How does the development of note-taking skills affect the effectiveness of learning biology in cytology by first-year high-school students?

Beata Sobocińska

Adam Mickiewicz High School nº 42 in Krakow

Summary

The study aimed to demonstrate skillful note-taking's effectiveness in obtaining better results in learning biology. During the research, we found that students need help with the proper note-taking, which they need in the learning process. After improving this skill, their academic performance improved.

Methods and materials

The study was conducted from November 2022 to February 2023 among 32 1st year students attending the class of advanced program in Polish language, biology, and mathematics, with two hours of biology per week.

During the research, we used the following data collection tools:

- **student survey twice**
- **own materials - notes** on the topic of different biological cells
- **documentation of student work** (sketchnotes, lapbooks, 3D models of cells)
- **list of students' grades in quizzes, tests, and student worksheets**
- **digital photos** illustrating the involvement of students while making lapbooks, as well as the results of student work

Hypothesis

The ability to keep notes from lessons affects the effectiveness of learning biology in the subject of cell science in the first year of high school.

Conclusions from the survey

1. **25%** of students in **class 1D are not able to take lesson notes** independently.
2. Students know from primary school mainly notes in the form of **points, mind maps, and graphic (drawing) notes.**
3. Students prefer to record the lesson in **points** and combine pictures with text notes.
4. Most students report a similar way of taking notes in all subjects, as this makes it easier for them to learn. Only ¼ of students believe that the type of note-taking depends on the subject. They pay the most attention to science notes, using them for learning science subjects.
5. Notably, notes are completed at home or made anew, which may indicate the importance of notes recognized by students in the learning process.

RECOMMENDATION:

It is necessary to show students tools to help them derive measurable benefits (taking qualitative notes).

The actions

1. Presenting the basic ways of taking notes and creating space for students to choose their own method.
2. Conducting a series of lessons on individual cellular organelles in terms of their structure and function - each with a note made differently.
3. Control of the knowledge acquired by students in the form of an unannounced quiz, prepared based on notes given to the class and equipped with tasks from the content written down by students themselves.
4. Summary of knowledge about cell topic prepared in the form of lapbooks and cell models made by students.
5. Checking the knowledge and skills of students in the form of an announced test from the resources of the *Nowa Era* publishing house, correlated with the textbook students used.

Test results

1. For tasks related to topics elaborated by the teacher using various note-taking methods, students obtained **43.7%** of the predicted points, and for the remaining ones - **39.11%**, which may indicate a lack of sufficient note-taking skills. The combined average score is **42.1%** (may be due to the holiday break).

2. It is noteworthy that **52%** of students had a better result in the topics for which the teacher provided own notes, **33%** of students - in the content elaborated by students individually, and in the case of **15%** of students, it did not matter (they obtained comparable results in each part of the quiz).

Conclusions from the survey after a short test

1. Most students (**88%**) **use notes** when preparing for the next lesson.

2. Over **60%** of them said that they learned how to take notes during the note-taking training for the mobile section.

3. For most students, **notes are helpful in learning.**

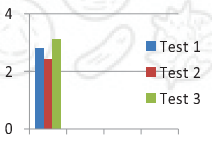
4. They definitely prefer **the linear-hierarchical method** as the most useful when recording lessons.

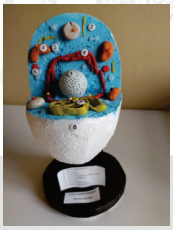
5. Most students did not change their current preferences. However, a significant part of them enriched their workshop with clusters and sketchnotes and improved the ability to create notes using the linear-hierarchical method.

Study conclusion

The ability to take notes improves the efficiency of biology learning.

Evidence: an increase in students' average grades in class Id based on the comparison of tests before the note-taking training (2 tests), and after completing it (cytology test).





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STUDENCKA 13

HEATING AND COOLING OF SUBSTANCES

Jure Štokovnik
Primary school Vojnik

In 5th grade, we have introduced inquiry based learning in Science and Technology for the Heat and Temperature topic. Students investigated the heating or cooling of different substances with the aim of actively integrating experience, prior knowledge, peer collaboration and the goal of giving the results and findings of the investigation a useful functional value. The whole learning process was successfully monitored and reflected upon in terms of the students' findings and the teacher's role.

1. MOTIVATION: What I was interested in

- What are students' ideas about the science topic?
- How to prepare an appropriate learning environment for the implementation of inquiry-based learning?
- How well will the students use a familiar research methodology?
- How does learning by exploration influence individual learner activity?

2. 5th GRADE STUDENTS ACTIVITY

- Duration of learning by exploring: 2 school hours
- Group work: 5 X 4 students [heterogeneous groups]
- Investigating the heating or cooling of different substances.

- Designing a research plan on research sheet [*Example of a research question*: What will happen to the temperature of a substance when we change type of substance?]

