METHODOLOGY OF TEACHING THE PROPERTIES OF A TRIANGLE USING GEOGEBRA CLASSROOM

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Abstract: *The first part of the article deals with a new key competence in the stage of basic education. It records the setting of teaching in a specific primary school for the fulfilment of digital competences in the educational area of Mathematics and its applications. The practical part deals with the teaching of the triangle curriculum using dynamic mathematical software. It includes the methodology of creating individual applets in an activity that will be entered in GeoGebra Classroom. It also includes suggestions from teaching in mathematics lessons at primary school and possible evaluation of the pupil's activities.*

Keywords: GeoGebra Classroom, triangle, Geogebra.org, digital competence of teachers and pupils.

INTRODUCTION

Digital competences in primary schools are essential to prepare pupils for the demands of the modern digital world, which is crucial not only for their future professional success, but also for their personal development. These competencies cover a wide range of skills from basic computer operation to advanced use of information and communication technologies (ICT). Updating the school education programme is essential for integrating these skills into the school curriculum. The implementation of changes in curricular documents in all primary schools represents a major step forward in integrating modern technologies into the educational process and is essential for the effective teaching of digital competences.

1 TEACHING MATHEMATICS USING DIGITAL DEVICES

The following text provides an insight into the practical aspects of teaching in a particular primary school and can serve as an inspiration for staff rooms, members of subject committees for mathematics, ICT methodologies, as well as for school management. A number of tools and strategies that this school has implemented in order to effectively use digital competences during teaching are presented. The way in which applications and modern technologies are incorporated into the educational process in the field is described in detail. The use of these set tools, technologies and applications enables the fulfilment of the objectives set out in valid curricular documents [4] and supports modern approaches to teaching.

Within the educational area of Mathematics and its applications, systematic teaching using digital devices is introduced at school from the third grade. Pupils have computer labs with desktop PCs or iPads directly in their classrooms. Each student has their own personal access account to the school domain, which allows them to log in to the school's computer network, use Microsoft 365 cloud services, and communicate via school email. Pupils also use the school information system Škola OnLine.

From the fourth year onwards, students are equipped with the skills needed to use these platforms and applications independently. By the end of the fifth grade, pupils have acquired skills such as assessing the completeness of data, searching for information, creating simple tables and graphs using the Excel platform. They draw data from websites such as the website of the Czech Statistical Office or other sources. To solve practical or verbal tasks and problems, they use standard operating system tools such as a calculator or special applications on iPads.

This integrated approach to digital education leads to the development of key digital competences that are essential for learners' success in an increasingly digitalised world.

In the second stage of primary school, pupils learn to effectively use digital tools such as Excel, the operating system calculator, as well as advanced symbolic calculation systems such as Microsoft Math Solver and Wolfram Alpha. These tools allow them to delve deeper into abstract mathematical concepts and solve mathematical problems effectively.

In the area of Dependencies, Relationships and Working with Data, pupils will learn to manipulate data using various spreadsheets, use data from state authorities, perform calculations using formulas and sort data according to various criteria. This skill is crucial for developing pupils' analytical skills and preparing them for further academic and professional use.

For the thematic field of Geometry in plane and space, the use of dynamic mathematical software GeoGebra is introduced, which allows students to interactively explore geometric concepts and solve problems corresponding to their year. In the field of spatial geometry, lessons are taught using modelling software such as Thinkercad or Sketchup, supplemented by the 3D Waterhouse module for practical modelling. These modern technologies allow pupils not only to better visualize and understand geometric shapes, but also to develop creative and project skills in the design and implementation of their own 3D models. As part of the research, pupils repeatedly participated in research surveys in this area. Research on pupils' information thinking recorded the state of pupils' cognition with the support of digital devices [3].

2 CURRICULUM TRIANGLE WITH THE APPLICATION OF DIGITAL COMPETENCES OF TEACHERS AND PUPILS

The practical part deals with specific teaching in the 6th grade at the 31st Elementary School in Pilsen in the thematic field of Geometry in plane and space in the educational area of Mathematics and its applications. According to [6], the age period of pupils in the 6th grade is crucial for acquiring basic knowledge and skills in the field of information and communication technologies (ICT). This chapter formulates specific requirements for teachers' pedagogical skills that are necessary for effective teaching of this subject. In addition to the theoretical foundations, there are specific requirements for the creation and modification of interactive applets, which are an integral part of the modern approach to geometry teaching. Furthermore, the chapter describes in detail the methodology that is suitable for involving pupils and making their learning process more effective. This is a good time to implement the outputs [1]. Special attention is paid to the practical implementation of teaching and the specific work of pupils, which allows for a better understanding of how to turn theoretical principles into practical skills.

