Teaching Physics at High Schools and University – Key Problems

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Abstract

The paper deals with the problem of physics education at high schools and problems that university students have in the first year of their study. Physics is a core subject in STEM education (STEM- science, technology, engineering, mathematics). The aim of the research was focused on parts of the physics curriculum that are difficult to teach and learn (concepts heat, temperature, density). Our research was provided in 2019-2022 at high schools (grammar schools) in the Czech Republic and in 2020-2022 at universities as part of the project Bridge2Teach solution.

The goal of the research was to answer two questions: 1. What are the critical places in the study program of the subject physics at high schools? 2. Can bridging courses at universities be helpful for pre-service science teacher students to overcome gaps in knowledge during the first term of the studies? The findings of this study are discussed in this manuscript. Examples of ways to prepare study materials for high school students are given.

Introduction

The teaching objectives in the Czech Republic are defined by the strategy of education in the documents of the Ministry of Education - Strategy 2030+ (https://www.msmt.cz/uploads/brozura_S2030_en_fin_online.pdf). Emphasis is given to the model of STEM education and on trends in how to prepare learners for the future job market.

A crucial element of STEM teaching is facilitating a different way of learning by developing students´ critical thinking, problem – solving, and teamwork skills. Students´ confidence, creativity, curiosity, and willingness to try and fail until they succeed should be developed. STEM education means that students learn the following in individual areas:

S (science) – the leading activities are observing, experimenting, making predictions, and asking questions; T (technology) – taught are skills of using tools, making things work, and using computers; E (engineering) – students are solving problems, using materials; M (mathematics) – emphasis on abstract concepts like functions, equations, relation between variables, etc.

The future labor market is based on all subjects covered in STEM education. With a foundation in these subjects, a STEM career allows learners to solve problems, develop new ideas, and conduct research. These professionals can work in a variety of settings, including in an office, laboratory, research facility, classroom, or out in the field. (Morris, 2021; OECD 2020) In addition to field-specific technical skills, STEM jobs require soft skills. Necessary soft skills in 2020-2025 were identified as follow (Karimi, 2021):

- Leadership
- Human Connection Communication
- Creativity
- Collaboration
- Critical Thinking
- Empathy
- Problem Solving
- Emotional Intelligence

According to Hestenes (Hestenes, 2015), physics is the most important subject in the science part of STEM education. All the skills mentioned above are taught in this school subject. Physics plays a key role in science and technology. It is the only subject where metrology is systematically taught. Although physics seems to be so important, among the school subjects it is the least popular (Dvořák, 2008, Pavelková, 2010). Several research activities into physics were conducted in the last few years. In one example, the research dealt with the problem of how physics is perceived by pupils, which topics are unpopular, and which activities pupils would like to do during class hours (Dvořák 2008).

Physics is unpopular because it is often difficult for learners to understand theoretical concepts and the ways they are explained. One way to change the perception of this subject is to find out topics of the physics curriculum that are extremly incomprehensible for leaners, find other methods how to explain them and connect these phenomena with applications in the everyday life of learners.

The first step to finding critical places in the secondary school physics curriculum was done in the frame of the project Didactics – Man and Nature A (2017-2019).

Thirty-one physics teachers working in Czech secondary and high schools answered the questionnaire, where 80 topics from all themes taught in physics were offered to them. They had to choose critical issues when no mathematics was involved and when mathematics was considered. Critical places are parts of the curricula in which students often fail.

The most cited problematic places are – trajectory, time and speed, electromagnetism, magnetic induction lines, lenses, Archimedes´ law, Pascal´s law, graphs in kinematics, and density. These topics are critical themselves. When we need to apply mathematics, most difficulties are with diagrams and at secondary schools also with the topic density.

