

Computer assisted proving from the perspective of the secondary school teacher

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Secondary school teacher of mathematics and informatics

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(Visualization of proofs using dynamic geometry software)



- Students find proofs difficult, boring and mostly useless.
- Many teachers consider proofs too time demanding.
- Many theorems in secondary school textbooks are without proofs. If the proofs are presented, they are mostly algebraic, even for geometric theorems.



„In the classroom the key role of proof is the promotion of mathematical understanding, and thus our most important challenge is to find more effective ways of using proof for this purpose. “

Gila Hanna, *Proof, explanation and exploration: An overview*, 2000



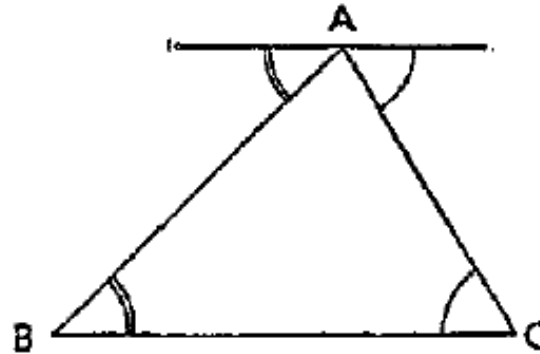


FIG. 23

„If a student has gone through his mathematics classes without having really understood a few proofs like the foregoing one, he is entitled to address a scorching reproach to his school and to his teachers.

George Polya, *How to solve it*, 1973



„... if general education intends to bestow on the student the ideas of intuitive evidence and logical reasoning, it must reserve a place for geometric proofs.“

George Polya, *How to solve it*, 1973



„Mathematical education helps cultivate abstract and analytical thinking, develops logical judgment, and teaches clear and factual reasoning aimed at finding objective truths rather than defending one's own opinion.“

Framework education program for secondary general education



Irena's aim: To promote the use of “visual proofs”

- Visual representations are more attractive to students
- More types of proof -> more students understand
- Connection between different fields of mathematics



- Pictures and diagrams always play an important role in the process of understanding various mathematics features.
- From the remote past pictures serve as visual proofs – “proofs without words”

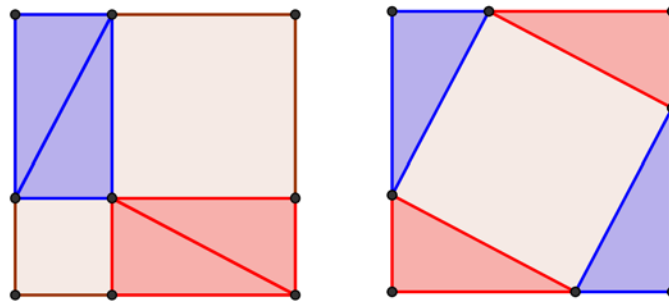


Earthen plate, Babylonia, about 1700 BC



„PWWs are pictures or diagrams that help the observer see why a particular statement may be true, and also to see how one might begin to go about proving it true.“

Roger B. Nelsen



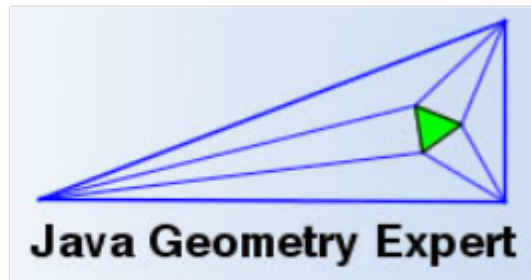
„We see the proof (in mathematics education) as a series of thoughts which persuades everyone.“

František Kuřina



BOOKS & WEB PAGES

- Roger B. Nelsen: Proofs without Words: Exercises in Visual Thinking, 1993
- Roger B. Nelsen: Proofs Without Words II: More Exercises in Visual Thinking, 2001



