

INTERACTIVE MATERIAL FOR MATHEMATICS INSTRUCTION

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ABSTRACT

The education area is developing constantly, with innovative approaches to instruction emerging all the time. Digital technology, programs, software and all kinds of applications are used on a daily basis not only in informatics instruction, but also in humanities subjects such as history, foreign language, etc. Since working with modern technology comes naturally for today's students, they find instruction which uses interactive elements more attractive as it is more active, dynamic and visual. The paper is aimed at interactive study materials which could be used in upper primary school mathematics instruction. The created interactive study materials should make instruction more effective and encourage students to be more active in class. Our proposals are based on the 7th grade curriculum. The created materials will be based on the key didactic principles, curriculum and teachers' ideas and requirements. Moreover, the created materials will be implemented into instruction. Afterward, the materials will be evaluated by both teachers and students through a questionnaire survey.

KEYWORDS

Interactivity, interactive whiteboard, mathematics, SMART Notebook, study material.

1 INTRODUCTION

In developed countries, computer technology is used in instruction. Computer programs are used on a daily basis not only in science-based subjects. Standard teaching aids have been replaced by modern teaching methods and aids. According to the Czech News Agency, modern teaching aids are popular among both students and teachers. The Ministry of Education, Youth and Sports supports the use of those aids, intending to expand it in the future (Novinky.cz, 2017). An interactive whiteboard changes the way in which teaching aids are used in instruction. In his book "Teaching Today" (2008), Petty quotes a Chinese proverb which goes, "I hear and I forget, I see and I remember, I do and I understand".

2 INTERACTIVE WHITEBOARD IN INSTRUCTION

Since the current generation of students grew up with modern technology, they find instruction which uses an interactive whiteboard more attractive as it makes it more active, dynamic and visual.

Despite their popularity, creating interactive whiteboard presentations is time consuming for teachers as they lack technical skills. Materials can be downloaded. However, they may not always be suitable for the particular type of instruction. The majority of materials are used in upper primary school instruction, especially in the following subjects: biology, geography and foreign language. However, the available materials are not detailed enough and thus are not suitable for upper primary school instruction. The

majority of available materials are aimed at humanities subjects and foreign languages. Materials for mathematics instruction are not that common. Moreover, mathematics is not a popular subject among students. That is why this paper is aimed at creating mathematics study materials suitable for an interactive whiteboard.

An interactive whiteboard is an electronic device used for educational purposes. Since it offers a number of new options, it should help make both the preparation and instruction itself easier for the teacher. As far as students are concerned, it makes the learning process more attractive and interesting (Skarda, 2016).

An interactive whiteboard was first used in Canada in 1991. In the Czech Republic, it was first used in 1996. Due to its high price, an interactive whiteboard was a scarce commodity (Neumajer, 2008). Between the years 2004 and 2005, the number of interactive whiteboards in schools increased from 300 to 871. Thanks to the “EU Money to Schools” project, the number of interactive boards in schools increased significantly between the years 2010 and 2012 (Cerny, 2015). The main goal of the project was to develop knowledge and skills related to information and communication technology, mathematics, foreign languages, reading and information literacy, etc (MEYS, 2010). Nowadays, interactive whiteboards are used in the majority of primary schools, kindergartens, grammar schools and special schools.

As any other device, aid or material, an interactive whiteboard and its use in instruction, too, has pros and cons (Dostal, 2009).

Table 1 Interactive Whiteboard Pros and Cons

Pros	Cons
Motivates students to learn	Students become disinterested
Learning by playing	Teachers only use it as a projector
Use of animations, images, sounds	Creation of interactive whiteboard presentations is time consuming and technically challenging for teachers
Visual presentation	Surface can be damaged
Draws students' attention and encourages them to be active	Students do not use a book
Helps develop computer and information literacy	Text might be difficult to read in bright light
Materials can be easily edited	Energy intensity
Enables users to share information on the Internet	
Materials can be used repeatedly	

3 APPLYING DIDACTIC PRINCIPLES IN INTERACTIVE MATERIALS

The following key didactic principles need to be taken into account when creating (not only) interactive study materials – motivation, visualization, appropriateness, feedback, self-reliance, learning by playing, continuity, permanency and control (Malach, 2002).