- Preparation of materials and equipment.
- Taking measurements of the temperature of a substance at specified time intervals.
- Recording measurement data.

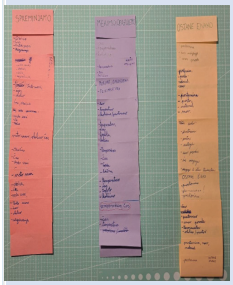
- Graphical display of the collected data.
- Record observations and findings, confirmation or rejection of the hypothesis.
- Oral reporting by groups and reflection on findings.

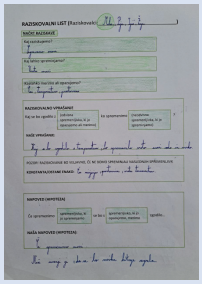
3. RESEARCH INTO YOUR OWN PRACTICE

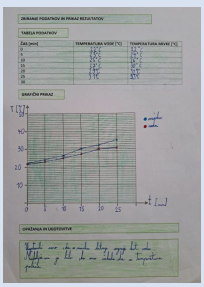
- Motivation = increase the active role of students.
- What will happen to learners' activity and outcomes if we change the way we teach?
- Monitoring the whole learning process and reflecting on the learner's findings and the teacher's own role.
- Data collection (students completed research sheets; teacher self-assessment using a questionnaire to evaluate the research lesson).
- Analysis and evaluation of the results obtained.

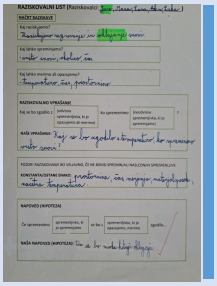
4. DATA COLLECTED AND CONCLUSIONS

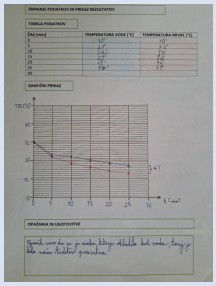
- Collecting data from student`s completed research sheets and self-evaluation using the Research Lesson Evaluation Questionnaire..

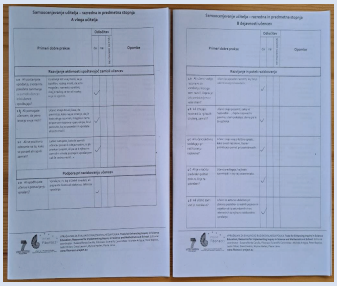












- The above examples of graphical representations were drawn by the students based on the results of the measurements. This was followed by drawing conclusions and presenting the work of the groups. The two groups that heated the two substances confirmed their hypothesis that sand heats up more than water over the same period of time. The groups that cooled the two substances outdoors (comparable results) found that water cooled less than sand, which reaches a lower temperature, over the same period of time.

5. CONCLUSIONS

The two school lessons on learning by exploring were successfully implemented. From an individual point of view, students were more active, independent and satisfied with the way they worked. In the groups, cooperation and communication between the groups led them to draw common conclusions. The teacher's role, although seemingly passive, is active in all phases of the learning process. There is room for improvement in developing activities, involving students more in the planning of research and encouraging reflection on conclusions.

Beata Świder
Eugeniusz Romer High School
Rabka-Zdrój, Poland

How to improve the calculus proficiency of high school students?

Research group

First class of high school math and physics class (15 students)

Results for the first half of the year	
Average grade in maths	Average grade in physics
3,2	3,6

Core curriculum

Grammar school

PHYSICS:
-performs calculations and records the result in accordance with the rules of rounding and maintaining the number of significant digits resulting from the accuracy of the measurement or from data;
-converts multiples and submultiples (micro, milli, centi, hecto, kilo-, mega-);
MATH:
exponential notation and exponentation

transition for student

High school

PHYSICS:
-presents units of physical quantities, describes their relationships with basic units; converts multiples and submultiples;
-uses auxiliary materials, including physical and chemical tables and a chart of selected formulas and physicochemical constants;
-performs estimated calculations and analyzes the obtained result;
-performs numerical calculations using a calculator;

Looking for the answer

conducting a few lessons to practice simple examples with an exact solution algorithm (one lesson a week)

$$E = \frac{h}{c\lambda} = \frac{6{,}626 \cdot 10^{-34} \cdot 3 \cdot 10^{8}}{484 \cdot 10^{-9}} = \frac{19{,}878 \cdot 10^{-25}}{484 \cdot 10^{-9}} = 0{,}0411 \cdot 10^{-16} \approx 4{,}11 \cdot 10^{-14}$$

checking the correctness of students' calculations several times on the basis of solved tasks

Task:	$E = \frac{h}{mv}$	$E = \frac{hc}{\lambda}$	$F_g = \frac{GMm}{r^2}$	$v = \sqrt{\frac{2E}{m}}$	five weeks off	$E = \frac{hc}{\lambda}$
Percentage of correct results	~ 13,3%	~ 26,7%	40%	20,0%	----	40%

Conclusions:
-there is a need to implement calculations on more difficult numbers in both mathematics and physics
-there is not enough hours of physics and time in class to practice properly
-additional exercises slowly improve the efficiency of calculations

To what extent working with the same physics teacher in primary and secondary school affects the effectiveness of students' learning?