Teachers evaluated "magnetism" as the most critical unit, which also has the largest share of problematic tasks. In terms of individual topics within the branches, in the case of "magnetism", teachers most often mentioned the organizational concept of the magnetic induction line (10 teachers) and the application concept of the electromagnet (7 teachers). Within "fluid mechanics", perceived by the teachers as the second most critical thematic unit, the organizational concepts of Archimedes' law (9 teachers) and Pascal's law (7 teachers) were most often mentioned as essential points. Teachers often said the substantive concept of density is a critical point (12 teachers). Finally, a relatively significant number of problematic tasks was found in the thematic unit "light phenomena". Teachers from this area most often identified the application concept of lens imaging as a critical point (10 teachers). The group of essential places thus includes the following topics: density, magnetic field and magnetic induction lines, electromagnet, Pascal's law, Archimedes' law, and lens imaging. An intense discussion about critical places in physics can be found in Kohout (Kohout, 2019, Pospiech 2015).

The challenge studied in the second part of this research was that many universities, especially those with a technical focus, have faced the problem of students leaving the university during their first year of study. Many higher education graduates enter the university with different levels of professional knowledge and other motivations to study the given field. It is a consequence of admission without an entrance exam, ignorance of the issues of the chosen field, and low motivation, especially to study university programs with a technical and scientific focus. One of the ways to help students overcome shortcomings in knowledge from high school and successfully study in the 1st year at the university is the existence of so-called bridging courses. (Frase, 2003, Finn, 1989, Hloušková, 2014; Holubová, 2020c)
Bridging courses are teaching units that are intended to enable students to supplement the necessary knowledge from secondary school. (Dale, 2010; Doll, 2013; EEA, 2023) The question is if bridging courses are offered at universities.

Research questions and methodology

Research activities were organized to discover more about the problems with motivation, success, and failure in STEM subjects at high schools and universities. The research included two main research questions:

1. what are the critical places (spots) in the physics study program at high schools from the perspective of students and their teachers
2. are there bridging courses at universities that can help physics students to overcome gaps in knowledge needed during the first term at the universities?

Methodology of the research – Research question 1:

1. Curricula and framework analysis (https://www.edu.cz/rvp-ramcove-vzdelavaci-programy/#rozcestnik) ;
2. Interviews with staff;
3. Interviews with students;

Educational programs of 59 high schools were analyzed, and 31 physics teachers took part in the interviews. The educational programs are available online – each school must prepare its study program and publish it on the school web pages. The interview with staff was semistructured. Transcripts of the interviews were summarised and analyzed. The discussions took approximately 45 minutes each. The interview was similar to the research realized in the project mentioned above.

Question 1: What topics in physics are typically discussed in the first to third grade of high schools considered by physics teachers to be critical?

Question 2: How do high school physics teachers perceive the relationship between mathematics and physics in the context of critical topics?

The interview was based on the following questions:

1. Please indicate which topics you consider critical in teaching physics.

2. Why did you choose the topics you did in the previous question?

3. What are your favorite and least favorite topics or subject areas within physics as broad and diverse disciplines (if you have such areas?)

3. Which topics are, in your opinion, the most problematic?

4. Which topics strike you as the most abstract?

The list, including the order, was prepared according to the subsections in physics textbooks of the Prometheus publishing house. These textbooks are used widely in our schools. (http://prometheus-nakl.cz/index.php?zobraz=katalog)

Methodology of the research – Research question 2:

Questionnaires about bridging courses

The research relating to question 2 was realized in 2019-2022 at universities in the Czech Republic, Austria, Italy, Lithuania, and Slovakia in the framework of the Erasmus+ project Bridge2Teach. At the Palacky University, 235 first-year students and 14 teachers were involved in this part of the research.
Students and teachers filled out the following questionnaires (each project participant prepared the questionnaire in their own language):

a) **Bridge2Teach - *Developing Bridging Courses for Mathematics and Science Teacher Students***

