



Received: 30.06.2023

DOI: 10.15584/jetacomps.2023.4.8

Accepted for printing: 15.12.23

Published: 29.12.2023

License: CC BY-SA 4.0

MILAN ĎURIŠ<sup>1</sup>, ALENA OČKAJOVÁ<sup>2</sup>, PETRA KVASNOVÁ<sup>3</sup>

## Designing Experiments for a Research-Oriented Model of Learning in the Subject of Technique in Lower Secondary Education

<sup>1</sup> ORCID: 0000-0002-4835-7733, University professor, Matej Bel University Banská Bystrica, Faculty of Natural Sciences, Department of Technology, Slovak Republic

<sup>2</sup> ORCID: 0000-0001-9347-4501, University professor, Matej Bel University Banská Bystrica, Faculty of Natural Sciences, Department of Technology, Slovak Republic

<sup>3</sup> ORCID: 0000-0001-8585-2269, Assistant Professor, Matej Bel University Banská Bystrica, Faculty of Natural Sciences, Department of Technology, Slovak Republic

### Abstract

In this article, attention is paid to the selected design of experiments that will be part of a research-oriented model of students' education in the subject of Technique in lower secondary education in the Slovak Republic. The proposed model of education reflects the long-term needs of students' education in the subject of Technique, which, despite the updated content of the curriculum in the Educational Standard of the subject of Technique, have not yet been met. Part of the model is the application of formative assessment of students in the framework of the implemented experiential learning of students. Due to the limited scope of this article, two experiments from the set of proposed experiments are presented with the methodology of the actual implementation. The given problem is solved within the KEGA project No. 006UMB-4/2022 in the years 2022–2024.

**Keywords:** primary school, model of education, subject Technique, experiment

### Home

In recent years, the results of students in the OECD PISA international tests have resonated in the Slovak Republic, as they have achieved statistically significantly lower performance than the average performance of students in OECD countries. This problem is receiving increased attention not only from teachers and the field of education, but also from parents and society as a whole. The school reform of primary schools in Slovakia is aimed at new goals of education in the 21st century, which is why the Act of the National Assembly of the Slo-

vak Republic No. 245/2008 Coll. on education and training (i.e. The School Act) and amendments and additions to certain acts has set the main goal of education – education of students to key competences. In the subject of Technique in lower secondary education, the performance standard clearly specifies the objectives, professional competences to be achieved and mastered by the student in a given year in the cognitive, affective and psychomotor areas.

### **Origins of the problem addressed**

At present, the teaching of the subject of Technique in lower secondary education is carried out in accordance with the updated State Educational Programme and in terms of content according to the updated Educational Standard for the subject. Despite the targeted undergraduate training of future teachers of the subject of Technique at teacher training faculties, teachers in pedagogical practice are not succeeding in meeting the set objectives in the subject of Technique to the required extent. This is mainly due to:

- insufficient material and technical equipment for the subject of Technique,
- absence of students’ experimental activity with ideas, materials, technologies and techniques,
- the still predominantly transmissive way of teaching and the prevailing summative assessment of students,
- not applying students’ creativity and own ideas in working and experimental activities and other reasons affecting the quality of education in a given subject in individual regions in Slovakia.

The objectives of the subject of Technique formulated in the updated State Educational Programme (iSEP) reflect the content of the subject in the 5th–9th grade of primary school (further as “PS”). From the aspect of addressing the given issue in the project, we are primarily interested in the fulfilment of the following objectives in the subject of Technique:

- students experiment with ideas, materials, technologies and techniques,
- students distinguish and safely use natural and technical materials, tools, equipment and devices,
- students apply creativity and their own ideas in work and experimental activities,
- students will also learn to self-evaluate on the basis of the experiments carried out,
- students acquire the necessary knowledge and skills relevant for employment opportunities, for the choice of their own professional focus and for further professional and life direction.

Updated Educational Standard for the subject of Technique in the 5th–9th grade of PS in individual thematic units also contains a performance standard,

which formulates performances that determine what a student should know and be able to do at the end of a given school year within the thematic unit (SPU, 2015).

