Case study: teaching reflection at secondary vocational school using interactive whiteboard and GeoGebra

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Abstract

The joint use of interactive whiteboard and GeoGebra brings new teaching method into the educational process. The paper deals with its use at secondary vocational school that is the type of secondary school teaching students to utilize their knowledge in practical life. Only the low percentage of students continues the study at university. Our research focuses on the joint use of interactive whiteboard and dynamic geometric software GeoGebra for teaching reflection. The study offers the examples of original tasks connected to the study branch of the class. Moreover, it discusses the basic principles of work with interactive whiteboard and GeoGebra on topic of reflection. The evaluation of students’ study results is performed comparing the results from the pre-test and post-test. The paper offers the advantages and problems of implementation of new teaching aid and some remarks from the students too.

Keywords: Reflection. Secondary vocational school. Interactive whiteboard. GeoGebra.

INTRODUCTION

State educational programme (ISCED 3A) in Slovakia describes the need for development of technical skills and informational competences, implementation of new teaching aids, and focus on the vocational practice of students. Secondary vocational school is a special type of school where Mathematics is not the profile subject. As it will be stated in the paper, the number of lessons for geometry is low and therefore the curriculum contains only basics. Moreover, the students attending vocational school are mostly not gifted, they learn more slowly and they need more examples. Our decision to look at the reflection is supported by the State educational programme. We try to include work with interactive whiteboard and the dynamic software GeoGebra while it can help to develop learners’ imagination and understand the topic more easily.

For many teachers the work with new technology brings up problems and they still prefer traditional educational process. However, there are still teachers trying to innovate their lessons and dynamic software and interactive board can help them.

LITERATURE REVIEW

Since the entry of computers into the education many teachers have been trying to implement this teaching aid into the lessons. With gradual development different educational software has been developed, like dynamic geometry software GeoGebra. It was developed by Markus Hohenwarter at University of Linz. As the use of new technology progressed it has become used more often in Slovak schools too. Nowadays, many people create applets appropriate for teaching and learning process. GeoGebra community merges Institutes with pedagogues all around the world who are dedicated working with GeoGebra. Many authors discuss the topic of dynamic geometric software. There are several studies on use of GeoGebra and many studies on integrating interactive whiteboards into educational process as well. Very beneficial are works of Markus Hohenwarter that offer not only the manual to GeoGebra [1] but also studies focused on methodology of mathematics and teaching mathematics with information and communications technology (ICT). [2]

GeoGebra

GeoGebra is free dynamic mathematics software highly appropriate for geometry education. It enables to perform all types of geometric constructions with just few clicks. GeoGebra can be described as
combined educational software, while it can serve for presentation of new information, its further practising and testing. [3] Software is free to download and new versions with new tools are still developed.

The work with the program is not difficult, mostly intuitive. After opening the window user decides about the perspective of the program. Subsequently, the toolbar edits according to the chosen perspective. The geometry toolbar contains tools organised into several main groups (the number of groups depends on the version of GeoGebra). Moreover, each tool is briefly described which helps the users to orientate.

**Fig. 1** GeoGebra toolbar ver. 4.2

Among the other tools there is a special tool to reflect the object in line. As for the reflection, there are various possibilities for the teacher how to utilize GeoGebra. Also the reflection of the object can be done step-by-step using perpendicular line and the circle or just the tool for the instant reflection of the object can be used.

The first possibility is more appropriate for the direct exposition when teacher does not use the tool “to reflect the object in line” immediately, but perform the construction using perpendicular line. When all the needed points are reflected, the image is constructed. This procedure is very similar to that one done by the students into their workbooks. Finally, the reflection tool can be used to check the accuracy of the construction. This procedure is beneficial for the students because they reflect the object in line step by step and are immediately aware of the right procedure.

The second possibility is based on the immediate use of tool to reflect the object in line. Then the relationship between the object and image is discovered. Students should also find out the relationship between axis and the line passing through the corresponding points (perpendicular lines). It is obvious that explanation organized like this develops students’ analytical thinking. The principles of reflection are discovered by students themselves and therefore they could be easier to remember.

The advantages of GeoGebra include the development of learners’ imagination, possibility of more perspectives, and change of traditional lessons into modern. From the point of reflection, the work with pictures and dynamicity is beneficial too.

Of course, there are some issues that can discourage teachers to implement GeoGebra into educational process. It involves the need to obtain computer literacy that is ability to use the personal computer and work with the data as well as with the software. [4] Moreover, preparation of materials in advance is mostly essential.