Evaluation Sheet: Students

Please tick off one of the boxes below.
-2 = ***Not at all***

2 = ***Absolutely yes***	**-2**	**-1**	**0**	**1**	**2**	**Do you have any comments or any suggestions for improvement?**
1) Did the course helped you to bridge the knowledge gap from school to university?						
2) Were your expectations satisfied?						
3) Was the topic relevant for my future work as a						

Mathematics/Science teacher at school?						
4) Was the didactic approach useful for your future work as a Mathematics/Science teacher at school?						
5) Did the didactic material discuss the content in a way that was relevant for your future work as a Mathematics/Science teacher at school?						
6) Was the language of the didactic materials understandable?						
7) Did the didactic activities you worked on help you to think about the proposed Mathematics/Science topic?						
8) Did the required workload seem consistent to you?						

These questionnaires have multiple-choice (Liket-choice) questions in the first part followed by free-response questions:

Considering the whole course, I liked most:
Considering the whole course, I would suggest to improve:

b) Bridge2Teach - *Developing Bridging Courses for Mathematics and Science Teacher Students*

Evaluation Sheet: Teacher educator

Please indicate the used material for the implemented bridging course: ________________________________

Please tick off one of the boxes below.
-2 = ***Not at all***
2 = ***Absolutely yes***

	-2	-1	0	1	2	Do you have any comments or any suggestions for improvement?
1) Was the course easy to deliver?						

2) Did the course fit well in the students curriculum / course plan?						
3) Was the course appropriate for the target group?						
4) Was the structure of the course clearly arranged?						
5) Were your expectations satisfied?						
6) Did the topic appear relevant for your students?						
7) Did the material illustrat the content in a relevant way for my future work as a Mathematics/Science teacher at school?						
8) Was the language of the material understandable for your students?						
9) Were the examples discussed in the material well chosen?						
10) Was the intended time for the course appropriate?						
11) Did the course enable students to play an active role in their own learning process (collaborating, discussing, reflecting, designing, enacting…)?						
12) Did the course support pre-service teachers' capacity to improve mathematics/ science learning in culturally diverse classrooms?						

Free-response question:
If you changed something in the material to adapt them to your need, please explain what and why:
Further comments:

Analysis of existing educational situation

Research question 1 – critical places in high school physics study program:

According to our activities, we can summarize:
Topics from mechanics that are related to problem solving - working with graphs, vectors, and scalar quantities - appear to be very difficult for high school students. In addition, so is the concept of moment of inertia, non-uniform curvilinear movement, and characteristics of physical fields using quantities. In thermal physics the most problematic topics are calorimetric

equations, and transport processes. There are problems with explaining the basic concepts of heat and temperature. In general, the physics of the microworld, i.e. processes and phenomena inaccessible to direct perception, appears to be difficult. From electricity and magnetism, Kirchhoff's laws are problematic. All these topics are closely related to the knowledge of mathematics.

Research question 2 - bridging courses

Based on the analysis, it was found what kind of bridging courses are offered by different universities in the Czech Republic. An overview of them can be found below. Based on completed questionnaires, topics were identified for materials that were prepared as part of the project and that can be used in bridging courses in mathematics, biology, physics, and chemistry. These materials one can find on the web pages of the project (https://www.bridge2teach-project.eu/).

Table 1: Overview of existing bridging courses

University	*Bridging course offered*			
	Physics	*Chemistry*	*Biology*	*Mathematics*
Charles University	*Repetition of high school mathematics*	*Repetition of high school physics*		*Repetition of high school mathematics*
University of South Bohemia			*2 day course*	*Five-day course*
Jan evangelista Purkyně Iniversity	*Repetition of high school physics*			*Mathematics course*
University of Ostrava	*Refresher course in high school physics*	*Refresher course in high school chemistry*		*Refresher course in high school mathematics*
Palacky University Olomouc	*Mathematic seminars for physics teachers*			

Universities in Hradec Králové, Plzeň and Brno have no bridging courses.

