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THE EFFECT OF THE MODIFIED KNOW-WANT-LEARN STRATEGY ON SIXTH-GRADE STUDENTS' ACHIEVEMENT IN PHYSICS

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Abstract. *Physics is generally regarded as difficult and uninteresting. The teaching of physics with the use of an appropriate teaching strategy can improve students' achievement. The aim of this research is to examine the effect of the modified Know-Want-Learn (mKWL) strategy on primary school students' achievement in physics. The Know-Want-Learn (KWL) strategy was modified to be used for students' inquiry. Quasi experimental research was carried out with 110 sixth-grade students divided into an experimental and a control group. The students in the control group were taught using direct teaching and the students in the experimental group were taught using TQHL charts. These charts consist of columns: T-What I Think and what I know, Q-What Questions I have, H-How can I find out, L-What I Learned. Pre-test and post-test were administered to both groups; two physics knowledge tests were constructed for that purpose. The data were analyzed using descriptive statistics, paired samples t-tests and independent samples t-tests. The implication of the research results is that using the mKWL strategy in a sixth-grade physics class has a positive effect on students' achievement. It can be suggested to implement the described strategy in teaching physics in order to improve students' achievement in this subject.*

Keywords: *KWL strategy, learning strategy, modified KWL strategy, students' performance.*

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Introduction

Physics is introduced as a separate school subject for Serbian students in their sixth grade of primary school (that is regulated in curriculum determined by the Ministry of Education, Science and Technological Development of the Republic of Serbia). In the Republic of Serbia, students enroll in primary school between age 6 and 7 and primary education is divided into two stages: lower grades (1-4) and higher grades (5-8). In the lower grades, students learn elements of physics within two school subjects: The world around us (in first and second grade) and Nature and society (in third and fourth grade) (Bošnjak, Obadović & Bogdanović, 2016). However, students do not see any connection between these contents and physics. Sixth-grade students (aged 11–12 years) already have prejudices that physics is a difficult subject and most students do not try to be good at it. Due to this fact, a number of average primary school students in the Republic of Serbia have bad marks in physics (marks are based on tests results and oral examinations). Therefore, physics teachers should find the way to help students to better acquire physics contents and that should result in better marks in physics. Since different students react differently to particular teaching and learning strategies, it is desirable to determine various strategies that are possibly useful in order to enhance students' acquiring of physics contents. Besides, various studies are implying that physics is generally regarded as conceptually difficult, abstract and uninteresting and that most students unwillingly study physics (Ancell, Guttersrud, Henriksen & Isnes, 2004; Checkley, 2010; Williams, Stanisstreet, Spall, Boyes & Dickson, 2003; as cited in Erinosho, 2013). In order for students to reach their full potential in science class, teachers must be well prepared for teaching (Hayes, 2002, Munck, 2007). Teachers have to find a way to enhance students' achievement. It is shown that using an adequate learning strategy is in correlation with students' achievement in different subjects (Yumuşak, Sungur & Çakıroğlu, 2007), including physics (Sağlam, 2010). Learning strategies can be defined as "behaviors and thoughts that a learner uses for processing information during learning" (Weinstein & Mayer, 1986; as cited in Selçuk, 2010). Each student is interested in different contents and activities. Therefore, learning strategies should be modified accordingly, in order to help them in acquiring knowledge (Ekwensi, Moranski & Townsend-Sweet, 2006).

Know-Want-Learn Strategy and Its Modifications

The Know-Want-Learn (KWL) strategy is initially developed as a learning strategy for guiding students through a text. It was first suggested by Ogle (1986). Since originally it was a reading strategy, it was rarely applied in teaching physics and science in general. However, it turned to be a simple and effective strategy that can be applicable in different school subjects (Foote, Vermette & Battaglia 2001). The use of the KWL strategy supports active learning and student-centered learning (Bryan, 1998; Ogle, 2009). This strategy consists of three phases where students: (1) activate prior knowledge, (2) determine what they want to know and (3) reflect and recall on the new knowledge (Blachowicz & Ogle, 2008).