Małgorzata Szymura
physics teacher

Participants

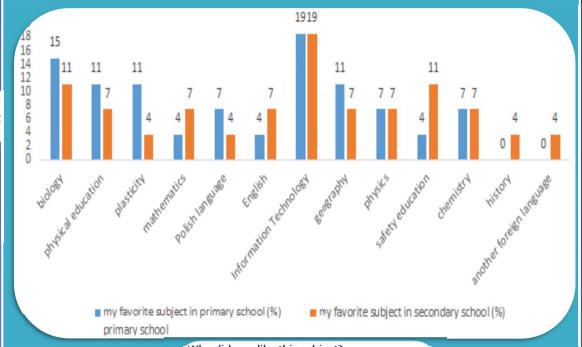
RESEARCH GROUP
Students having the same elementary and high school physics teacher

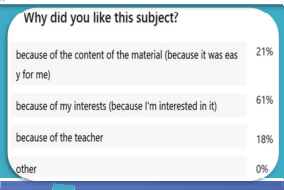
4 boys and 7 girls from the first classes of high school and technical school, whom I taught and still teach physics

CONTROL GROUP
Students having different teachers in elementary and high school

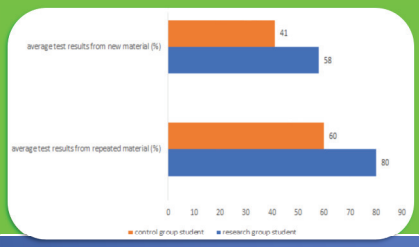
11 students from the first classes of technical and high school, whom I did not teach in primary school, but they had the same final grades and results from the competency test at the entrance to secondary school

Analysis the results of the initial survey

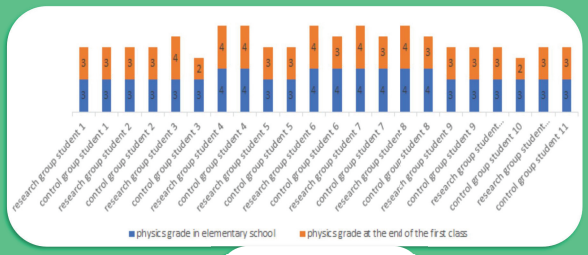


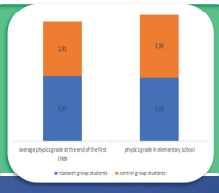


Analysis of the test results of the research group and comparison with the control group



Analysis of final grades and competency tests and selection of the control group





Individual interviews with selected students from the research group

„I knew three primary school teachers and in every subject it was useful in the new school. I already knew the requirements of each teacher and it was much easier for me to prepare for a lesson or tests and it caused me less stress. At the beginning of the year at a new school because I knew that I would meet a familiar face"

„It was very heplfull for me. Thanks to this, I was abe to assimilate the new material better, because I was used to the way of conducting lessons. Thanks to that, I didn't feel lonely either, and I knew that if I had a problem, I could count on help"

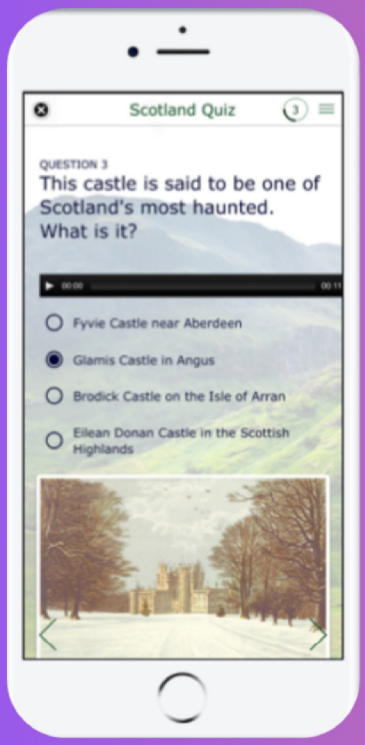
„For me, working with the same physics teacher helped me a lot. It didn't bother me at all. Even the opposite...I like that you are now my teacher because of that I feel more confident in a new school as a foreigner. And I'm fine with physics. Thank you for that"