<http://www.cut-the-knot.org/>

<http://www.cs.wichita.edu/~ye/>

<http://demonstrations.wolfram.com/>

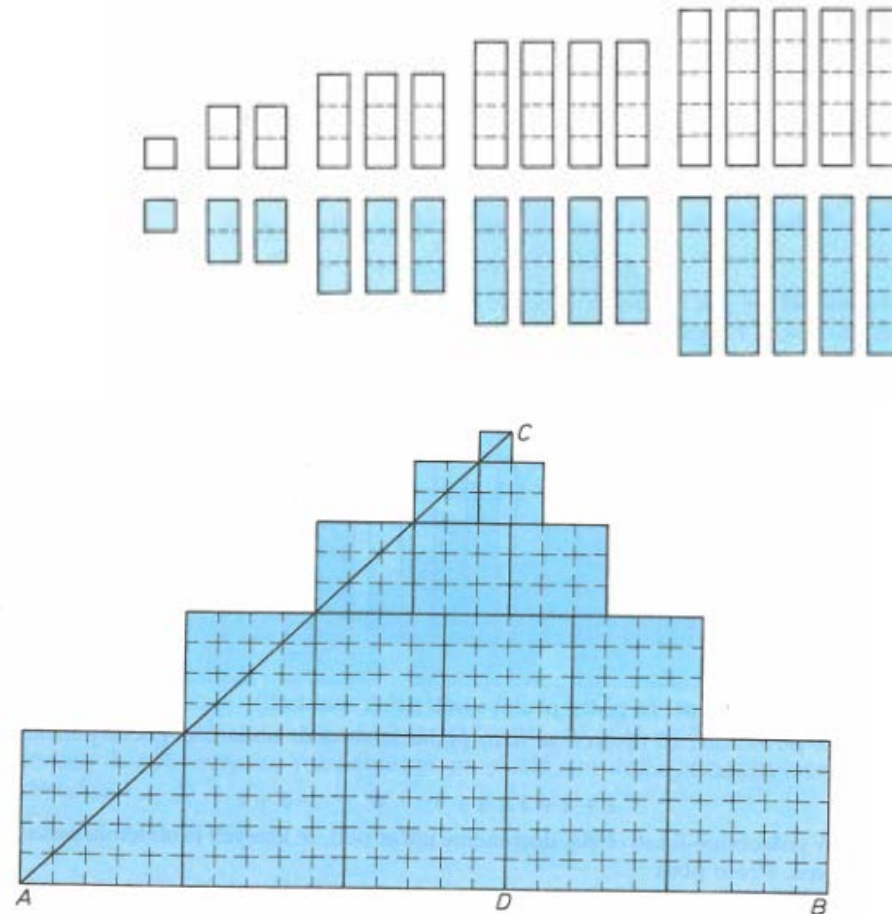
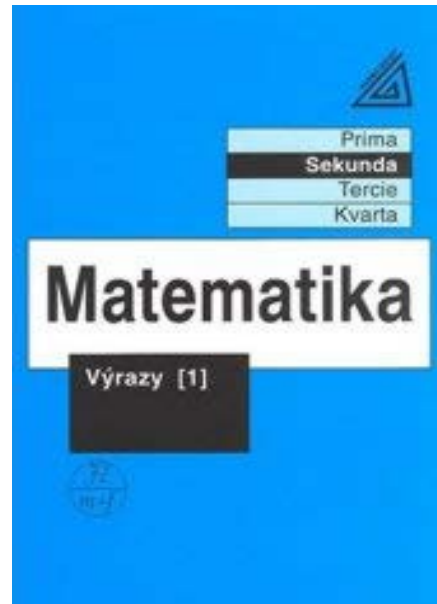


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TEXTBOOKS

- Lots of theorems without proofs
- Most of proofs are algebraic
- The only exception



Dynamic visual proofs in GeoGebra



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Despite the caveats we have outlined, the works reported here seem to be underlain by a robust appreciation of visual reasoning, particularly about images' capacity to encompass ideas that cannot be made overt in a formal definition or an algebraic computation.

However, a concern that comes across, often intensely, from these works is that teachers' and, consequently, students' ambivalence towards visualization may cause prejudice against it and a consequent loss of its unique benefits.

Further research and pedagogical action are necessary to make sure that this is not (or ceases to be) the case.

DREYFUS, Tommy, Elena NARDI a Roza LEIKIN. Forms of Proof and Proving in the Classroom. Proof and proving in mathematics education, 2011.



„Just as it is unrealistic to expect students to see a need for proof without purposeful and focused action by the teacher, it is unrealistic to expect teachers to be able to attend to this element of teaching without appropriate preparation and support.“

O. Zaslavsky et al. *The need for proof and proving: Mathematical and pedagogical perspectives*



Reserach question: „How teachers use in the classroom dynamic visual proofs?“

Research participants: Mathematics teachers, who are using computers (DGS) in their lessons

Metodology: qualitative research

Design: grounded theory

Data collecting: semistructured interviews and videorecords

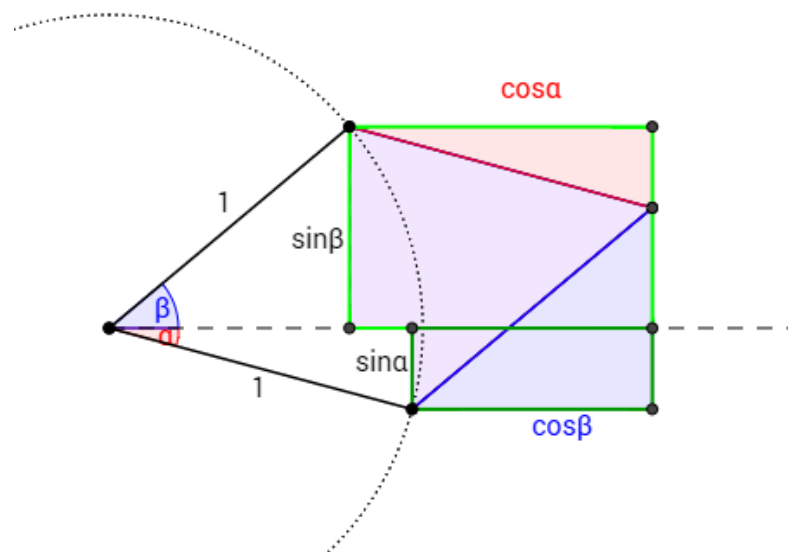
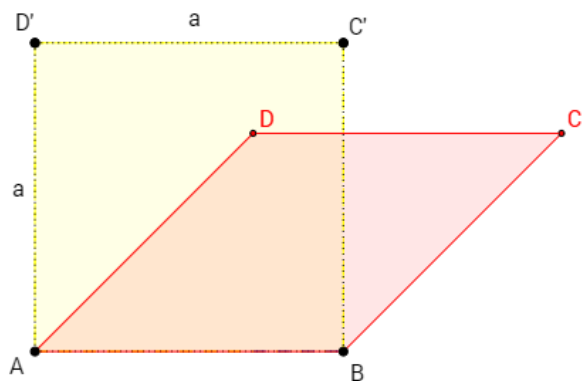


- Mathematics teachers, who are using computers (DGS) in their lessons
- They were asked to use dynamic visual proofs during their lessons
- Semistructured interviews with teachers focused on using of technologies and proving
- Videostudies of mathematics lessons where dynamic visual proofs were used