Students´ feedback about bridging courses is that repetitive biology, chemistry, physics, and geography courses are unnecessary. The crucial problem is mathematics, especially for physics students. They would welcome a bridging course, maybe before the beginning of the first semester.

Students browse materials they have to study during the first semester, and most students have a problem understanding the physics behind the mathematics problems.

The problem is deep because of the level of mathematics knowledge obtained at high schools. Bridging physics courses will be helpful because many high schools do not teach physics in the last year (before the final exam - the matura). Only a physics-chemistry seminar is conducted (in the better case) for those students who plan to study medicine or technique.

Outcomes of the research

The findings of this research led to innovations in how to teach critical topics in physics. In-service teachers are introduced to the newly emerging materials, and attention is also paid to the strategies in the teaching of physics didactics in preparation of future physics teachers. As an example, we present, in the section below, a module dedicated to the issue of thermal physics. (Holubova, 2007a; Holubova, 2015b; OECD, 2020; Rybárová, 2019)

Learning activity on critical topic heat transfer

This activity deals with the physics topics of heat transfer, insulation properties of materials, thermography. Thermography is a branch of science that can analyze and graphically represent the temperature on the surface of objects, using non-contact methods. One task of this project is to study materials focused on the issue of thermography (the theory). The other task, the main part of the work, is concentrated on designing experimental tasks using a thermal imaging camera, then their conduct and analysis. This material is important and useful for students living in geographic areas where about six months a year the outdoor temperature drops below ten degrees Celsius.

Keywords: thermography, temperature, humidity, heat, insulation, conduction

Defined project scheme

Learning outcomes: All students - can work with algebraic expressions, and can apply knowledge of mathematics in solving physical problems. Most students - can solve numerical tasks, and they prepare and measure experimental laboratory tasks to determine the heat transfer coefficient. Some students - apply these observations to the issue of the construction and insulation of residential buildings. Students study materials on the issue of low-energy buildings.

Initial activity: Application of knowledge of mathematics – modifying mathematical expressions, and computation with fractions. Students will solve some numerical problems.

The main activity: Laboratory work - students simulate the heating of a house, whose walls are made of different materials. They study the thermal insulating properties of glass, wood, and polystyrene. Students calculate the heat transfer coefficient for the material.

Final activity: Students present the results of their measurements. They discuss the issue of the construction of low-energy houses and the importance of building insulation for energy savings.

Excerpt of the material provided to students

Motivation
The largest portion of the energy is consumed on the heating (cooling) of habitable rooms (homes, schools, theaters, cinemas, and department stores) (https://vytapeni.tzb-info.cz/elektricke-vytapeni/18057-oc-fenix-prehled-spotreby-energie-prvniho-roku-provozu-budovy). In older buildings, we can reduce energy consumption by suitable insulation. Complete insulation can save 50-80 percent of energy costs. In winter, a well-insulated house means low heating costs, and no thermal bridges (for example no damp walls of houses causing mould), in new buildings we can achieve savings for the heating system with less power consumption. In summer the residents can recognize the advantages of wall insulation by comparing their accounts for air conditioning where the energy consumption is three times higher than for heating in the winter time.
A standard house is insulated by polystyrene with a thickness of about 15 cm, a low-energy one – of 25 cm, and a passive one with a usual thickness of 30 cm. Based on practical experience one can say that the optimum insulation appears to be at least 15-20 cm, or you can use a slightly thinner gray foam polystyrene. Insulation panels of this type are graphite new-generation insulators with an increased insulating effect.
The required thickness of materials to obtain the same effect of thermal insulation (Fig. 1):

Figure 1. Comparing the insulating ability of the materials related to their thickness