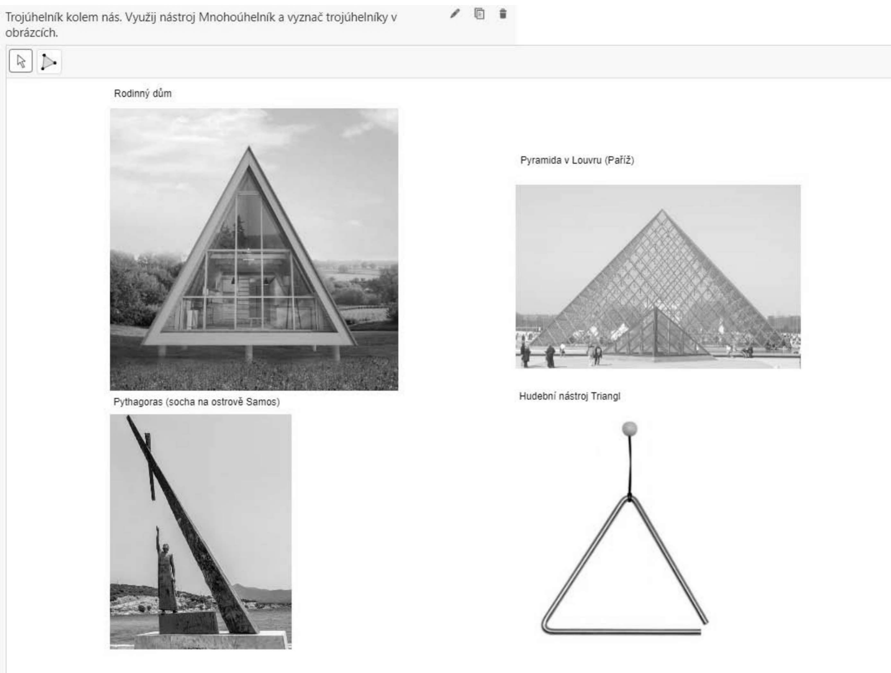
2.1 Digital Competence Framework for Educators

For the effective creation and modification of applets in dynamic mathematical software, it is necessary for mathematics teachers to have digital competencies. As a theoretical basis for integrating digital technologies into the educational process, the DigCompEdu framework has been developed by the European Commission, which identifies six key areas of digital competence that teachers should control. These competencies include the ability to create and

edit digital content, effective digital communication and collaboration, understanding the use of digital technologies and platforms with an emphasis on cybersecurity and data privacy, the creation of mathematical tasks and scenarios that support critical thinking and problem-solving, and finally the ability to use digital technologies to individualize teaching, track progress and provide feedback [2].
The DigCompEdu framework further defines competence levels, from novice (A1) to explorer (A2) and practitioner (B1) to expert (B2), leader (C1) and pioneer (C2), allowing educators to objectively assess and develop their digital skills. This audit can be carried out on the website RVP.CZ methodological portal under the name Profile Učitel 21, where teachers can identify their current competencies and set goals for their further development. Such an approach not only supports teachers' professional development, but also contributes significantly to a significant improvement in the quality of mathematics education using digital tools and technologies [1].
Each teacher can audit their own digital competences in a set scale on the website of the RVP.CZ methodological portal. – Profile Učitel 21.

2.2 Activity settings, creation and methodology of applets

Before starting classes using the GeoGebra Classroom platform, it is necessary to carefully prepare and set up individual activities so that they form a coherent set of tasks corresponding to the subject matter. Educators should actively use the Geogebra.org web platform to create, store, and share math projects and educational materials in the cloud.
To ensure the effective use of this platform, a demonstration activity for pupils was prepared, which included a series of graded tasks on the topic of triangle. These tasks were designed to be accessible to all pupils, while for more gifted students, extension examples were provided to provide additional challenges after completing the basic tasks.
The methodology of setting up these activities includes an emphasis on the use of dynamic software functions to support pupils' skills and knowledge as much as possible. A detailed description of tasks and activities allows the teacher to fully exploit the potential of GeoGebra Classroom and at the same time ensures that pupils acquire the key concepts and skills needed for successful mastery of the curriculum.
Task set1: Triangle Sorting
The introductory task includes four pictures from the world around us. The pupil has only one *Polygon tool* in the toolbar displayed. Using this tool, he marks the basic element of the picture – a triangle. Edits its colour. The task is supplemented by the Question section. An open question is a record of the state of the task for the pupil. In the text, the pupil must answer what geometric shape he or she has constructed.
Digital competence of the teacher for setting up the applet:
The teacher chooses suitable pictures from the world around us to create this applet. Selects an image under a Creative Commons (CC BY) license. Inserts objects into a file, anchors, fixes. In the advanced settings, it is advisable to consider the screen resolution (1920 x 1080), display the icon for resetting the structure and displaying the toolbar in which the toolbar is set and only the selected tools are selected. Add a question section, edit a question and select an open question.