The methodology of mathematics is described in more details in A Practical Guide to Teaching Mathematics in the Secondary School. As the title implies it analyzes various aspects of methodology of mathematics and provides the guide to teaching mathematics at secondary school with use of ICT. The authors offer a guide to “unlock” the power of interactive whiteboard (IWB) in the form of activities suitable for active involvement of learners into educational process. The built-in software enables you to make the whiteboard truly interactive, and allows the pupils to be involved more in the lesson by doing instead of just watching. [5]

**Interactive whiteboard**

Nowadays, interactive whiteboard presents quite expanded teaching aid. It can be defined as “a touch-sensitive screen that works in conjunction with a computer and a projector.” [6] Its utilization for geometry teaching can be supported by implementation of any dynamic software. Together, they can fulfil the next stated functions of a learning process [7]:

- Motivational- our learners like using technology. It is right to predict that they would appreciate work with interactive board and new software too.
• Informational- the possibility to work with information and material from Internet or other media helps to maintain appropriate educational process.
• Directional- the application of highly interactive learning programmes and its suitable utilization can direct the meaningful and interactive change of views between the learners and computer.
• Rationalization- the utilization of interactive whiteboard and dynamic software brings new methods and procedures into educational process. It can contribute to individual development of each student.
• Control- through the dynamic software and interactive whiteboard it is possible to diagnose and evaluate the results of education.
• Communicational- computer based learning increases communication between teacher and learners, as well as communication between students working in groups.

In secondary vocational school the most important one is motivation while many students do not realize the importance of learning mathematics. Implementation of IWB encourages students and supports student’s motivation and renews teachers’ enthusiasm for teaching mathematics [8]:
• Intrinsic simulation- through the combination of visual, kinaesthetic, virtual, manipulative and auditory path to learning
• Sustained focus- through teachers’ strategic classroom management and orchestration skills
• Stepped learning- through constant challenges with frequent assessment of achievements as stimulants for further developments

The joint use of GeoGebra and IWB

The synergy of interactive board and GeoGebra creates the teaching aid fully suitable for teaching geometry. The joint use of IWB and GeoGebra brings new possibilities to educational process, like:
• Learners solve the tasks in GeoGebra more simply and visually and still in an interaction with the whole class
• The computers serve only as a connection between the board, projector and software, teacher does not need to operate with the computer itself
• The functions of GeoGebra can be extended by the functions of IWB like highlighting, Internet,...
• The static figures on the IWB can be extended by the dynamicity if GeoGebra therefore enriching the visualisation and representational opportunities of IWB
• Broadens the whole- class communication and vitalise mathematics conversations

For the joint use there is need for not only the proper environment but especially the teachers prepared to change their habits. If we want to educate young people who are information- skilled, creative, with the ability to solve real life problems independently, the teacher has to prepare the lessons for their “clients” in an interesting, modern and creative way. [9]

RESEARCH

The research was focused on teaching and learning of reflection at secondary vocational school. Especially, the focus was on students of four-year study. To fully understand the whole educational process it is important to describe educational standards, state and school educational programmes and thematic plans. According to the state educational programme (ISCED 3A) the students should learn to apply the rules and laws of congruence transformations on simple tasks and use the congruence of the triangles to solve problems connected with the vocational practice. [10] It means the learners’ knowledge from primary school about reflection should be fixed and applied on specific examples at secondary school. There is no need for more difficult tasks.

To be familiar with the number of lessons available for reflection and transformations at all, we need to study number of lessons for Mathematics stated in state educational programme. The number of lessons is later adjusted by the school educational programme and finally by the thematic plan. [11] At the vocational school where we performed our research, the topic of reflection is situated in the first year of study. The
thematic plan states two lessons for reflection. That is the reason students were given easier but specific tasks.

**Aim of the research**

We suppose the implementation of joint use of IWB and GeoGebra helps to increase the motivation of students and is suitable for interesting task solving. In our opinion the solving of tasks from practical life could increase the interest in learners and their active involvement in teaching and learning process. The aim of the research is to investigate whether the joint of IWB and GeoGebra could change the students’ view on reflection, raises their interest, forces them to work more active and subsequently improves their study results.

The research was performed in the class of beauticians and cooks in two lessons, with the main focus on the second lesson:

1. lesson: definition of reflection in a line, properties of a reflection, reflection of a point and a segment
2. lesson: students were supposed to write notes and do the constructions into their workbooks; the tasks were solved on interactive whiteboard in GeoGebra by students. The lesson could serve as an example of combination of two teaching aids, GeoGebra and IWB. It is described in more details on the following examples.

After these two lessons students are given a post-test and the results of the test are compared to the students´ results from the pre-test. (the pre-test contained 4 complex tasks including the curriculum of the previous 6 months).

**Task 1**

Construct the image of the circle \( k \) under reflection in the line \( o \).

![Fig. 2 Task 1 in GeoGebra](image)

**Comments**

The first task can be solved in three ways. The first one is the most simple using the tool “reflect object in line”. The second one utilizes the tool offered by GeoGebra “circle through three points” when learners need the images of three arbitrary points of the circle \( k \) to create an image of the circle \( k \). The third method requires finding the centre of the circle \( k \). Then learners need the image of the centre and one arbitrary point. The choice of the method depends on the level of students´ knowledge.

When the image is created teacher can utilize the advantages of work with GeoGebra and manipulate with the objects. The radius of the circle can be changed as well as the position of the axis (line \( o \)). Various variants are shown in the figures below.