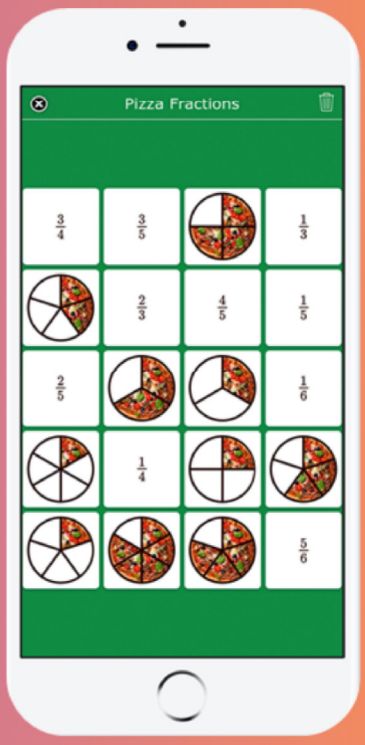
Conclusions

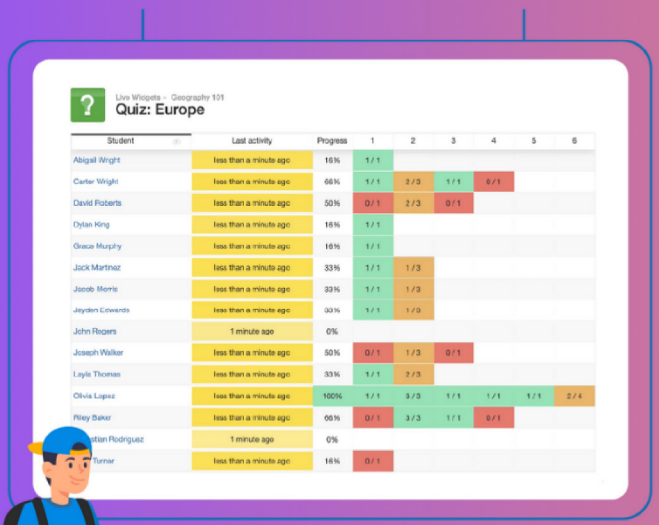
- Working with the same physics teacher (and not only) in primary school and secondary school has a positive effect on the effectiveness of teaching this subject
- Students who continue working with the same teacher in the new school perform better in the subject which s/he teaches.
- Students feel better in a new school when they know the teacher who taught them before. They perceive that this positively affects their teaching results in this subject.

BookWidgets

interactive learning







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AREAS OF QUADRILATERALS

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When learning by heart, we often focus only on facts that need to be memorized for a certain period of time, but over time, this knowledge can be lost or fade away. If the knowledge acquired in this way is not regularly used or connected to other information, it is quickly forgotten. This is precisely what happens when learning various formulas and equations.

I WAS INTERESTED IN:

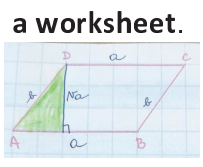
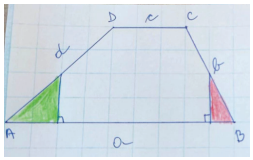
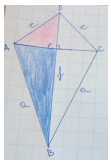
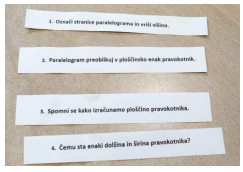
- ❑ how pupils will transfer what they have already learnt knowledge to a new situation,
- ❑ if the students would write the formula for area using symbols,
- ❑ if they would require prepared hints for that?

RESEARCH INTO YOUR OWN PRACTICE

I put the students in a new situation with a given problem and observed how they applied their previously acquired knowledge to the task. I created worksheets to help them solve the given problems, as well as models of quadrilaterals and hints. I observed their work, thinking, and problem-solving strategies.

ABOUT THE STUDENTS' ACTIVITIES

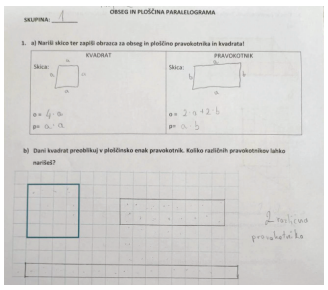
The research was conducted in the 7th grade of elementary school on the topic of quadrilateral areas. The average age of the students was 12 years. The work was guided and supported by a worksheet. The students first independently derived formulas for calculating the area of different quadrilaterals (parallelogram, rhombus, deltoid, trapezium) in their respective groups. They achieved this by transforming the given quadrilaterals into rectangles of equal area. If they needed assistance, they could receive various hints. They had access to drawn quadrilaterals that they could cut, hints, and a worksheet.