This strategy suggests the use of the KWL charts, which are the graphic organizers that help students to organize information, before, during, and after a unit or a lesson. The use of the KWL charts successfully inspires students' inquiry (Ogle, 2009). These charts help students not only to adopt given concepts but also to activate their prior knowledge (Martorella, Beal & Bolick, 2005). Many studies have shown that activating prior knowledge is a mean to support students' reading comprehension (Riswanto, Risnawati & Lismayanti, 2014). Such KWL charts consist of three columns: *K – What I Know*, *W – What I Want to know* and *L – What I Learned* (Table 1). When they are used in the schools, the KWL charts can be applied through four students' activities: (1) brainstorming about what they already know about a topic and listing responses in the first column of the chart; (2) brainstorming about what they would like to know about the topic and writing responses in the second column of the chart; (3) reading and learning and (4) filling what they have learned in the third column of the chart with special attention to the information that is related to what they wanted to know. This strategy can be used by a teacher working with all students in the classroom or it can be used by students for their independent study (Tok, 2013).

Table 1. The KWL chart.

Topic: Before you begin learning, list details in the first column. After completing it, fill in the last column.		
What I Know	*What I Want to know*	*What I Learned*

The students who use the KWL strategy can easier establish the purpose of reading and develop skills for monitoring their comprehension (Szabo, 2006). The KWL strategy promotes active learning and encourages academic success (Tran, 2015) and increases reading comprehension (Al-Khateeb & Idrees, 2010). Moreover, it makes learning and remembering easier and, since each student is studying questions in which he/she is specially interested in, the understanding of content is improved this way (Gammill, 2006). Accordingly, the KWL strategy can be used for acquiring physics contents.

Modified KWL strategies can be developed in order to adjust charts for different students' activities. One of the earliest modifications of the KWL strategy is the KWL Plus. In this modification, concept mapping and summarizing of learned content is added to the original strategy (Ogle, 1987). One of the simplest modifications of the KWL strategy is the KWLH chart, where additional *H* stands for *How can I learn more*. With this additional column students are encouraged to think of the possible ways of expanding their knowledge and hence the future learning is supported (Weaver, 1994). Walker Tileston (2004) indicated that the KWLH strategy is an effective teaching strategy. Cavner (2013) discussed strategies for preparing children in early childhood education programs to learn about new topics and found that the KWLH is supporting the organization of new information. Sumardiono (2013) suggested using the KWLH strategy to understand local descriptive texts in teaching reading.

Another modification of the KWL strategy is TWL, where *T* stands for *What I Think about a topic*. When the *T* column replaces the *H* column, the strategy is more useful for learning sciences, it supports inquiry and investigation (Akerson, 2001). The first column of the TWL chart encourages students to think and discuss about the problem.

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The students who use this strategy are encouraged to think to a great extent. The *W* stands for *What else I Want to know* and it enables proposing questions and formulating hypotheses for inquiry.

The THC strategy expands on above-mentioned strategies. It is suggested by Crowther and Cannon (2004) as a useful strategy that helps students to think about scientific research and propose hypotheses. The use of this strategy trains students to think as scientists; students ask questions, choose methods for their inquiry and evaluate the results of their work. Crowther and Cannon note that the first column *T – What do you Think* is encouraging students to freely share their ideas. In the next column *H – How can we find out* students think of ideas that may lead to different ways of inquiry. After the inquiry process is completed, students should be able to draw conclusion about a given content and write it in the column *C – What do we Conclude*. The teacher can guide the students to conclusions by appropriate questions. Nevertheless, the teacher gets the opportunity to monitor the progress of each student based on student's conclusion, and therefore to evaluate student's understanding of a teaching unit (Crowther & Cannon, 2004).

The KLEW(S) strategy is another modification of the KWL strategy. In this adaptation for science teaching (Hershberger, Zembal-Saul & Starr, 2006; Hershberger & Zembal-Saul, 2015), the components of chart are used to document the following: *K – What do we think we Know, L – What are we Learning (claims), E – What is our Evidence, W – What do we still Wonder about* and *S – What Scientific principles help explain the phenomena*.

For successful physics text comprehension and solving tasks in order to strengthen critical thinking, Sumardino (2014) suggested the effective strategy in the form of the KNWS chart that consists of four columns: *K – Know the information, N – Not relevant, W – Want to find* and *S – Strategy used*.

The mKWL strategy used in this research consists of learning with the help of TQHL chart (Table 2). This choice was made since authors realized that the TQHL chart appeared to be very convenient as a tool during the physics classes, due to the fact that it encourages students' learning and inquiry.

Table 2. The TQHL chart.

