Erasmus +

27. – 28. JUNE 2023

Organised by
UNIVERSITY OF LJUBLJANA
FACULTY OF EDUCATION
SLOVENIA

BOOK OF ABSTRACTS

FINAL INTERNATIONAL CONFERENCE

Remote Inquiry in Science Education

2020-1-SI01-KA226-SCH-093576

RISE

University *of Ljubljana*

Dear participants of RISE conference

After two years and few months of life of Erasmus+ project Remote Inquiry in Physics Education (RISE), during which we lived through several Greek lettered COVID variants, lock downs, remote lectures etc., we are able finally to meet in person, to share our experience, knowledge, ideas, and meet friends and coworkers from different countries in person.

The final conference of RISE project comprises and resumes the work of four partners, who focused on development of methodology of inquiry-based learning under remote conditions. The project RISE was accepted in financing at the beginning of 2021 as one of the projects in Erasmus+ call, which responded to new situation that occurred because of COVID provoked lockdowns. The project was submitted in Slovenia and with University of Ljubljana, Faculty of Education, Slovenia as a principal coordinator in collaboration with Arteveldehogeschool from Gent in Belgium, Dublin City University from Dublin in Ireland and Jagellonian university from Krakow in Poland.

As partners were experienced in inquiry-based learning already from a previous project Three Dimensions of Inquiry in Physics Education, where they have already worked together, the goal to develop methodology for inquiry-based learning under remote conditions was natural. Therefore, we focused on experimenting that is an essential part of teaching Science at all levels of education. Experimental work during lectures tremendously decreased during remote work due to the lack of experimental equipment at home, but also due to the lack of support for development of new experiments that can demonstrate phenomena in an adequate way as teachers are students can achieve by using regular standardized school equipment. Teachers struggled for finding alternative ways of teaching and welcome the ideas of remote work that we prepared together with partners and teachers.

Luckily today, the COVID developed to a cold-like disease and we all sincerely hope that no horrid mutations will evolve in future, so we can focus again on climate and energy problems. However, remote teaching remains important. On several occasions students need support during absence because of illness. Parents nowadays often decide for home schooling, but some sort of remote support is still needed as also home-schooled students have develop certain scientific skills. So, techniques to supervise inquire based learning under remote conditions is still needed. Even more, as remote communication became a natural mode to meet virtually across continents, also remote learning has developed to a new science. Therefore, we developed two remote courses on inquiry based learning for less and more advanced teachers, which allow attendance also to teachers that are not able to benefit from various mobilities Erasmus+ enables.

This conference reflects mostly the work of teachers that joined professional learning communities and remote courses, that used new knowledge in their situation in classroom and will share their experience, findings, and new knowledge. Besides, workshops will focus on practical examples of inquiries and practical experimental work. As there are many teachers willing to share, we have to organize the conference in two parallel sessions, but some teachers were willing to prepare posters, which will enable to discuss the content of

their work also with participants that were not able to break the major physics rule, one body cannot be at the same time at two places.

I sincerely hope that you will enjoy the conference, meeting colleagues and friends and discussing new ideas.

Mojca Čepič

Coordinator of RISE and Chair of RISE conference

In Ljubljana, 20th of June 2023

Program**: Final conference RISE,** 27th and 28th of June 2023

Tuesday, 27th of June 2023

SESSION 1 *P006*		
Chair: Eilish McLaughlin		
14:00 - 15:00	**Remote Inquiry in Science Education, experiences from Erasmus+ project** *Mojca Čepič, Ana Gostinčar Blagotinšek, Reinout Putman, Paul Grimes, James Lovatt, Eilish McLouglin, and Dagmara Sokołowska*	
WORKSHOP		
	WORKSHOP A *P006*	**WORKSHOP C** *P020*
15:00 - 16:00	**Trains, bells and whistling bottles** *Dagmara Sokołowska*	**How to explain Ohm's law online in an inquiry based way?** *Reinout Putman*
16:00 - 17:00	**coffee** **poster session** **Even numbers of posters are manned**	
17:30 – 20:00	City Tour (40 persons) Social Dinner for All	

Wednesday, 28th of June 2023

		SESSION 2 **SESSION 2A** *P073*	**SESSION 3B** *P037*
		Chair: Paul Grimes	*Chair: Wim Peeters*
9:00 - 10:20	9:00 – 9:20	**Modelling round bodies** *Miran Kučer*	**Getting started with Inquiry – learning to develop hypotheses and plan experiments through common everyday tasks** *Kristian Dimitrov*
	9:20 – 9:40	**How does the IBL method affect on student's knowledge about density at physics in primary school** *Primož Podrzavnik*	**Pressure and my shoes** *Alenka Mravljak*
	9.40 – 10.00	***Challenge - Circuits*** *Irena Jelenko*	**Report on Polish teachers' inquiries** *Dagmara Sokolowska*
	10.00 –10.20	**A model based approach to give a deeper understanding of aspects of atomic and particle physics** *Denis McCarthy*	**Discount-price increase or price increase-discount** *Verdinek Špenger Simona*
10:20 - 10:40		**Coffee break**	

