26.-28. AUGUST 2020

ORGANISED BY

UNIVERSITY OF LJUBLJANA

FACULTY OF EDUCATION

SLOVENIA

BOOK OF ABSTRACTS

FINAL INTERNATIONAL CONFERENCE OF PROJECT

3DiPhE

Three Dimensions of Inquiry in Physics Education

Exploring the power of inquiry, passion for teaching, knowledge, and collaboration.

www.3diphe.eu/me3

University of Ljubljana

Book of abstracts
Final International Conference of Project 3DIPhE
University of Ljubljana, Faculty of Education
Ljubljana, August 2020

Editor: Maja Pečar
Publisher: University of Ljubljana, Faculty of Education
For the publisher: Janez Vogrinc, Dean

Local organizing committee:
Chair: Mojca Čepič
Co-chair: Ana Gostinčar Blagotinšek
Scientific secretary: Maja Pečar
Jaka Banko
Terezija Rupnik
Lana Peharc

International advisory board:
James Lovatt (Ireland)
Paul Grimes (Ireland)
Eilish McLoughlin (Ireland)
Dagmara Sokołowska (Poland)
Jan De Lange (Belgium)
Wim Peeters (Belgium)
Renaat Frans (Belgium)

Online at: http://archive3diphe.splet.arnes.si/files/2020/09/ME3-Book-of-abstracts.pdf

3DIPhE is project NO. 2017-1-SI01-KA201-035523 funded under program ERASMUS+ KA2.

Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici v Ljubljani
COBISS.SI-ID=26935811
ISBN 978-961-253-263-5 (pdf)

WELCOME AND PRELIMINARY INFORMATION

At the end of June 2017 UL PEF and partners of the project were informed that we have been successful with our proposal entitled Three Dimensions of Inquiry in Physics Education, shortly 3DIPhE, in our second resubmission. The project started at 1st of September 2017 and in a few days it will end on 31st of August 2020.

The project focused on three very important aspects of education:
- On inquiry based learning as a recent promising approach highly relevant for learning physics.
- On practitioner's inquiry, which enables the teacher to support her/his teaching ideas with evidence.
- On work in professional learning communities of teachers. Especially physics teachers are often alone at the school and being involved in a group of teachers of the same subject with similar problems allows for exchange of experience and motivates its members for professional development.
- Last but not least, we applied the inquiry methodology also at the level of the project, collecting and analysing the data relevant for our activities.

During the life of the project, professional learning communities were established in all partner countries (Belgium, Ireland, Poland and Slovenia), teachers actively participated in them, introduced inquiry based learning to their students and inquired about their work in the classroom with the help of instruments and protocols, other materials developed in this project and motivated by ideas gained through exchange of experience among teachers in the community.

This Final conference, which was moved to a virtual space because of the second wave of COVID-19, has enabled the teachers from different partners' countries to present their work and meet. Although the Final conference was a planned multiplier event, only a few teachers from partners' countries were planned to join due to financing restrictions. The virtual conference actually lifted the travelling barriers and provided an opportunity to everybody. We sincerely hope that loads of new information will be valuable to all the participants and those they will be satisfied for remaining active in a virtual group.

The Final conference is organized in a following way. Main outcomes of the project are presented and discussed as lectures. As three trainings were developed in the project, the mode of working in these trainings will be presented in virtual workshops. We sincerely hope that COVID-19 will retreat in future and we will be able to carry out the trainings in personal contact. You can imagine that they are more efficient and pleasant. Finally, two sub events are planned. On Thursday, a meeting of teachers from different countries and partners to share their experience from being a part of the project and to meet internationally will be organized. At the end of the conference, the Round table meeting to reflect on the conference and on expectations for future will be held before the closing ceremony. Besides, as we can meet only virtually, we will leave a chat room open for one hour after the conference on Wednesday and Thursday for anybody wanting to meet, chat, discuss … You are invited to join this non-official room without a further notice.

Those three years were precious. We as partners have learned a lot. Partners established great relationship with teachers/practitioners. Teachers form an active circle of friends having similar attitudes toward teaching and learning. We developed several examples of IBL units accompanied with materials, worksheets and instructions. In two months we will upload the final versions of four e-books: on tested IBL examples, on practitioner's inquiry, on coaching professional learning groups, and a multiple case study focused on our work with professional learning communities, how we learned from our teachers, how we learned among partners, etc… All of them will be available publicly at the official project's side www.3diphe.si. All participants will be notified on the release. At this point I would like to stop. I am inviting all of participants to join as many sessions as possible, to learn and enjoy, to exchange experience and find new ideas, etc. As we were lucky to get a new ERASMUS+ project, where we intend to continue with the work in a similar way, you are invited to become active members of continuing groups.

Mojca Čepič
Coordinator of 3DIPhE

Erasmus +

3DiPhE
Three Dimensions of Inquiry in Physics Education

THE PROJECT

is an ERASMUS+ project involving partners from Slovenia, Belgium, Poland and Ireland. It started on September 2017 and ended on August 2020.

Three Dimensions of Inquiry in Physics Education (3DIPhE) is focused on different levels of inquiry relevant for physics education:
a) inquiry based learning (IBL) for pupils,
b) practitioners' inquiry (PI) for teachers,
c) inquiry of coaching for partners and
d) educational research design of 3DIPhE.

3DIPhE is project No. 2017-1-SI01-KA201-035523 funded under ERASMUS+ Programme KA2 and signed by The National Agency for Slovenia CMEPIUS.

CMEPIUS

www.3diphe.eu

artevelde university college ghent
MEMBER OF GHENT UNIVERSITY ASSOCIATION

DCU
Dublin City University

KATHOLIEK ONDERWIJS .VLAANDEREN

University of Ljubljana
Faculty of Education

JAGIELLONIAN UNIVERSITY IN KRAKÓW

UC Leuven Limburg
MOVING MINDS

National Education Institute Slovenia

CONTENT

PROGRAM

Final International Conference of Project 3DIPhE
Three Dimensions of Inquiry in Physics Education
2017-1-SI01-KA201-035523
Erasmus+

Wednesday, 26th August 2020

ROOM 1

14.00 – 14.05	**Janez Vogrinc, SI**: *Dean's welcome*	Chair: Eilish McLoughlin
14.05 – 14.45	**Mojca Čepič, SI**: *The life of 3DIPhE Project*	
14.45 – 15.30	**Rik Vanderhauwaert, BE**: *LINPILCARE project*	
15.30 – 16.00	COFFEE BREAK	
16.00 – 17.00	*Teachers presentations (parallel sessions):*	

	ROOM 1 *Examples from 3DIPhE*		*ROOM 2* *Examples from 3DIPhE*	
16.00 – 16.15	**Barbara Szymańska-Markowska, PL**: *How IBL method affected classes in physics lessons students were not interested in?*	Chair: Rik Vanderhauwaert	**Bram Neyens, BE**: *Does the amount of teacher scaffolding influences the learning outcomes of an interdisciplinary IBL-project?*	Chair: Wim Peeters
16.15 – 16.30	**Jordy Zwaenepoel, BE**: *Can connecting Music & Science motivate learners?*		**Lidija Eler Jazbinšek, SI:** *In what capacity does the students's learning type express depending of the way of presenting a project about birds?*	
16.30 – 16.45	**Jasmina Petek Pecl, SI**: *Exploring with tangram*		**Kimara Goethals, BE**: *How can I adapt my teaching methodology so all students are involved?*	
16.45 – 17.00	**Simona Verdinek Špenger, SI**: *Exploring the scope and area of composite characters*		**Špela Gec Rožman, Špela Povše Pistotnik, SI**: *Strike a balance*	

17.00 – 18.00	**Mojca Čepič, SI**: *Inquiry Based Learning (IBL) Virtual workshop: Relative motion*
18.00 – 19.00	OPEN HOUR on theme: Reflection on teacher's learning

Thursday, 27th August 2020

Final International Conference of Project

3DIPhE Three Dimensions of Inquiry in Physics Education

2017-1-SI01-KA201-035523

Erasmus+

	ROOM 1	
9.00 – 9.45	**Dagmara Sokołowska, PL**: *IBL and 3DIPhE e-Book examples*	Chair: Ana G. Blagotinšek
9.45 – 10.30	**Jan De Lange, BE**: *Practitioner's Inquiry (PI) - 3DIPhE outcomes*	

10.30 – 11.00 COFFEE BREAK

11.00 – 12.00 *Teachers presentations (parallel sessions):*

	ROOM 1 *Examples from 3DIPhE*		*ROOM 2* COVID-19 and school experience	
11.00 – 11.15	**Matej Rožič, SI**: *My experience with IBL in PTI programs*	Chair: Justyna Kniaź	**Vesna Kotnik, SI**: *Different didactic approaches of teaching while working remotely*	Chair: Jeroen Op den Kelder
11.15 – 11.30	**Uroš Medar, SI**: *A plastic bottle is all you need*		**Marija Žigart, SI**:*Distance learning and online exams*	
11.30 – 11.45	**Roman Klara, PL**: *How do students perceive the physics lesson on the subject of the electromagnetic induction carried out via an IBL method?*		**Ivana Štibi, Mojca Čepič, Jerneja Pavlin, HR/SI**: *Impact of the SARS-CoV-2 pandemic on pre-univesity physics education: Croatian teachers' point of view*	
11.45 – 12.00	**Małgorzata Szymura, PL**: *IBL ON PHYSICS LESSONS … IN THE EYES OF A STUDENT*		**Ivana Štibi, Manca Hafner, Mojca Čepič, Jerneja Pavlin, HR/SI:** *Physics lessons in Slovenian primary and secondary schools during the SARS-CoV-2 pandemic*	

12.00 – 12.50 LUNCH BREAK

12.50 – 13.30 **Ana G. Blagotinšek, SI**: *3DIPhE Practitioners Meet (for 3DIPhE teachers and partners)*

12.50 – 12.55	*Introduction in ROOM 1*
12.55 – 13.20	*Working in Groups 1 – 5*
13.20 – 13.30	*Conclusions in ROOM 1*

13.30 – 14.30 *Teachers presentations (parallel sessions):*

	ROOM 1 Examples from 3DIPhE		*ROOM 2* COVID-19 and school experience	
13.30 – 13.45	**Damienne Letmon, Eilish McLoughlin, IE**: *Pre-service physics teachers' knowledge and understanding of mandatory experiments*	Chair: John De Poorter	**Jasmina Petek Pelcl, SI**: *Use of online tools during covid-19*	Chair: Paul Grimes
13.45 – 14.00	**Beata Sobocinska, PL**: *How the gender structure of student groups affects effectiveness of IBL implementation during science classes*		**Natalija Podjavoršek, SI**: *Teaching physics during COVID-19*	
14.00 – 14.15	**Andreja Eršte, SI**: *Investiganting physical properties of pendulums: three experimental approaches*		**Ruth Chadwick, Eilish McLoughlin, IE**: *Impact of COVID-19 crisis on science teaching and facilitation of practical activities in Irish schools*	
14.15 – 14.30			**Matjaž Pintarič, SI**: *Distance physics lessons at Primary School Prule*	

14.30 – 15.30 **Dagmara Sokołowska, PL**: *IBL workshop on Spaghetti bridge*

15.30 – 16.00 COFFEE BREAK

16.00 – 17.00 *Teachers presentations (parallel sessions):*

	ROOM 1 Examples from 3DIPhE		*ROOM 2* COVID-19 and school experience	
16.00 – 16.15	**Jasmina Žel, SI**: *Weight of unknown object*	Chair: James Lovatt	**Nataša Jelen, SI**: *Physical phenomena - independent learning*	Chair: Jerneja Pavlin
16.15 – 16.30	**Maja Ilar, SI**: *Which is bigger: one liter or one kilogram?*		**Anja Smrtnik, SI**: *Applied mathematics project: Renovation of my room*	
16.30 – 16.45	**Monika Jurek, PL**: *What kind of a classroom desk arrangement during the physics lesson conducted by the IBL method contributes to the development of social competences of students at risk of social maladjustment?*		**Andreja Eršte, SI**: *Optics in the kitchen*	
16.45 – 17.00	**Marko Rožič, SI**: *What is wrong with mechanical energy conservation?*		**Gregor Rapuš, SI**: *Series or parallel connection?*	