*What I **T**hink and what I know*	*What **Q**uestions I have*	***H**ow can I find out*	*What I **L**earned*

Although different charts (THC, KLEW, KNWS) appeared to be very well adjusted for the scientific inquiry, it seemed more convenient to make new adjustments of chart for the students included in this research. The idea was to activate students' prior knowledge but also to allow and encourage them to present their own thoughts. Because of that the first column covers both, Know and Think – *What I **T**hink and what I know*. It is followed by the column *What **Q**uestions I have,* so the students can propose problem and hypotheses for an inquiry. Further on students should think of different ways of how to come to answers and hence write their ideas in column ***H**ow can I find out*. They can propose hands-on activities, learning from books, an inquiry process and other, and the teacher can lead them to choose different methods. In the last column *What I **L**earned* the students write about knowledge they gained.

Problem of Research, Research Aim and Research Hypothesis

It is shown that different teaching strategies can help students in learning physics contents but there is no strategy that can be regarded as the best. It is helpful to find various strategies appropriate to use in physics class to encourage students' learning and inquiry. That way the teacher can decide which strategy will fit best in certain conditions, depending on the teaching contents, structure of the class and teacher's personal affinity. Different modifications of the KWL strategy are examined as a tool for teaching various academic disciplines. In this research the KWL strategy was adjusted such that the proposed modification can be a useful strategy for teaching physics.

The research was carried out with the aim to examine the effect of the mKWL strategy on primary school students' achievement in physics.

In accordance with the given theoretical framework the research hypothesis is formulated. The hypothesis is that using the mKWL strategy has a positive effect on sixth-grade students' achievement in physics, which means that this strategy increases sixth-grade students' achievement in physics. This positive effect of using the mKWL strategy can be indicated by determining: (1) if the mean score in the physics knowledge test is significantly (statistically) higher after implementing the TQHL charts in physics class, (2) if there is a significant difference between the mean score in the physics knowledge test for the group of students taught using direct teaching and (3) if the mean score in the physics knowledge test of the students taught using the TQHL charts is significantly (statistically) higher than the mean score in the physics knowledge test of the students taught using direct teaching.

Methodology of Research

General Background and Design

Quasi experimental research was carried out in order to examine the effect of the used mKWL strategy on primary school students' achievement in physics. A pre-test and post-test control group design was used. The research was carried out for 14 school weeks (from the beginning of March to the end of June) during the school year 2016-2017. The research design is shown in Figure 1.

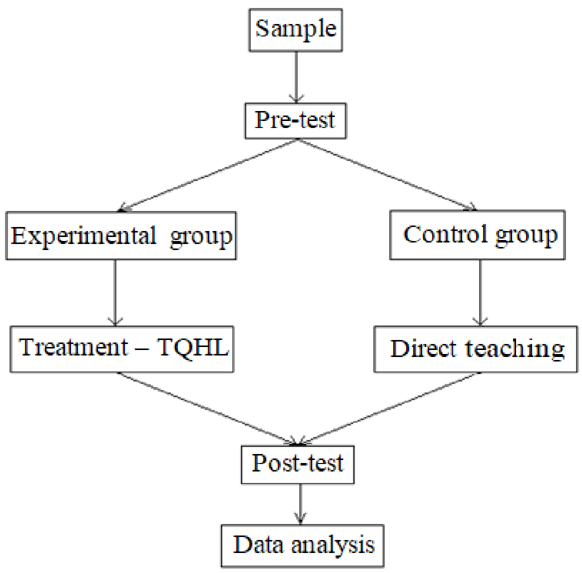

Figure 1: Research design.

The students in the experimental and control groups were pre-tested. The students in the control group were taught physics using direct teaching, in terms of explicit teaching through lectures and teacher-led demonstrations planned according to the sixth-grade curriculum determined by the Ministry of Education, Science and Technological Development of the Republic of Serbia. The treatment in the form of teaching by using the TQHL charts in physics class was applied to the students in the experimental group. The same teaching units were taught to the students in both groups for the same time. The teaching units taught during the research were: The law of inertia; Mass; Measurement of mass; Mass and weight as different concepts; Density; Determination of density; Determination of density of solid bodies of regular and irregular shape; Determination of density of liquid by measuring its mass and volume; The concept of pressure; Solid body pressure; Hydrostatic pressure and Atmospheric pressure. Afterwards, a physics knowledge test created by the researchers was administrated for post-testing.