The assessment of a student cannot be just an assessment of his/her current performance, but should be directed towards formative assessment and self-assessment. The essence of self-assessment is that students are responsible for their learning and are actively involved in the learning process. From a didactic point of view, self-assessment can be seen as a competence that promotes self-activity and independence from the teacher.

Self-assessment and self-check are the most important motivational tools for the learner. Formative assessment of students in the teaching process aims at obtaining feedback on the student's progress in learning, on deficiencies and mistakes, with the aim of their elimination. As stated by several authors (Turek, 2014; Kalaš, 2013; Shute, Kim, 2014; Đuriš, Stadtrucker, Pandurović, 2019a, 2019b; Pavelka, 2020), the formative assessment of students should be used more extensively because it improves the quality of students' knowledge and skills.

In order to meet the above goals, the research-based model of education will include learning of how to apply experiential learning to students, how to apply formative assessment to students, and how to develop and support students' key competencies and 21st century skills (creativity and innovation, creative and critical thinking, problem solving, etc.).

### **Structure and implementation of the designed experiments**

The structure of the designed and selected experiments reflects the content of the thematic unit Technical materials and working procedures of their processing, which is included in the updated Educational Standard of the subject Technique in the 6th and 7th grade of primary school.

Since teachers cover the content with different emphases, we need to achieve equivalence of the students. We can achieve this by having the students learn before the experiment and let them understand the basic theoretical information on technical materials, wood, metals and plastics and their mechanical, physical, technological or chemical (metals) properties, which they will apply during the experiment.

These properties are characteristic in that they can be observed directly or by simple experiments. On the basis of an experiment carried out by themselves, students can more easily understand the phenomena observed, they can explain and justify the changes that have occurred in the process of the experiment they have carried out.

After the implementation of each experiment, students carry out a self-assessment and self-check. They answer the prepared questions in their own words, express their opinion on the experiment in writing, express how they understood the material and how it was to work with the task of the experiment.

Among the physical properties of wood, we also include its feature of water absorption. Structure and the methodology for the implementation of the experiment focused on this feature are presented below.

### *Experiment No. 1 Absorption of wood*

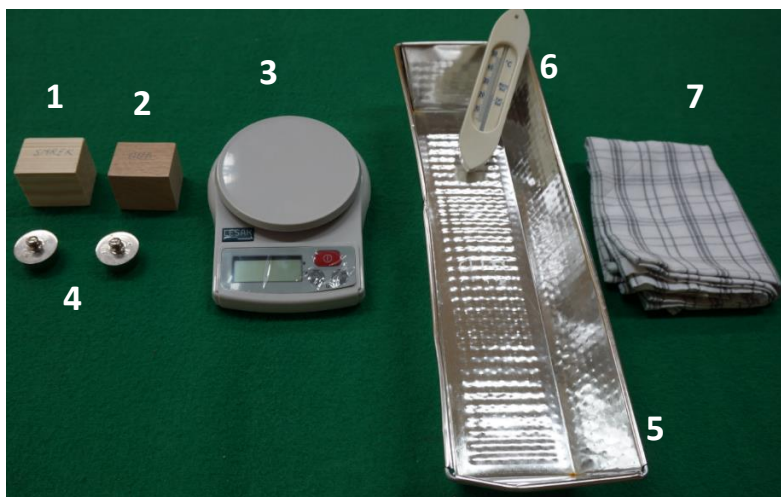
The aim is to determine the water absorption of softwood and hardwood and to compare them to each other.

#### *Task for the student:*

Determine on selected soft and hard wood samples the degree of water absorption of the wood, under the condition that both, softwood and hardwood, samples are immersed with their entire volume in water at the same time interval.

#### *Tools:*

- softwood sample (spruce, pine, or fir), hardwood sample (beech or oak) with dimensions 40 x 40 x 100 mm (alt. 20 x 20 x 50 mm),
- digital, or laboratory scales, 2 pcs of sinkers,
- water container, water thermometer,
- water of 25–30°C, cloth or paper towel.