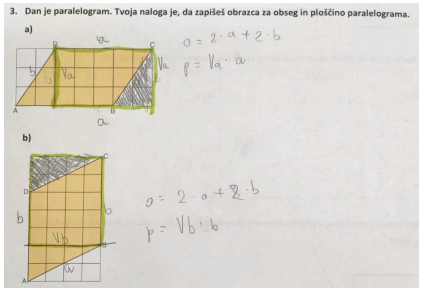





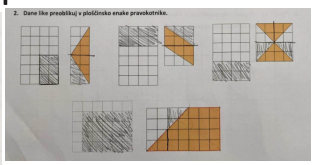
In the second part, they had to apply the acquired knowledge to a new situation and justify their solutions.

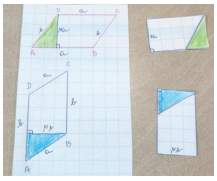
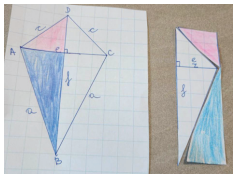
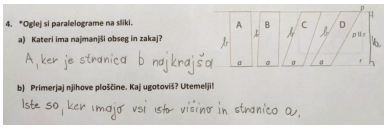
DATA COLLECTED AND FINDINGS

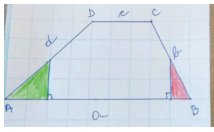
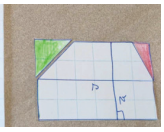
The students were motivated and worked well together as a group. The majority of students wrote formulas for area using symbols (one group needed a little assistance). All groups, except one, required at least one hint. They also used prepared models of quadrilaterals to help them.







The majority of students were able to apply the acquired knowledge in a new situation. Interestingly, some students did not simply memorize the formulas for area, but rather derived them on their own.

CONCLUSION

The students who participated in the research recalled the conducted activity after some time and successfully applied the acquired knowledge to new situations. The tasks related to the area of quadrilaterals were also well solved during knowledge assessments. Therefore, it is important to encourage students to engage in research where they can arrive at their own insights. The knowledge gained in this way will endure and enable them to successfully tackle challenges in life, as well as develop their critical thinking and creativity.

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DISCOUNT-PRICE INCREASE OR PRICE INCREASE-DISCOUNT

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When is a purchase more favorable: if an item is first discounted and then increased by the same percentage, or vice versa, if it is first increased and then discounted by the same percentage?
We encounter such and similar questions in everyday life, so it is important to equip students with knowledge that they will be able to effectively apply in various new situations. To achieve this, we need to use different approaches and activities and connect the subject matter with examples from everyday life.

I WAS INTERESTED IN:

- how pupils will transfer what they have already learnt knowledge to a new situation,
- what their expectations will be,
- how they will justify their predictions and answers,
- what conclusions will they reach?

RESEARCH INTO YOUR OWN PRACTICE

I put the pupils in a new situation with a given problem and observe how they apply what they have learnt to everyday life. I created worksheets to help them solve the problems. I observed their work, their thinking and their reasoning.

ABOUT THE STUDENTS' ACTIVITIES

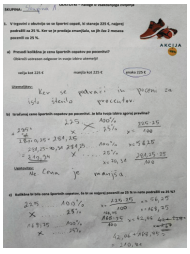
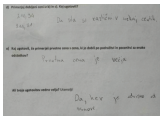
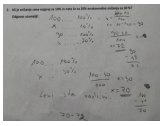
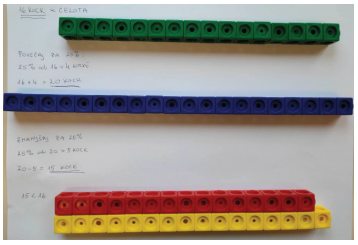
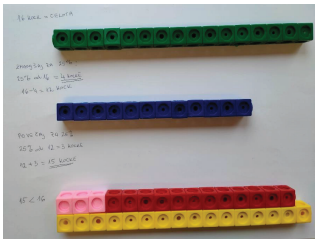
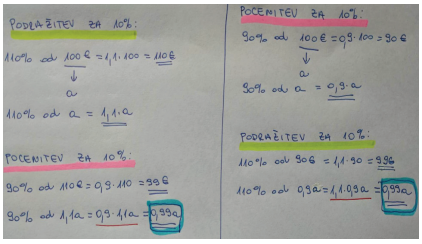
The activity was conducted in the 7th grade. It was divided into two parts. In the first part, the students formed four heterogeneous groups on their own, while in the second part, they solved the tasks individually. The average age of the students was 12 years. The research was conducted in a guided manner using a worksheet. In the first part, the students investigated what happens to the price of sports shoes when they are first increased by 25% and then later discounted by 25%. They had to predict whether the new price would be lower, equal to, or higher than the original price. They had to justify their choice and then solve the given task. Next, they examined what happens to the price of the shoes when they are first discounted by 25% and then increased by 25%. They compared the obtained results and justified their findings. The students had access to a calculator and linking cubes, along with the worksheet.



In the second part, the students individually determined whether a price reduction of 10% followed by an additional reduction of 20% is equivalent to a total reduction of 30%.