Motivation

Motivation is the basis of every class. Working with an interactive whiteboard (i.e. a new aid) alone is motivational as it offers new options. However, nothing lasts forever. Therefore, the teacher needs to find a way to draw the attention of students. One way to do so is to use an image, song, video file related to the topic when using an interactive whiteboard for the first time. For instance, in science-based subjects it is recommended to start with an experiment which students conduct themselves.

Visualization

Komensky considers visualization to be the most natural part of education. An interactive whiteboard offers a variety of options. Moving text/images, use of sound/video catches students' attention and helps them understand the rules and remember new information. If the teacher wants to teach students about animal sounds, they can either choose from a variety of sounds in the gallery or record the sounds themselves.

Appropriateness

An interactive whiteboard should be used for approximately 30 minutes at a time. However, the teacher needs to realize what age group they are teaching and adjust not only the time spent with an interactive whiteboard but also the content, length and form of study materials accordingly.

Feedback

Feedback from students (what they have learned) is extremely important for teachers. An interactive whiteboard can be used to test knowledge, e.g. the layering of objects when the correct answers are hidden behind objects. Also a part of the software is predefined interactive exercises which the teacher can adjust and then use to test knowledge.

Self-Reliance

The student should be able to use the acquired knowledge to solve practical tasks. Creating such tasks is challenging for the teacher.

Learning by Playing

No activity, including working with an interactive whiteboard, is stress-free. That is why games should be used to motivate students. They can be used both at the beginning of class or as a reward for completing a task. However, instruction should not be based on games, but rather use them as a motivational tool.

Continuity

An interactive whiteboard can be used to logically structure a class (step by step). The teacher can use links to provide additional information which is related to the discussed topic.

Permanency

Motivational, expository and fixation exercises, which can be easily created using the predefined exercises from the interactive whiteboard software, can be used for knowledge retention.

Control

Students can come across websites, which contain misleading or incorrect information. The teacher should be aware of this possibility and inform students about it.

4 PROPOSING AND CREATING STUDY MATERIALS

The proposed materials are based on the 7th grade curriculum taught in two Vratimov primary schools (Masaryk Square and Datynska Street, respectively), taking into account the requirements of mathematics teachers. As far as content is concerned, the following mathematics textbooks were used: Primary School Mathematics 7: arithmetic; Primary School Mathematics 7: geometry; Mathematics Workbook 1, 2 and 3.

Application of interactive elements

To create the study materials, the SMART Notebook 16 program was used, which is compatible with the previous versions of the software and is intended for creating content for interactive whiteboards.

All the materials are identical, they only differ in color. The header and footer are made of shapes offered by the SMART Notebook program. All the study materials contain a title page with the topic title (Figure 1) and content divided into chapters (Figure 2). Using the function "link to page", one can choose a

particular chapter. By tapping on the aforementioned link, the user is redirected to the beginning of the selected chapter.