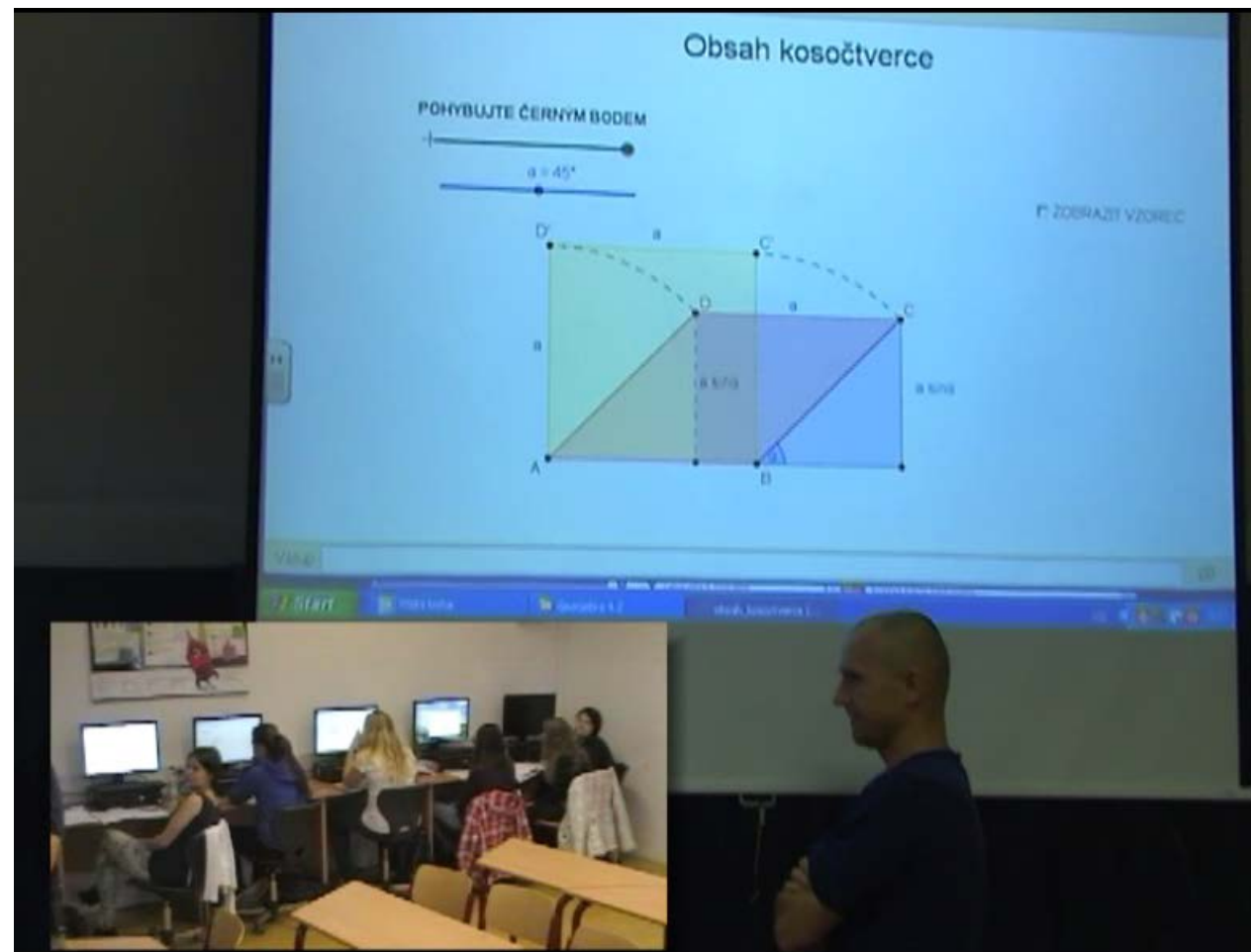
Goal of the lesson: To derive formula for the sine of the sum of angles

Dynamic visual proofs used in this lesson:



RESEARCH – 1st SCHOOL

- Projector
- Students have their own computers
- Very difficult to organize and to force students to focus on proof