		SESSION 3	
		SESSION 3A *P073*	**SESSION 3B** *P037*
		Chair: James Lovatt	*Chair: Ana Gostinčar Blagotinšek*
10:40 – 12:00	10:40 – 11:00	**We learn to ask. How does working on students' questions bring us closer to a well-posed inquiry question?** *Roman Klara*	**Angles in a triangle** *Vesna Lindič*
	11:00 – 11:20	**Movement with IT** *Špela Gec Rožman*	**How can you evaluate an out of school engineering academy?** *Ruben Visser*
	11.20 – 11.40	**How can you ensure that students work independently in class and remain motivated?** *Femke Vanden Broecke*	**Inquiry of soil** *Mateja Kelner*
	11.40 – 12.00	**The use of inquiry based practical work on student's understanding of classifying conductors and insulators** *Jennifer Kelly*	**Report on Belgian teachers' inquiries** *Laura De Keyser*
		WORKSHOP	
		WORKSHOP B *P037*	**WORKSHOP C** *P020*
12:00 - 13:00		**Patterns and Questions: Supporting all students to think, explore and collaborate in mathematics and physics classrooms** *Paul Grimes*	**How to explain Ohm's law online in an inquiry based way?** *Reinout Putman*
13:00 – 14:00		**Lunch break**	
14:00 – 15:00		**coffee** **poster session**	
		SESSION 4 *P006*	
		Chair: Jan de Lange	
15:00 – 16:20	15.00-15.20	**Placement of an object in space using bisectors** *Urška Krajnc*	
	15.20-15.40	**Supporting students to develop hypotheses and plan investigations through the context of learning about factors required for chemical reactions** *Gerard Hughes*	
	15.40 – 16.00	**How to keep a large, busy class motivated for math** *Blomme Maes*	
	16.00 – 16.20	**An inquiry on the effect of wonder on the motivation of students and their ability to ask questions** *Wannes Vande Voorde*	
		ROUND TABLE *P006*	
16:20-17:20		**What have we learned in RISE: Experiences from Erasmus+ project** *Ana Gostinčar Blagotinšek, Mojca Čepič*	
17:20 – 17:30		Distribution of certificates **RISE Closing**	

Contents

INTRODUCTION

Remote Inquiry in Science Education, experiences from Erasmus+ project

Mojca Čepič[a], Ana Gostinčar Blagotinšek[a], Reinout Putman[b], Paul Grimes[c], James Lovatt[c], Eilish McLouglin[c], and Dagmara Sokołowska[d]

[a]*University of Ljubljana, Faculty of Education, Ljubljana, Slovenia*

[b]*Arteveldehogeschool, Gent, Belgium*

[c]*Dublin City University, Dublin, Ireland*

[d]*Jagellonian University, Krakow*

In 2020 COVID pandemic enforced students and teachers to remain at home and lectures were implemented remotely. While social sciences widely studied impacts of students' isolation and lack of social contacts, impacts on knowledge in specific subjects were addressed more hesitantly. Subjects in general and their special methodological requirements are very different. A different impact on sports, music and science could have been expected as on geography or math for example.

The main problem of science subjects is their experimental nature. While the Erasmus+ project Three Dimensions of Inquiry in Physics Education (3DIPhE) developed several activities[1] where students inquire various phenomena and gain experience on which the teaching later can be based, practical experimental work became almost negligible during remotely teaching COVID era. To bridge this gap, and following the goals previously studied in 3DIPhE projects, in Erasmus+ project Remote Inquiry in Science Education (RISE) we developed the methodology to include practical experimental inquiries also under remote conditions.

Although nowadays seems that COVID is long gone and we do not need to fear the lockdown again, there are several situations, where remote teaching is still valid. For example, for students with lengthy illness or a lengthy need for isolation; for students who travel accompanying their parents; for home schooling students; and finally, also for remote courses in inquiry based learning, which allow teachers that have difficulties to travel to improve their knowledge and competences.

In RISE project we developed the methodology for inquiry based learning in remote conditions. Besides, we developed two remote courses, one for beginners in inquiry based learning and the second for teachers with an initial level of experience in inquiry based learning upgraded by practitioner inquiry methodology.

[1]Dagmara Sokolowska (2020), Volume 1: Inquiry Based Learning to Enhance Teaching, http://archive3diphe.splet.arnes.si/files/2021/01/3D_VOLUME1.pdf

ORAL CONTRIBUTIONS

Report on Belgian teachers' inquiries

Laura De Keyser
Arteveldehogeschool, Gent, Belgium

Inquiries of the following teachers are reported

What is the impact of an investigative (inquiry mathematics) approach in mathematics on students' motivation?

Jade Dedobbeleer
Arteveldehogeschool, Gent, Belgium

We want to increase students' motivation for the subject of mathematics. Often, they perceive it as a boring subject without any practical value. By emphasizing its relevance in daily life, we hope to engage students more actively in the subject. A more investigative approach would help students to look at the subject with a more interesting perspective. This, in turn, would increase motivation among students. Specifically, our goal is to develop/implement a series of lessons that adopt an investigative approach and assess whether it indeed enhances motivation.

For our practical research, we utilized a math prompt (obtained via the website "Inquiry Maths")[1]. A math prompt is an instruction or question given to encourage students to explore mathematical concepts, solve problems, and develop their problem-solving skills. This statement should stimulate students' curiosity with the aim of eliciting specific observations and inquiries. Throughout the course of the research, students seek answers to these questions. At the end of the lesson, we would then reflect on their experience. (What did you enjoy about it? Would you like to have more lessons like this?)

We noticed that the students are clearly eager to seek answers. They often rely on learned behavior (trial and error). When a certain combination of numbers doesn't work, they actively seek an explanation and look for a universally applicable rule. This approach is teacher guided. The questions and observations the students write down come entirely from themselves. There is no right or wrong. They search for answers on their own. The research itself is already the goal. When they achieve something through their attempts, it automatically increases their sense of competence. This, combined with the autonomy they experience through solving the prompt on their own, indicates that the ABC method is being employed. This aligns strongly with increased motivation according to research.

How can ChatGPT be used as a tool for students to solve physics exercises?

Manu Soto De Graeve
Arteveldehogeschool, Gent, Belgium

This study investigates the potential of AI-driven chatbots as supportive tools in learning scientific concepts with a focus on physics in a secondary school environment. The research

focuses on the quality and consistency of the chatbot's responses, as well as the students' interaction with the tool and specific ways to enhance the use of the chatbot in class.

Findings demonstrate that the AI chatbot can be beneficial in guiding students in solving exercises, yet its efficiency varies depending on the nature of the exercise and expertise of the student. The results suggest that chatbots have the potential to offer effective learning support, provided they are well-integrated into the learning process and carefully guided by teachers. The study also emphasises the necessity of continual development and enhancement of the AI chatbot and integrate personal user data to ensure better quality and consistency of responses.