The pilot research with the same research design was carried out during the school year 2015-2016. The pilot research was used to detect unexpected problems in carrying out research such that researchers could be prepared for them. Moreover, it enabled researchers to check students' understanding of test items in constructed research instruments (pre-test and post-test). The research sample that was used in the pilot research consisted of 59 students from two sixth-grade classes of primary school in Novi Sad, Republic of Serbia.

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Sample

This research was carried out with 110 sixth-grade students (51 boys and 59 girls) from four different classes of a primary school in Subotica, Republic of Serbia. School administration allowed carrying out research and all students were voluntarily participating in the research. Students' privacy is respected during the research. The KWL strategy and its modifications are not being used by Serbian teachers. Hence, selected primary school was convenient because researchers knew that physics teacher employed there was prepared to be trained for implementing the TQHL charts in physics class. The teacher took an active part in preparing the material and has done necessary preparation in order to use this teaching strategy. Researchers wanted to eliminate a possible influence of imposing substitute teacher to the group of students, hence the sample size was limited by the number of sixth-grade students taught by the teacher (trained for implementing the TQHL charts). There were 54 students in the control group and 56 students in the experimental group. Used sample is valid for all tests performed in this research.

Procedure and Instrument

In primary schools in the Republic of Serbia the groups of students are pre-constituted (in the form of school classes) in order to meet the requirement of the obligatory school structure defined by the Ministry of Education, Science and Technological Development of the Republic of Serbia. Besides, the participants could not be randomly assigned to the groups, hence quasi experimental research design was used. Five school classes were pre-tested to enable choosing the experimental and control groups to be as similar as possible. Two school classes formed the experimental group and another two school classes formed the control group. A physics knowledge test created by researchers was administrated for pre-testing. Two physics knowledge tests (pre-test and post-test) were constructed for the purpose of this research. Reliability and validity of both tests will be discussed. An independent samples t-test showed that there was no significant difference in the pre-test scores (PKTi) of the students in the experimental group ($M=9.95$, $SD=4.52$) and the control group ($M=10.67$, $SD=4.57$); $t(108)=-0.831$, $p=.408$.

The topics taught during the research were: (1) Mass and Density and (2) Pressure. Both topics are determined by the regular primary school curriculum. One teacher was teaching both groups (experimental and control) while the lessons were prepared by the teacher and the research team together. These lessons were realized by the teacher during the regular class hours. Since the teacher had to be trained to use the TQHL charts in class he had to be informed about research. The teacher was probably able to anticipate proposed hypothesis, but regardless this fact, the expected results were not specified to him/her. Researchers have no reason to think that the teacher influenced on the results of the research in any other way than using suggested teaching interventions. During the research, researchers were constantly in the contact with the teacher and were assisting if needed.

In order to introduce the mKWL strategy to the students, the teacher filled in the TQHL chart on the blackboard and each student wrote down for him-/herself the same chart. When introducing the mKWL strategy to the students, the teacher wrote in the TQHL chart on the blackboard and each student wrote the same chart for him-/herself at his/her desk. The teacher additionally explained to the students that they should write in the T column not only those things they know undoubtedly, but their opinion and ideas as well. This column was very useful for Serbian students because they are rarely connecting teaching content with their prior knowledge (although students have experiential knowledge or knowledge about the same content taught within other school subjects) (Milošević & Luković, 2006). Nevertheless, they usually have fear to make a mistake when they need to express their opinion. Furthermore, this column gave the teacher the information about students' possible misconceptions about the assigned teaching unit.

The teacher and the students filled in the Q column by writing down all the questions the students thought about. In the H column they listed students' proposals of how they can get the answers to these questions. The most common students' proposals for inquiry were searching internet, reading textbooks, conducting experiments. In order to fill the L column students had to summarize and recall what they learned. For two more weeks the students worked in the groups and the teacher was helping them with their TQHL charts. The teacher reminded students about chart columns when needed. Afterwards, each student was ready to write the TQHL charts individually. When students became trained for this strategy, some teaching units were realized using the TQHL charts while students worked in the groups (or even as a whole class activity) and others were realized using the TQHL charts while students worked individually. Moreover, students started using the TQHL charts for homework and even for independent learning of the given teaching units. During the classes the teacher helped students only by providing them the opportunity to implement inquiry they have chosen. If the students were working individually during one physics class (or for homework), the next class was dedicated for the analysis of the same teaching unit. Each student analyzed his/her chart and then the whole class was included in the discussion about different questions, inquiries and conclusions that students had. Afterwards, each student had to insert into the L column some new information that he/she had adopted.