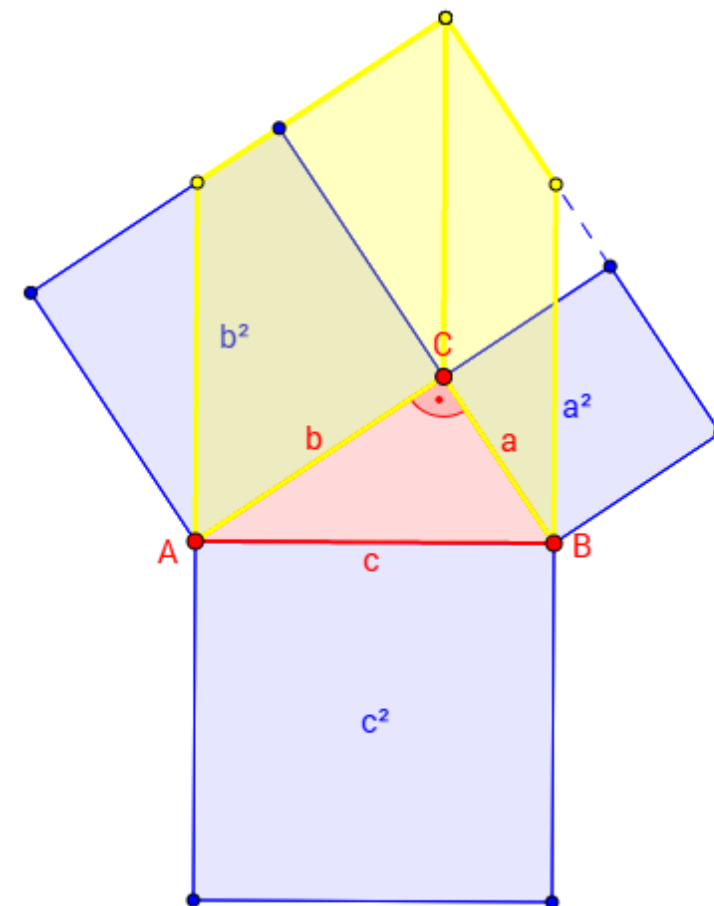
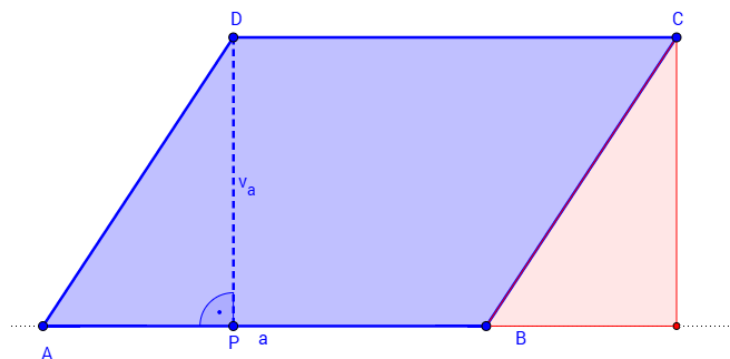
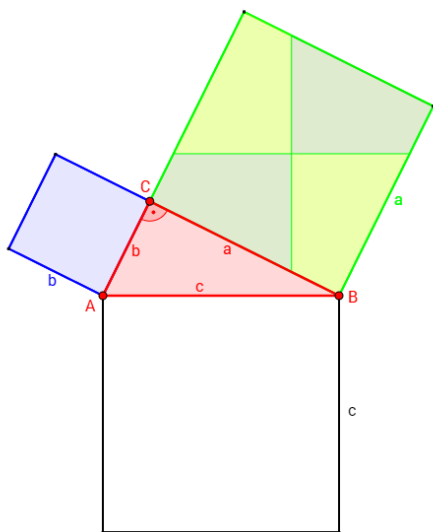


- Very difficult to organize and to force students to focus on proof
- Teacher as the main actor – students are not engaged
- Combination of different kinds of mathematics topics



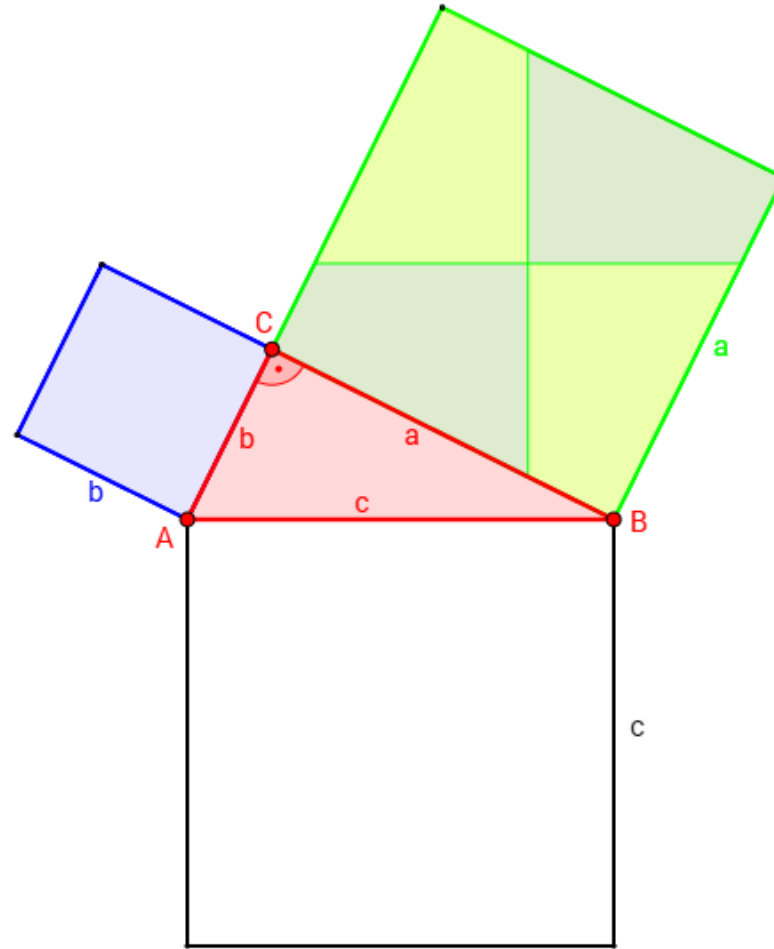
Goal of the lesson: To prove Pythagoras' theorem