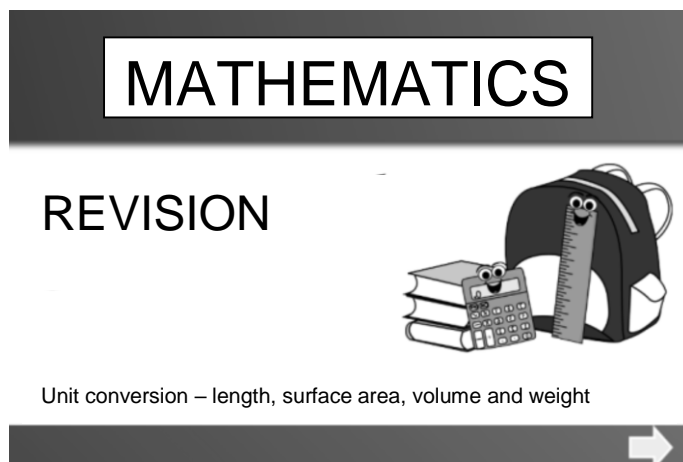


Figure 1 Title page

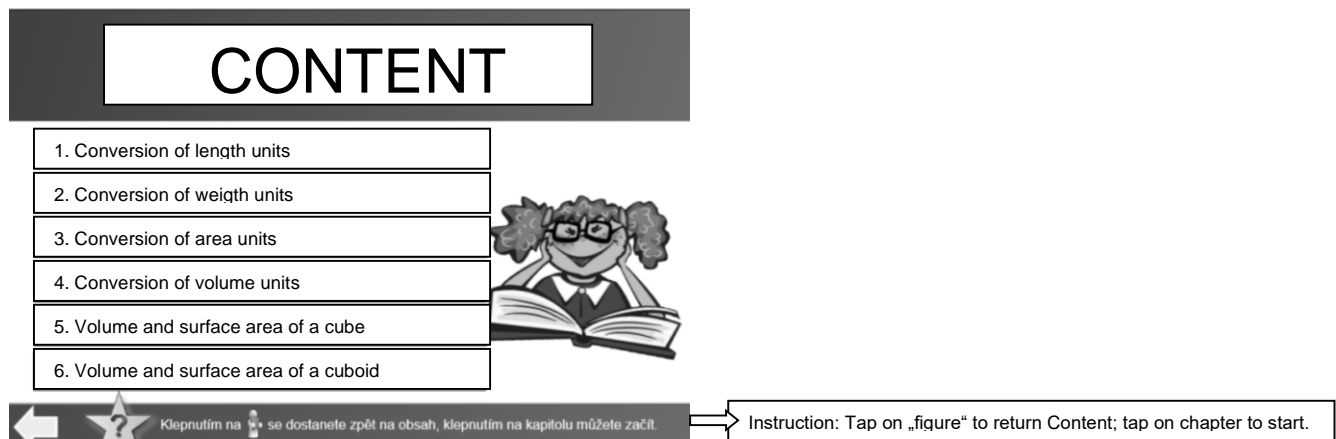


Figure 2 Content

Arrows (which are also based on the “link to page” function) are used to navigate in the materials. In order to return to Content, all one has to do is tap on the figure in the top left corner (Figure 3).

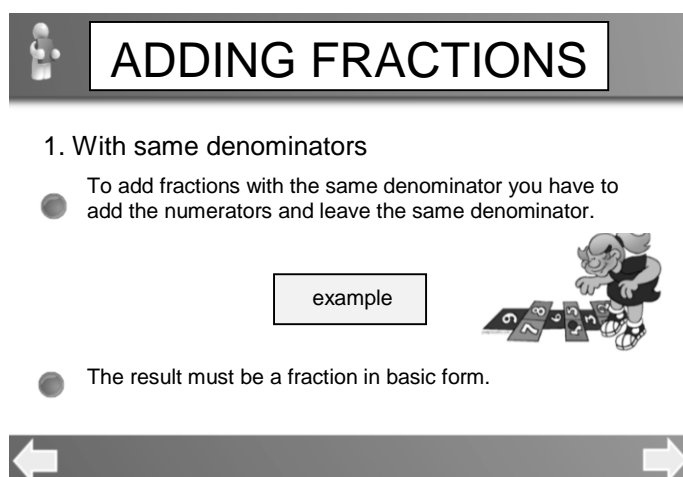


Figure 3 Material controls

The “link to page” function is also used for word problems where students are required to write down the solution process. When they solve the problem, they tap on the apple (Figure 4) and are redirected to the correct answer (Figure 5).