The problem that the teacher has encountered while using the TQHL charts was the lack of time for the realization of the teaching unit within a school hour. Besides, the teacher stated that much more time is needed to prepare lessons when this strategy is being used. The teacher must anticipate all possible ideas for students' inquiry and prepare materials for experiments that students might propose, and also provide different study materials and internet access (whereas most schools in the Republic of Serbia do not have internet access).

Examples of chart columns written by one student for the teaching unit "Atmospheric pressure" are given:

Column *What I **T**hink and what I know*:

- It has something to do with weather forecast.
- It is expressed in millibars.
- The air is everywhere around us.
- The air has its weight.
- I suppose that atmospheric pressure is pressure exerted by air.
- Atmospheric pressure is not the same somewhere on the mountain and on the sea level.

Column *What **Q**uestions I have*:

- What is correlation between atmospheric pressure and weather?
- Why the atmospheric pressure is not the same somewhere on the mountain and on the sea level?

Column ***H**ow can I find out*:

- Look up on the internet.

Column *What I **L**earned*:

- Atmospheric pressure is measured by barometer and it can be expressed in millimeters of mercury as well as in other units.
- Usually if the atmospheric pressure is high it will be warm and sunny, and if the atmospheric pressure is low, the weather will be bad.
- Atmospheric pressure is not the same somewhere on the mountain and on the sea level because it is not the same height of the air column that exerts pressure by its weight in these two cases.

Two physics knowledge tests were constructed for the purpose of this research: pre-test and post-test. Both tests consist of 12 items in the form of multiple-choice tasks. The researchers have estimated reliability and validity of both tests. The obtained Cronbach's alpha coefficients for the pre-test and the post-test are .74 and .68, respectively. According to Murphy and Davidshofer (1988) Cronbach's alpha coefficient is, even low, acceptable above .60. Moreover, Nunnally (1967) stated that self-developed scales are acceptable with Cronbach's alpha coefficient of .60. Although the obtained values for the pre-test and the post-test are relatively low, they indicate that the tests have acceptable reliability. Since scale constructed for this research consists of 12 items and Cronbach's alpha coefficient strongly depends on the number of items, and since in the pilot research these coefficients were over .75 for both tests (.75 for the pre-test and .72 for the post-test), the researchers retained those 12 chosen items in the tests. Based on the students' understanding of the test items in the pilot research, some minor revisions were made in the formulations of the test items. Further, as proposed by Segedinac, Segedinac, Konjović and Savić (2011; as cited in Hrin, Fahmy, Segedinac & Milenković, 2015), the expert team was formed in order to estimate the validity of the applied tests. Two primary school physics teachers, a school pedagogue (school pedagogue, among other things, assists teachers with pedagogy and advices about teaching) and a university professor constituted the expert team. According to this expert team, the test items were appropriate for sixth-grade students, formulations were precise and easy to understand. Moreover, the tests complied both with the school curriculum and the available physics books, hence the formed expert team confirmed that the tests were valid. The time assigned for the pre-test and the post-test was the same – one class hour (45 minutes).

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The following are the examples of the test items in the level of knowledge, comprehension and application, respectively:

1. The SI unit for pressure is:
   a) Kilogram (kg)
   b) Newton (N)
   (c) Pascal (Pa)

2. If two bodies have equal masses, and the contact surface of the first body and the floor is greater than the contact surface of the second body and the floor:
   a) The pressure exerted by the first body is greater than the pressure exerted by the second body
   (b) The pressure exerted by the second body is greater than the pressure exerted by the first body
   c) We cannot know which body exerts greater pressure

3. A table on four legs has weight of 40 N. Each leg sets against the floor with the area of 0.001 m^2. What pressure the table exerts on the floor?
   a) 400 Pa
   b) 1000 Pa
   (c) 10 000 Pa
   d) 40 000 Pa

Data Analysis

The obtained data were treated statistically using the software package IBM SPSS. A score in the physics knowledge test given for pre-testing (PKTi) and a score in the physics knowledge test given for post-testing (PKTf) are examined within this research. These variables were described using descriptive statistics. Since the variables follow a normal distribution, a paired samples t-test was used in order to compare the PKTi and the PKTf for the experimental group, as well as for the control group. In order to compare the post-test scores between the students in the experimental and the control groups, an independent samples t-test was performed. Additionally, percentage of the correct answers on the PKTi and the PKTf items in both groups is shown in the form of histogram. Students' test scores, both PKTi and PKTf, could range from 0 to 20 points. Higher score on the test denotes greater physics achievement.