Getting started with Inquiry – learning to develop hypotheses and plan experiments through common everyday tasks

Kristian Dimitrov
St.David's C.B.S, Dublin, Ireland

The Nature of Science is a unifying strand within the Irish Junior Cycle Curriculum (12-15 years). The learning outcomes of the strand requires pupils to be able to pose testable hypotheses, compare strategies for investigating hypotheses, design and plan investigations considering aspects such as fairness, equipment choice etc. They also must analyse data to identify patterns and relationships. Pupils are often used to experiments where they are given prescribed procedures which they follow and can struggle with terminology such as dependent and independent variables. IBL has the benefit of pupil engagement and learning about scientific concepts through investigations; however, when first engaging in such activities pupils may suffer cognitive overload if they have not developed an understanding of how to develop hypotheses or plan investigations. This presentation will discuss the use of investigations on everyday tasks familiar to students as a scaffold approach to help develop pupils' inquiry skills.

Movement with IT

Špela Gec Rožman
Piran Gymnasium, Electrical and Maritime School, Piran, Slovenia

Teaching and learning have recently been increasingly oriented towards the use of information and communication technology (IT). Teaching has recently become »wildly digitalised" and, given the developments in science and technology, this cannot and perhaps should not be avoided. Personally, I have considerable misgivings or prejudices about this. Is the knowledge acquired in this way of the same quality? Useful? Is it deficient? How do students accept this way of learning and is it suitable for everyone?

The pupils completed three laboratory exercises on the topic of motion in a physics course using IT. In the first activity, the pupils drew a motion chart using an ultrasound tracker (K. Appel, 2003), and in the second activity, they used the same measuring system to analyse the free fall. In the final activity, free fall, vertical and horizontal throw were investigated by video

analysis. Special attention was paid to the analysis of data collected with IT technology and to the understanding of the position and velocity versus time chart.

I was curious to see how learning the use of digital tools together with exploring physical phenomena would work, and how successful the pupils would be and how they would feel or how they would evaluate this way of learning. I wanted to find out whether students would be more successful and efficient at analysing motion charts compared to the generations before them who did not do these exercises. Last but not least, I was interested in the organisational aspect of such work, as we do not have the possibility to set up a physics laboratory at our school.

I found IT learning was well received by pupils, and I personally think they are more confident, if not more successful, at reading charts than the generations before them. From an organisational point of view, we were creative and successful, and the learning of digital content was also well blended with the exploration of movement. According to the results of the evaluation I carried out with the students, they are keen to continue such activities in the future and are no longer intimidated by working with the measuring system used.

K. Appel, J. E. (2003). *Physics with Computers.* Beaverton, Oregon: Vernier Software & Technology.

Supporting students to develop hypotheses and plan investigations through the context of learning about factors required for chemical reactions

Gerard Hughes
Ballymakenny College, Ireland

In this work I will discuss my approach to develop students' inquiry skills particularly developing hypotheses and planning investigations, whilst learning about the conditions required for chemical reactions. The sub-microscopic nature of reactions is something that challenges my students' understanding of what is happening during a reaction. The fact that they cannot observe what is happening at this sub-microscopic level impacts their understanding of factors such as collision theory, limiting reagents etc.

To break down this barrier, I use a model of baking to help and allow students to appreciate the factors involved at a macroscopic level. My approach is also used to support the development of inquiry skills where students are required to form a hypothesis and plan an appropriate investigation to test and justify their ideas regarding the 'baking reaction'.

In this context I use pancakes as an example. Students test factors such as amount of ingredients, temperature, state of reactants etc. Their experimental results are discussed and reflected upon under two lenses (1) the factors affecting reactions and (2) their experience conducting an investigation. I will discuss student learning, my learning from this approach, future amendments and possible extension activities leading to the teaching of rates of reactions.

Challenge - Circuits

Irena Jelenko
Primary School Brezno-Podvelka, Podvelka, Slovenia

Students of the 9th grade in physics use experiments to study the current and voltage in a circuit in which two devices/resistors are connected in series or in parallel. The activity was carried out at the end of the topic as a knowledge test.

Using two identical batteries, two identical light bulbs and an AV meter, the students solved the challenge:

Assemble and draw circuits (write measurements) in which:

1. the maximal current through the bulb
2. then maximal total voltage
3. the maximal voltage on the bulb

They hypothesized:

I believe that

1. there will be more current through the bulb when ….
2. the total voltage will be maximal when …
3. the voltage on the bulb will be maximal when …

The teacher observed their work (in threes or pairs). I was mainly interested in how well they can build circuits and confirm/disprove their hypotheses.

Out of the fourteen students, most of them can confirm/disprove the hypothesis, only one group needed help to make the record physically correct.

Otherwise, the students liked the activity, as they assembled circuits (which they like to do) and tested their knowledge.

The use of inquiry based practical work on student's understanding of classifying conductors and insulators

Jennifer Kelly
Scoil Pol Kilfinane, Ireland

My practitioner inquiry investigated "Does the use of inquiry based practical work improve student's understanding of classifying conductors and insulators?" I investigated how the use of inquiry based practical work to develop student understanding. Inquiry-based learning (IBL) "refers to a range of strategies used to promote learning through students' active, and increasingly independent, investigation of questions, problems, and issues, often for which there is no single answer" (Lee, Greene, Odom, Schechter, & Slatla, 2004, p. 5). From my readings and learnings of the PRIMAS project I looked to use the following skills: identifying what is already known, posing questions, making observations, planning investigations, reviewing, gathering, analysing and interpreting data, communicating results and proposing answers, explanations and conclusions. My role throughout the inquiry was not to provide the

knowledge but to instead motivate and facilitate the student's learning. For this purpose, I attempted to guide students to help them work in profitable ways.