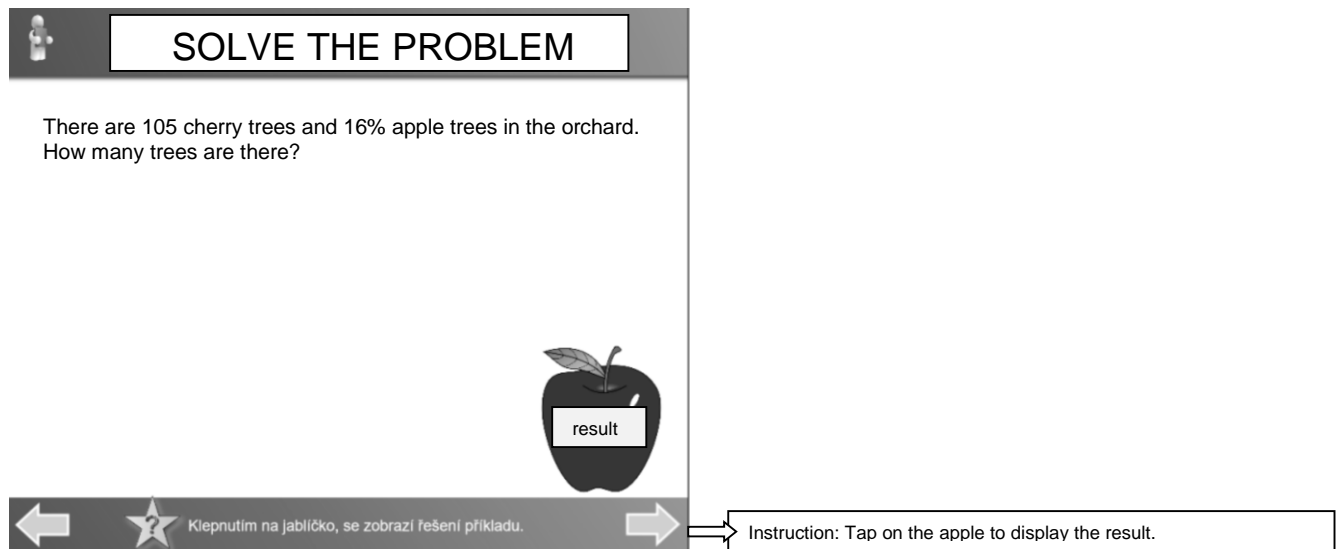


Figure 4 Link to correct solution – image of apple

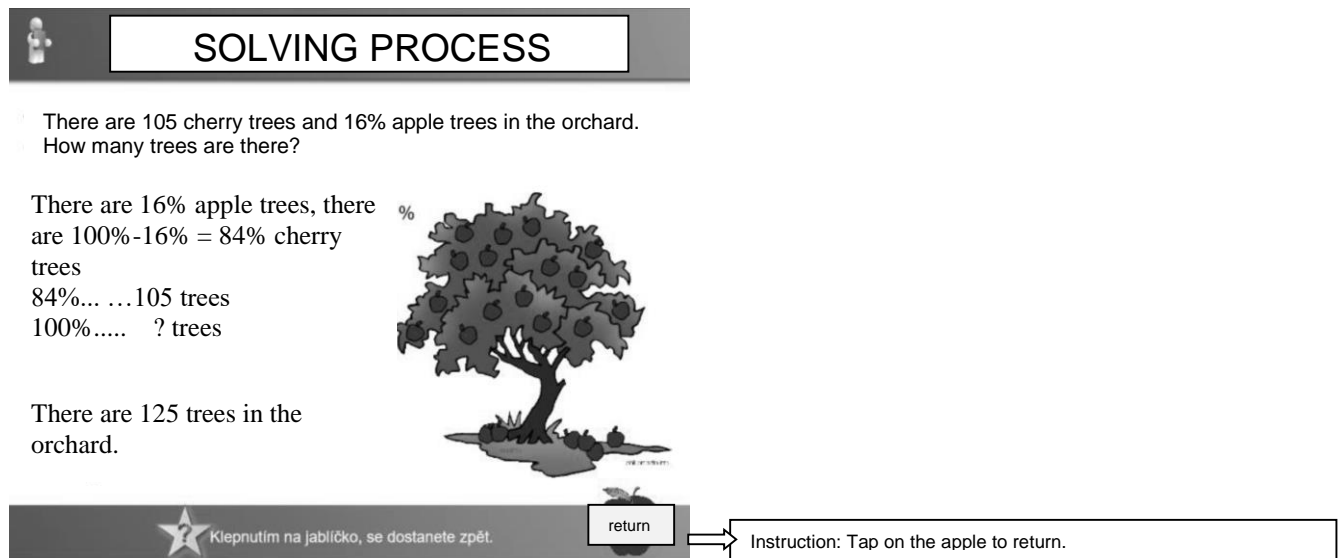


Figure 5 Displaying correct solution

The second most used function in the materials is “*object animation*” – darken. The authors used this function to hide the correct results. When the student solves the problem, they tap on an object which becomes dark, and the correct result appears (Figure 6).