Results of Research

The students in the experimental group increased their test scores (from the PKTi to the PKTf) by 4.12 points, as indicated in Table 3. A paired-samples t-test was performed to compare the PKTf and the PKTi scores. There was a significant difference in the PKTf (M=14.07, SD=4.20) and the PKTi (M=9.95, SD=4.52) scores for the students in the experimental group; t(55)=-5.20, p<.0001.

However, there was no significant difference between the PKTf (M=11.17, SD=4.49) and the PKTi (M=10.67, SD=4.57) scores for the students in the control group; t(53)=-1.88, p=.065.

Table 3. Basic descriptive statistics related to Physics Knowledge Test scores.

	Control group		Experimental group	
	PKTi	PKTf	PKTi	PKTf
N	54	54	56	56
Mean	10.67	11.17	9.95	14.07
Standard deviation	4.57	4.49	4.52	4.20
Minimum	3.0	3.0	3.0	5.0
Maximum	20.0	20.0	19.0	20.0
Standardized skewness	0.12	-0.05	0.27	-0.46
Standardized kurtosis	-0.81	-0.71	-0.81	-0.56

An independent-samples t-test was performed to compare the PKTf scores between the students in the experimental and the control group. There was a significant difference in the PKTf scores of the students in the experimental group (M=14.07, SD=4.20) and the control group (M=11.17, SD=4.49), in favor of the students in the experimental group; t(108)=-3.505, p=.001.

According to these results it can be suggested that the use of the mKWL strategy increases students' physics achievement if achievement refers to teacher's assessment of students' achieving learning objectives based on test results and therefore is reflected in students' marks in physics.

Additionally, there is an evident difference between histograms that show percentage of the correctly answered test items in the experimental and control groups on the PKTi (Figure 2) and on the PKTf (Figure 3).

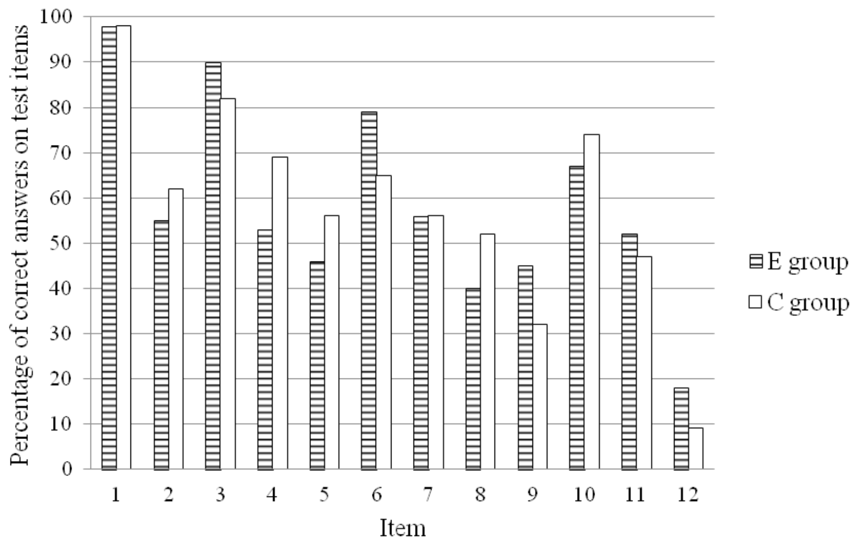

Figure 2: Comparison of percentage of the correctly answered test items in the experimental and control groups on the PKTi.

There is no apparent difference in percentage of the correctly answered test items in the experimental and the control group on the PKTi. For some items more successful were the students in the experimental group and for other items more successful were the students in the control group.