**Figure 1. Tools for the experiment of water absorption of the wood**

1 – softwood sample (spruce), 2 – hardwood sample (oak), 3 – digital scale, 4 – 2 pcs of 100 g sinkers, 5 – water container, 6 – thermometer, 7 – cloth towel

#### *Work procedure*

1. Using the digital scale to determine the weight of the softwood and hardwood samples and enter the values in the table.

2. Immerse softwood and hardwood samples in the water container at the same time and load the weights (with sinkers) of each sample so that it is completely immersed in the water and does not float.

3. Leave the wood samples immersed in water for 15–20 min (30 min).

4. After a given time, remove both samples from the water, dry them with a cloth, find the weight of the softwood and hardwood samples and enter the values in the table.

**Table 1. Recording data on the course of the experiment in the table**

Wood sample	Sample weight [g]		Difference in weight [g]
	Start of the experiment	End of the experiment	
spruce (soft)			
beech (hard)			
other (hard)			

Explain in your own words what caused each sample to change the weight at the end of the experiment compared to its weight in the beginning of the experiment.

..... *student replies*

Explain in your own words why the weight of the soft wood sample is different compared to the hard wood sample after the experiment.

..... *student replies*

Your comments on the experiment (briefly justify the difficulty and clarity of the learning task): ..... *student answers*

In each row of the table mark one of the emoticons with an (x) based on your understanding of the task and how you liked the experiment (*the student answers*).

**Table 2. Student’s self-assessment after the experiment**

How did I understand the lesson? How was it to work out the task?	☺ very well	😊 good	☹ I need to improve
1. I know the reason why soft wood is lighter than hardwood.	( )	( )	( )
2. I understood that softwood and hardwood have different water absorption abilities.	( )	( )	( )
3. I can name the feature of wood which enables soft or hard wood immersed in water to gain more weight.	( )	( )	( )
4. I understood the task and the experiment was illustrative and interesting to me.	( )	( )	( )

Among the physical properties of metals, we include electrical conductivity. Structure and methodology for performing the experiment focused on this feature are presented below.

### **Experiment 2 *Electrical conductivity***

The aim is to find out the electrical conductivity of different types of materials and to compare them to each other.

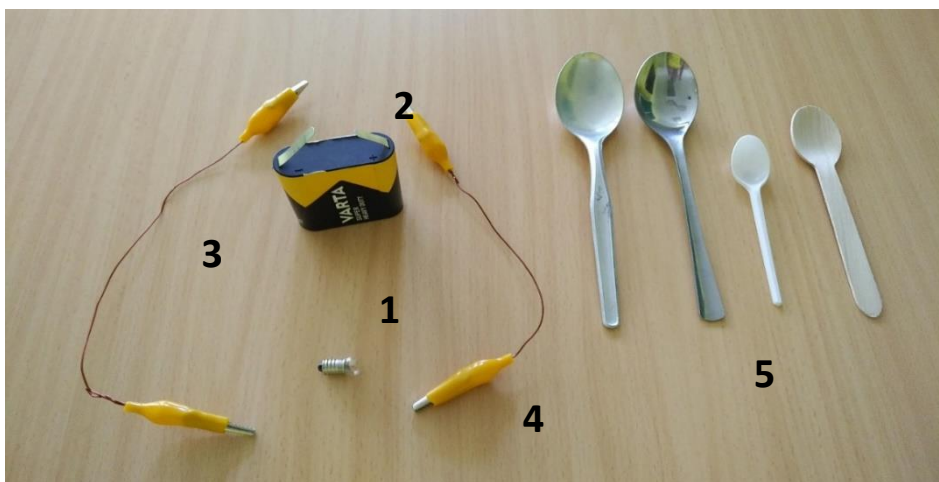
#### **Task:**

Connect a simple electrical circuit and determine the electrical conductivity of selected samples of metal (stainless steel spoon), non-ferrous metal (aluminium spoon), plastic (plastic spoon) and wood (wooden spoon).

*Note: silver, porcelain, silicone spoons, etc. can also be used.*

#### **Tools:**

- 6 V bulb,
- 4.5 V flat battery,
- copper wire as a conductor of electric current,
- 4 pcs current clamps,
- spoons of different materials (aluminium, stainless steel, plastic, wooden).