Theoretical basis for the laboratory task – heat flow through a wall

$$\Phi_1 = \frac{\lambda_1}{d_1} S(t_1 - t_2)$$

$$\Phi_2 = \frac{\lambda_2}{d_2} S(t_2 - t_3)$$
$$\Phi_3 = \frac{\lambda_3}{d_3} S(t_3 - t_4)$$

where Φ_1 is the heat flow transported between the walls 1 and 2, t_1 is the temperature of the wall 1, t_2 is the temperature of the wall 2, t_3 is the temperature of the wall 3, S is the area of the wall, d_1 is the thickness of the wall 1, d_2 is the thickness of the wall 2, d_3 is the thickness of the wall 3, λ_1 is the thermal conductivity coefficient of the wall 1, λ_2 is the thermal conductivity coefficient of the wall 2, λ_3 is the thermal conductivity coefficient of the wall 3.
Heat flow is stable, and has the same value for all the walls, the equation can be modified:

$$(t_1 - t_2) = \frac{\Phi}{\lambda_1 S} d_1$$
$$(t_2 - t_3) = \frac{\Phi}{\lambda_2 S} d_2$$
$$(t_3 - t_4) = \frac{\Phi}{\lambda_3 S} d_3$$

The equations add up and get $t_1 - t_4 = \frac{\Phi}{S}\left(\frac{d_1}{\lambda_1} + \frac{d_2}{\lambda_2} + \frac{d_3}{\lambda_3}\right)$
From this, we can express the heat flow $\Phi = \frac{t_1 - t_4}{\frac{d_1}{\lambda_1} + \frac{d_2}{\lambda_2} + \frac{d_3}{\lambda_3}}$

The ratio $\frac{d}{\lambda}$ is the so-called thermal resistance, in our expression, the sum in the denominator is the total thermal resistance of the wall. You can also use the expression of the heat transfer coefficient k (U) = $\frac{1}{R}$,

$$k = \frac{1}{\frac{d_1}{\lambda_1} + \frac{d_2}{\lambda_2} + \frac{d_3}{\lambda_3}}$$

The relationship above can be expressed by

$$\Phi = k(t_1 - t_4)$$

Example: Two small plates, copper one with the thickness d_1 = 6 mm and iron one, with thickness d_2 = 4 mm are stacked. Let us calculate the value of the coefficient λ of thermal conductivity of a single homogeneous plate of thickness d = 10 mm, to conduct heat as well as the two plates. The coefficient of thermal conductivity of copper is
λ_1 = 390 W·m^{-1}·K^{-1}, iron λ_2 = 60 W·m^{-1}·K^{-1}.
Solution: Denote the temperature on the outer part of the copper plate t_o, the temperature at the plate interface t_1 and the temperature on the outer part of the iron plate t_2. Suppose that $t_o > t_1 > t_2$. At steady heat conduction heat flow density in both plates is the same; the temperature gradient in each plate is constant. So, heat flow:

$$\Phi = \lambda_1 \frac{t_o - t_1}{d_1} = \lambda_2 \frac{t_1 - t_2}{d_2}$$

From this equation, the temperature differences can be expressed by heat flow density

$$t_o - t_1 = \Phi \frac{d_1}{\lambda_1}, t_1 - t_2 = \Phi \frac{d_2}{\lambda_2}$$

Adding up these temperature differences we obtain the temperature difference between the outer surfaces of the composite plate.

$t_o - t_2 = \Phi\left(\frac{d_1}{\lambda_1} + \frac{d_2}{\lambda_2}\right)$, from here $\Phi = \frac{t_o - t_2}{\frac{d_1}{\lambda_1} + \frac{d_2}{\lambda_2}}$

The homogeneous plate to replace both little plates must have such thermal conductivity that, at the same temperature differences on their outer surfaces the heat flow density is the same as in the composite plate,

$$\Phi = \frac{t_o - t_2}{\frac{d}{\lambda}}$$

From the correlation for the density of heat flow, it follows:

$$\frac{d}{\lambda} = \frac{d_1}{\lambda_1} + \frac{d_2}{\lambda_2}$$

And so $\lambda = \frac{d\lambda_1\lambda_2}{d_1\lambda_2 + d_2\lambda_1}$.