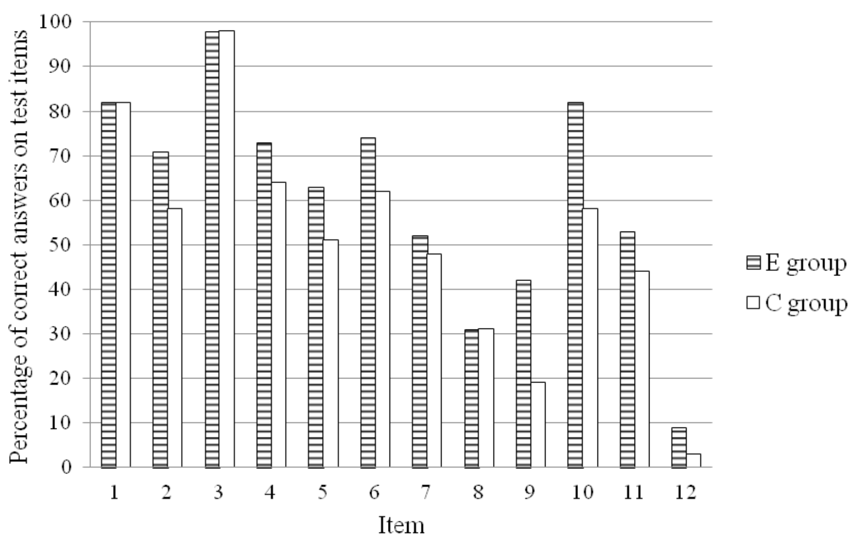

Figure 3: Comparison of percentage of the correctly answered test items in the experimental and control groups on the PKTf.

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Figure 3 shows comparison of percentage of correct answers on the PKTf items in the experimental and control groups. There were only three questions that students of both groups have answered equally good. Two of those were the questions in the domain of knowledge that required recalling facts. In higher levels of knowledge, it is shown that the students in the experimental group were more successful.

Discussion

Numerous studies are carried out to examine how enriching and improving teaching strategies can help in teaching physics, and science in general (Cvjeticanin, Obadovic & Rancic, 2015; Popović, Miljanović, Županec & Pribićević, 2014; Sağlam, 2010).

The effect of the mKWL strategy on sixth-grade students' achievement in physics is examined in this research.

It is shown that two groups of students had similar prior knowledge regarding some physics topics. That was expected since the students in both groups were taught by the same physics teacher in the same manner (before this research).

Based on Table 3, it can be observed that the mean post-test score in the physics knowledge test of the group of students taught using the TQHL charts is 20.6% higher than their mean pre-test score in the physics knowledge test. That difference reflects results in higher average mark of the students in the experimental group. It was expected that students will achieve better results in physics after using the TQHL strategy, because different studies indicated that this strategy enables students to activate their prior knowledge, choose the problem they are interested in and choose the method of inquiry. Students easier realize connection between prior knowledge and new knowledge. Since the students' interests are considered, students' motivation is enhanced. However, it is questionable whether the post-test scores were better only for the fact that the use of the TQHL charts was new and therefore interesting to students. It cannot be stated whether continuous use of this strategy would result in even better scores (since the students would be better trained to use the strategy) or in poorer ones (if students lose interest for using the strategy).

As the students taught using direct teaching were taught in the way they were used to, it was expected that there would not be significant difference between the pre-test and the post-test scores.

The results revealed that the post-test scores of students taught using the TQHL charts was 14.5% higher than the post-test scores of students taught using direct teaching (Table 3). This was precisely the result that was expected together with the first one. It can be suggested that this better achievement is the result of the use of the TQHL charts.

Based on Figure 3, it can be observed that after the implementation of this strategy, the students achieved better results at all levels of knowledge. The use of the TQHL charts can help students acquire functional knowledge. Students use prior knowledge to design and implement inquiry, thus students practice the application of knowledge. In case of using the TQHL charts one finds that high levels of student engagement results with higher levels of knowledge compared to the case where students are mainly trying to memorize facts during the use of direct teaching.

There are no other studies that examined the usage of the same mKWL startegy in physics learning, hence these findings can be compared only with findings of similar studies. The findings of this research are consistent with the findings of other researchers that have examined the efficiency of the KWL strategy or its modifications to enhance students' achievement in various academic disciplines. The main difference between this research and the similar ones is that the use of the TQHL charts was particularly examined within this research, and it is proposed as an appropriate strategy for teaching physics.

