solved. In addition to texts, students are given a scenario, the problem is divided into phases, and students are given instructions about the material which is available to them.

Questions are asked in the form of prepared homework during the class that precedes the presentation class. In this way, as Jovanović & Živković pointed out (2007), homework is used to prepare students for learning new contents. Homework should be in the form of problem-based tasks, which require thinking and practical engagement on the part of students (Jovanović & Živković, 2007). Homework should be adjusted to students' age and the applicability of the adopted contents. The contents prescribed by the curriculum may be combined with the events that are covered by the media, or that are a part of everyday life.

Data collection and processing should help students to be prepared and qualified for similar research, not necessarily in the field of geography. In this phase the use of the media gains more and more importance. Firstly, they are used as the source of data and facts and, secondly, as a means of presenting students' solutions (Jovanović & Živković, 2005). Solving problems with the help of the media in geography teaching is necessary and irreplaceable. Data which can be obtained via the Internet are numerous and opulent- geographical maps, photographs, animations, statistical data, etc. However, one should be careful when collecting data. What is offered on the Internet sometimes resembles a "flea market". There are many valuable and exact data, but there are also superficial, unproven, or even wrong ones.

Ready-made solutions can often be found in the problem that is being solved. Students should avoid using these "products" in order to present themselves to teachers.Teachers should, provided that they know their students well, eliminate such materials and insist on the students' working independently. These activities can consume a lot of the teacher′s time, but they need to be carried out nevertheless. Students also tend to seek easy solutions through slight modifications of the found and ready-made solutions.

If students' data and maps are beautiful and not so numerous, they are more valuable than "ready-made" answers to the set problem. By collecting data independently, students practice this activity, acquire the skill and ease in selecting data. They free themselves from the fear of starting to collect data. By creatively analyzing the data, they reduce the original amount of information and select only the most important, beautiful and interesting ones for the problem that they are trying to solve. At this stage, such an approach prepares students for solving real-life problems, which often involve many additional limitations. That is why students should be prepared to carefully choose from what is offered, constantly controlling the source and the quality of data. Whenever it is possible, they need to compare data about the same event, phenomenon, structure, region, thing, an individual or a group, using two or more sources. Such an approach to data collection can influence later behaviour in life; it can contribute to building criteria for making choices in important moments of life. When information is collected, it needs to be adequately recorded, sorted out, compared, analyzed, etc. Given that data processing is important, the processing method should be carefully chosen. After individual work, where students' activity is fully expressed, students can choose one or more methods on their own or with the help of their teacher.

As an outcome, it is expected to analyze the close connection between the real-life situation and the issue learned in the given lesson. It is expected that students should more easily accept the geographical contents covered in a chosen lesson if there is an interesting connection with the questions asked at the beginning of the lesson.

If a student solves the problem successfully, it means that he has performed numerous activities successfully. First of all, he had to accept the problem, define it properly, and

then start solving it. Independence in work begins with data collection, processing and presentation in the process of solving the given problem. Facing the problem, readiness to solve it and independence in work are extremely important results, maybe even more important than solving the problem itself. Jovanović & Živković (2005) point out that "solving problems in teaching geography has many didactic advantages." In this way it is possible to increase the educational effect concerning the level of knowledge, the acquisition of facts and the understanding of geographical concepts and laws. By solving problems, students develop their thinking (creative, logical, critical…) and their ability to observe and perceive. Furthermore, students' characteristics, such as persistence, independence and tenacity, are being developed.

In this way, students are well prepared for self-education.

When evaluating students' work, in addition to evaluating the final result presented in an appropriate form (oral presentation, presentation through different media or through a discussion with the teacher and the whole class), it is necessary to take into account students' approach to data collection and processing, their ability to deal with facts and to employ them in different contexts. Answers to the questions posed in the course of a discussion should be evaluated separately. These answers should be evaluated in terms of correctness, but also in terms of the willingness of students to defend their attitudes, to justify them and expose them to criticism, and, finally, to manage the situations which are common in everyday life.

The formal, numerical mark, grading students' accomplishment, can be verified by peer evaluation at the end of the class.

Methods

This research presents a class model based on problem-based learning. Classes were modelled relying on Hill-Slater′s model. Homework served as preparation for the class. Students were expected to use the Internet to collect data. The aim of the research was to indicate to the possibility of modernizing geography teaching in high schools, having in mind that the same can be implemented in primary schools and faculties.