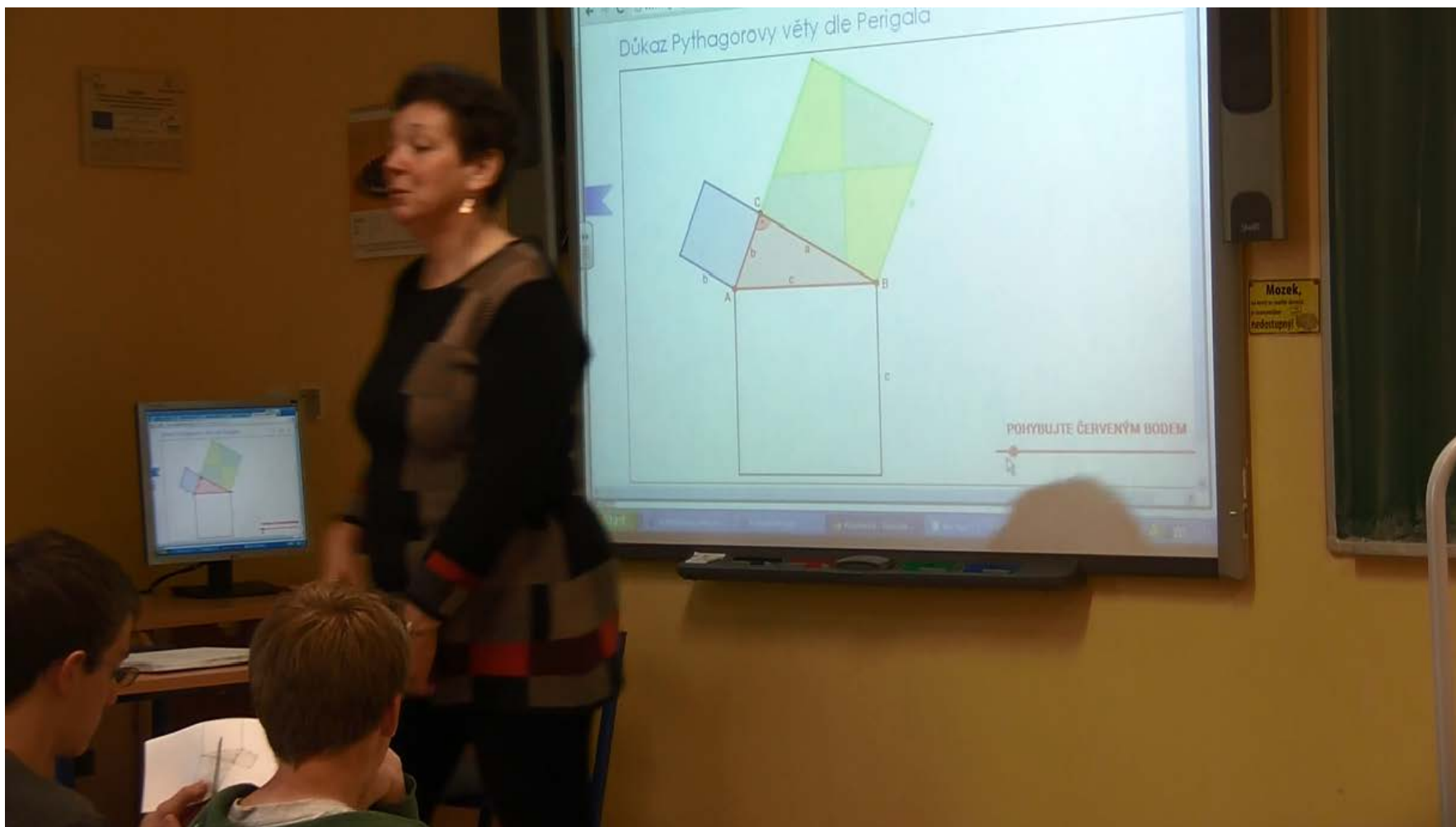
Dynamic visual proofs used in this lesson:



- Interactive whiteboard
- Students did not have their own computers
- Combination of dynamic visual proof and paper