17.00 – 18.00 **Maja Pečar, SI**: *PI on IBL workshop on water rockets*

18.00 – 19.00 OPEN HOUR on theme: Discussion on the link between IBL and PI

Final International Conference of Project 3DIPhE
Three Dimensions of Inquiry in Physics Education
2017-1-SI01-KA201-035523
Erasmus+

Friday, 28th August 2020

	ROOM 1
9.00 – 10.30	**Wim Peeters, BE**: *Coaching guide and the workshop on coaching a PLC*
10.30 – 11.00	COFFEE BREAK
11.00 – 12.15	*Teachers presentations (parallel sessions):*

	ROOM 1 *Examples from 3DIPhE*		*ROOM 2* *Examples from 3DIPhE*	
11.00 – 11.15	**Urška Kranjc, SI**: *By research the similarities to quality and lasting knowledge in mathematics*	Chair: Dagmara Sokołowska	**Nathalie Dillen, Anja Roelof, BE**: *How do I give feedback during laboratory work in a more efficient way and achieve my goals?*	Chair: Jan De Lange
11.15 – 11.30	**Vesna Lindič, SI**: *Mirroring shapes across the line and inquiry based learning*		**Deirde O'Neill, Eilish McLounghelin, IE**: *Investigating the impact of embedding reflective practice as a professional learning tool in physics*	
11.30 – 11.45	**Beata Świder, PL:** *What effect does the IBSE method have on the results of teaching Gravity to high school students?*		**Uroš Medar, SI**: *A small PI can make a great difference*	
11.45 – 12.00	**Anna Bekas, PL:** *How does the IBSE method affect remembering physical quantities and application of acquired knowledge in practical tasks?*		**Jure Štokovnik, SI**: *Research on the usefulness of thermally insulated products in the subject of science and technology*	
12.00 – 12.15	***Gerdy Olivier, BE***: *How can students work more independently and inquiry-based during STEM-projects?*		**Barbara Jančič, SI**: *Usability of the cooler bag*	

12.15 – 13.00	LUNCH BREAK		
13.00 – 14.30	**Ana G. Blagotinšek, SI**: *PI and IBL Workshop on double shadow*		
14.30 – 15.00	COFFEE BREAK		
15.00 – 15.45	**Paul Grimes, IE**: *Report on Case studies*		Chair: Maja Pečar
15.45 – 16.30	*Parallel and new Horizons:*		
	15.45 – 16.00	**Ana G. Blagotinšek, SI**: *The Unteachables* Project (ERASMUS+)	
	16.00 – 16.15	**Jerneja Pavlin, SI**: *Erasmus+ project ARphymedes*	
	16.15 – 16.30	**Paul Grimes, IE**: *The STAMPEd* project	
16.30 – 18.00	**Mojca Čepič, SI**: *Round table on levels of inquiry, discussions and closing*		

The life of 3DIPhE project

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

The ERASMUS+ project entitled Three Dimensions of Inquiry in Physics Education considers three very important aspects in teaching and learning physics and other subjects

- Inquiry based learning, where students gain experience about phenomena by their own experiments and later upgrade these experience with scientific knowledge.
- Practitioner's inquiry, where teachers inquire the teaching and the learning process in the classroom and informed by collected data they decide on future actions.
- Teachers work in professional learning communities, because the exchange of information, and discussion among colleagues generates ideas, increase and sustain motivation for additional efforts required for both, inquiry based learning and practitioner's inquiry.

Finally, the inquiry dimension of the project was additionally enhanced by systematic accompaniment of all activities in the project as a quality assurance using the methodology of educational design research.

The final outcomes of the project are two courses and four e-books on inquiry based learning examples, on practitioner's inquiry, on coaching professional learning communities and case studies of our work. The contribution presents the modes of working in the project, the methodology to reach the results and the effects of COVID on our activities.

Contact information

Dr Mojca Čepič
University of Ljubljana, Faculty of Education
Slovenia
E-mail: mojca.cepic@pef.uni-lj.si

LINPILCARE project

Rik Vanderhauwaert
Katholiek Onderwijs Vlaanderen, Belgium

The Erasmus+ KA2 project Linpilcare forms the base on which 3DIPhE has further developed. Linpilcare has developed a frame of thinking on evidence informed teaching & learning. The frame of thinking shows how practitioner inquiry and professional learning communities enhance evidence informed professional learning of school teams.

During this session, we delve deeper in the frame of thinking of Linpilcare and present a publication of protocols that guide practitioner inquiry and professional learning communities.

References

Cordingley, P. (2008), *Research and evidence-informed practice: focusing on practice and practitioners*. Cambridge Journal of Education, 38, 1, 37-62.

Dana, F.N. and Yendol-Hoppey, D. (2008), *The reflective educator's guide to professional development. Coaching inquiry-oriented learning communities.* London: Sage publications

Dana, F.N, Thomas, C., Boynton, S.(2011), *Inquiry. A districtwide approach to staff and student learning*. London: Sage publications

Dana, F.N, (2013), *Digging deeper into action research*. London: Sage publications

Dixon, N. (2000), *Common Knowledge: How companies thrive by sharing what they know*. Boston: Harvard Business School Press

Dumont, H. Istance, D. and Benavides, F. (eds.) (2010), *The Nature of Learning. Using research to inspire practice*. Paris: OECD

Earl, L. and Katz, S. (2006), *Leading schools in a data-rich world, harnessing data for school improvement*. California: Corwin Press

Earl, L. and Timperley, H. (2009), *Professional learning conversations, challenges in using evidence for improvement*, New York: Springer

Earl, L., Katz, S. and Ben Jafaar, S. (2009), *Building and connecting learning communities*, California: Corwin press

Early, P. and Bubb, S. (2004), *Leading and Managing Continuing Professional Development*. London: Sage Publications

Fox, R.D. (2000), *Using theory and research to shape the practice of continuing professional development*. Journal of Continuing Education in the Health Professions, 20, 4, 238-246.

Hammersley, M. (2002), *Some Questions about Evidence-based Practice in Education*. Paper presented at the Annual Conference of the British Educational Research Association, University of Leeds, England, September 13-15, 2001.

Hargreaves, A. and Fink, D. (2006), *Sustainable Leadership*. San Francisco: Jossey Bass

Hargreaves, A., Fullan, M. (2012), *Professional capital: transforming teaching in every school*. New-York: Teacher college press

Hattie, J. (2009), *Visible Learning. A synthesis of over 800 meta-analyses relating to achievement*. Abingdon: Routledge

Hattie, J. (2012), *Visible learning for teachers: Maximizing impact on learning*. Abingdon: Routledge.

Jones, J. (2002), *Practitioner Research: an opportunity to enhance quality in schooling*, in, In search of the Treasure Within: towards schools as learning organisations. Antwerp: Garant

Kerr, D., Lines, A., McDonald, A., & Andrews, L. (1998), *Mapping Education Research in England: an analysis of the 1996 Research Assessment Exercise*. Bristol: HEFCE.

Lomos, C., Hofman, R. H. , & Bosker, R.J. (2011), *Professional community and student achievement – a meta-analysis*. School Effectiveness and School Improvement. 22(2), 121-148.

Mc Donald, J.P. (2003),*The Power of Protocols: An Educator's Guide to Better Practice*, Second Edition, tcpress.com

NTRP (2000), *Teacher perspectives on the accessibility and usability of research outputs*. Paper presented at the British Educational Research Association annual conference, September 7-9, in Cardiff, UK.

Contact information

Rik Vanderhauwaert
Katholiek Onderwijs Vlaanderen
Belgium
Rik.vanderhauwaert@katholiekonderwijs.vlaanderen

How IBL method affected classes in physics lessons students were not interested in?

Barbara Szymańska-Markowska[1]

[1]*Primary School Number 5 in Zabrze (Poland),* [2] *Silesian Centre for Education and Interdisciplinary Research in Chorzów (Poland)*

Physics is a hard but important subject at school. A lot of students think that it is not necessary to learn it. That's why two years ago I started an IBL innovation in one of my two physics classes, consisting of students aged 12-13. In school year 2018/2019 I studied how the IBL method affected the classes in physics lessons students weren't interested in. Two classes took part in the study: I – a class in which IBL method was implemented (23 students), and II – a class taught traditionally (21 students). In all classes behavioral and specific problems had been detected from time to time. My study started from a pre-test. All groups obtained very similar results – I – 54%, II-55%, III – 53% on average. During my PI I recorded my lessons and took observational notes. Students worked with worksheets prepared by myself. I had about five lessons per month leading by IBL method.

In the middle of the school year, I administered to students a questionnaire which consisted of four questions:
1. Which lessons stick to your mind?
Class I: 78% - lessons with experiments, 9% - I do not know, 9% N/A, 4% - other
Class II **:**63% - lessons with experiments, 16% - I do not know, 21% N/A
2. What kind of a lesson is attractive?
Class I: 48% - with experiments, 17% - in a good mood, 13% - I do not know, 9% - without homework, 9% - others, 4% - N/A
Class II: 74% with experiments, 11% - all are attractive, 5% - it depends on topic, 5% - lessons without calculations, 5% - I do not know,
3. Do you like when the teacher provides and explains everything or it is better when you do inquiry by yourself?
Class I: 61% - when teacher explains, 26% - when teacher helps and is close to me, 9% - I do not know, 4% - it doesn't matter
Class II: 74% - when teacher explains, 21% - -when teacher helps and is close to me, 5% - it doesn't matter
4. What would you change in physics lessons?
Class I: 40% - experiments all the time, 17% - nothing, 17% - I do not know, 17% - others , 9% - less tests
Class II: 53% - more experiments, 32% - nothing, 5% - less counting, 5% I do not know, 5% - N/A
After school year I did post-test. The results obtained in a post-test – I – 63%, II-67%, III – 56%.

<u>Conclusion:</u> During IBL lessons, the teacher and students undergo a process. The teacher opens up to the students, notices more of their problems and develops different sensitivity. Students value lessons where they can do experiment in groups and come to conclusions on their own. However IBL in primary school needs to be implemented at a structured level.

Contact information

Barbara Szymańska-Markowska
Poland
E-mail: barbara.szymanska-markowska@smcebi.edu.pl

Can connecting Music & Science motivate learners?

Jordy Zwaenepoel [1,2]
[1]*IKSO, Hoeselt* [2]*St.-Ferdinand, Leopoldsburg*

In a technical secondary school we wanted to motivate the children more for physics and science. Since we were fascinated ourselves about the physics behind music, we developed in an interdisciplinary team of teachers, interdisciplinary learning materials that connected physics to music. These materials were developed to enhance Inquiry Learning as well as self-activity of the students. Real experimental materials and simple musical instruments were provided to the students. By means of the iMuscica workbench [1] students could inquire these science & music phenomena. The IBL was guided but the students had quite some part in it not at least because of many musical activities that went along the science inquiry path.

As we were part of a Professional Learning Community (PLC) on Practitioner Inquiry (PI) we decided to investigate, by means of PI [2], whether connecting physics to music, has the power to motivate our students more for science. After a Litmus test our Research Question was refined. We collected data by means of videoing most of the lessons, by a questionnaire for the students and by field notes of external observators.

The result was that connecting music to science worked actually positive on the learners' motivation. The learners experienced it 'as something different and unique' and stated that 'the music gives meaning to science'. Is this approach transferable to other schools or classes? To be honest, we don't know. We did learn that teachers of different background (physics and music) are needed both for the preparations as for the interdisciplinary class activities.

References

[1] Katsouros, V., Fotinea, E., Frans, R., Andreotti, E., Stergiopoulos, P., Chaniotakis, M., ... & Martín-Albo, D. (2018). iMuSciCA: Interactive Music Science Collaborative Activities for STEAM Learning. In *Designing for the User Experience in Learning Systems* (pp. 123-154). Springer, Cham.

[2] Cochran-Smith, M., & Lytle, S. L. (2015). *Inquiry as stance: Practitioner research for the next generation*. Teachers College Press.

Contact information

Jordy Zwaenepoel
St.-Ferdinand, Leopoldsburg
Belgium
E-mail: zwaenepoel20@gmail.com

Exploring with tangram

Jasmina Petek Pelcl
OŠ Ljudski vrt Ptuj,

We conducted a research activity with seventh grade pupils using a tangram. A tangram is a Chinese jigsaw puzzle made up of seven geometric shapes that together form a square. The basic parts of a tangram are two small, middle, and two large isosceles right triangles, a square, and a parallelogram. Tangram shapes can be used to assemble different shapes, which consist of all seven parts of a tangram, and should not overlap.