The intention was to create a situation where students could learn independently, guided by the teacher.

The subject of the research is the model of problem-based learning, i.e. examining its effects on the teaching process and the quality and quantity of knowledge, reflected in the better understanding of geographical contents and solving particular problems.

Using computers in class was possible, but not obligatory. Students made their own decisions as to whether they would use the computer and the Internet or not. A large amount of data, texts, sketches and photographs were made available to all students.

The subject of the research is the empirical study of the contribution of this model to mastering geographical contents, as compared to the traditional learning styles. The above mentioned model was applied in an experimental group. The results of the experiment were considered from the standpoint of more efficient learning and more successful task solving. The efficiency of the model was evaluated based on the achieved quantity of knowledge, i.e. the number of correct answers in the knowledge test.

The aim of the research was to look into the effect of this model. The tasks of the research established how successful the implementation of this learning model was, based on the results of the knowledge test. Proceeding from specific problems, defined subjects, goals and tasks set, the null hypothesis of the research was established:

The model of problem-based learning does not contribute to greater learning achieve-

ment, as compared to traditional teaching styles.

The research includes an experiment with parallel groups. The experiment involved 171 students from 3 high schools in Novi Sad during the school year 2010/2011. Groups were chosen in such a way that each included one second grade class from those high schools. The experimental group included 76 students, and the control group 95 students. The groups were not equalized proceeding from individual members; they were rather observed as a whole. The groups were uniform because, statistically speaking, there was not a remarkable difference between the student's average mark in geography and average mark in other subjects.

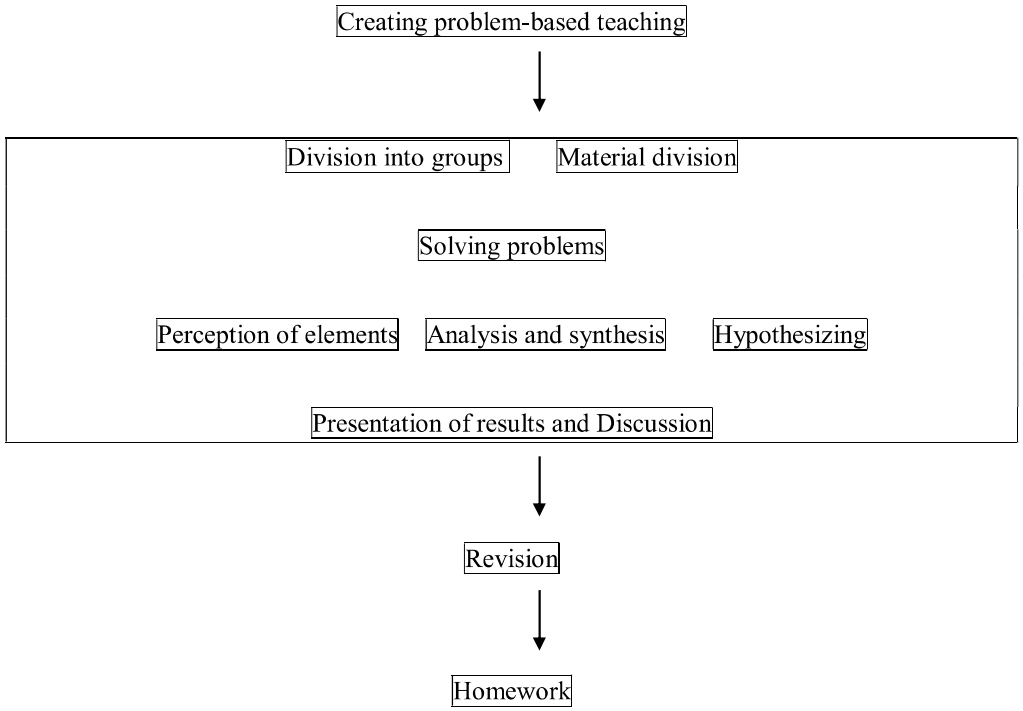
Problem-based learning, as an independent variable, was introduced into the experimental group, in order to establish its effect on the knowledge of the students.