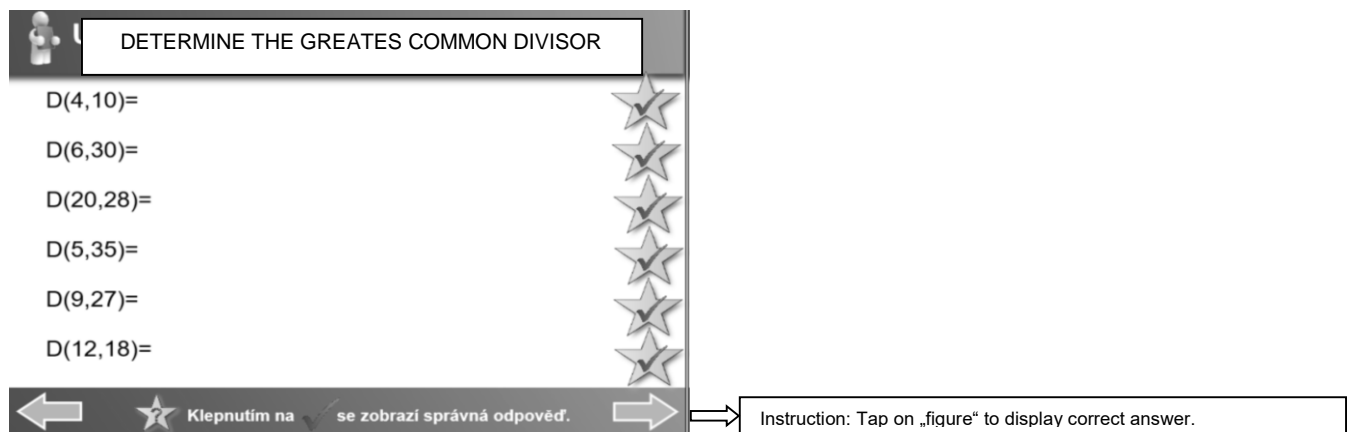


Figure 6 Using object animation “darken”

In order to make the tasks as well-arranged as possible, the authors used tables (and the “cell shading” function to hide the results). Tapping on the shaded cell reveals the correct result (Figure 7).

	17,256		0,987		21,049	
dozens		20				
units						
tenths						
hundredths						

Figure 7 “Cell shading” function in use

Using the “infinite cloner” function, one can make a number of copies of the object. All one has to do to clone the object is drag it with their finger. In the materials this function is used when the student is required to fill in the missing number (Figure 8).

Figure 8 “Infinite cloner” function in use

As many as 5 interactive study materials were created (Revising 6th grade curriculum; Fractions I; Fractions II; Unit conversions – volume and surface area of a cube and cuboid; Percentage), with each study material corresponding to one class.

5 STUDY MATERIAL IN PRACTICE

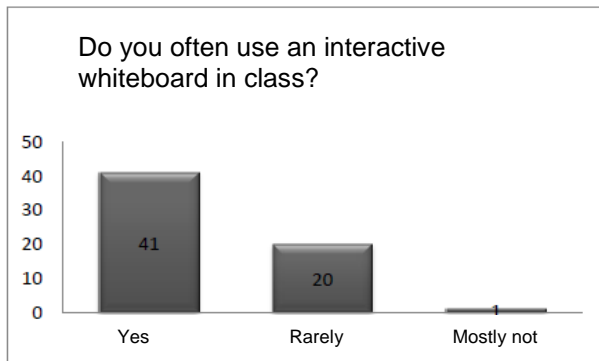
The created study materials were used in four 7th grade classes, with approximately 20 students in the classroom. However, since some students were absent due to illness, the number of students in the classroom varied.

A questionnaire survey was used to obtain feedback from both the students and the teachers. The questionnaire was anonymous and contained both open-ended and close-ended questions. The questionnaire was aimed at determining whether or not the created study materials were effective and whether or not it motivated the students to be more active in class. The students were asked whether or not they enjoyed interactive whiteboard-based mathematics instruction and whether or not it helped them better understand the discussed curriculum.

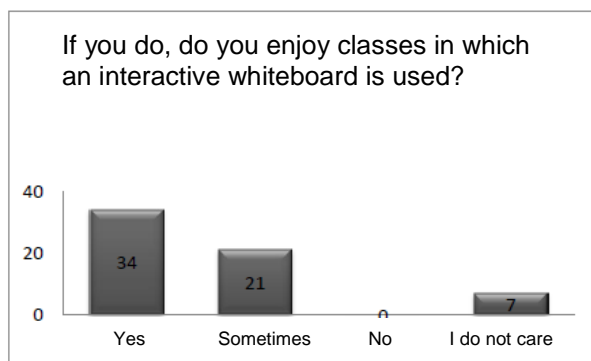
Student questionnaire evaluation

Since some students were absent due to illness, 62 students filled out the questionnaire. The answers were converted to graphs for better clarity. The x-axis contains respondents' answers while the y-axis contains the number of students.