The use of questioning is one of the key teaching competences in inquiry methods and I asked appropriate questions to enhance students' reflection, critical and logical thinking and self-regulation. I also prompted and promoted class discussions to aid the social construction of knowledge. During each lesson I asked questions, encouraged group and class discussions, made observations and took field notes before and during the investigation. After the investigation I took examples of student/group work (i.e. the write-up template, photos etc..) as well as carrying out and collecting student surveys and reflections. I also welcomed feedback from students on what they thought of the use of inquiry-based practical work to improve their understanding.

References:

- Lee, V.S., Greene, D.B., Odom, J., Schechter, E., & Slatta, R.W. (2004). What is inquiry-guided learning? In V.S. Lee (Ed.), Teaching and learning through inquiry: a guidebook for institutions and Instructors (pp. 3-16). Virginia: Stylus.
- PRIMAS guide for professional development providers. Primas-project.eu. (2011). https://primas-project.eu/wp-content/uploads/sites/323/2017/10/PRIMAS_Guide-for-Professional-Development-Providers-IBL_110510.pdf.

Inquiry of soil

Mateja Kelner
Ljudski Vrt Primary School, Ptuj, Slovenia

I have carried out my inquiry in the 5th class, at the subject of Natural Science and Technology. The average age of the students was 10 years. I conducted the inquiry after the contents about water, air and soil had been learnt. This was the only way they could use the already acquired knowledge in their inquiry in a new situation.

I got an idea for the implementation at the RISE meeting, where we were looking for different ways and motivations for inquiries. At planning and carrying out the inquiry, I helped myself with the material from the Fibonacci project entitled "How we inquire", by Ana Gostinčar Blagotinšek.

The students had already been introduced with the inquiry process within the previous inquiry based learning lectures. Now they just applied their knowledge in a new situation.

The work was done in random groups.

First, I presented to them the material (five different types of soil, bulbs, trays, measuring containers, measuring cylinders, filter paper, cups, spoons, telephones for timing). Afterwards, in each group they agreed on what they would like to inquire. In groups, they set their inquiry question and a hypothesis. Then there inquire themselves and record the findings of what had happened.

I observed the students' participation in the groups and the implementation of acquired knowledge in new situations. I monitored their formulation of the inquiry question and hypothesis, their findings and evaluation of the work and I collected evidence of the work.

We learn to ask. How does working on students' questions bring us closer to a well-posed inquiry question?

Roman Klara
Podkarpackie Centrum Edukacji Nauczycieli w Rzeszowie – Oddział w Krośnie, Katolickie Liceum Ogólnokształcące w Krośnie, Poland

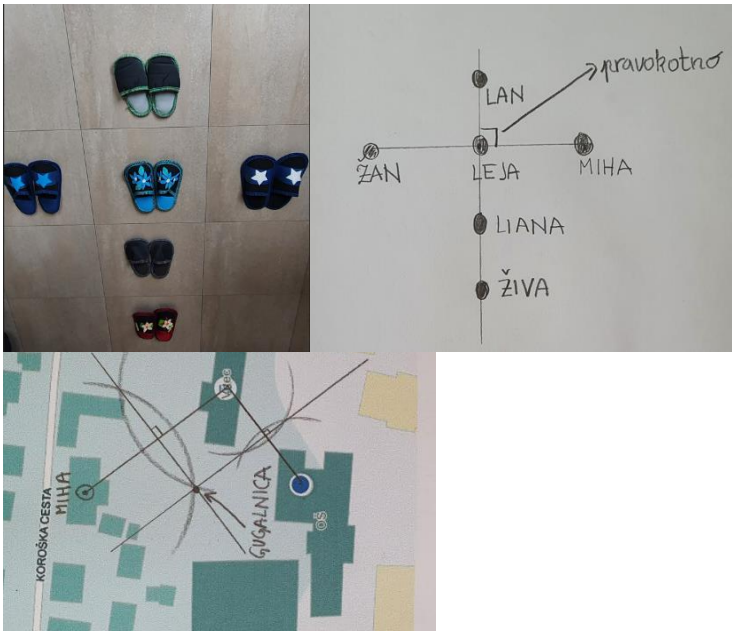
In my presentation, I would like to show how working on students' questions brings us closer to well-formulated research questions. The process of arriving at well-formulated research questions was a sequence of asking questions, discussing questions already asked, and refining the questions asked. The students approached well-formulated research questions by formulating and writing down better questions.

The conclusions resulting from the conducted tests are definitely positive.

Placement of an object in space using bisectors

Urška Krajnc
Radlje ob Dravi Primary School, Radlje ob Dravi, Slovenia

Pupils often struggle to understand and relate different mathematical topics to concrete life situations. Knowledge often remains at a theoretical level, as pupils are unable to apply what they have learned to real-life problems. In order to improve understanding and, consequently, knowledge for all students, I include a variety of activities in the classroom to help students to put themselves in a concrete life situation.



Students had to position themselves in the classroom so that they were equidistant from two people at the same time. They then checked that they were correct by measuring the distance and drawing a sketch. They worked in groups to identify the properties of symmetry. They used a hexapod to check the distance of each point on the symmetry from

two points. They found that all the points on the symmetry line were equidistant from the two selected points and that the line intersected the symmetry line at right angles.

The pupils then worked in pairs to solve concrete problems from everyday life (placing a bank and a swing in a room).

My inquiry was focused on in how well students would do in solving a concrete problem in everyday life and whether their knowledge and understanding would improve. I found that students initially struggled to solve a problem in everyday life, but later it became clear that both their understanding of the material and their knowledge improved.