Substituting numerical values $\lambda = 122\ \mathrm{W \cdot m^{-1} \cdot K^{-1}}$.

Laboratory exercise: Simulation of a residential building and measuring heat transfer coefficient (Fig.2).

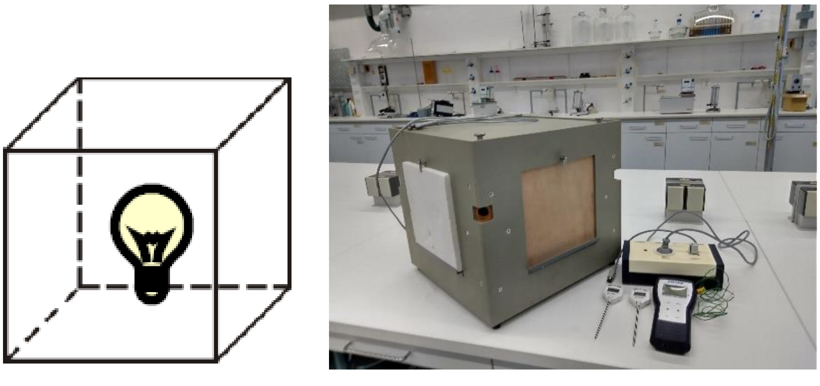

Figure 2. Model of a building and laboratory equipment used for the measurement

In our investigation of the structure, we simulate a box (for simplicity, square). The walls of the box are made from polystyrene and during the measurement the material of the wall is changed (wood, glass, etc.). From inside, the box is heated with a bulb. Necessary mathematical relations:

$$\Phi = \frac{\lambda}{d} S(t_1' - t_2')\ ,\ U = \frac{\Phi}{S(t_1 - t_2)}$$

where
- *d* …. is the wall thickness
- *S* ….. is the wall area
- t_1' …. is the wall temperature inside
- t_2' …..is the wall temperature outside the space
- *S* ….. is the area of the wall
- t_1 ….. is the air temperature inside the space
- t_2 ….. is the air temperature outside the space

The values of the coefficient *U* for different materials and types of walls are determined in the construction normative regulations. The following value of the coefficient is related to a certain internal temperature in the range of 18 °C to 22 °C inclusive.

Table 2. Heat transfer coefficient (https://www.izolace-info.cz/technicke-informace/hodnoty-soucinitele-prostupu-tepla-pro-budovy/)

Description of construction	Selected values of $U_{N, 20}$ W / m^2·K	Recommended values	Recommended values for passive buildings
Outer wall	0.30	0.20 – 0.25	0.18 – 0.12
Flooring ceiling over the outdoor area	0.24	0.16	0.15 – 0.12
The floor and wall heating space adjacent to the soil	0.45	0.30	0.22 – 0.15
The wall between adjoining buildings	1.05	0.70	0.50
Windows	2.70	2.50	1.50

Task: Based on the tables try to answer the following questions:
- Which of the following materials has the worst thermal insulating properties?
- Which material is the best thermal insulator?
- Explain how to produce adobe! (the answer can be found on Wikipedia http://cs.wikipedia.org/wiki/Vep%C5%99ovice, http://en.wikipedia.org/wiki/Adobe)

Procedure:
1. Measure: box dimensions, the thickness of the box walls, and the thickness of the material for a replaceable wall, calculate the area *S*.
2. Place a lightbulb with an output of 40 W inside the box and install thermometers for the inside box (penetrative digital thermometer) and box walls inside and outside measurement (using temperature probes). Read the temperature of the room.
3. Start the lightbulb and at regular intervals (three up to five minutes) read the temperature values of all the thermometers. Write the measurements in the table. Keep measuring for about 40 minutes.
4. From the values measured calculate the heat flow .
5. Calculate the coefficient value from the correlation.
6. Repeat the measurements for different materials appropriate for replaceable windows (polystyrene, wood, glass, apparently paper).
7. By using an electric hair dryer simulate different weather conditions (wind) around closed and open “windows”. Compare measurement results and discuss them.