The findings of this research are in parallel with the findings of various researchers who showed that the use of the KWL strategy increased students' achievement in science (Akyüz 2004; Taslidere & Eryilmaz, 2012; Reichel, 1994; as cited in Tok, 2013). Akyüz (2004) examined students' achievement regarding the topic Heat and Temperature when the KWL strategy was used, and suggested that the use of this strategy increased ninth-grade students' achievement. Taslidere and Eryilmaz (2012) showed that integrating the KWL strategy and the conceptual physics approach improves students' achievement in Optics. This research is carried out with ninth-grade students. According to Reichel (1994; as cited in Tok, 2013) students subjected to the KWL strategy perform better in science. Tok (2013) showed the positive effect of using the KWL strategy on the sixth-grade students' achievement in mathematics, students' metacognition and mathematics anxiety. Davis (1993) suggested that proposing questions and giving answers promote content comprehension, which largely reflects on physics achievement. It is shown that the KWL strategy is effective in increasing sixth-grade students' physics achievement and their metacognition (Zouhor, Bogdanović & Segedinac, 2016).

Sumardiono (2014) showed that the application of the KWLH charts made students automatically sharpen their critical thinking such that they were able to filter what they need in comprehending and solving the physics tasks. This strategy encourages students to think about the possible ways of expanding their knowledge (Weaver, 1994) and it supports the organization of new information (Cavner, 2013). Therefore, the KWLH is an effective teaching strategy (Walker Tileston, 2004; Sumardiono, 2013). Adoptions of the KWL strategy that can enhance students' achievement in science are the KLEW(S) (Hershberger et al., 2006; Hershberger & Zembal-Saul, 2015) and KNWS (Sumardiono, 2014). According to Crowther and Cannon (2004) the use of the THC strategy in primary school improves learning sciences and literacy.

The implication of the results of this research is that sixth-grade students' achievement in physics is higher when students are taught using the TQHL charts rather than direct teaching, or in other words, better marks in physics are expected when using a proposed strategy. Based on that, it can be suggested that using the mKWL strategy in teaching physics has a positive effect on students' achievement.

Conclusions

The problem of low students' achievement in primary school physics can be overcome, but it will take the time and effort of the researchers in education, as well as the physics teachers. Negative perceptions of the teaching practice tend to arrive when teachers rely only on direct teaching. The researchers should find the strategies that may be better suited to particular lessons, and the teachers should implement those strategies in practice. The use of appropriate strategy can improve students' comprehension and increase students' achievement. The research directed to examine the effect of the mKWL strategy (TQHL charts) on physics achievement is carried out. While using the TQHL charts, the students in the experimental group made connections of their prior knowledge and applied it to the new contents. Moreover, students became trained to think as scientists, as well as to implement inquiry process. All this contributed to the acquiring of applicable physics knowledge and enhanced students' physics achievement in the experimental group. Based on the results of research, it can be stated that using the mKWL strategy in the sixth-grade physics class increases students' physics achievement. It helps students to be successful in learning physics contents.

A limitation of this research is related to the sampling of the groups. The groups were pre-constituted and not selected by random choice. Moreover, the groups were not completely isolated since students were able to communicate outside the school. In addition, this research included only sixth-grade students and just two physics topics.

The implications for the practice and the further research derive from the results of this research. It can be suggested to implement the described strategy in teaching physics in order to improve students' achievement. Additionally, teachers can use the TQHL charts in order to notice possible students' misconceptions about teaching contents and to assess students' prior knowledge. The teachers can be successful in using the proposed strategy in class if they receive needed material and training about the TQHL charts. Therefore, it is necessary to carry out the additional teachers' professional development. The teachers should teach students not only about the given topics but about using useful learning strategy as well. As soon as students adopt using the TQHL charts during their physics class, they will use the KWL strategy or its adequate modifications for learning other subjects as well. The problem of applying this strategy in primary schools in the Republic of Serbia is reflected in limited time available for the realization of each teaching unit. This problem can be overcome by teacher's good planning and organizing skills. Although the application of the TQHL charts requires from teachers more time in order to prepare their lessons, the use of the TQHL charts helps students to successfully acquire teaching contents.

This research raises new questions and gives some new directions for the further research, that should include wider teaching contents and different grade levels for obtaining additional results regarding this issue. Since the use of the TQHL charts is not sufficiently studied, more findings about using this strategy will be gained by extending this research. Further research can investigate the effects of described strategy on attitudes toward science, students' motivation, students' metacognition, cognitive load or other variables. Using the mKWL strategy in teaching physics can have more positive effects than indicated in this research.

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