DATA COLLECTED AND FINDINGS

Three groups predicted that the price of sports shoes would be the same (because the percentage of increase and discount was the same), while one group predicted that the price would be higher. After solving the task, they all correctly wrote down their findings. They proved their findings using linking cubes (they needed some hints and assistance). They had difficulties in generalizing the proof for a general basis, so we did it together.

In the second part of the investigation, solving the task was more successful, as the majority of students were able to transfer the knowledge from the first part to a new situation. They reached the correct conclusion faster than in the first part.

CONCLUSION

The majority of students, even after a two-month period, remembered the conducted activity and successfully applied the acquired knowledge to new situations. The tasks related to percentages were also well solved during knowledge assessments. For better understanding, students need "hands-on experience." They should be allowed to make mistakes, find them on their own, and correct them. This way, their knowledge will be of higher quality and more long-lasting.

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Final conference RISE
26th - 27th of June 2023, Ljubljana
Slovenija

How can you evaluate an out of school engineering academy?

Ruben Visser
Arteveldehogeschool

In Belgium we have something called engineering academies: it's an out of school technology class meant for 10-12 year olds to stimulate their interests in technology and to help them build, design and create things. It's meant to show students what technical professions actually entail, in the hopes of getting more students to end up in technological studies and/or professions.
The question is, how do we work on the skills needed for actual technological professions? How can we evaluate wether or not we have achieved those skills or to what extent they can be improved with young students?
This is where the 4 C's of the 21st century skills come in handy.
It's a combination of 4 skills:

- Critical thinking
- Collaboration
- Communication
- Creativity

To examine to what extent these 4 C's can be incorporated in these workshops and how we can work on them, an evaluationform was made, peer-reviewed and updated throughout 10 workshops.
Results were as follows:

1. Creativity is the easiest to work on, young kids have a wild imagination
2. Critical thinking proved difficult, individual interactions work, but it's difficult to plan in advance
   Tip: If students have a question, don't give the answer but allow them think about it first.
3. While communication and collaboration do require pre-existing social and communication skills, they can be improved upon by adding group projects.
   Tip: Make them work in groups and present their design to other groups. Make them explain their ideas.

An inquiry on the effect of wonder

Wannes Vande Voorde - Arteveldehogeschool

INTRODUCTION

A significant amount of students isn't motivated to ask questions on their own.

Our educational systems are still focused on reproductive knowledgde where students are being rewarded for knowing the answer, not for asking a good question. The act of learning gets dull and going to school is viewed as a chore. Students feel that there is a disconnection between the school and reality. With this inquiry we wanted to measure the effect of wonder on the motivation of students and their ability to ask questions. A sense of wonder leads to asking questions and is the beginning of the learning proces.

To accomplish this feat we needed a context that lends itself to wonder and a subject that students want to know more about.

We decided on the combination of two things: First and foremost we chose the universe as a context. It is the frontier of the unknown and lends itself to deep and meaningful questions. It's a source of wonder.

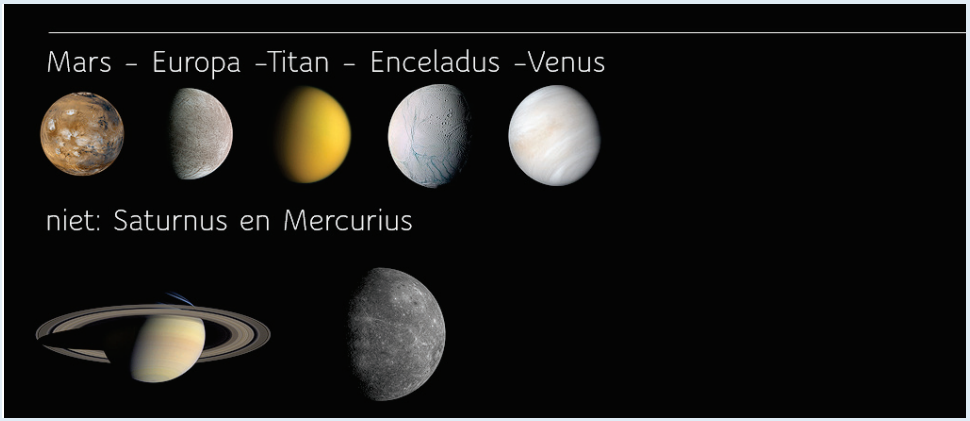
We combined this with the subject of climate change. A questionnaire in Belgium concluded that 80% of students worries about the climate and that they wanted to learn more about it at school.