A t-test was used for statistical data processing, in order to test the hypothesis on the difference in arithmetic means. The choice and application of statistical and mathematical procedures was based on the nature of the phenomenon which was the subject of this research. The software package Mathematica and Excel was used for statistical data processing, as well as for drawing tables and graphs.

The efficacy of our model was examined in the framework of the teaching unit Australia and Oceania. This teaching unit provides numerous possibilities for a creative presentation. A textbook (Gavrilović & Gavrilović, 2009) was used, as well as data, photos and sketches collected via the Internet, and some teaching materials.

In order for group work to yield positive results, the contents of the mentioned teaching unit were analyzed and divided into logical segments (Scheme 1).

In each class students were divided into 7 groups according to the position of their



Scheme 1. Articulation of the class/classes

seats. The groups consisted of 3, 4 or 5 students.

At the beginning of the group class, each group was handed out a written material by their teacher, including specific questions, tasks, data, photos, sketches and figures. Furthermore, each student in the group received his/ her task and instructions. The teacher gave some additional instructions and appointed the leader of each group; each leader received a table to fill in. The group members were suggested to put their heads together, divide the task into smaller segments, work cooperatively, and prepare the report on their work. In addition, they were told that they could share the material prepared for the whole class, use the geographical maps that had been brought to the classroom earlier and the Internet.

The atlases, encyclopaedias and geographical maps that were used in everyday classes had been prepared as materials to be shared by everybody. Numerous photographs, drawings and sketches were copied and made available to students. Short texts about Cook, Magellan, John Harrison and his chronometer, as well as Vasko da Gama, were attached. Additionally, a few short pieces of news were given, like: 11 March 2011 at 15:39, photo: aft, *Earthquake in Japan: The Earth's axis shifted by 10 cm*; 17 January 2011, 12:59, Srna, Australia: T*he worst natural disaster in the history of the continent*; 18 July 2010, 17:27 (Beta), photo: Reuters, T*wo intense earthquakes struck Papua New Guinea*. Also, a few mute maps of the world sea and its parts were provided. An abundance of historical data related to Magellan's, Cook′s and da Gama′s journeys, to the Titanic, as well as to the most famous channels and seas, can be very inspiring for students and can arouse their interest in the teaching unit at hand.

The questions which each group was given were supposed to enable the easier and simpler identification and exploration of the segment of knowledge covered by the question. The basic question was problem-based and almost always implied in the title of the teaching unit or in some part of it. Here are some of the questions:

1. Look at the map of Cook′s journeys. Why did Cook travel in such a way? Did Cook get lost during his journey or was he looking for something? Explain.
2. What does the word "Aborigine" mean? What are the characteristics of Aborigines?
3. One part of Australia has recently been struck by a natural disaster. Say which part and what disaster it was.
4. Mention some animal species which you can encounter only in Australia.
5. What tropical plants are typical of Oceania?
6. The population of Australia and Oceania accounted for 0.22% of the world′s population in 1800, while in the year 2000 it accounted for about 0.54%. How can we explain this increase?
7. Earthquakes are frequent in Oceania. How can we explain this?

These questions contain data which can be found in the students' textbook (Gavrilović & Gavrilović, 2009). However, students cannot offer sufficient answers to the questions only based on their knowledge and the textbook. They realize that they lack certain segments of knowledge, which creates a problem. Thus, not only do they have to perform a demanding task based on their existing knowledge, but they also have to solve a problem, which can be done only if they deal with it and find a solution. Students are given the opportunity to master new knowledge, acquire new information, formulate the stages of solving the problem, reach a final solution and, finally, to demonstrate the solution.

A 90 minute block class was envisaged for experimental work. In the class preceding the experimental class, the students were told what teaching unit was going to be pre-

sented and informed of the intention to present it in a different way. It was pointed out that they would analyze the unit and draw the conclusions on their own, while their teacher would just coordinate their activities. They were also informed about their obligations. They were told to bring to class their school atlases, literature according to their own desires, and the results of their Internet search (texts, sketches and other data related to the unit presented).

The groups were expected to finish their work in about 40 minutes. The work report was supposed to be done in the form of a poster on which the results were displayed. The expected time for browsing the posters was 20 minutes. All the students were scanning the posters and discussing them together with their teacher.