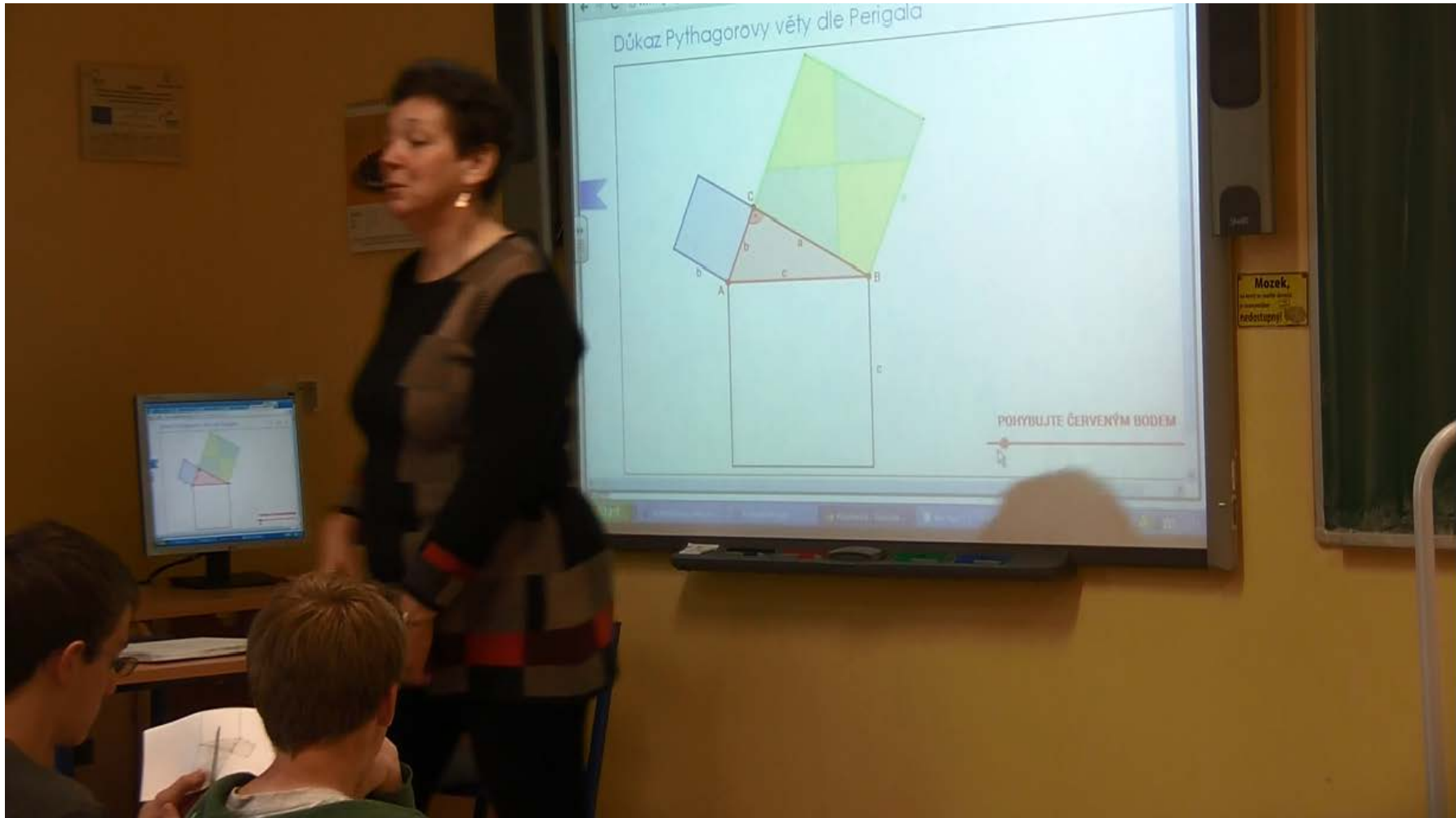




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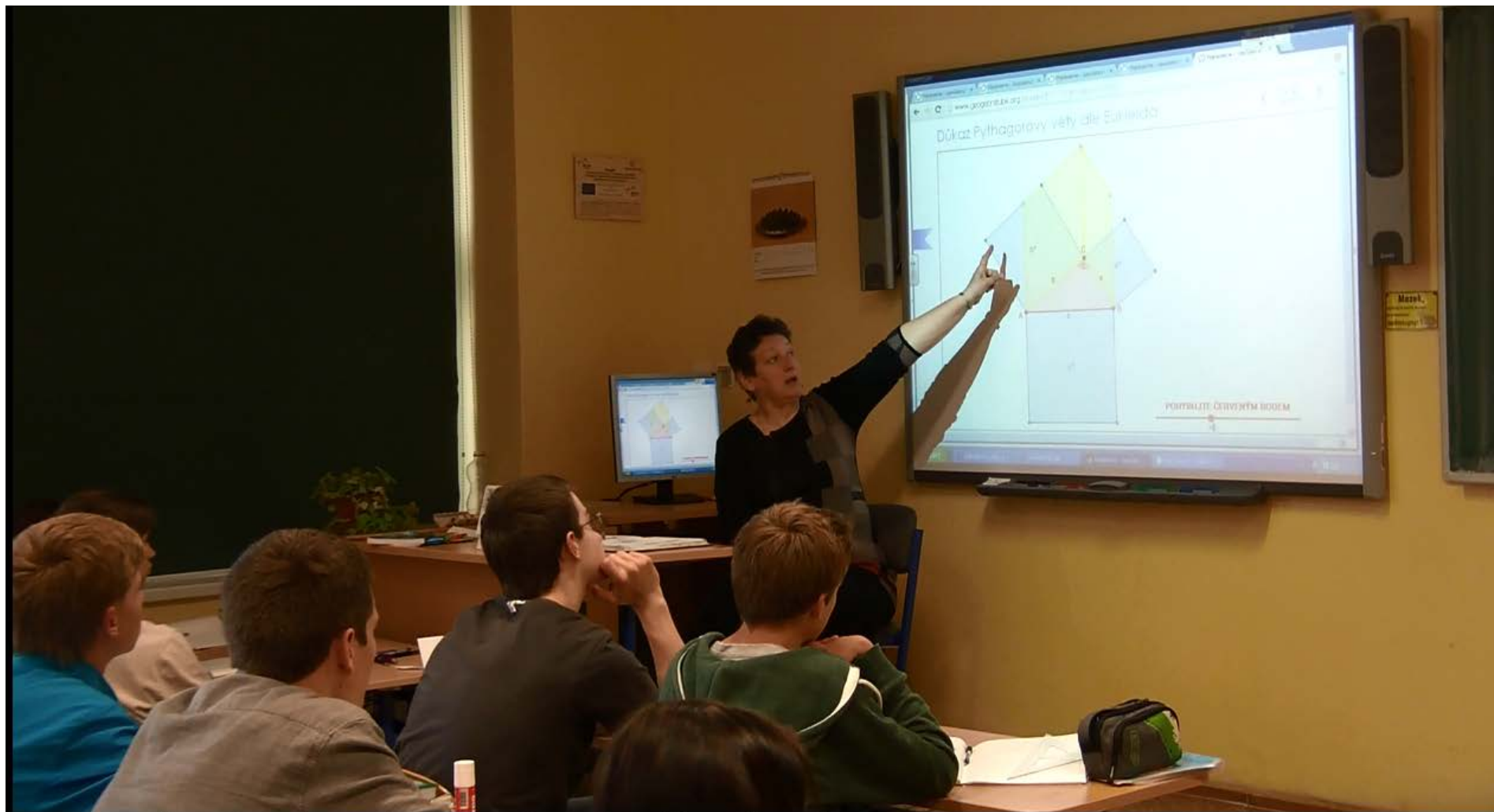
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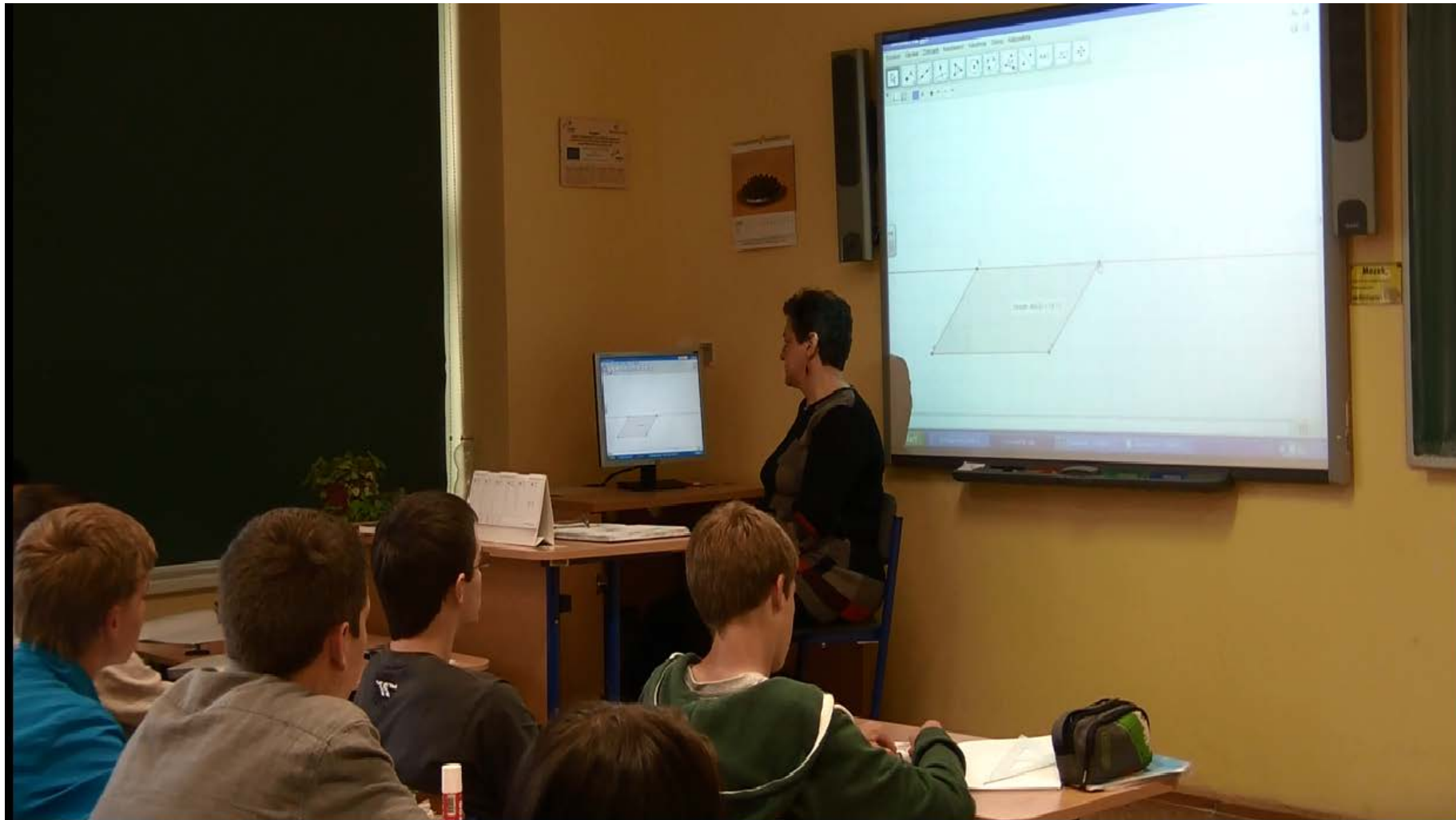
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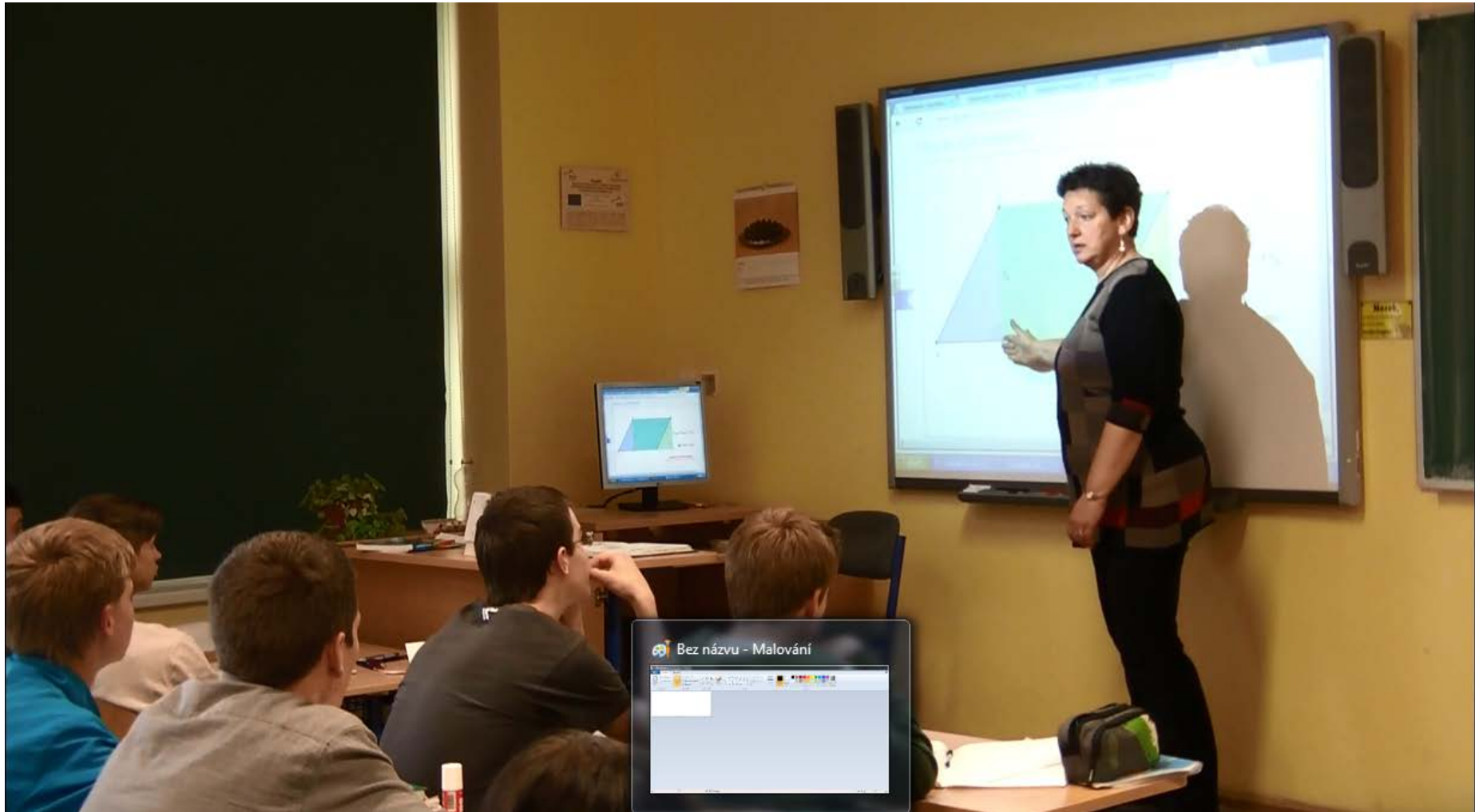