The pupils made their own tangram during the math class. We explored which of the following geometric shapes (triangle, parallelogram, trapezoid, square, and rectangle) we can compose and with how many parts if we change the rules that apply to a tangram and do not use all seven parts of a tangram. We also researched in how many different ways an individual character can be put together.

We made a plan of the research, as we started the research step by step. We first started with one piece of the puzzle. We found that we could not assemble a trapezoid and a rectangle. Using two pieces of the puzzle, we found that we could not assemble a rectangle. We continued our research with three pieces of the puzzle, where we found that we could put together all the shapes. When using four parts, we could not assemble a rectangle. Using five parts, we assembled all the shapes except the triangle. Using six parts, we were unable to assemble a square and a parallelogram. We explored that with all seven parts, in addition to the square, we can also assemble a triangle, a rectangle, a parallelogram, and a trapezoid.

Research in mathematics is pupils-centered and emphasizes its active role. The pupils were highly motivated to explore as some encountered the tangram for the first time. Tangram encourages pupils to solve problems and think critically, and teaches them perseverance and thinking. Pupils who have a well-developed spatial representation stood out in the search for solutions. The pupils were not satisfied with just one solution, but were looking for and checking if there was any other solution. In the research, pupils asked questions, formulated hypotheses, planned the research, collaborated with classmates, and presented their findings.

Contact information

Jasmina Petek Pelcl
Osnovna šola Ljudski vrt Ptuj, Župančičeva 10, 2250 Ptuj
Slovenija
e-mail: jasmina.petek@os-ljudskivrtptuj.si

Exploring the scope and area of composite characters

Simona Verdinek Špenger
Osnovna šola Brezno-Podvelka, Slovenija

Increasingly, I notice that students in math have the most difficulties in solving problem-solving tasks and tasks from everyday life. Pupils often learn the material superficially or learn the rescue procedures by heart. As a result, their knowledge is not long-lasting. Therefore, I include in the lessons various activities with which I want to bring the learning material closer to students on the most concrete level and thus improve their understanding and consequently raise the level of knowledge that students need in everyday life.

I conducted the research in the 6th grade of elementary school on the topic - circumferences and areas of composite shapes. The average age of the students was 11 years. The students' inquiry was guided using a worksheet.

Pupils investigated different shapes of top surfaces consisting of two sets of three school desks. One set consisted of square desks and the other of rectangular desks. Students' task was to find what happens to the area of a composite shape if we change the position of the desks and the desks have to stay in contact with one entire side.

After 6 months, I checked how effectively the students had mastered the learning material and if they knew how to apply the acquired knowledge in a new situation. I was interested in how much time the students needed to draw conclusions. I also checked what misconceptions remained after experimentation. I monitored the work and thinking of the students and wrote down the time in which they formed the conclusion.

During the implementation of the presented learning unit, it turned out that the students from the expert group in solving the task after 6 months mostly came to a conclusion faster than in the first inquiry. They also recorded the conclusion 75% faster than students who did not participate in the inquiry. The differences were most visible in students with weaker academic performance. There were almost no misconceptions among the students from the expert group after the experimentation, only one student wrote the wrong conclusion, while the other students had several wrong conclusions.

Pupils need "own experience" for longer knowledge and better understanding and faster retrieval of knowledge, they must be actively involved in the process of acquiring knowledge and research. Therefore, I will continue to try to include this way of working in my lessons as often as possible.

Contact information

Simona Verdinek Špenger
Osnovna šola Brezno-Podvelka
Slovenija
E-mail: simonave@gmail.com

Does the amount of teacher scaffolding influences the learning outcomes of an interdisciplinary IBL-project?

Bram Neyens [1]
[1]*KJ, Hasselt*

A general secondary school at Hasselt choose to completely reorganize the courses of natural sciences, geography and technology. So far, these subject matters were offered in separate courses, but since this school year a STEM-course was built in which the 3 subject matters are taught in an integrated way.

In order to develop STEM learning materials a Professional Learning Community (PLC) was established in the school together with the university college. The teachers of the PLC were looking for support on their STEM-materials: i.e. ways to improve their materials as well as their teaching. They were trying to figuring out best practices (e.g. more guided or more open approach).

In the PLC integrated STEM materials were developed to enhance the Inquiry Learning of the students. The chosen theme was the bicycle. It became a context to learn physics, biology and computer programming. The doubt that we had been the degree of scaffolding the students would need: more open or more guided? So we decided to investigate this issue by means of Practitioner Inquiry (PI) [2]. We defined a research question and refined it after a Litmus test: does the amount of scaffolding given by the teacher influences the learning outcomes of this interdisciplinary bicycle project? We collected data by means of permanent evaluation of the students, by classroom talk and by field notes taken by observators.

Our conclusion was that you need to have a good balance between scaffolding and inquiry learning, especially for weaker students. Good and creative students do benefit from the inquiry methodology.

The learners stated for instance ‘I often do not know how to start solving a problem’ and ‘I can remember better the new insights I’ve discovered myself’. Students lost also a bit the overview over what was learned. We discovered also that the composition of the students groups is a very important factor for self-directed learning. We want to work on that further in a next PI.

References

[1] Cochran-Smith, M., & Lytle, S. L. (2015). *Inquiry as stance: Practitioner research for the next generation*. Teachers College Press.

Contact information

Bram Neyens
KJ, Hasselt
Belgium
E-mail: bram-neyens@telenet.be

In what capacity does the student's learning type express depending of the way of presenting a project about birds?

Lidija Eler Jazbinšek, prof.

Vojnik Elementary School

People learn in different ways – some get the most knowledge by reading, others by listening or with the help of visual material. Some people learn most efficiently when they test their ideas in discussions; others prefer to study on their own. A certain percentage of people needs the information to be shown systematically and they learn gradually, while the rest use the so called »integrated approach«. The way we process information, which learning stategies we use and how we bring them into our consciousness is called a learning style. (Marentič Požarnik, 2000). A learning style includes perception, processing and evaluation of information and is conditioned by which cognitive channel is at the forefront of the individual. Visual learning style is typical for people who learn most easily with the help of books and visual presentations. With the listening learning style listening is at the forefront, while someone with the kinestethic learning style with process the information while in motion. As an example of use and upgrade of the knowledge in a new situation, fourth graders did some independent research about birds after discussing the learning material about the animal kingdom in class. For me this exercise was an opportunity for inquire my own practice and gaining information about the way we can confirm or deny the student's learning style based on their final product. My research might help other teachers and also myself to adapt the classes to different learning styles of the students.

References

Marentič Požarnik, B. (2000). *Psihologija učenja in pouka*. Ljubljana: DZS.

Contact information

Lidija Eler Jazbinšek, prof.
Elementary School Vojnik
Slovenia
e-mail: lidija.jazbinsek@gmail.com

“How can I adapt my teaching methodology so all students are involved?”

Kimara Goethals
Land en Tuinbouwinstituut Oedelem

This practitioner inquiry is not being conducted within in a physics or science class, but in a different subject, called "Entrepreneurial project". It is a cross-curricular subject in which students work project-based on entrepreneurial competences. Examples of these competences are taking initiative, persevering and motivating, financial and economic knowledge, creativity, problem solving,...
At the moment there isn’t a clear framework or curriculum in the school. Not all students and colleagues acknowledge the added value of this subject in the whole curriculum of the school. Therefore, the teacher delivering this course would like to test a new methodology that is suitable for this course. She wanted to start from more clear objectives and also increase the involvement of the students to the entrepreneurial projects.
How did she proceeded? By first setting up central objectives based on curriculum plan and literature (EntreComp). The students had to take a self-evaluation based on these central objectives. While looking for literature and interviewing experts on new methodologies that stimulate entrepreneurship, she developed a new methodology “Design Thinking” in collaboration with expert. She tested a unit that incorporated this methodology which comprehends certain elements of IBL and project based learning. Starting from a question ‘How does your ideal lunch break look like?’ students tried to solve this relevant and meaningful question during a sequence of 15 lessons. Making video recordings and create a weblog to capture notes from the teacher were important data collection tools. At the end a class discussion with students about this new methodology gave a lot of extra information.
Because of the COVID-19 crisis the intervention is not completely tested, but will be continued next school year.

Contact information

Kimara Goethals

E-mail: jan.delange@arteveldehs.be

STRIKE A BALANCE

Špela Gec Rožman[1], Špela Povše Pistotnik[2]
[1,2]*Gimnazija, elektro in pomorska šola Piran*

The subject of forces and Newton's laws are discussed in detail in middle school, when students first encounter vectors. Building equations and expressing the unknown variable are also subjects of middle school mathematics. Why do students face such difficulties solving physics problems? We are looking for methods and ideas on how to help them by teaching both subjects collaboratively.

What are the main obstacles for our students solving problems in regard to balance of forces? To what extent do our students use proper mathematical tools outside math lessons? How many students are able to apply knowledge of Newton's first law and resolving forces to components in an authentic situation?

The group engaged in activity was composed of 25 students, all boys (Electrical engineering program; aged 15-16). This is their first year of physics on high school level. Students were divided in heterogeneous groups determined in advance. The students performed a guided study – the questions were set up in advance, all the groups were solving the same task at a time.

The students were shown an assembly of strings and weights. They were asked to observe the situation and determine the size of the forces in strings. After the calculation of the forces, they compared their value with the measured values. Later we wanted to encourage them to make their own assembly and repeat the action. Students had to detect the angle between the two strings so that the forces in the strings would be equal to the force of gravity on the weight. The transfer of acquired knowledge was tested by an authentic task: how to pull a car out of a ditch using only a rope and a tree on the other side of the road.

The students were less independent than expected, especially with the first task. They did not use the correct labelling of the forces, they did not draw the relevant diagrams of forces, and consequently they did not use the diagrams to solve the task. They needed quite some guidance and motivation to draw the correct diagram of forces. Some problems occurred with identifying the triangle that would enable the use of trigonometric functions. Once the right triangle was recognized, the majority of groups used the correct trigonometric function and consequently expressed the required valuable.

The students were unable to complete all planned activity as it was too excessive concerning their abilities and motivation. For the same reason our tracking of their results was difficult, almost impossible.

We were surprised to see that heterogeneous groups do not encourage group work. Students who considered their knowledge and skill inferior did not contribute to the common goal and were totally dependent on those considered superior.

Our joined activity was nevertheless successful because students had the opportunity to connect their knowledge of physics and mathematics and also it gave us a new insight on how to improve ourselves as teachers. We are already planning new practitioner inquiries on the subject of the usage of linear, quadratic and other functions in high school physics.

Contact information

Špela Gec Rožman, Špela Povše Pistotnik,
Gimnazija, elektro in pomorska šola Piran
Slovenia
spela.gec-rozman@guest.arnes.si, spela.povse-pistotnik@guest.arnes.si

Virtual workshop: Relative motion

[1]**Leoš Dvořák* and** [2]**Mojca Čepič**
[1]*Faculty of mathematics and physics, Charles University, Prague, Czech Republic,* [2]*Faculty of Education, University of Ljubljana, Slovenia*

A set of activities from [1,2] that might be used also in virtual school setting provides experience related to relative motion. Two systems are involved in the study: one system is bound to a railway carriage, the other system is bound to rails and their environment. In this two systems a person moves here and there and the workshop demonstrates by simple activities how observers in the carriage or on the ground see the person's motion.

We will experiment with and discuss the following cases

- Uniform rectilinear motion with respect to the carriage

- Uniform rectilinear motion with respect to the rails

- Uniformly accelerated rectilinear motion with respect to the rails

- Uniform motion perpendicular to the rails

*The workshop was designed and tested by Leoš Dvořak who kindly provided materials, comments and was available for discussion but was unfortunately not able to lead the workshop by himself. Materials in references discuss rotational reference frames as well. Experience provided in this workshop allows for inquire also such frames using instructions [1,2].

References

[1] L. Dvořak (2013) *Inerciální a neinerciální systémy názorně,* Heureka Workshops 2013. Available online: https://kdf.mff.cuni.cz/heureka/sborniky/DilnyHeureky_2013.pdf .
[2] L. Dvořak (2014) *Inertial and non-inertial frames: with pieces of paper and in an active way.* In Teaching/Learning Physics: Integrating Research into Practice, *Proceedings of the GIREP-MPTL 2014 International Conference,* Palermo, Italy, July 7 - 12, 2014, p. 787-793.