Picture. 1 Use the Polygon tool
Source: own

Note: The screen resolution is the same for all other tasks. It depends on the technical equipment of the computer room in which the teaching will take place.

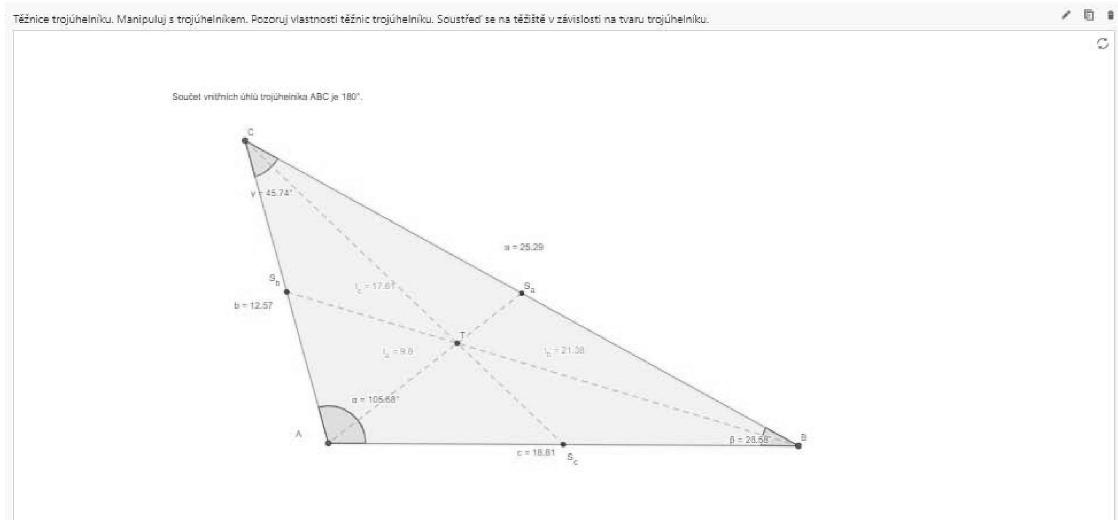
Task set 2: Triangle – sorting by sides and angles

The next task includes a set of examples for sorting triangles. The problems culminate in the difficulty of the solution. In the first task, the pupils are assigned three triangles and the lengths of the sides of the triangles are displayed in them. In his task, the pupil models the given figure according to the assignment. Only *the Pointer* tool is available. In the second task, he models a triangle according to angles. For two triangles, it measures the magnitudes of the angles using the available Angle, respecting the recommendations in the assignment [5]. This occurs in this skill shift from manipulating objects to getting data about objects. The set ends with a set of questions that the pupil answers in the context of the acquired knowledge of the given tasks.

Picture. 2 Triangle – sorting by sides
Source: own

Digital competence of the teacher for setting up the applet:
To create these applets, the teacher creates a set of triangles with the required properties, where the lengths of the sides are displayed, the sizes of angles are displayed only for the first triangle. In the settings, it chooses the colours it uses as text markings in the assignment. It will only make available to pupils the tools that are necessary to solve the given task. In the advanced settings, it only displays the icon for resetting the structure in the first task. In the second task, the menu (tool limitation set in the applet). Adds a question section, edit question and choose open question.
Task set 3: Heights and centroids of a triangle
The next problem includes a set of problems for the heights and centroids of a triangle. In these tasks, the pupil always manipulates objects and obtains information about the properties of the given figure. The first tasks are for the properties of the heights of the triangle, the second tasks for the properties of the centroids of the triangle. The key is to observe the change in modelling the acute, right-angled, and obtuse-angled triangles. Subsequently, he creates his own figure using tools. In these tasks, the pupil has all the tools at his disposal. In the construction, he uses tools and procedures that correspond to traditional drawing from mathematics lessons and well-known drawing aids (triangle with a line, ruler, compass). Individually, the sets end with a set of questions, the answers to which are in the context of the knowledge gained by the knowledge of these tasks.
Digital competence of the teacher for setting up the applet:
To create the first applet of this task, the teacher constructs the heights (centroids) of the triangle. Appropriately edits their properties, designations, and types of lines so that they correspond to the assigned designation in the lesson. It only gives pupils the opportunity to use some tools. He/she uses his/her didactic prerequisites for teaching so that the figure is clear for the pupil, marked in the context of his/her knowledge.
In the advanced settings of the first task (heights, centroids), it only shows the reset of the structure. In the second applet, the pupil has prepared a triangle (construction of heights,