Graph 1 shows whether or not students use an interactive whiteboard often. Nearly 70% of the students answered *Yes*. Graph 2 shows students' answers to the question whether or not they enjoy interactive whiteboard-based classes. More than 30% of the students answered *Sometimes*. This may be caused by the materials being inappropriate or being presented as regular presentations (i.e. not containing any animations, etc.).

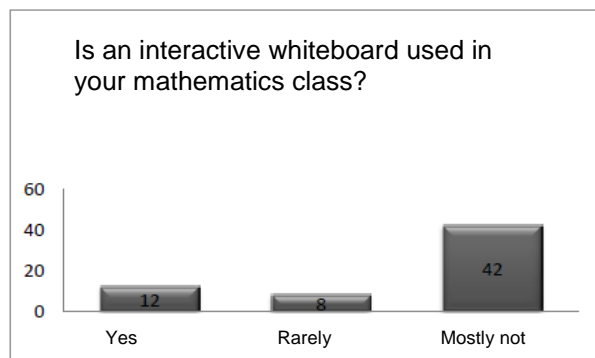


Graph 1 Use of interactive whiteboard in class



Graph 2 Popularity of interactive whiteboard

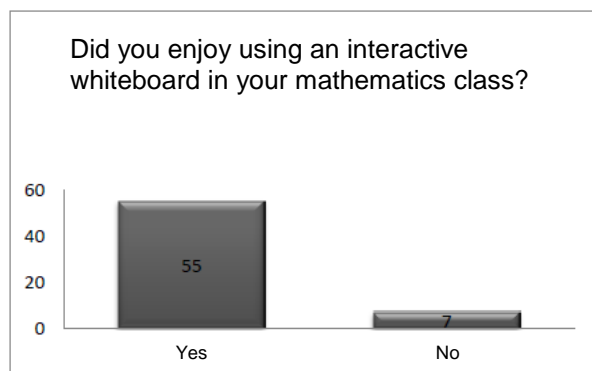
Is an interactive whiteboard used in your mathematics class? Answers to this question can be seen in Graph 3. The majority of students answered *Mostly not*.



Graph 3 Use of interactive whiteboard in mathematics class

When asked if they liked using an interactive whiteboard, nearly 90% of the students answered *Yes* (Graph 4). Only seven respondents answered negatively. The respondents were required to provide at least three

reasons why they *did/did not like using an interactive whiteboard*. The majority of students stated that their mathematics classes were more attractive, materials were easier to follow and the curriculum was easier to understand. The students also stated that they enjoyed the “created” activities such as tests, clozes, etc. Nearly all the students who answered *No* stated that they preferred to solve problems in their journals.



Graph 4 Did you enjoy using interactive whiteboard in mathematics class?

In the last question, the authors asked the students whether or not the created materials and an interactive whiteboard helped them better understand the curriculum. Nearly 84% of the respondents answered *Yes* (which was the authors’ goal – apart from wanting students to enjoy interactive whiteboard-based instruction).

Teacher questionnaire evaluation

Three primary school teachers who rarely use an interactive whiteboard in mathematics instruction filled out the questionnaire. They do not create interactive whiteboard presentations because it is time consuming and technically challenging for them, which they see as a minus. However, they will be able to use the created materials in other classes. The teachers were excited about an interactive whiteboard, especially about the participation of the students and the overall visualization of the material.

CONCLUSION

Since today’s students are familiar with information technology, they find instruction which uses modern teaching aids – such as an interactive whiteboard – much more attractive. The paper was aimed at designing and creating innovative interactive whiteboard presentations based on the mathematics curriculum. The created materials were supposed to make mathematics instruction more diverse and motivate students to be more active in class.

The students stated that they enjoyed interactive whiteboard-based mathematics classes as it helped them better understand the curriculum. They would like more such classes as they find them more attractive and beneficial. The teachers’ answers showed that they rarely use an interactive whiteboard in their mathematics classes. They do not create interactive whiteboard presentations because it is time consuming and technically challenging for them. However, the teachers like the created materials and will use them in other classes. They agreed that the students were more active and enthusiastic.

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