Contact information

Dr Mojca Čepič
University of Ljubljana, Faculty of Education
Slovenia
E-mail: mojca.cepic@pef.uni-lj.si

Inquiry-based Learning and 3DIPhE e-book examples

Dagmara Sokołowska[1], Mojca Čepič[2]
[1]Smoluchowski Institute of Physics, Jagiellonian University, Krakow, Poland,
[2]University of Ljubljana, Slovenia

Inquiry-based Learning (IBL) is an active learning method in which students, in order to develop knowledge or find solutions (e.g. to discover laws or trends, measure quantities of objects, confirm the laws, find out the limits etc.), following a scientific method used by researchers in science studies. IBL emphasizes the student's role in the learning process where students are encouraged to explore the scientific issues, ask questions, and share ideas. Instead of memorizing facts and rules students discover them by doing [1]. Unlike traditional teaching, inquiry-based learning involves thorough thinking, action and authentic engagement of learners, thus stimulates and reinforces development of competences, seen as combination of content knowledge, skills and attitudes [2].

One of the objectives of the 3DIPhE project was to reinforce teachers' skills in teaching with use of the IBL method. Teachers' experiences of implementation of IBL at different levels of inquiry are gathered in the 3DIPhE e-book, prepared in the project. During the presentation we will navigate through the e-book structure and show some of the teachers' good practices in IBL and the coaches' IBL examples.

References

[1] M. Artigue, J. Dillon, W. Harlen, P. Lena (2012) *Learning Through Inquiry*; https://www.fondation-lamap.org/sites/default/files/upload/media/minisites/action_internationale/learning_through_inquiry.pdf

[2] *Key Competences for Lifelong Learning*, Luxembourg: Publications Office of the European Union, 2019; https://op.europa.eu/en/publication-detail/-/publication/297a33c8-a1f3-11e9-9d01-01aa75ed71a1

Contact information

Dagmara Sokołowska
Smoluchowski Institute of Physics, Jagiellonian University
Poland
E-mail: ufdsokol@cyf-kr.edu.pl

Practitioner's Inquiry (PI) – 3DIPhE outcomes

Jan De Lange
Artevelde University College Ghent, Belgium

An important outcome of the 3DIPhE project is a course for teachers on how they can conduct a Practitioner Inquiry (PI) in the context of IBL. A corresponding guide has been developed on how to coach a group of teachers doing a Practitioner Inquiry in the context of IBL.

During the 3DIPHE project several iterations of coaching courses have taken place in 4 different countries. Important learnings from these experiences were collected which eventually led to the development of this final course and corresponding guide. The core of this project lies within the combination of doing a Practitioner Inquiry in the context of Inquiry Based Learning within a group of teachers, called a Professional Learning Community (PLC). By making PI more specific in the context of IBL, it supports teachers by giving direction and focus and, at the same time, amplify their teaching methodology of IBL.

The structure of the course consists of 6 PI elements: motivation (*searching for your inquiry question*), inquiry (*formulating the inquiry question*), development (*planning your inquiry*), conducting (*go out there and collect evidence*), analysing (*drawing conclusions from evidence*) and sharing (*sharing is the start of something new*). Each of these elements in this course are devoted to the 3 course pillars: PI-IBL-PLC.

The guide elaborates the 6 elements and provides specific support on how to coach a course on PI in the context of IBL. This includes theoretical background of PI, example structure, activities, protocols, goals, step by step instructions, tips, examples from participating 3DIPhE teachers and alternative protocols and activities.

At this moment the guide is still in a preliminary version but will be finalised in September 2020 and will be distributed via the 3DIPhE website.

Contact information

Jan De Lange
Artevelde University College Ghent
Belgium
E-mail: jan.delange@arteveldehs.be

My experience with IBL in PTI programs

Matej Rožič
School Centre Novo mesto, Šegova ulica 112, SI-8000 Novo mesto, Slovenia

In the 3DIPhE project, I came across a way of teaching IBL (Inquiry Based Learning). Students often perform measurements of experiments according to the instructions given by me, however that by itself is not inquiry. When learning through research, it is necessary for students to plan and carry out investigations about a phenomenon, part of which is an experiment.

I tested the approach to teaching by IBL in the PTI program in two departments, in which 25 students participated in the activity. I set the students the task: "Order the given liquids according to the increasing density of the liquid." Once they had written down the order of samples (their research hypothesis), they had to estimate the density of each liquid to order the samples. They planned an experiment to determine the density, namely to read the recorded value of the volume from the packaging and to measure the mass of the full packaging of the liquid with a scale. For the experiment, they had to select the necessary equipment from the laboratory inventory. The experiment was then performed in pairs for the given liquid packaging, and the values were recorded in a table. Next, the data were processed and calculated in order to estimate the liquid density. Depending on the estimate density the new order of liquids was written down and compared with the hypothesis.

The students were a bit confused at the beginning of the activity, as they encountered this way of working for the first time. With some initial encouragement, they were highly motivated and independent during the activity. During the activity, I was observing their activity and, if necessary, guided them when performing measurements, especially when recording measurements in an organized table. The implementation of the activities and the responses of the students encouraged me to try to use the approach more often in my teaching.

Contact information

mag. Matej Rožič
School centre Novo mesto, Šegova ulica 112, SI-8000 Novo mesto
Slovenia
E-mail: matej.rozic@sc-nm.si

A plastic bottle is all you need

Uroš Medar
Primary school Preska, Preška cesta 22, 1215 Medvode, Slovenia

When I started the 3DIPhE journey my knowledge of IBL was very pour. Then I started discovering it and I thought that you always have to do all the steps from the beginning. Now I know you can do it differently and from different angles.

I did a small PI to see if my students can think of different inquiries based on a plastic bottle. I showed my student a plastic bottle with 5 holes in it and asked them what they could inquire with it. They started giving ideas about inquiries such as *How the number of holes affects the time to empty the bottle*, *How the shape of the bottle affects the length of the water jet* … So I prepared different experiments for their IBLs, based on their inquiry questions.

To accompany students' work systematically, I followed the practitioner inquiry (PI) approach. During this PI I also saw how bad they were at reporting their results. Most of the students didn't understand what the team wanted to present. The teams didn't know where to begin, how to interpret their results. One of the groups even forged their results because they could not believe the results.

Based on the facts I gathered in this small PI, I learned two things:

1. I have to start IBLs from different points of the process so the students can start thinking in a different way.
2. My students and I have to seriously improve in analysing, interpreting and reporting the results gathered in the IBLs.

Contact information

Uroš Medar
Osnovna šola Preska
Slovenia
E-mail: uros.medar@gmail.com

How do students perceive the physics lesson on the subject of the electromagnetic induction carried out via an IBL method?

Roman Klara
Podkarpackie Centrum Edukacji Nauczycieli in Rzeszów – Oddział w Krośnie
(Podkarpackie Teachers' Training Center in Rzeszów – Department in Krosno)

The topic of my examination was students' perception of the physics lesson regarding electromagnetic induction. The lesson was carried out in Zespół Szkół Elektrycznych and Ogólnokształcących in Krosno (known as „Elektryk in Turaszówka") in December 2019 r. It was presented to the 3rd-grade high school students majoring in Mathematics and Physics. In total, 21 students, male and female, divided into two groups, took part in the class exercise (with the first group being 10 students, and the second - 11). The students carried out individual work in groups of 3 to 4, with the help of instructions on the exercise sheet. The working method could be described as a guided inquiry**.**

The day after the lesson, I met with the whole class, conducted a survey as well as talked with students about their feelings and impressions left after the lesson. The question I had risen was: „How do the students respond to the physics lesson on the subject of the electromagnetic induction carried out via an IBL method?". The research hypothesis set by me was as follows: „Students' response to the physics lesson on the subject of the electromagnetic induction carried out via an IBL method is in majority positive".

The results of the survey, combined with personal notes done during class observation and talks with the students, let me validate the research hypothesis. The students rated as 'very high' and 'high' such elements of the lesson carried out via an IBL method as the possibility of avoiding the fear of failure, opportunity of-coming to conclusions on their own pace, working in small groups, discussing the way of solving the problem between the members of the group, to reach the right conclusion on their own, and to gain knowledge based on 'trial and error'. While sharing their experiences of the physics lesson on the subject of the electromagnetic induction carried out via an IBL method the students wrote/said i.e.: *„I like this way of carrying out lesson*", *„working in groups can teach us a lot more than just listening to the teacher", "because you learn how some phenomena occur on your own, you can understand them way easier", "I believe these kinds of lessons are more stimulating than the 'normal' ones".*

Results of the experiment are yet another argument for introducing the IBL method to schools.

Contact information

Roman Klara
Podkarpackie Centrum Edukacji Nauczycieli in Rzeszów – *Department in Krosno*
Poland
E-mail: rklara@pcen.pl

IBL ON PHYSICS LESSONS ... IN THE EYES OF A STUDENT

Małgorzata Szymura

Zespół Szkół w Czerwionce-Leszczynach (Complex of School in Czerwionka-Leszczyny)

I am high school physics teacher in Complex of School in Czerwionka-Leszczyny where I try to interest my students in my subject. For this reason, I like to use various innovative teaching methods in my lessons.

I have been running the "Kamerlik" Young Explorer Club for 5 years. These are extra activities for students. In these classes I use IBL (inquiry based learning) which fascinates me a lot. That's why I decided to introduce this method to regular physics classes.

In my school I guided some pedagogical innovation, called: High school student as scientific researcher. I chose one 1st class where I taught 1out of 4 lessons per week with the IBL method. It lasted from October 2018 until April 2019. During the inplementation this innovation, I conducted my Practitioner Inquiry to get the answer: How do students perceive IBL in phisics lessons? I performed surveys, tests and interviews with students. I prepared recordings of my lessons and analyzed student responses.

During my presentation I want to present the results of these tests. I will also present conclusions and my recommendations for further work. I hope that my experiences will be interesting and helpful to the audience. .

Contact information

Małgorzata Szymura
Zespół Szkół w Czerwionce-Leszczynach (Complex of School in Czerwionka-Leszczyny)
Poland
E-mail: Gosia-czka@wp.pl

Different didactic approaches of teaching while working remotely

Vesna Kotnik, prof.
Vojnik Elementary School

People differ in which sensory channels we prefer to communicate, learn and present. Therefore, when teaching, we must also pay attention to the different learning styles of students. We need to design and adapt the way we teach to suit as many learning styles as possible. When teaching at a distance, we are sometimes limited in didactic approaches. This paper presents the most efficient method for teaching 5th grade students social sciences. Using different didactic approaches (visual, auditory and sensory-emotional/kinesthetic style), I investigated which one is the most productive. The study was performed during COVID-19 isolation with a small group of 5th grade elementary students at a rural environment. I did an extensive survey at the end of isolation as well as oral examination during the learning process to determine the extent of knowledge. Results show agreement with my theoretical predictions that the audio-visual learning style is the most efficient. The work presented here may help improve teaching and working from a distance in the future.

References

Marentič Požarnik, B. (2000). *Psihologija učenja in pouka.* Ljubljana: DZS

Contact information

Vesna Kotnik, prof.
Elementary School Vojnik
Slovenia
E-mail: vesnapkotnik@gmail.com

Distance learning and online exams

Marija Žigart
Secondary School of Hotel Managment and Tourism Maribor, Slovenia

During the time of the pandemic teachers were faced with a difficult task. The teaching process had to be moved online almost overnight. Some of the teachers at our school have already been using virtual classrooms prior to the pandemics, so my first thought was that lessons will be held in the online classrooms. We certainly did not expect distance learning to become such a continuous part of our lives – we suddenly had to explain the subject, asses children's knowledge and give them a final grade all online. However, teachers have been constantly learning and gaining new knowledge in the field of technology use. That is why we managed to conclude this school year successfully.

For the first 14 days, I only worked with the virtual classroom *Moodle,* where clear instructions for its use and a description of work were given. I explained to my pupils, what their weekly assignments are. They were given links to important readings, a quiz to consolidate their knowledge, study sheets and a deadline for submission of homework to the virtual classroom. The students had to make their own notes and solve the assignments. Then they had to take a photo of their work and submit it to the virtual classroom. I checked their submissions regularly and gave them weekly feedback on their work. I notified the class teachers, if a student was not participating.