Modelling round bodies

Miran Kučer
Ljudski Vrt Primary School, Ptuj, Slovenia

My inquiry question was: What role does experiential learning and practical experience have in mathematics? For my inquiry I was observing the 9th grade students during a lecture on geometric bodies. As a part of the STAMPEd project, I recently gave a presentation about my other lecture on the connection between angular bodies. This time the topic of my lecture was round bodies. I have decided to use the methods of experiential learning in order to see if the active role of the students will help them better understand the content and imagine the abstract concepts more easily. Through cooperative work and their active engagement during the lesson, the students gained knowledge about round geometric bodies. During the lesson, I observed their ability to learn independently, their experiences of mathematics in everyday life, their confidence in their own mathematical abilities, their precision, creativity and spatial perception. At the end, we compared their initial answers with the insights they gained and evaluated the lesson. The student also prepared an exhibition of their products.

Angles in a triangle

Vesna Lindič
Tončke Čeč Primary School, Trbovlje, Slovenia

As part of the project, I implemented IBL – inquiry based learning in mathematics lessons and also researched my own practice – PI – practitioner inquiry. In the 7th grade, the students found out the rule about the sum of the interior angles in a triangle by researching through practical examples.

For the introduction, with the help of brainstorming, we revised everything they have already known about triangles, what kind of triangles there are and how we label them. Then, the students investigated what applied to the interior angles of a triangle using practical examples. The students were divided into small groups of 4 or 5 students. Everyone was given the same instructions: as a group, create a rule that says what applies to the sum of the interior angles of a triangle. The students' task was to check within the group if the property applied to all different types of triangles (acute, obtuse and right triangle).

The students first drew different triangles on a sheet of paper and cut them out, and then it was their task to find the rule. The research was undertaken in various ways. Some folded the

triangles, others tore them. Only the measuring of the internal angles was forbidden. The groups successfully worked out the rule that the sum of the interior angles of a triangle was always equal to 180°. The property was then checked by measuring and together we created a note and a picture in the notebook. I observed how successful the students were in researching and finding characteristics. The students were motivated to work and helped each other in the group. All groups successfully found and formulated the rule. Some had several problems with the very idea of how to tear or cut out the triangle. Most of the problems were caused by assembling the internal angles in the extended angle so that all the vertices were united and two and two sides of the angle overlap each other. In groups, students also checked whether the rule applied to all different triangles, as each group drew and cut out an acute-angled, right-angled, and obtuse triangle.

I found that the research motivated a larger number of students. The students were also more connected, they cooperated more and helped each other. Academically stronger members of the teams guided those whose work caused them more problems and explained to them how to find a solution on their own. The research itself was interesting to the students, and it was also shown that they remembered the rule about the sum of the interior angles of a triangle faster.

How to keep a large, busy class motivated for maths?

Blomme Maes
OLVP Bornem, Belgium

Last year, I taught 3 Society and Welfare, a technical subject with 3 hours of maths. This class group consisted of 30 students. I found it very difficult to manage all 30 students equally well and find a way to make the lessons run smoothly. It was a busy class making it difficult to concentrate for 50 minutes and very easily distracted. As the year progressed, students' motivation declined more and more. Exercises were not being completed at home, they were not studying for tests, there was constant chatting during class, students were busy with other things than mathematics, they did not take their materials needed for class (calculator, book, compasses, geometry, laptop...).

So, I needed to find ways to motivate them more for maths. I made an appointment with an educational tutor in mathematics. Together we came up with different solutions, all of which I tested and evaluated.

A model based approach to give a deeper understanding of aspects of atomicand particle physics

Denis McCarthy
Hazelwood College, Ireland

In the teaching and learning of atomic and particle physics the lack of relevant experimental work can limit inquiry based learning in. To overcome this, an activity using Lego and information & keyword cards was used to promote inquiry among students working in pairs. In atomic physics this activity can be used to brainstorm student ideas of the atomic theory or Bohr model. This leads readily to the idea of isotopes and radioactivity. A graph of radioactive decay using Lego proves very effective. Some concepts in nuclear fission or fusion can be investigated. In the area of particle physics, the Cockcroft/Walton experiment can be demonstrated easily. An assessment that examines connections between concepts was used to give some formative feedback. An overview in the form of a narrative was also used to reinforce connections. The students used the model to classify the particle zoo into the quarks model. Fundamental forces are also linked to the particle types.

Pressure and my shoes

Alenka Mravljak
Brezno-Podvelka Primary School, Podvelka, Slovenia

Students love to inquire, especially when the problem is related to daily life. They approached the given inquiry question, 'How does my choice of footwear affect the pressure under my shoes?' with interest.

I conducted the activity in grade 8 at my school. The activity lasted two school hours.

The topic of pressure is always addressed in 8th grade towards the end of the school year, when students' motivation to work and learn has already dropped significantly. Therefore, I wanted to make the lesson a little different. I started with a simple equation for pressure and enumerated the variables on which it depends. Students then made hypotheses that they successfully confirmed as they worked.

Their first inquiry focused on the sole area of three different shoes and determined the pressure given a known mass. They then used a practical and calculated example to confirm their hypothesis that the area of the surface is related to pressure. They also calculated and confirmed the hypothesis that different masses or weights (given a known surface area) are related to pressure.

All participants were satisfied with the results of the class, which was also reflected in the evaluation.

How does the IBL method affect on student's knowledge about density at physics in primary school

Primož Podrzavnik
Radlje ob Dravi Primary School, Radlje ob Dravi, Slovenia

Teaching science, such as physics, is crucial for fostring understanding of the natural world among students. When teaching physics, it is important to recognize different approaches to delivering content that allow students to actively engage and explore indenpendently. This research focuses on comparing two teaching approaches for teaching *density* in elementary school; delivering content through teacher explanation and students engaging in their own exploration.

I formed an experimental group where the content was delivered through teacher explanation, and a control group where students independantly explored the concept of density. Then I conducted an analysis of the achievements of the experimental group and an analysis of the achievements of the control group, and compared the student's feedback. This was followed by a comparison of the achievements between the groups and an extrapolation of the advantages of each method.

The study provided insights into the effectivness of two different approaches in teaching density in elementary school. It was found that delivering content through teacher explanation enables faster acquisition of basic knowledge, while student's own exploration promotes a deeper understanding of concepts and connection with the real world. I prefer to combine both approaches when teaching density to allow for a balanced learning experience and the development of various competencies.