Workshop - goal

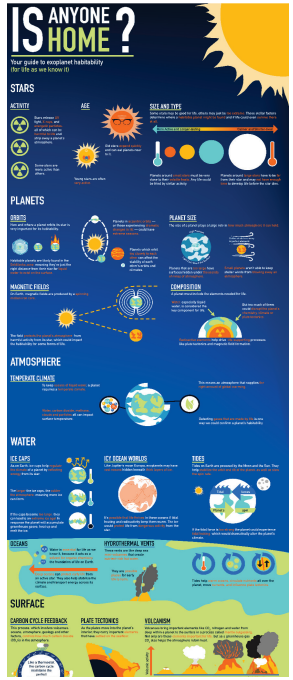
We wanted to highlight the uniqueness and underscore the fragility of our planet with this series of investigations. Our main source of inspiration is the photo: 'A Pale Blue Dot'. It depicts the Earth as a mote of dust suspended in a beam of light. The goal of the workshop is to research the criteria that makes a planet or moon habitable.

Workshop - investigations and systems thinking

We developed eleven investigations. Each investigation researches one system that a planet or moon needs to be habitable (the investigation magnetism researches the magnetic field, gravity researches the effect of a planet or moon's mass and size , ...). Every investigation gives an answer that the students need to fill in on the research overview (see below). When this overview is filled in they can discuss a planet's or moon's habitability. At the end of the workshop students have to classify given planets and moons and rank them according to their potential to sustain life.



Criteria



Conlusions

We concluded that students asked deep and meaningful questions after and during this workshop and that they developed an understanding of the Earth as one system in a very large and mostly empty universe.

Credits

Sagan, C. (1994). Pale Blue Dot: A Vision of The Human Future in Space. New York: Random House.

NASA Goddard Space Flight Center (2020). What makes an exoplanet habitable?

How the diversity of methods of work affects the interest and level of understanding of physics laws by first-year high school students - on the example of Newton's second law of motion.

Dorota Zbijewska, physics & computer science teacher
Ursuline High School, Wrocław/Poland

1A

the main subjects:
- Polish language
- History
- English language

Methods:
- experiment
- working with MS Excel
- solving physics problems

1B

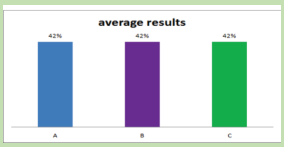
the main subjects:
- Biology
- Chemistry
- English language

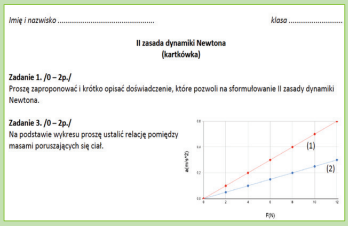
Methods:
- no experiment in the classroom
- not working with MS Excel
- solving physics problems

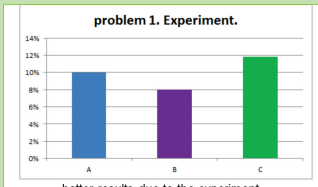
1C

the main subjects:
- Maths
- Geography
- English language

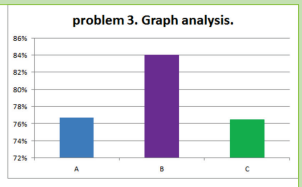
Methods:
- experiment
- working with MS Excel
- solving physics problems
- working on Moodle platform



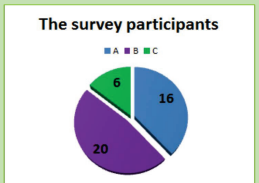




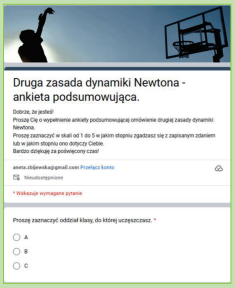
better results due to the experiment
in the classroom and the MoodleCloud activity

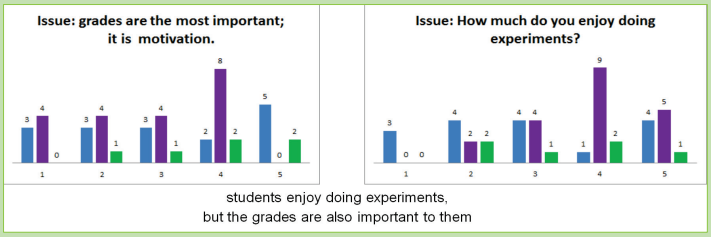


class B is better in the graph analysis

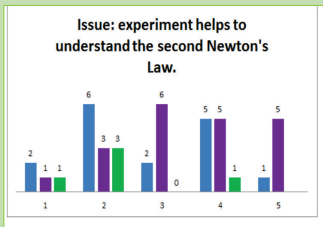


the Likert' scale:
1 - "I strongly disagree"
5 - "I strongly agree"