I soon realised how important live contact between teachers and students is. Therefore, I started to use the online platform *Zoom.* I had at least one *Zoom* physics and mathematics lesson per week in each of my classes. To explain new contents and to enable better notetaking I prepared PowerPoint presentations, which I supplemented during my lesson. I uploaded the presentations to the virtual classroom, so the student had access to it at all times. I tried to elaborate my explanation with relevant online videos and other e-learning materials. For the students with special needs, I prepared visual guides and recordings of my explanation on the topic. The children's knowledge was consolidated and checked with the help of online quizzes, such as *Socrative, Kahoot, Quizizz* and the *Moodle* quiz option. The application *Quizizz* has proven to be the most appropriate quiz for assessing knowledge in physics and mathematics. It allowed the use of mathematical symbols and formulas, of various photos and videos. It is also very useful for the evaluation of knowledge. It is easy to use, and it offers a simple analysis of the results. The only downside is that it requires a user registration.

I also used the *Padletlet* application for remote work; I prepared instructions, explanation of materials and links for submission of the weekly assignments. The students had to submit photos or videos of their homework and various presentations. They were also able to calculate the carbon footprint with the help of *UMANOTERA* calculator.

During the pandemic, I used quite a few other applications that allowed me to stay in touch with my students. Together we successfully completed the school year. We cannot be sure what will happen in autumn, but if we will still have to hold classes online, we will probably start using applications such as *MS Teams* and other new online tools.

Contact information

Marija Žigart
Srednja šola za gostinstvo in turizem Maribor
Mladinska ulica14 a, 2000 Maribor, Slovenia
marija.zigart@ssgt-mb.si

Impact of the SARS-CoV-2 pandemic on pre-univesity physics education: Croatian teachers' point of view

Ivana Štibi[1], Mojca Čepič[2], Jerneja Pavlin[2]

[1]*Department of Physics, J. **J. Strossmayer University of Osijek,** Osijek, Croatia*
[2] *Faculty of Education, University of Ljubljana, Ljubljana, Slovenia*

Physics is one of the natural sciences based on experiments, measurements, mathematical analysis and theoretical models of nature. Both experiments and theories are important in physics lessons and complement each other. Physics education, which formally begins at lower secondary school, continues through upper secondary school, and up to university, is therefore extremely demanding. Due to the SARS-CoV-2 **(**COVID 19) situation, all schools in Croatia were completely closed down on 16.03.2020 and start was made with "Škola na trećem" and virtual classrooms. Based on this, the study was designed to investigate how this COVID 19 closure affected the teaching and learning of physics, more precisely the effects of long absences from school, alternative teaching, experimental work and learning methods.

The study relies on both quantitative and qualitative PER methods. In the qualitative part, semi-structured interviews were conducted with at least 5 teachers of lower and at least 5 teachers of upper secondary schools. Based on the results of the interviews with the teachers, an online questionnaire was designed, which is suitable for a wide range of physics teachers in the population, and covers the whole of Croatia. We collected 179 responses from teachers (28.7% male and 71.3 % female). If we know that in Croatia are 916 elementary schools and 443 high schools (246 those which have at least one year of physics), then percentage teachers who answered (71,9 % teachers from elementary and 28,1 % teachers of high schools) the online questionnaire is rather good.

These results are of an utmost value at the present state, because the whole world has been confronted with similar distant learning conditions. The unique insights into physics education in such situations, can be used to develop protocols that can be used when distant learning becomes a necessity due to similar or different circumstances. Furthermore, the results will provide insights into the flexibility and responsiveness of physics teachers. Information on topics, about which the entire generation of students is less informed due to COVID-19 absence from school, is also of great importance for later teaching later. The contribution will presented the results of the conducted study in details.

Contact information

Ivana Štibi
Department of Physics, J. J. Strossmayer University of Osijek,
Croatia
E-mail: istibi@fizika.unios.hr

Physics lessons in Slovenian primary and secondary schools during the SARS-CoV-2 pandemic

Ivana Štibi[1], Manca Hafner[2], Mojca Čepič[2], Jerneja Pavlin[2]

[1]*Department of Physics, J. J. STROSSMAYER UNIVERSITY OF OSIJEK, Osijek, Croatia*
[2] *Faculty of Education, University of Ljubljana, Ljubljana, Slovenia*

In Slovenia, due to the SARS-CoV-2 epidemic, primary and secondary schools were temporarily closed on 16 March 2020, which had an impact on the way teaching is organised, including physics lessons that encourage experimentation. In Slovenia, similar to Croatia, school closures started on the same day and a study on the impact of the pandemic on physics teaching and pre-university learning was planned in Croatia. Therefore the online question on physics teaching was prepared. It consists of 5 parts: general data, implementation of physics teaching during pandemic COVID 19, experiments in physics teaching, sociological component, exchange of experience about pandemic COVID 19. The prepared questionnaire was translated into Slovenian and the survey was also conducted in Slovenia. The questionnaire was filled in by 154 Slovenian teachers, about 3/4 of whom teach in primary schools. During the pandemic, 23% of the teachers taught physics and 51% physics and mathematics.

The results show that teachers of physics are confident in using computers. They are also familiar with the more advanced use of mobile phones and video conferencing programs. E-mail (84%) and zoom for video conferencing (63%) were the most commonly used tools for communicating with students during the pandemic. Direct instructions (videoconferencing) were always given by about one tenth of respondents, often by almost a third. A good fifth of teachers did not give direct instructions. Half of the teachers conducted no experiments or only rarely. They report that during the pandemic, students received 1 mark, usually through a test. Teachers report on the many challenges of distance learning related to new technologies, communication, their own challenges in teaching from home, the nature of the experimental subject, growth opportunities, production of teaching and learning materials, etc. In the contribution, we will present the preliminary results of the survey of Slovenian teachers of physics.

Contact information

Dr Jerneja Pavlin
University of Ljubljana, Faculty of Education
Slovenia
E-mail: jerneja.pavlin@pef.uni-lj.si

3DIPhE Practitioners Meet (for 3DIPhE teachers and partners)

Mojca Čepič[1], Ana Gostinčar Blagotinšek[2]

[1] University of Ljubljana Faculty of Education, [2] University of Ljubljana Faculty of Education

"Meet your colleagues" is an opportunity for all teachers from PLCTs to meet virtually – as it is impossible to do it in person. Throughout the conference there will be also a (Zoom) chat room opened to enable participants to meet, chat, discuss and establish contact. "Meet your colleagues" meeting is focused on sharing 3DIPhE experiences and outline the course for some future actions.

To make exchange and sharing more efficient, participants will first meet in smaller groups and then gather in Zoom chat room 1 for reporting on summaries to all participants. We developed a short protocol for this meeting to go through it as efficient as possible.

The questions to help sharing are:

Who are you? (personal/professional profile)

Why have you joined the project? (passion?)

What have you learned from/What was your benefit of being part of 3DIPhE Project?

What expectations do you have for the future (STAMPEd Project)?

As the time for the meeting is limited, please, reflect on your answers in advance. You are also kindly invited to visit chat room as often as possible for further discussions.

Contact information

Dr Ana Gostinčar Blagotinšek
University of Ljubljana Faculty of Education
Slovenia
E-mail: ana.gostincar@pef.uni-lj.si

Pre-service physics teachers' knowledge and understanding of mandatory experiments

Damienne Letmon and Eilish McLoughlin

CASTeL, School of Physical Sciences, Dublin City University, Dublin 9, Ireland

This practitioner inquiry was carried in the context of the 3DIPhE Irish professional learning community of experienced teachers. The aim of this inquiry was to investigate Physics Pre-Service Teachers (PSTs) prior knowledge and understanding of the role of mandatory Leaving Certificate physics experiments - a set of 24 experiments that have been assigned as mandatory for pupils to complete as part of their final two years of second level physics. The participants in this study were a group of seven PSTs who were facilitated to plan and carry out six of the mandatory experiments and submit a written laboratory report for each experiment. The PSTs were introduced to the relevant physics topics using a range of different approaches, e.g. a sketch of apparatus set up or a circuit diagram. The PSTs decided on what data they would collect and how they would analyze their findings. The PSTs communicated their findings and discussed their understanding of the related physics concepts. The inquiry examined the PSTs laboratory reports across the knowledge domains of Content, Procedural and Epistemic Knowledge. This presentation will share approaches used to introduce experiments, e.g. to investigate the variation of current with potential difference. In this case the PSTs were presented with labelled circuit diagrams and were required to identify circuit components and build their own circuits. The PSTs had much difficulty in constructing circuits based on the circuit diagram and explaining the direction of flow of current. The overall analysis of the laboratory reports revealed that PSTs exhibited a lack of knowledge across all three knowledge domains. This lack of PSTs knowledge and understanding of core physics concepts raises concerns about their ability to facilitate inquiry approaches to teaching and learning in physics.

Contact information

Damienne Letmon
Dublin City University
Ireland
E-mail: d.letmon@gmail.com

How the gender structure of student groups affects effectiveness of IBL implementation during science classes

Beata Sobocińska
XLII High School in Krakow, Poland

The aim of the project was to implement IBL method in science lessons on physics topic and to conduct Practitioner Inquiry in order to answer two research questions:

1. To what extend the implementation of IBL increases the effectiveness of teaching physics?

2. How the gender structure of student groups working in IBL influences effectiveness of teaching by inquiry in science classes on physics topics?

The intervention took place in the second grade of high-school students (K-10) during implementation of four teaching units on energy in class divided into several groups of four students: only girls, only boys and mixed gender. The results were compared to the results of the control class taught traditionally.

Various tools and working methods were used: experiment, laboratory worksheet, students' self-assessment, multimedia presentation, rubrics (assessment of thinking skills and scientific argumentation), lesson observation protocol, worksheet, short test, questionnaire for students participating in the project, consensogram.

The research shows that comparing to the traditional method, the results obtained by the class taught in IBL were definitely higher, which proves the effectiveness of the method. Teaching with the use of IBL led to diverse results depending on the gender structure of individual groups. The effectiveness of content knowledge acquisition was higher in mixed-gender groups and in groups of boys than in the group of girls. However, during the phases of planning and conducting the experiment - the groups of girls were much more creative than their colleagues. Regardless of the learning outcomes, the method was very much appreciated by all students. We conclude that it seems necessary to use the method more frequently to unequivocally determine the correlation between its effectiveness and the gender type of student group in which it is applied.

Contact information

Beata Sobocińska
XLII High School in Krakow, Poland
Poland
E-mail: beata.sobocinska123@gmail.com

Investigating physical properties of pendulums: three experimental approaches

Andreja Eršte

School Centre Novo mesto, Šegova ulica 112, SI-8000 Novo mesto, Slovenia

Experience-based learning is an important aspect of physics education and provides students first-hand experience of a given phenomenon. As educators we have several options regarding how students can conduct experimental work in classroom environment, from closed concept experiments with set tasks to completely open concept experiments. When selecting tasks we want students to perform, we are often faced with constrictions and questions regarding time, depth and width of the topic, materials used, etc. In this contribution, three conceptually different experimental approaches for investigating the physical properties of mathematical and spring pendulums for high-school students' laboratory exercises will be presented. All experiments were performed by 2nd year high-school students, SSI programme engineering technician during school years 2018/19 and 2019/20.

First approach used a guided laboratory exercise [1] performed by students after all theory was explained during lessons – here the purpose of the exercise was to re-confirm the properties of pendulums (e. g. the influence of pendulum length on single-swing time of a mathematical pendulum). In other two approaches, no theory regarding the influence of pendulum properties on swing-time, velocity, etc., was explained to students before the experimental work. In the second approach, the students had to draw their own conclusions using the same set of instructed exercises [1] as used in the first approach. The third approach was set-up as completely open concept exercise, in which students were given the task of setting up their own experiments in order to determine the physical properties of pendulums. The work presented here compares the use of various concepts of laboratory exercises and may shed some light regarding selecting and implementing experimental work in order to enable students to investigate physical properties of a given phenomenon.

References

[1] I. Tomić, M. Forjan (2018) *Zbirka Laboratorijskih vaj iz fizike*. Šolski center Novo mesto, Tiskarna PRESENT d. o. o., Novo mesto, p. 113 – 120.

Contact information

Dr. Andreja Eršte
School centre Novo mesto, Šegova ulica 112, SI-8000 Novo mesto
Slovenia
E-mail: andreja.erste@sc-nm.si

Use of online tools during covid-19

Jasmina Petek Pelcl
OŠ Ljudski vrt Ptuj

This school year has been a real challenge for teachers. We first encountered remote education, and we had to adjust overnight. We found ourselves in a dilemma, which online tool to use, how to present the teaching material and how to check or assess pupils' knowledge. In this article, I will present which online tools we used and how we evaluated the acquired knowledge of pupils.