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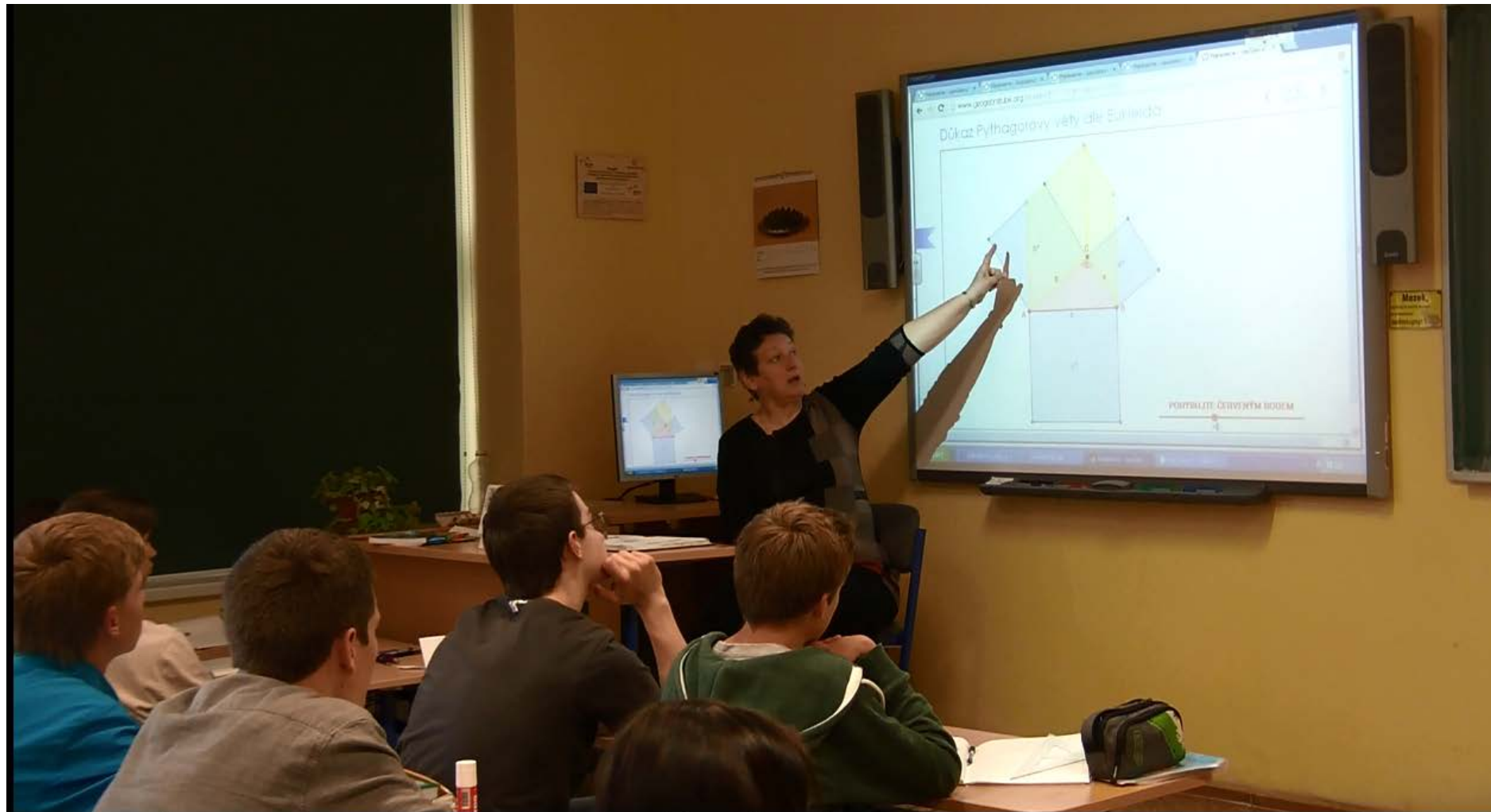
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- Various kinds of activities and materials
- Great interaction with students
- Combination of different kinds of mathematics topics



RESEARCH OBJECTIVES

A detailed analysis of the records



Understand the situation of using dynamic visual proofs



Creation of a theory



Adapt pre-service and in-service teacher training courses



THANK YOU FOR YOUR ATTENTION



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