**Figure 2. Tools for the experiment of detecting the electrical conductivity of materials**

1 – bulb, 2 – battery, 3 – copper wire, 4 – current clamp, 5 – spoons

#### **Work procedure**

1. Attach the first copper wire to the contact of the battery with a current clamp, and connect the other end of the copper wire to the bulb by wrapping it around the screw.

2. Attach the second copper wire to the second contact of the battery using a current clamp, and attach the other side of the copper wire with the current clamp to the stainless-steel spoon.

3. Attach the third copper wire to the other end of the stainless-steel spoon with a current clamp and connect the other side of the copper wire with the current clamp to the electrical foot contact of the bulb to close the electrical circuit.

4. If the bulb has lit up, write it in the table in the field for the given spoon material.

5. Repeat the same procedure for all available spoons.

**Table 3. Recording data in a table on the course of the experiment**

Sample	Electrical conductivity (yes/no)
stainless steel spoon	
aluminium spoon	
plastic spoon	
wooden spoon	
other.....	

Explain in your own words what caused the difference in the measured electrical conductivity for each material.

..... *student replies*

What do we call substances that conduct electricity?

..... *student replies*

What do we call substances that do not conduct electricity?

..... *student replies*

Write in your own words where you might encounter this feature of materials in your home.

..... *student replies*

Your comments on the experiment (briefly justify the difficulty and clarity of the learning task):

..... *student replies*

In each row of the table mark one of the emoticons with an (x) based on your understanding of the task and how you liked the experiment (*the student answers*).

**Table 4. Self-assessment of the student after the experiment**

How did I understand the lesson? How was it to work out the task?	☺ very well	😊 good	😞 I need to improve
1. I know the reason why the light bulb was lit with some materials.	( )	( )	( )
2. I understood that not all materials are electrically conductive.	( )	( )	( )
3. I can name the feature of metals which enables conduction of the electric current.	( )	( )	( )
4. I understood the task and the experiment was illustrative and interesting to me.	( )	( )	( )

## Conclusion

We assume that the proposed model of education will not only be illustrative and exploratory for students, and that its implementation will not only apply experiential learning to students, but it will also include formative assessment of students. And this is the intention of the proposed research-based learning model with the application of appropriately designed experiments in the subject of Technique. The given model of education should preferably be adopted by students of undergraduate studies in the study subject Teaching of Technique (bachelor and master studies), the target group is also teachers of the subject of Technique enrolled in the extension study of the subject of Technique, but also qualified teachers teaching the subject of Technique in lower secondary education.

*The solved problem is part of the KEGA project No. 006UMB-4/2022.*

## References

- Ďuriš, M., Stadtrucker, R., Pandurović, I. (2019a). *Formatívne hodnotenie žiakov v kognitívnej oblasti v predmete technika*. Banská Bystrica: Belianum.
- Ďuriš, M., Stadtrucker, R., Pandurović, I. (2019b). *Stratégie a postupy vyučovania podporujúce formatívne hodnotenie žiakov v predmete technika*. Banská Bystrica: Belianum.
- Kalaš, I. et al. (2013). *Premeny školy v digitálnom veku*. Bratislava: SPN.
- Pavelka, J. a kol. (2020). *Záujem žiakov základných škôl o technické činnosti a technické vzdelávanie*. Prešov: Vydavateľstvo Prešovskej univerzity.
- Shute, V.J., Kim, Y.J. (2014). Formative and stealth assessment. In: *Handbook of research on educational communications and technology* (pp. 311–321). New York: Springer.
- ŠPÚ (2015). *Inovovaný ŠVP pre základné školy. Inovovaný vzdelávací standard predmetu technika, nižšie stredné vzdelávanie*. Bratislava: ŠPÚ.
- Turek, I. (2014). *Didaktika*. Bratislava: Iura Edition.
- Zákon NR SR č. 245/2008 Z.z. o výchove a vzdelávaní (Školský zákon) a o zmene a doplnení niektorých zákonov.