Initially, communication with pupils took place via e-mail, but due to the large number of messages, there was no overview of pupils' work, and the material of each subject was not collected in one place. That's why we set up the Moodle classroom. The pupils used a mobile phone a lot and did not know how to submit assignments to Moodle, so we later set up a Google classroom, which proved to be the easiest and most effective to use. All the material was collected in one place, and the pupils were able to submit the material very easily by phone.

We explained the material to the pupils by making a board picture, preparing a video or live via videoconference. We recorded the videos in the Interwrite Workspace. This program contains a gallery with mathematical functions and symbols and is also used in school to work on an interactive whiteboard. Videoconferencing was conducted through Jitsi meet and later Zoom. We also uploaded videoconferences and videos to the online classroom. We used a graphic board to explain the learning material and evaluate the knowledge, because this was the easiest way to give the pupils feedback on their knowledge.

To test and assess knowledge, we used the Goformative online tool, which is freely available on the internet. Goformative is an online learning environment that allows pupils to evaluate their knowledge and provide immediate feedback on the correctness of the answers. In doing so, it is important to select appropriate learning chapters for online evaluation of knowledge and tasks of different taxonomic levels.

During remote learning, we learned a lot of new things, especially when using online tools. In doing so, it is important for the teacher to choose such learning tools that are simple and effective to use, and it is best that they are useful both for remote work and in the classroom. With the transition to the virtual world, it was necessary to adapt the delivery of learning material and learning. Teachers quickly found that online tools allow for good delivery of learning material, but not in the same way and with the same intensity as in the classroom. In addition to the lost personal contact with teachers and classmates, the disadvantage of remote education is that the teaching material has not been sufficiently processed and well consolidated. The good side of remote education is that pupils were able to choose when and where they will learn, and above all, they became more independent and responsible for their knowledge. Together, we gained invaluable experience and new knowledge in the field of online education.

Contact information

Jasmina Petek Pelcl
Osnovna šola Ljudski vrt Ptuj, Župančičeva 10, 2250 Ptuj
Slovenija
jasmina.petek@os-ljudskivrtptuj.si

Teaching physics during COVID-19

Natalija Podjavoršek
Primary school Ledina, hospital school in Ljubljana

At the hospital school, we teach children who are unable to attend their local school during illness. I teach them math and physics. Sick children are in the hospital only on therapies, but time when they have to be at home is longer and longer. This is the reason why we started distance teaching 10 years ago. We use the VOX videoconference system for teaching. At the beginning of March 2020, when COVID-19 closed all schools in Slovenia, I already had a lot of experience with distance teaching. Sick children can choose subject where they need the help of a teacher. There is always a lot of requests for physics. Students have many problems with physics themselves. They can't learn physics from books. Not only sick children, but also healthy children ask me for help during this time. I teach all the sick students with videoconferences, but I didn't have enough time to help also other children in such a way. But I wanted to help them too. Those children were children's of my friends. I started making video explanations of basic physics laws.

Video lessons have to be even more interesting than classroom lessons. A lot of visual material should be included. If it is possible to include any experiments it is great. I tried to include many experiences from everyday life. The explanation should be supported by good notes on the board. The graphic pen is a great help for this. Video lessons shouldn't be too long. No more than one minute of video lessons for each year of a child's age. Here is an example of such a video lesson https://www.youtube.com/watch?v=eEToEfTvRp0.

I prepared 25 such videos for physic and also some for mathematics. I published my video lessons on my Youtube channel and on the portal Razlagamo.si. The video material was used by many children from all over Slovenia. Sometimes I also told my sick students to watch a certain video lessons for homework. They also made notes. The students enjoyed learning with the video explanations. If they didn't understand something on the first run, they could play it multiple times. I also prepared some quizzes with which the students could check how much they had learned. On videoconference I had enough time to explain things that were hard for students to understand and together we were able to solve a lot of problems. So we started to do flipped learning and teaching.

My plan is to prepare video material for all basic physic content in primary school by the end of September 2020. I would also like to prepare some quizzes to test knowledge. Everything will be made public and put to use. If students watch a video lessons for homework, there will be plenty of time during class for experiments. I believe this would be a great benefit to all students.

Contact information

Natalija Podjavoršek
Hospital school in Ljubljana, the part of Primary school in Ljubljana
Slovenia
E-mail: Natalija.Podjavoresek@bolnisnicna-sola.si

Impact of COVID-19 crisis on science teaching and facilitation of practical activities in Irish schools

Ruth Chadwick & Eilish McLoughlin
CASTeL, Dublin City University.

Due to the COVID-19 crisis the Irish government called for the emergency closure of all schools in March 2020. Over the following months teachers strived to continue to provide high quality learning experiences for their students and meet the curricular demands of their subjects through distance learning. This research aims to explore the impact of the COVID-19 crisis on science teaching, learning and assessment in Irish primary and second-level schools. The data presented in this study was collected through a national survey of primary and second-level teachers. Participants included 107 primary teachers, teaching science as part of Social, Environmental and Scientific Education (SESE), and 172 second-level science teachers responsible for one or more of Junior Cycle Science, Leaving Certificate Biology, Chemistry or Physics. Participants completed an online questionnaire exploring their experience of teaching science in the weeks leading up to and during the COVID-19 school closures. The questionnaire included both closed and short response questions and a mixed methods approach to analysis was employed. Data was analysed quantitatively, using SPSS, and qualitatively, using thematic analysis. Findings indicate that the school closures had a 'somewhat negative' impact on teachers' capacity to support student learning, differentiate, gather evidence and assess/make judgements based on this evidence, and facilitate practical activities. While the use of learning technologies increased during the school closures, facilitation of practical activities decreased. This study highlights the impact of the COVID-19 school closures on a range of aspects of teaching, learning and assessment in science, and will discuss the positive aspects and challenges faced by teachers.

Contact information

Ruth Chadwick
Dublin City University
Ireland
E-mail: ruth.chadwick@dcu.ie

Distance physics lessons at Primary School Prule

Matjaž Pintarič

Teacher of physics and technique and technology at the Primary School Prule in Ljubljana

At the time of distance learning, I taught physics to 126 students aged 13 to 15 years. I tested myself in various areas of giving material and collecting student responses. I was aware that I had to prepare the material in such a way that most students would be able to use it also with their phones. In addition to using the textbook and workbook that each student had at home, I also used other activities that could be done online to discuss the new content. For the students, I recorded my PowerPoint presentations and added my voice comments to them and posted on a YouTube channel that is easy accessible to everyone also over the phone. I included my own and other video presentation experiments in the videos. I stuck to the fact that the prepared video was no longer than 5 minutes. When working remotely, students also used physical online simulations and solved online quiz tasks that I created with Google forms. I followed the activities of the students in four ways:

- by checking responses of students after they solved a quiz,

- by checking responses of students solving interactive tasks on the webpage ucimse.com,

- by reviewing of solved worksheets with the help of online experimentation on the webpage fizikalne.simulacije.si, that the students sent me,

- by reviewing the photographed solved workbooks that the students sent me.

As an agreement at the school, the teachers wrote down the children's activities on a weekly basis in a joint list for the class teacher. Results of student activities were so presented to the students and occasionally also to their parents.

I see the disadvantage of distance learning in the fact that 30-50% of the students were not active in physics lessons. I think the reason for this is the fact that the current work was not awarded with a grade. All students already had enough grades for the completed grade and certain students did not prepare or study the last material. Nevertheless, the assessment (grades) on last test were good on average, students got 70% of all points.

Contact information

Matjaž Pintarič
Osnovna šola Prule
Slovenia
E-mail: matjazpintaric@gmail.com

IBL workshop on Spaghetti Bridge

Dagmara Sokołowska
Smoluchowski Institute of Physics, Jagiellonian University, Krakow, Poland,

Inquiry-based learning can be very challenging for both, teachers and students, since it combines in one class the acquisition of content knowledge, development of manual and research skills, strengthening of social skills, and on the top of all that – also revilement and reinforcement of creativity. The most challenging, however also the most exciting and motivating for students, is to practice inquiry-based learning at the highest – open level, when students have the most independence in completing the experimental tasks.

The set of topics for practicing open inquiry is endless. We chose for the workshop the Spaghetti Construction topic, based on the idea of Spaghetti Bridge annual competition started in Okanagan College in British Columbia in 1983. The competition is open to contestants around the world, however the rules state that contestants must be full-time secondary or post-secondary students. So far the world record belongs to Norbert Pozsonyi and Aliz Totivan Szechenyi Istvan University of Gyor in Hungary who managed to build the bridge supporting the weight of 443.58 kg before shattering [2].

During the workshop the participants will be asked to build the construction at least 25 cm high, using only one package of spaghetti (500 g) and any kind of material sticking the spaghetti threads together (warm glue, blue tack, plasticine etc.). The construction is supposed to support one can of any soda drink (330 ml) for at least 90 s.

References

[1] Spaghetti Bridge on Wikipedia: https://en.wikipedia.org/wiki/Spaghetti_bridge
[2] https://www.youtube.com/watch?v=_pejHjPJlcE

Contact information

Dagmara Sokołowska
Smoluchowski Institute of Physics, Jagiellonian University
Poland
E-mail: ufdsokol@cyf-kr.edu.pl

Weight of unknown object

Jasmina Žel
Osnovna šola Ljudski vrt Ptuj, Slovenia

More and more pupils in primary school do not show interest in learning science subjects. In physics, we use experiments for easier understanding of the content and greater clarity, and last but not least, for enriching the lessons. Pupils love to experiment and explore. Many times their work is too guided and later they do not know how to use the knowledge acquired through experimental work. I did a inquiry activity with eighth graders, where they had to find, without weighing, what the weight of an unknown object is and how the force and elongation of a flexible body are interdependent (the Hooke’s law). In the case of Hooke's law I also wanted to show, that the share of pupils who know how to use the acquired knowledge in new cases, increases, if they independently inquire and record findings.

I conducted the practitioner’s inquiry in parallel in three classes (8. A, 8. B, and 8. C). Initially, I asked pupils an inquiry question on how to determine the weight of an unknown body, such as a pencil case, without weighing it. They had flexible bodies (spring, elastic), ruler, weights, bottles, water and stand. In classes A and B, the pupils drew up the research plan themselves, in class C the experimental work was guided by instructions in the workbook. At the end, everyone had to draw graphs and write down the findings. I checked the acquired knowledge with a calculation task, which the pupils have solved poorly in the past years.

Initially, pupils in classes A and B had some problems. Mainly by conducting inquiry, the method of recording and displaying measurements, and measuring the elongation of the spring, as they forgot that the unloaded spring has an initial length. Pupils in class C were guided and had no major problems with the experiment. Most of them had difficulty drawing a graph due to a lack of mathematical knowledge. On average, pupils in grades A and B solved the arithmetic task better. Pupils with weaker learning results were also successful. They had difficulty only in reasoning.

Pupils in all three classes successfully found out through inquiry and independent experimentation how the elongation of a flexible body depends on the force acting on it. The knowledge gained through inquiry can be used by most pupils well in new situations and in computational tasks. This way of work was very much appreciated by the pupils. They were active and motivated. In the future, I will meaningfully include learning by research in as many hours of lessons as possible.

Contact information

Jasmina Žel
OŠ Ljudski vrt Ptuj
Župančičeva 10, 2250 Ptuj, Slovenia
e-mail: jasmina.zel@os-ljudskivrtptuj.si

Which is bigger: one liter or one kilogram?

Maja Ilar
Osnovna šola Kašelj

In my professional work which is teaching mathematics and physics pupils aged between 11 and 15, I often realize that understanding of quantities and units is one of the most challenging concepts that we all – teachers and pupils – have to deal with.

In the first years of my teaching I teached those concepts very superficially, but soon I faced the fact of inefficiency of their knowledge. For example, my pupils were able to convert from ml to dm^3, but they did not recognize the quantity that can be measured by graduated cylinder that was shown in the picture. Some pupils even found this measuring device most suitable for measuring the temperature and the unit would be millilitre, which was even more interesting to me. At my beginnings I was often shocked.

So I gradually changed my way of introducing this area of physics to my pupils. And this led to even bigger shocks. My project for this year was to investigate how are my pupils in 9^{th} grade confident in measuring the mass and volume and how they are able to distinguish between these two quantities. For these purposes I created an experimental activity and a set of questions for pupils before and after the activity.