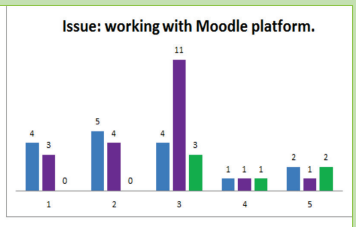




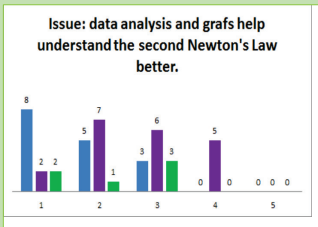
students enjoy doing experiments,
but the grades are also important to them



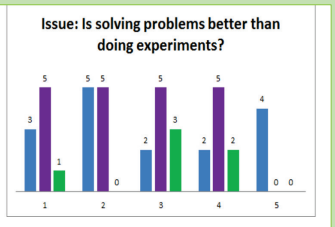
students realise that the experiment help them understand the second Newton's Law



students moderately like to work with MoodleCloud platform



students have problems with data analysis and they do not like to do it



students' preference between doing experiments and solving problems is inconclusive

For now:

- necessity of using various methods;
- doing experiments is the best way to understand students physics laws;
- for basic level it is advisable to limit the maths methods;
- trying to use MoodleCloud courses more frequently.

For the future:

- it is worth keeping in mind that students like blended learning;
- it is good to prepare as many as possible experimental lessons on different subjects;
- prepare the classes working in the small groups;
- try to find an idea to combine physics and maths in basic level classes.

DEPENDENCE OF QUANTITIES IS A FUNCTION

Sonja Zorman Grabner
Osnovna šola Koroški jeklarji

Integrating inquiry-based learning into mathematics lessons has a significant impact on the understanding and quality of the knowledge acquired. It is the most helpful for the progress and understanding of the material of weaker learners. Pupils have great difficulty in understanding and mastering the concept of function, so we have turned to inquiry-based learning.
The conclusions that pupils reach independently through the method of investigation contribute to deeper understanding and longer-lasting knowledge.

WHAT INTERESTED ME

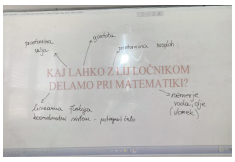
- How skilled will the pupils be at investigating?
- How many pupils will write and define the quantities correctly?
- How many pupils will draw the graph correctly?
- Will the better pupils be able to write the dependence equation on their own?
- Can I get more activity from all pupils?

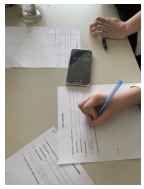
MY RESEARCH PLAN

Working in heterogeneous groups, pouring water.
Completing the table and comparing measurements. Drawing a graph.
Plotting the equation of dependence.
Plotting the equation of dependence with initial value.

ABOUT STUDENT ACTIVITIES

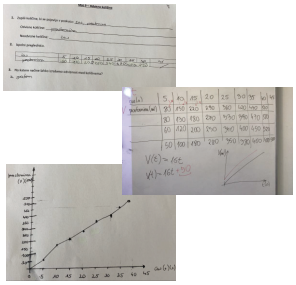
The pupils were divided into 4 heterogeneous groups of 4 pupils each. In groups, they poured water into a measuring cylinder using a funnel separator, read the amount of water in the cylinder every 5 seconds and recorded the data in a table.





The measurements were repeated three times. Each pupil in the group had a task, and then they swapped. Meanwhile, they worked out which quantities were involved in the problem, how they were related and how each quantity depended on the other. By exploring independently, they thought about the ways in which we can express dependence between quantities.
They tried to draw a graph and write an equation for the dependence. The pupils then repeated the measurement so that the amount of water in the measuring cylinder had already been determined.

COLLECTED DATA AND FINDINGS



Although this way of measuring (water flow) is not the most reliable, after each group repeated the measurement three times, the pupils made good inferences and got almost identical results.
Most pupils correctly recorded and identified the two quantities that appeared in the problem. Most pupils answered that the relationship between the quantities can be expressed in a table and a graph. By working in heterogeneous groups, the better pupils helped the others to draw the graph. The only difficulty was knowing on which axis to draw the independent and dependent quantities.
In the case where the amount of water in the measuring cylinder had already been determined, even the weaker pupils quickly came to the correct conclusion that the initial amount in the measuring cylinder represents the initial value of the function.
The pupils had some difficulty in writing the dependence equation, and it was only with the teacher's help that the better pupils, using the appropriate strategy, came to the correct conclusion and wrote the equation. However, when writing the initial value equation, most pupils then correctly concluded that this was only added to the first equation. All pupils were active in the activity.

CONCLUSION

By dividing the pupils into heterogeneous groups, I ensured that all pupils were active and motivated at all times.
My research has confirmed that inquiry-based teaching has a significant impact on understanding and the quality of the knowledge acquired, especially in the understanding of more complex mathematical content, which is also important in physics and chemistry.