Based on research findings, it is recommended to use different approaches when teaching density, including content through teacher explanation and encouraging student's own exploration. Teachers should recognize the need for interactive methods, practical examples, and experiments that stimulate students to actively explore and construct their own knowledge.

The study has several limitations, including a limited sample size, constrained time for conducting the research, and the influence of other factors such as student's prior knowledge and teacher's instructional abilities. These limitations should be considered when interpreting the results.

In the future, it would be interesting to explore similar approches in teaching other topics in physics or other natural sciences and consider different age groups of students. Research could also include a longer period to assess the effectiveness of different approaches on long-term understanding and student motivation in science education.

Report on Polish teachers' inquiries in RISE

Dagmara Sokolowska
Jagiellonian University, Kraków, Poland

The cohort of RISE teachers consisted of 36 participants. Two groups of teachers were formed, each participating in seven meetings organized online once a month in the school year 2021/22. During the Local Multiplier Event in June 2022, 24 teachers presented their implementations of the IBL modules in their classes, fourteen in primary school and ten in high school. Most of the IBL activities were organized during regular lessons except for two conducted in the afternoon series of meetings with students particularly interested in science.

Most teachers designed their own IBL modules and prepared data collection tools (surveys to evaluate students' motivation and interest in the IBL activities, short exams to assess the learning outcomes regarding knowledge acquirement, student worksheets, and teachers' reflection tools). The overall picture emerging from all presentations was that most students appreciated the IBL method, got engaged in the course of implementation, and obtained better results in tests than when taught traditionally, disregarding their level of abilities. Teachers indicated many benefits of the IBL implementations recorded by them during and after interventions, pointing out at the same time that the method is quite demanding in terms of time, resources, and class management. However, they all agreed it would be worthwhile to continue and organize learning in the IBL form, at least from time to time.

How can you ensure that students work independently in class and remain motivated?

Femke Vanden Broecke
Imacolata, Ieper, Belgium

When I started as a teacher, I quickly noticed that in large classes of 20-30 students, I couldn't help everyone. Some students were already finished with the given task, while I still had to explain it to others. Result: at the end of the lesson, every student was at a different level, some received the answers without attempting the task themselves, and as a teacher, you no longer have enough energy for the next lessons.

Know in my lessons, I try to work more and more with learning paths. This allows each student to work at their own pace. Each lesson begins with an introduction and context in which students are given a case related to the lesson. In the introduction, they are provided with the learning objectives, what they need, the lesson flow, and evaluation criteria.

At school, we have to provide a description for each point, so that students know how they are assessed. We are not allowed to simply give a score of 5/10, for example.

In a learning path, you can add various documents such as PowerPoint presentations, Word documents, links to websites, and so on. One tool I often use at school is "BookWidgets." BookWidgets quizzes and worksheets offer various evaluation options and over 35 different question types. This allows you to also administer tests and assignments through BookWidgets. It's a very handy tool because it automatically grades the questions, reducing

workload, and ensuring that no one loses or fails to submit their test. With BookWidgets, teachers can design and implement learning paths that cater to individual student needs, allowing for personalized and self-paced learning. They provide a clear roadmap for students to follow, ensuring that they cover all the necessary material while giving them the flexibility to progress at their own speed.

In addition to its interactive features, BookWidgets also offers seamless integration with learning management systems such as Smartschool, an digital school platform that we use in Belgium. This integration streamlines the assessment process, as grades from BookWidgets exercises can be automatically transferred to the grade book, eliminating the need for manual data entry and saving valuable time for teachers.

What kind of exercises can you create in BookWidgets?

Quiz, timeline, worksheet, flashcards, exit slip, split whiteboard, webQuest, whiteboard, split worksheet, bingo card, jigsaw puzzle, pair matching, randomness, memory game, crossword, hangman, mind map, spot the difference, and more.

You can also have students submit documents in the upload zone in Smartschool. As you can see, there are many possibilities to actively engage and empower students to study the material on their own. Usually, in the middle of the learning path, students are required to complete a task that requires them to apply the knowledge.

Overall, BookWidgets and learning paths provide a powerful combination for creating student-centered and independent learning experiences. By leveraging the interactive exercises, immediate feedback, and multimedia integration offered by BookWidgets, teachers can design engaging learning paths that foster student motivation and empower them to take ownership of their education.

Discount-price increase or price increase-discount

Simona Verdinek Špenger
Brezno-Podvelka Primary School, Podvelka, Slovenia

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 investigated the above question in the 7th grade of elementary school during the topic of percentages. The research was conducted in a guided manner, using a worksheet. The students explored what happens to the price of sports shoes if they are first increased by 25% and then later discounted by 25%. Their task was to first predict whether the new price would be lower, equal to, or higher than the original price, justify their choice, and then solve a specific task and apply the acquired knowledge to a new situation.

Then they had the reverse situation, where they investigated what happens to the price if the shoes are first discounted by 25% and then increased by 25%.

During the investigation, I was interested in how students would apply the previously acquired knowledge to a new situation, how they would justify their predictions and answers, and what conclusions they would draw.

During the implementation of the presented learning unit, most students made incorrect predictions about the new price compared to the original price. However, when they solved the specific task, most students also discovered the reason for their initial incorrect predictions.

After some time, I checked if the students were able to transfer the acquired knowledge to a new situation. Most students remembered the conducted activity and successfully applied the knowledge to the new situation. The tasks related to percentages were also well solved in knowledge assessments.

For better understanding, students need "hands-on experience." They need to be allowed to make mistakes, find them on their own, and correct them. Their knowledge will thus be of higher quality and more long-lasting.

How can you evaluate an out of school engineering academy?

Ruben Visser
Arteveldehogeschool, Gent, Belgium

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.