Few examples of challenging questions are:

- A girl has 100 g of water and a boy has a 100 ml of water. Who has more water?
- 1 kg of flour has volume 1 l. Which is bigger: 1 l of water or 1 kg of flour?
- The density of oil is 0,81 g/ml and the density of water is 1 g/ml. What is more: 1 g of water or 1 ml of oil?

The analysis of their answers confirmed my expectations and previous experiences. The next step was to form pupils in groups of 4 and to shortly explain the practical task, which was to prepare required amounts of given substances (water, oil, flour, oat etc.) The amounts of substances were given in different units (for example: prepare 100 ml of oil and the same amount of flour, 81 g of oil and the same amount or flour) which created a lot of cognitive conflict in their learning process. During this process pupils were expected to realize that the crucial part is to determine which quantity they observe. In advance they could observe that in some cases the amounts of different substances are the same and in other cases only one quantity is equal. My wish was that pupils would be able to link this with density.

After these activities another set of questions (similar to previous one) was given to pupils. In this time the analysis showed much better results. After performing activities pupils actually started to talk about density while trying to explain the phenomena. For these objectives I found my research effective but still some adjustments would be needed in further occasions.

References

Inspired by pupils and IBL programme.

Contact information

Maja Ilar
Osnovna šola Kašelj, Slovenia
E-mail: maja.ilar@oskaselj.si

What kind of a classroom desk arrangement during the physics lesson conducted by the IBL method contributes to the development of social competences of students at risk of social maladjustment?

Monika Jurek
Młodzieżowy Ośrodek Socjoterapii w Ustce

Working with students at risk of social maladjustment requires reflection on their own workshop and continuous search for methods and forms of work adapted to the needs and capabilities of students. While participating in the 3DIPhE project, I decided to examine whether the arrangement of classroom desks during classes conducted with use the IBL method has an impact on developing the social competences of my students.

The concept of 'social competence' is very broad and defined in various ways. I assumed that social competences are interpersonal skills that allow students to make contact with other people, facilitate group work and social functioning. A class of eight students aged 14-16 took part in the study. Using the initial survey, class observations, conversations with students and the final surveys, it was evidenced that students really like working independently, looking for solutions, and drawing conclusions.

The results show that the arrangement of classroom desks has an impact on social competences shaped and consolidated at a given moment. When setting desks into islands, the ability to work in a group, exchange of experiences, mutual assistance, putting forward joint hypothesis, verification and drawing conclusions are developed. A horseshoe arrangement increases the skills of communication, dialogue and listening to others. These results should encourage teachers to think over the changes in the classroom arrangement in order to enhance the opportunities for full development of all students.

Contact information

Monika Jurek
Młodzieżowy Ośrodek Socjoterapii
w Ustce
Poland
E-mail: jurmonika@gmail.com

What is wrong with mechanical energy conservation?

Marko Rožič
Osnovna šola Drska, Ulica Slavka Gruma 63, SI-8000 Novo mesto, Slovenia

Mechanical energy conservation is often assumed when discussing mechanical energy transformation with pupils in primary school during Physics class activities, e.g. elastic energy of the bowstring is equal to kinetic energy of the arrow soon after arrow leaves the bow. It is seldom that pupils are able to find reasons for mechanical energy losses and confirm them with calculations. The main reasons for that might be due to difficult mathematical model needed for calculations, or the lack of appropriate laboratory equipment for measuring all needed parameters. In order to shed some light on this matter, this presentation will show an exercise where pupils performed an experiment in which mechanical loses can be accounted for.

The pupils of 9th grade proposed to conduct an experiment during the discussion of conservation of mechanical energy using a cart, light rope, spring, and some sensors. One end of the rope was tied to the cart; the other was tied on the spring, which was fixed to the wall. When the rope was aligned, the spring was expanding while the cart was moving. When the cart was being pushed away by the spring, kinetic energy of the cart was determined. Theoretically, all kinetic energy of the cart should be transformed into elastic energy of the spring. However, when pupils compared kinetic energy of the cart to elastic energy of the spring, the values were different, i.e. elastic energy of the spring was lower in comparison to kinetic energy of the cart. Pupils then tried to find an explanation of this phenomenon and suggested that main reason for energy losses is energy of longitudinal waves occurring in the spring, which was difficult to determine on primary school level. On the other hand, the occurrence of the waves in spring itself was quite easy to prove simply by attaching one end of the spring to a sensitive force meter. The experiment revealed (i) when spring was slowly pulled, there were no waves in spring, and (ii) that waves appeared when spring was pulled quickly and a closer look to the spring revealed waves to be longitudinal. In the end, pupils suggested that using a shorter and much stronger spring should minimize energy losses, as no standing waves in spring should occur, although the deformation of the spring would be difficult to measure.

Contact information

mag. Marko Rožič
Osnova šola Drska, Ulica Slavka Gruma 63, SI-8000 Novo mesto
Slovenia
E-mail: rozicmarko@gmail.com

Physical phenomena - independent learning

Nataša Jelen
Osnovna šola Tončke Čeč Trbovlje, Slovenia

During the distance learning course, I wanted to find out if the students have progressed in these long two months in terms of independence and innovation, how much they are able to put their inquiry, either theoretical or practical, on paper and present it in front of the board. The results have been surprising many times - and the main purpose of my inquiry has been confirmed (at least for me) - primary school students are by no means mature enough to study at a distance.

Contact information

Nataša Jelen
Osnova šola Tončke Čeč Trbovlje,
Slovenia
E-mail: natasa.jelen@guest.arnes.si

Applied mathematics project: Renovation of my room

Anja Smrtnik
OŠ Preserje, Slovenia

For many students mathematics can seem irrelevant and unnecessary. Many of them ask “When will we ever need to use this?!” During the pandemic, when we were all forced to start remote learning, it was even harder to motivate students to learn. I spent a lot of my time thinking about how to make learning more interesting and effective for my students.

I put together an applied mathematics project that covered all the knowledge and skills that students are expected to master by the end of the 7th grade. Students had to put a lot of effort and their time to complete that project. However, in the end it was all worth it. Using all the mathematical processes, they have accomplished the assignment.

Applied mathematics projects can make mathematics interesting, while also showing the real-world value of certain concepts. For students who are struggling to get excited about mathematics, such projects can make the subject exciting and relevant.

The students’ responses to this project exceeded my expectations. The assignments were finished with very good results. Students were impressed by the work they have done and were surprised to learn how relevant and how much fun mathematics can be. From this experience, I also learned that all the effort invested in work as a teacher eventually pays off. I decided to use applied mathematics projects more often in my professional work.

Contact information

Anja Smrtnik
OŠ Preserje
Slovenija
E-mail: anja.smrtnik@ospreserje.si

Optics in the kitchen

Andreja Eršte
School Centre Novo mesto, Šegova ulica 112, SI-8000 Novo mesto, Slovenia

In the spring of 2020 the area of education, learning and development was heavily influenced by the coronavirus (COVID-19). Educators had to adapt to novel circumstances in which the education and learning process now took place. For science teachers, one of the main challenges was how to implement practical and experimental work into remote-online learning experience for the students. In this contribution, an experimental approach in which students study the optical properties of mirrors will be presented.

In order to study optical properties of mirrors, students performed a guided laboratory exercise during an online Physics lesson. Students observed reflections in plane, convex and concave mirrors, using mirrors or other reflective surfaces or items they had in their households, e.g. metal spoons or ladles, commonly found in a kitchen, can be used as convex and concave mirrors. All experiments were performed by 2^{nd} year high-school students, SSI programme engineering technician in May 2020.

Contact information

Dr. Andreja Eršte
School centre Novo mesto, Šegova ulica 112, SI-8000 Novo mesto
Slovenia
E-mail: andreja.erste@sc-nm.si

Series or parallel connection?

Gregor Rapuš
Šolski center Novo mesto, Srednja strojna šola

Due to certain challenges, the use of simulation as an additional tool may be highly recommended. It provides students with a safe environment that does not require excessive effort from them and can therefore be more committed to cooperation. The use itself was sometimes too demanding for students, but with the advancement of technology it has become simpler and more user-friendly. Also, students encounter technology earlier and this leap does not cause them headaches but benefits them, as they can associate use with everyday play.

The article is dedicated to strengthening self-confidence in connecting electrical components by performing experiments in an imaginary space or simulation. Students mistakenly believe that only one conductor is needed for a component to work, as all devices have only one cable to connect. Therefore, it is difficult to understand parallel and serial binding. The analogy with the flow of the river proved to be very successful here.

To explore their own practice, the question was chosen: "What misconceptions exist before and after experimentation?". It was verified by collecting drawn electrical diagrams created before and after the experiment on the same day. It was also checked whether students who successfully connect the components in the simulation know how to connect these in the real world as well.

After analyzing the question posed, it turned out that certain misconceptions are still present, otherwise in areas that are not the subject of the substance currently under consideration. From this it can be concluded that it is recommended to use simulations in the learning process from the very beginning. In the analysis of the task, where the success of the binding in the real world was checked, the following pattern was shown. Anyone who successfully completed the exercises in the simulation had no problems with the binding of the real components and vice versa. Here came the possibility of re-performing the experiment at home. Thus, even a minority was able to understand the problem over time and successfully connect the components with the guides.

During covid-19, the pre-implementation of simulations greatly facilitated the implementation of lessons via videoconferencing. By explaining the theory, it was possible to show an experiment that everyone on the screen saw equally. To interact with the students, it was also worthwhile to run quizzes with various prepared answers or even the possibility of raising your hands.

References

[1] https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc (13. 7. 2020)

Contact information

Gregor Rapuš
Šolski center Novo mesto, Srednja strojna šola
Slovenia
E-mail: gregor.rapus@sc-nm.si

PI on IBL workshop on water rockets

Maja Pečar
University of Ljubljana, Faculty of Education, Ljubljana, Slovenia

Inquiry Based learning (IBL) is an already known method but teachers do not have much experience with it. Practitioner Inquiry (PI) is a relatively new method of working on professional development of teachers. To our professional learning communities (PLC) was both of the methods quite a challenge.

After the experience with the PLC groups within the 3DIPhE project, we found that there is confusion in distinguishing between the research questions that students are supposed to ask in the IBL method and between the one that the teacher is supposed to ask in his PI inquiry.

In the workshop we will discuss a practical example of both – IBL and PI questions on a real case from the international project Chain Reaction (FP7 funding).

The second part of the workshop will be in groups. A real example of IBL activity on water rockets for students will be given to the participants with all details. We will go through steps and some tools for PI inquiry. The participants will be divided in groups to work on the PI plan for the given IBL. The differentiation between the inquiry questions for IBL and PI will be clarified.

Contact information

Dr Maja Pečar
University of Ljubljana, Faculty of Education, Ljubljana, Slovenia
E-mail: maja.pecar@pef.uni-lj.si

Coaching guide and the workshop on coaching a PLC

Peeters, Wim
Catholic Education Flanders

Teacher learning for better student learning is a key element in the 3DIPhE project. As it has become clear that learning in groups, teams, communities is an excellent strategy for learners, this is equally valid for teachers. Also for them, working in professional learning communities is motivating, stimulating and inspiring. This “group” of teachers that wants to learn together needs guidance. This is where the teacher coach comes in. This coach is a person taking responsibility to learn himself and also to make “his” community of teachers learn. This 90 minutes session informs participants on this “dimension” of 3DIPhE. It gives an overview of the content of a guide that is put together based on a lot of experiences of international courses, and the experiences of the 3DIPhE coaches in the different countries. During the session we focus on one procedural strategy (sequence of sessions) used in the guide, but we give also alternatives for activities, protocols, schemes, time schedules and possible different approaches.

A key element in this “pillar” of 3DIPhE is the evidence informed philosophy: the teachers must provide evidence for their learning, and so does the coach. A practitioner inquiry (PI) is the way we promote this learning and gathering evidence for learning. PI is implicitly present throughout most activities.

Initially all this information was meant to be given during a one week course. We also will take a look at the scheme this one week course, because it gives another, fresh view on the content of the guide. No need to say that both guide and course go hand in hand.