The coefficient *U* can be also determined by using the output of the bulb, and then it is not necessary to measure the walls' temperature. For this, we connect the bulb in a way for its output (measured wattmeter) to be regulated. By this, we can predetermine the temperature to be achieved. This temperature is the same for every material. The output of the bulb we regulate in a way to achieve its stabilization (temperature inside the box remains unchanged for at least five minutes). Then we just monitor the wattmeter reading and inside and outside air temperature. While calculating we should keep in mind that 1/6 of the energy penetrates through a replaceable window, the remaining 5/6 - by the other walls of the box. The box should be placed on a mat to allow the same outlet of heat through the bottom.

Topics for discussion: The parameters of low-energy houses (Fig. 3), heat pump, excursions around the residential area - where and what kind of houses to build? (low-energy, classic, timber). Materials for the construction and their physical and technical characteristics, etc.

Figure 3. Low-energy house (https://www.living.cz/predstavujeme-nejlepsi-domy-ceska-vyberte-viteze/24/)

The described lesson was implemented as part of the physics lesson at grammar schools as well as secondary schools. The laboratory work was carried out in laboratories at our department at the university. At the end of the teaching activity, the students filled out a short evaluation questionnaire. The feedback from students dealing with these topics was positive.

Bridging courses addressing critical topics

Bridging courses have been created for mathematics, biology, physics, and chemistry.

The content of these courses is as follows.

1. Mathematics: Introduction, Geometry, Logic, Sets, Linear and quadratic equations, Exponential, logarithmic functions, Trigonometric functions, Introduction to functions, Limits, derivatives, integrals, Probability, statistics, Vectors;

2. Physics: Nature research – general concepts and laws, Natural science about the micro-, macro-, and mega-world, 21st-century physics, quantum physics essence, Introduction to natural science practical work;

3. Chemistry: Laboratory guide, Periodic table of elements, chemical reactions;

4. Biology: Cells, Simple organisms – viruses and bacteria, The chemicals of life, Transmission of nerve impulses.

A listing of the available courses is on the web pages of the project Bridge2Teach https://www.bridge2teach-project.eu/.

Conclusion

It follows from our research that the critical points in the teaching of physics found in the secondary school syllabus persist in some cases also in high schools. Further, other problem areas are added to them.

Most of them are due to a lack of knowledge of mathematics, in high school these topics are inaccessible to direct sensory perception and theoretical. When students enter university, there are several shortcomings and gaps between what they have learned in high school and what the requirements are of the university. Based on these findings, modules are being prepared for teaching high school physics; their focus is also given by the needs of practical life.

The requirement to adjust and modernize the framework education program is one of the logical conclusions arising from the 2030+ Strategy in education in the Czech Republic (Ministry of Education 2022). The amendments to the Framework educational program will support the fulfillment of two strategic goals:

- Focus education more on acquiring the competencies needed for an active civic, professional, and personal life.
- Reduce inequalities in access to quality education and enable the maximum development of the potential of children, pupils, and students.

In addition to the two strategic goals, the 2030+ Strategy also contains partial guidelines for their fulfillment. Key points are developing competencies and literacy, simplification of the curriculum, the definition of core and developing outputs, model school educational program, emphasis on formative assessment, and connecting formal and informal education.
It is necessary to motivate pupils to study STEM subjects at universities and teachers have to look for ways to increase success in their studies. The first step in motivation to study science is the possibility to overcome the gap between high school and university with the use of bridging courses at universities.
Teachers must focus on teaching topics that are difficult for students. The materials prepared at our workplace can help them with this. These modules are designed in such a way that students acquire the necessary competencies, understand the given problem, and can apply their knowledge in practice. This also requires educational strategies that support STEM concepts of teaching, cross-curricular relationships, and real-life applications. An example of teaching proposals for one of the problematic topics was given in this text.

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