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An inquiry on the effect of wonder on the motivation of students and their ability to ask questions

Wannes Vande Voorde
Arteveldehogeschool, Gent, Belgium

A significant amount of students aren't motivated to ask questions on their own. The educational system is still focused on reproductive knowledgde where students learn a chapter of a textbook and get graded on a test before they move on to the next chapter. 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 students motivation and their ability to ask questions. A sense of wonder leads to asking questions and is the beginning of the learning proces. We asked ourselves what context stimulates a sense of wonder and the act of asking questions.

A lot of students where worried about climate change and how this affects the Earth. Because of this we wanted to know if a global perspective, where the Earth and it's place in the universe is being researched as a whole instead of a collection of fragmented systems, raises the motivation of students to learn and to develop a sense of responsibilty for our planet.

The inspiration for this series of investigations comes from the photograph 'A Pale Blue Dot'. This picture of Earth is taken at the border of our solar system and depicts the Earth as a mote of dust suspended in a sunbeam.

The workshop contains eleven investigations. Each investigation researches a particular system that makes our planet so unique; it's capacity to sustain life. For example, the students research magnets and their magnetic fields, the properties of gravity and the density of moons and planets in our solar system, and so on. The investigations are all linked together. Every system exerts influence on another system (for example, because of gravity the Earth can hold it's atmosphere) and when these are all combined the uniqueness of our planet comes into view. Studens also compare other planets and moons in our solar system and their capacity to sustain life. The goal is to highlight the fragility and uniqueness of our planet and to show how small it is compared to the scale of our universe.

Throughout our trials we saw that students were frequently asking meaningful and challenging questions and that the perspective of Earth as an insignificant dot in the universe raised their sense of responsibility.

WORKSHOPS

Patterns and Questions: Supporting all students to think, explore and collaborate in mathematics and physics classrooms

Paul Grimes
Dublin City University, Ireland

During this workshop, participants will get the opportunity to explore how all students can be supported to look for patterns as a first step to encourage thinking in mathematics and physics classrooms. We will look at the ways that different students might interpret and approach the same tasks. We will then look at two different strategies to encourage all students to try to investigate patterns and engage in mathematical and scientific thinking: *parallel tasks* and *open questions*. These strategies can allow teachers to meet the varying needs of all students in the classroom. Topics explored will include algebra, graphing, and area & volume.

How to explain Ohm's law online in an inquiry based way?

Reinout Putman
Arteveldehogeschool, Gent, Belgium

Ohm's law is one of the most important laws of electricity. In secondary schools, this law is determined quite practically by working with lights, cables and multimeters.

During the corona pandemic, not all of our pupils and students could get started with this materials as not everyone has these items at home. That is why we started looking for alternatives.

We started with the Phet applets developed at the University of Colorado Boulder. Through these applets, the students can get to work in a virtual research lab. They can make circuits and determine the current and voltages with a multimeter.

Of course, this alone is not enough to determine Ohm's law. The students need more guidance to work towards a solution. For this we guided them in separate breakout rooms in which they could share their results with each other by means of a Mural. This is an online platform on which you can share information with each other via whiteboards and how you can build up the learning material.

Using these programs and an online spreadsheet, the students were able to look for the physical relationships between the current, the voltage and the resistance value. After their research, the students could process their results and present them to each other on the basis of the Mural.

The students evaluated this lesson as very pleasant because they were able to conduct the research themselves despite the fact that it was given online. This also ensured that the students remembered the subject matter longer than things that were applief theoretically in class.

[1]Rouinfar A. et al, Circuit Construction Kit: AC – Virtual Lab, University of Colorado Boulder

Trains, bells, and whistling bottles

Dagmara Sokolowska
Jagiellonian University, Kraków, Poland

In this workshop, we use an Inquiry-Based-Learning (IBL) approach to introduce a module in physics for lower or upper secondary school. The teaching module is based on household materials and tools; partakers will also use smartphones to collect data.

The participants will take the roles of students and go through all steps of the IBL cycle with particular emphasis on the Brainstorming phase, recognized as the most important one in motivating students to engage in the IBL activity[1] during the lesson. During the workshop, we will take special care to draw participants' attention to the particular steps of the IBL cycle in practice.

[1]Dagmara Sokołowska (2000), *Inquiry based learning to enhance teaching* (e-book), M. Čepič and D. Sokołowska (Eds.), University of Ljubljana, Faculty of Education.
https://www.3diphe.si/files/2021/12/3D_volume1_v1_MC.pdf

POSTERS

How does the use of own notes during tests students' performance in physics?
Anna Bekas
Primary School No.62 im. kmdra. por. F. Dąbrowskiego in Krakow, Poland

How collaboration between students during physics lessons affects teaching results
Agnieszka Bożek
VIII Liceum Ogólnokształcące im. Stanisława Wyspiańskiego, Kraków, Poland

Let`s play
Mojca Buršič
Primary school Vojnik, Slovenia

Can the Use of a Refutation Text Increase Students' Understanding Earth and Space Science?
Alan Casey
Scoil Chonglais, Baltinglass, Ireland

The use of visual strategies with student-generated questions on student understanding in Speed/Distance/Time and Trigonometry
Peter Cummins
Edmund Rice College Dublin, Ireland

Asking questions as a crucial part of the scientific method within secondary education
Laura De Keyser
Arteveldehogeschool Gent, Belgium

Getting started with Inquiry – learning to develop hypotheses and plan experiments through common everyday tasks
Kristian Dimitrov
St.David's C.B.S, Dublin, Ireland

Connecting Physics with Mathematics through Experiential Learning
Stephen Gammell
School of physical Sciences, CDU, Ireland

Movement with IT
Špela Gec Rožman
Piran Gymnasium, Electrical and Maritime School, Piran, Slovenia

Supporting students to develop hypotheses and plan investigations through the context of learning about factors required for chemical reactions
Gerard Hughes
Ballymakenny College, Ireland