In the end, after all the groups had presented their results, the teacher synthesized the unit in the form of short notices, and stressed the essential points. In that way, all the students were able to get the impression about the results of their group work and to revise the unit once again. When evaluating the students, the teacher gave his opinion about the realization of group work, and suggested alternative forms for presenting the tasks. Thus, the teacher directed the students' future work.

Results

In order to get an insight into how successfully the students' mastered the teaching unit in question and to register any differences in their scores based on statistical indicators, a knowledge test was administered.

Proceeding from the results of the knowledge test, we drew a conclusion on the contribution of this teaching model to the more successful mastering of geographical contents. The knowledge test was administered in 6 classes following the class in which the unit Australia and Oceania was presented. The test was designed based on the text and questions from the students' textbook. It was formulated in the same manner as the questions from the textbook. The results of the test for both groups with average marks are shown in Table 1.

On the basis of the data acquired, we verified the null hypothesis that the results of the experimental group are not better than the results of the control group. The confidence interval statistics are as follows: [3.77632,4.17105] for the experimental and [3.43374,3.89257] for the control group. A t- test was applied in order to compare the statistical mean of the groups. The corresponding t-value is t= 2.0402, while p=0.0491. As $p < 0.05$, it is with 95% certainty that we can reject the null hypothesis and accept the alternative hypothesis, concluding that there is a statistically significant difference in the students' average grades, i.e. the control group has a statistically significantly lower score.

The results of the knowledge test testify to the better results of the experimental group

Table 1. Results of the experimental and control groups in the knowledge test

	Number of					Average grade	Number of students
	5	4	3	2	1		
E	24	29	20	3	0	3.974	76
C	25	34	18	15	3	3.663	95
Total	49	63	38	18	3	4.930	171

in mastering the chosen teaching unit. That is in accordance with the theory in this field and numerous other studies (Jovanović & Živković, 2005; Kurnik 2002, 2003). This model has proven to be efficient, underlying the advantages of problem-based learning, group work and the use of computers for work (Solem, 2001). Group work leads to independence and the ability to learn independently. By solving problems, students acquire new, more qualitative knowledge and relate this new knowledge to other segments of knowledge, which is one of the basic characteristics of problem-based teaching. This has been verified by so many excellent grades (grade 5) in the knowledge test. The results from table 1 show that the experimental group has a greater number of excellent grades than the control group, shown in percentages. (31.58% vs. 26.32%).

The same is true of grade 4 (38.16% vs. 35.79%), grade 3 (26.32% vs. 18.95%); there was no grade 1 in the experimental group; as for grade 2, 15.79% of the students in the control group and 3.95% of the students in the experimental group have that grade.

Conclusion

Numerous requirements of the modern teaching process can be met by the right choice of method and form of work, and by an adequate use of modern teaching technologies.

In order to enable students to learn better in class, both in terms of quantity and quality, we need to inspire them to be active. It is not always easy, because students are all different concerning their previously acquired knowledge, psychophysical characteristics and abilities. Problem- based teaching is one of the ways to ensure successful learning, bearing in mind the individual abilities of students.

The experiment has shown that this form of work contributes to the greater success of students in mastering geographical contents. Teachers do not have to invest much effort in the preparation of classes and problem-based teaching, and yet this method of teaching significantly contributes to the more successful teaching process and students' good grades.

The successful outcome of this method depends on many factors. First of all, it is important to choose the right problem, to prepare classes well, select written and other materials and devote enough time to this form of work. The application of this model yields good results and students are satisfied with it. Therefore, it should be applied more often.

It has been proven that this method develops numerous competences that cannot be developed to the same extent through the traditionally designed teaching and learning process: solving problems, making decisions, team working, cooperative learning, independent learning, critical and creative thinking. Students are taught to collect information from different sources (including the teacher).

Students will learn how to compare the acquired information with that acquired by other students in the group, thus recognizing their own advantages and weaknesses in the process of learning.

Students will learn to appreciate other students' opinions and perspectives, and recognize their own contribution in achieving the results of the group. The active use of information will facilitate the storage of information and strengthen long-term memory.

Based on the experience and the studies conducted, it can be concluded that in geography teaching it is not of primary importance to notice and solve only a couple of the "right" problems. Rather, it is important to create situations in the daily teaching process in which students think independently in order to apply their knowledge, discover a new piece of information or cause-effect relationships between geographical concepts.

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