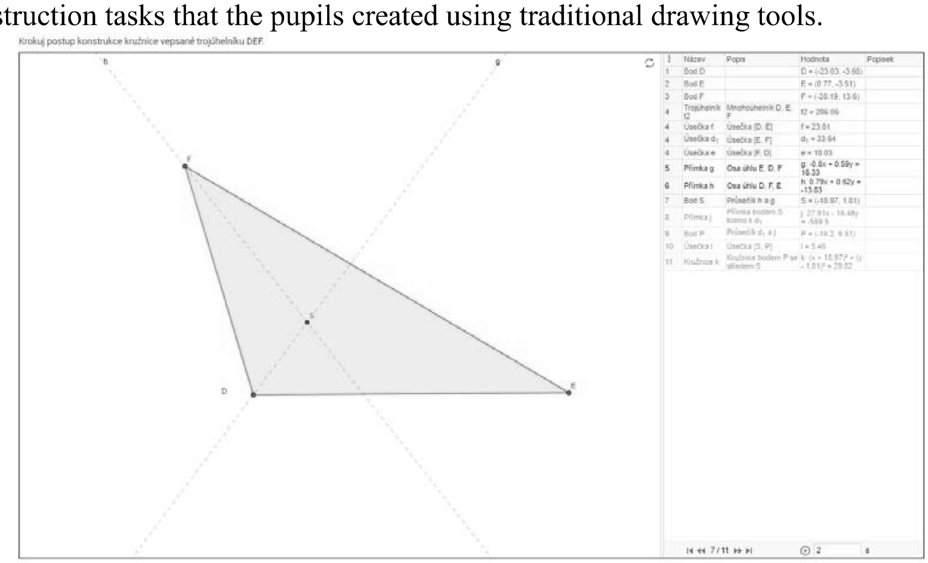
centroids) including interior angles. In this task, the student has a complete menu of tools at his disposal.



Picture. 3 Triangle – centre of gravity of the triangle, manipulation with the figure
Source: own

Task set 4: Circle inscribed and circumscribed by a triangle

The set includes a set of circumscribed and inscribed circles for modelling, the procedure for constructing both circles, and triangles for constructing a circumscribed and inscribed triangle circle. In the first task, the pupil has the Pointer tool and the ABC Text tool at his disposal. Using the above tools, he performs the first task. Other tasks escalate. The pupil has at his disposal the procedure of constructing a circle circumscribed (inscribed) of a triangle. It has the option to freely display the steps of the construction process. The acquired knowledge will be used in the actual design in the noon task. Here, using all tools, he constructs a circle circumscribed (inscribed) of a triangle into a triangle. The tasks are chosen by complementing the construction tasks that the pupils created using traditional drawing tools.



Picture. 4 Triangle – inscribed circle construction procedure
Source: own

Digital competence of the teacher for setting up the applet:
For the creation of the first applet of this task, the teacher constructs a circle inscribed (circumscribed) by a triangle. Appropriately edits their properties, designations, and types of lines so that they correspond to the assigned designation in the lesson. It only gives pupils the opportunity to manipulate the figures and determine the position of the centre of both circles depending on the shape of the triangles. He/she uses his/her didactic prerequisites for teaching so that the figure is clear for the pupil, marked in the context of his/her knowledge.
In the advanced settings of the second task (the construction progress of both circles), it only displays a menu to display the construction progress. In the last applet of this set, the pupil has triangles ready. In this task, the student has a complete menu of tools at his disposal.

3 CONDITIONS FOR IMPLEMENTATION AND VERIFICATION OF THE CURRICULUM

The case study was attended by pupils of the 6^{th} grade (VI. B and VI. C) in a total of forty-three pupils. The pupils had prepared tasks in GeoGebra Classroom. The sharing link was stored on the school's network drive. The reader can use the link. After activation, it is possible to try out the described role of the pupil and perform the tasks https://www.geogebra.org/classroom/bzv8p3vf.
The role of the teacher in this phase of teaching, which is conducted in the computer classroom, is the role of an advisor and mentor. He monitors the work of pupils and is an advisor to partial tasks. The interactive board shows the activity of the pupils' work (it is recommended to hide the names at this stage).

3.1 Evaluation of pupils' activities, feedback

Based on the teaching experience, the work is evaluated in the next hour. The teacher uses a display device in the classroom and demonstrates to the pupils their activities, successfully solved tasks and mistakes they made in individual tasks. The activity is conducted with hidden names. At the same time, it immediately models the right solutions. The assessment is formative, leading to an overall view of the subject matter. It then generates a new Classroom for pupils. The link is made available to pupils through the school information system and for voluntary home practice.

CONCLUSION

The above example of good practice provides a view of specific solutions to tasks at the end of the triangle curriculum in the 6^{th} grade of primary school using digital devices. It is a unique view of practical involvement in teaching in the Czech Republic. It can be stated that the teacher must be able to work effectively with digital technologies in order to fully exploit the potential of these tools in education. The integration of digital technologies into teaching then brings several benefits, such as student motivation, personalised learning, and preparation for digital skills essential for today's world of work. In this way, educators contribute to a better and more engaging learning environment for their pupils.

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