Physics Phenomena – Connection of Theory and Practice
Nataša Jelen

Tončke Čeč Primary School, Trbovlje, Slovenia

Angles in a polygon
Irena Jelenko
Brezno-Podvelka Primary School, Podvelka, Slovenia

Challenge - Circuits
Irena Jelenko
Primary School Brezno-Podvelka, Podvelka, Slovenia

Test in the form of a group work
Mikołaj Kałdan
Primary School, Kraków Montessori School, Kraków, Poland

The use of inquiry based practical work on student's understanding of classifying conductors and insulators
Jennifer Kelly
Scoil Pol Kilfinane, Ireland

Line or stap?
Mateja Kelner
Ljudski Vrt Primary School, Ptuj, Slovenia

Inquiry of soil
Mateja Kelner
Ljudski Vrt Primary School, Ptuj, Slovenia

We learn to ask. How does working on students' questions bring us closer to a well-posed inquiry question?
Roman Klara
Podkarpackie Centrum Edukacji Nauczycieli w Rzeszowie – Oddział w Krośnie,
Katolickie Liceum Ogólnokształcące w Krośnie, Poland

The Pythagorean theorem
Metka Klinc
Vojnik Primary School, Vojnik, Slovenia

Laying Tiles: Area of a Shape
Vesna Kotnik
Vojnik Primary School, Vojnik, Slovenia

Geometric mathematical problem solving
Urška Krajnc
Radlje ob Dravi Primary School, Radlje ob Dravi, Slovenia

Placement of an object in space using bisectors
Urška Krajnc
Radlje ob Dravi Primary School, Radlje ob Dravi, Slovenia

Modelling round bodies
Miran Kučer
Ljudski Vrt Primary School, Ptuj, Slovenia

Where in Asia would you live?
Ana Lavre
Vojnik Primary School, Vojnik, Slovenia

Angles in a triangle
Vesna Lindič
Tončke Čeč Primary School, Trbovlje, Slovenia

How to keep a large, busy class motivated for maths?
Blomme Maes
OLVP Bornem, Belgium

A model based approach to give a deeper understanding of aspects of atomic and particle physics
Denis McCarthy
Hazelwood College, Ireland

Effect of Peer Feedback on Higher Academic Achieving Students in Mathematics
Larissa O'Neill
Kildare Town Community School, Ireland

Circumference and Area of Shapes
Jasmina Petek Pelcl
Ljudski Vrt Primary School, Ptuj, Slovenia

What will the Pythagorean Theorem do for me?
Špela Povše Pistotnik
Gymnasium, Electrical and Maritime School Piran, Slovenia

How does the development of note-taking skills affect the effectiveness of learning biology in cytology by first-year high school students?
Beata Sobocińska
XLII Liceum Ogólnokształcącego im. Adama Mickiewicza w Krakowie, Krakow, Poland

How to improve the calculus proficiency of a high school student
Beata Świder
Eugeniusz Romer High School in Rabka-Zdroj, Poland

To what extent working with the same physics teacher in primary and secondary schools affects the efficiency of teaching this subject
Małgorzata Szymura
Complex of School in Czerwionka-Leszczyny, Czerwionka-Leszczyny, Poland

Light and Shadows

Nataša Škorjanc
Vojnik Primary School, Vojnik, Slovenia

Heating and Cooling Substances
Jure Štokovnik
Vojnik Primary school, Vojnik, Slovenia

An inquiry on the effect of wonder on the motivation of students and their ability to ask questions
Wannes Vande Voorde
Arteveldehogeschool, Gent, Belgium

How can you ensure that students work independently in class and remain motivated?
Femke Vanden Broecke
Imacolata, Ieper, Belgium

Areas of Quadrilaterals
Simona Verdinek Špenger
Brezno-Podvelka Primary school, Podvelka, Slovenia

Discount-price increase or price increase-discount
Simona Verdinek Špenger
Brezno-Podvelka Primary School, Podvelka, Slovenia

How can you evaluate an out of school engineering academy?
Ruben Visser
Arteveldehogeschool, Gent, Belgium

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
Liceum Ogólnokształcące Sióstr Urszulanek Unii Rzymskiej, Wrocław, Poland

Dependence of quantities is a function
Sonja Zorman Grabner
Koroški Jeklarji Primary School, Ravne na Koroškem, Slovenia

ROUNDTABLE

What have we learned in RISE: Experiences from Erasmus+ project

Ana Gostinčar Blagotinšek, Mojca Čepič
University of Ljubljana, Faculty of Education, Slovenia

Covid-19 pandemic presented our society with many challenges which required unique solutions in a very short time. Education was no exception; teaching and learning was fundamentally changed almost overnight. Classrooms were closed, teaching was done remotely, with little or even no personal communication.

Inquiry-based teaching and learning in science (and beyond) offers many advantages[1, 2], so there were (and still are) many initiatives and projects devoted to promoting and implementing this approach to teaching. But again, with classrooms closed and no experimental equipment available, and pupils and teachers working alone at their homes this seemed impossible.

RISE project (Remote Inquiry in Science Education) was devoted to overcoming these obstacles. At the end of the project, round table will give opportunity to share lessons learned and challenges still waiting for solution. Participants will be asked to share and discuss:

- How has RISE addressed the issues that arose during Covid-19 pandemic?
- What inquiries have you addressed/would you like to address in your teaching?
- What were the benefits to you being part of the RISE project?
- What remote tools do you use/would you like to use?
- What do you use in school?
- Has participation in RISE impacted on your practice? How?
- What will you try in the future?
- What skills have you developed?

[1]Rocard M. (Chair) (2007), Science Education NOW: A Renewed Pedagogy for the Future of Europe. Luxembourg: Office for Official Publications of the European Communities, 2007. Retrieved from: http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf

[2]D. Sokołowska (2018), Effectiveness of learning through guided inquiry, in: The Role of Laboratory Work in Improving Physics Teaching and Learning, D. Sokołowska, M. Michelini (eds.), p. 243-255