![Fig. 3 Variants of the reflection](image)
During the manipulation learners realize the rules and results following from the different position of the axis. All variants could be performed on interactive board and are visible to all students.

The technical side of this task does not request special preparation and requirements for technical skills are also primary ones.

**Task 2**

Draw the eyebrow, lips, nose and eye of the lady under the reflection in the line o.

**Fig. 4 Human face**

**Comments**

The second task is a little more difficult than the first one. Students are given handouts and they are asked to utilize their knowledge about reflection. Some students draw the face intuitively, without the use of perpendicular lines and circles. However, when the correct construction is performed on the whiteboard, they redraw their constructions.

The use of the picture makes this task more attractive for students. The task is oriented on the group of beauticians where it is essential to have certain imagination. Many activities in their future profession are based on the reflection of human face. In this task students should realize how important geometry is for them. The fact that the picture and the whole solution of the task could be performed at the whiteboard is a big advantage as for the students as for the teacher while students can check for the solution.
For this task it is essential to prepare materials in advance. The preparation is easy, but teacher needs to choose appropriate picture and print out the handouts.

**Task 3**
Draw the rest of the white pattern of the Easter egg under the reflection in the line o.

![Fig. 5 Easter egg pattern](image)

**Comments**

The third task is based on the same principle as the second one. It is adjusted for the group of students who study to be cooks. In their future profession the reflection is important, especially when they deal in carving. After the second task students should be aware of the correct procedure of the construction. However, some students do not follow the rule of the perpendicular lines on the axis. This task needs to be prepared in advance as well.

The great advantage of this lesson is the possibility of saving the applets in order to be used in the future. The interactive whiteboard and GeoGebra is above the all the teaching aid for the teachers, but it is useful and effective only if the teacher is willing and able to change his teaching habits. [12]

**RESULTS AND DISCUSSION**

When the tasks where clearly solved and the solutions were understood by the students the discussion about the use of interactive whiteboard and GeoGebra starts. Students like their joint use and the use of the pictures as well. They picked up the dynamicity, especially helpful in the first task. They claimed that the lesson organized this way was more interesting than their traditional lessons of Mathematics. Only two of the students had worked with the interactive whiteboard at the primary school and none of the students had ever worked with any dynamic program like GeoGebra before our lesson. One student was also interested in the GeoGebra and wanted to download it and work with it at home.

Besides the fact that the theory of reflection is included also in the curriculum of primary schools, more than half of the students still had problems with the fundamental rules during the solving of the first task. We connect this problem with the fact that students were not good at Mathematics at primary school and they probably did not maintain the curriculum.

On the other side, students depicted also some problems and claims about the lesson. Two students had problem with visibility, while they were sitting in the last row and the sun was shining. The lack of technical skills was depicted by other three students they were not able to write with the interactive pen. Students agreed on the fact that the work with GeoGebra is not difficult but they need to practice it a while. They
liked the lesson but they said they would not want to work with interactive board more often than twice a week.

Our research was based on the practice of reflection at secondary vocational school. The lesson was supported by the use of interactive whiteboard and GeoGebra. Because of the fact that the number of lessons of mathematics at this type of school is low and the main aim is to include the tasks connected with the vocational practice, Mathematics becomes the subject that should teach basics in an interesting way. Moreover, students at this type of school are not gifted, but they are manually skilled. Therefore, the content of the curriculum is quite simple and teachers should still look for new ways how to help students to learn effectively and develop their imagination.

Post-test

Task A: Reflect the triangle ABC in a line o.

Fig.6: Triangle ABC

Task B: Draw the right part of the pattern of butterfly.

Fig.7: Butterfly
The results of the students’ tests are recorded in the table below:

**Tab.1:** Results

<table>
<thead>
<tr>
<th></th>
<th>Percents [%]</th>
<th>Average [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>75 90 55 20 65 35 25 85 60 15 70 65 70 80 40</td>
<td>56.67</td>
</tr>
<tr>
<td>Post-test</td>
<td>63 90 63 9 81 27 18 100 81 18 54 90 72 90 36</td>
<td>59.47</td>
</tr>
</tbody>
</table>

According to the average of students’ grades the results from the post-test are better on 2.8% than the results from the pre-test. Although the deviation is not very significant we can conclude that students have understood the topic of reflection a little better than is the average of the class. However, this could become due to various factors. The implementation of interactive whiteboard and GeoGebra into lessons could raise the students’ interests, motivate them to pay attention and help them to understand the issues better. On the other way, the deviation is small enough to consider that it is caused just by the coincidence.

**CONCLUSION**

Although we were working with the students not so good at Mathematics, they seemed to like the transformation of the traditional lesson into modern. The topic of reflection is interesting and attractive for students because it is easy to understand. The joint use of interactive whiteboard and GeoGebra evoked new platform of Mathematics for students. We hope teachers will not be afraid to implement new technology a teaching aids into educational process.

However, they need to be aware of the fact that very often use of new technology can make the lessons vague for students. Teachers should also prepare themselves to more work at home with the preparation of the suitable materials.

**REFERENCES**