This course is meant for educators (teachers, coordinators, section leaders, etc) that are confident to establish a learning process with a group of teachers. We do not particularly aim at physics or science educators. The content is transferable to most disciplines or other groups of teachers. The sessions give hints, ideas, background thinking and act on the generic level of the learning of the teachers. How to build confidence in the group, how to make them express their opinions, how to generate new insights, how to provide evidence for their learning and how to motivate each teacher to continue. This is a different perspective, but we will show that – no surprise- learning is a universal activity, in the sense that there are many parallel strategies between the (modern way of) learning of pupils and of teachers.

References

Volume 3 of the 3DIPhE e-book: *“Evidence-informed Coaching of Professional Learning Communities”*.

Contact information

Wim Peeters
Catholic Education Flanders
Belgium
E-mail: wim.peeters.int@gmail.com

By research the similarities to quality and lasting knowledge in mathematics

Urška Krajnc
Osnovna šola Radlje ob Dravi, Slovenija

In mathematics, students often have difficulties in understanding more complex learning content, their ideas are often wrong. This problem is more pronounced in students with learning disabilities. Due to poorer understanding, the acquired knowledge is also worse; often the knowledge is only superficial and does not become part of long-term memory.

In order to improve the understanding and, consequently, the knowledge of students, I include various activities through which students develop correct ideas. Such knowledge lasts longer and is of better quality.

Through independent inquiry students found out how changing the distance between an object and a lamp affects the size of the shadow. Students thus got to know similar characteristics and found out what applies to the ratio between the shadow and the objects borders, ratio of volumes and the ratio of areas. They drew a sketch of the experiment, wrote down the measurements and their findings.

The students performed the experiment by shining a light on opaque object, and the shadow of the object was visible on the wall. They found through an experiment that in the case where the object is equidistant from the lamp and the wall at the same time, the dimensions of the shadow are twice as large and the area of the shadow is four times larger than the area of the base object. Thus, they themselves came to the conclusion that the ratio of the volumes of similar figures is equal to the ratio of the parallel sides, and the ratio of the areas of similar figures is equal to the square of the ratio of the parallel sides.

After finishing the reading of the subject matter, I also checked the students' knowledge. By comparing the achievements of the students included in the survey with the achievements of the students who did not participate in this inquiry, I found that the achievements did not differ significantly: a difference of 1%. An obvious difference, however, was shown in comparing student achievement with learning difficulties. Students from the research group were as much as 50% more successful.

I also checked the acquired knowledge at the end of the school year and found that the students from the inquiry group were as much as 13% more successful than the students who did not participate in inquiry. The knowledge of students with learning difficulties even improved by 5% in the inquiry group.

A comparison of achievements showed that learning through inquiry has a significant impact on the quality and sustainability of knowledge, especially in students with learning difficulties.

Contact information
Urška Krajnc
Osnovna šola Radlje ob Dravi
Slovenija
E-mail: urska.krajnc@osradlje.si

Mirroring shapes across the line and inquiry based learning

Vesna Lindič
Primary school Tončke Čeč Trbovlje

As part of the project, I decided to bring inquiry based learning closer to students and at the same time perform my own practitioner's inquiry. Inquiry based learning took place in 7th grade on the subject of mirroring shapes across the line. The lesson objective was to find the properties of mirroring shapes across the line using geometric tools. Since the students weren't familiar with inquiry based learning, the research was guided.
We introduced inquiry based learning on the subject of mirroring a point across the line. We set ourselves an inquiry question; the students formulated a hypothesis and then performed an experiment. By folding the paper, they mirrored the point drawn with ink across the line. We found the mirroring axis, marked it, marked the original point and then marked the image with appropriate markings. Afterwards, the students have drawn the mirroring in their notebooks using geometric tools. Once the students learnt inquiry steps, they explored with guidance what happens to the line segment, line, angle and orientation of the geometric shape when mirroring across the line. As a part of my practitioner's inquiry I observed their activity on an ongoing basis and at the end of the class they filled in an anonymous questionnaire. Using the questionnaire, I came to a conclusion that students are rather successful in finding mirroring properties, but more difficulties arise from planning the mirroring procedure.
At the end of the school year I expanded my practitioner inquiry and tried to find out whether there were differences in memorizing the acquired knowledge among the students who had attended the class during inquiry based learning lesson and those who had just copied the subject matter from their classmates. Since there were 10 students absent from the inquiry lesson, I was able to compare the answers. I found out that students remembered the properties of mirroring over the straight line much better if they had found the rules by themselves and that the same students were also more precise at planning.
Based on what has been observed, I can conclude that inquiry based learning helps students to memorize the subject matter more easily and accurately.

Contact information

Vesna Lindič
Osnovna šola Tončke Čeč Trbovlje
Slovenia
E-mail: vesna.lindic@os-toncke-cec.si

What effect does the IBSE method have on the results of teaching gravity to high school students?

Beata Świder
„Eugeniusz Romer" High School, Rabka-Zdrój, Poland

As a physics teacher in a high school in a small town in Poland I had the opportunity to learn the method IBL only a year and a half ago when I started participating in the 3DiPhE project. I conducted my PI research on two classes with very similar learning outcomes and student numbers. The first-grade physics material is very simplified and contains about seven lesson hours of basic gravity. After completing three lessons with the IBL method, surveys and tests were administered to students. The results of tests show that students learn more effectively using the IBL method as comparing to the traditional method. The second conclusion is that the use of IBL method is very much limited in elementary school; nevertheless my students needed only a few lessons to be more interested in this form of a lesson. For a teacher, this is a very big satisfaction when students willingly and creatively spend time during the lesson.

Contact information

Beata Świder
E-mail: beata_swider@wp.pl

How does the IBSE method affect remembering physical quantities and application of acquired knowledge in practical tasks?

Anna Bekas

physics and chemistry teacher in Primary School No.62 im. kmdra. por. F. Dąbrowskiego in Cracow

As part of the 3DiPhE project, from October 2019 to January 2020 at Primary School No. 62 im. kmdra. por. F. Dąbrowskiego in Krakow, an educational study was carried out in the Practitioner Inquiry (PI) strategy, during which attempts were made to answer the above research question.

The study was conducted in two 7th grade classes (13-year-olds) during the implementation of the lesson topic: What is the density ? The topic in one class (7b) was conducted using the guided IBL method, providing students with the materials they needed to carry out the experiment themselves. On this basis, the students derived the formula for density. In the second class (7a), the lesson was conducted using the classical method, providing students with a density formula, which was later proved by presenting the experiment.

During the PI, the following research tools were used: tests, Quizizz tests, evaluation questionnaire, observations and lesson notes. We compared the results obtained in both classes. In addition these results were compared with the results from other 7th grade students, obtained in 2018/2019 school year, who in 2019/2020 attended 8th grade class.

The control tests show that the IBL method has a great impact on remembering physical quantities and the application of acquired knowledge in practical tasks. Some students remember the introduced physical quantities even after a long time, and they can associate these quantities with the conducted experiments. As to compare with 7th graders from the previous school year, the results show a better understanding of the topic by current students. In addition to that, the IBL method allows students to develop an interest in the subject. The vast majority of students indicated that by carrying out experiments they remember relations between physical quantities for much longer.

Contact information

Anna Bekas
Primary School No.62 im. kmdra. por. F. Dąbrowskiego in Cracow
Poland
E-mail: bekas.anna.sp62@gmail.com

"How can students work more independently and inquiry-based during STEM-projects?"

Gerdy Olivier
Guldensporencollege, Kortrijk

This Practitioner Inquiry started from several difficulties and challenges a teacher faced in a STEM class in the first and second grade (12-13 years old) of secondary school. Sometimes students were not motivated, and they did not always learn (and take home) the essence of the STEM unit. As a coach during these STEM units the teacher always got the feeling that he needed to be everywhere at the same time. It was often not clear what the goals for the students were during a STEM project.
The inquiry question about his practice evolved a lot during the course. It was important not to get stuck on focusing the big picture but try to solve and face small aspects and changes of the STEM unit. Eventually the inquiry question resulted in "How can students work more independently and inquiry-based during STEM-projects?". For a specific assignment the teacher made a new evaluation form that highlighted skills and content that were essential. This small adaptation in this unit created more clear goals for the students and it made them work more focused. In the near future the teachers will make this change in all his projects by updating them. The question about working more inquiry-based was not tackled but this is an important to do for the future.

Contact information

Gerdy Oliver
E-mail: gerdy.olivier@guldensporencollege.be

"How do I give feedback during laboratory work in a more efficient way and achieve my goals?"

Anja Roelof
Land en Tuinbouwinstituut Oedelem

Students in the fifth grade (17 years old) of technical school on agriculture learn at their own pace and gradually learn important skills how they plan and organize their laboratory work. The needs of each student during a laboratory can be very different: learning to plan and organize their experiments, working with specific measurement devices, collecting and visualizing their data or extra support on the content knowledge of the topic there are working on (some theory). Therefore, it is essential that the feedback must be give, quickly, focused on the specific questions and needs from every student but also be as efficient as possible to guarantee the feasibility for the teacher. Ideally, students should have a written feedback every week.
The teacher made some small changes and adaptations and tested these interventions by collecting different kind of data. For example, she used a timeline (to be pursued by students) that was written on the board in front of the class. Each group used a whiteboard to monitor this timeline & to note questions. When there were stuck, students have to follow a step-by-step plan. After each lab, students had to take a photo of their whiteboard and linked it with their digital logbook.
Some preliminary results is that the timeline is a very useful tool for the students. About the whiteboard, it seems that some groups do not write their questions on this board. Filling in the logbook requires an extra effort and a lot of time for both the student and the teacher. This way of feedback need some practice and learning time for both student and teacher.

Contact information

Presenter: Nathalie Dillen
E-mail: Nathalie.Dillen@lti-oedelem.be

Investigating the impact of embedding reflective practice as a professional learning tool in physics

Deirdre O'Neill[1], Eilish McLoughlin[1]

[1]*CASTeL, School of Physical Sciences, Dublin City University, Dublin 9, Ireland*

This practitioner inquiry was carried in the context of the 3DIPhE Irish professional learning community of experienced teachers. Inquiry Based Learning encourages the exploration of questions raised by teachers and students to discover meaningful concepts and understandings [1]. Hewson's interpretations of conceptual change consider extinction, exchange and extension of former understanding helpful to explain the difficulties learners experience in changing from one explanatory framework to another [2]. Using reflection as a tool to develop different perspectives and a deeper understanding for learning can be helpful in extending professional learning in teaching. Reflection is used to help refine understandings of an experience [3]. The practitioner inquiry examined the reflective practice of seven pre-service physics teachers (PSTs) participating in a twelve-week module which modelled inquiry-based approaches in physics education. Triangulation of PSTs written understanding of inquiry-based learning and reflective journals were examined to identify the level of conceptual change evidenced after participation in the module.. Thematic analyses of twenty one reflective journals have been contextualised to make connections between themes and build a coherent argument supported by the data as recommended by Bazeley [4]. The themes outlined from this analysis will outline the wider implications of reflective practice on deeper student understanding and professional learning.

References

[1] LH. Plevyak (2007) *What do preservice teachers learn in an inquiry-based science methods course?,* Journal of Elementary Science Education. 19(1):1

[2] PW. Hewson (1992) Conceptual Change In Science Teaching And Teacher Education, 16.

[3] EM. Boyd, AW. Fales (1983) *Reflective learning: Key to learning from experience.* Journal of humanistic psychology. 23(2):99–117.

[4] P. Bazeley (2009) *Analysing qualitative data: More than 'identifying themes*', Malaysian Journal of Qualitative Research. 2(2):6–22.

Contact information

Deirdre O'Neill
Dublin City University
Ireland
Deirdre.oneill49@mail.dcu.ie

A small PI can make a great difference

Uroš Medar
Primary school Preska, Preška cesta 22, 1215 Medvode, Slovenia

I did an IBL with my students regarding Hydrostatic pressure. This is a part of the curriculum that I find is one of the most difficult for students and they usually had the worst grades. So I started wondering what could be the problem. My premises were that they do not remember the experiments. So I made two different knowledge tests. The first test had sketches of the experiments and the second test had photographs of the experiment itself.

The results were shocking. I expected that there would be a slight difference in favour of the photographs; however, such a big difference was a surprise. There was a general difference of almost 20 % in favour of the test that had photographs of the experiments.

Based on the facts I gathered in this small PI, I will try to improve two things next year:

1. More knowlege tests will have photographs.
2. I have to think of a way to teach my students to recall the experiment based on a sketch.

Contact information

Uroš Medar
Osnovna šola Preska
Slovenia
E-mail: uros.medar@gmail.com

Research on the usefulness of thermally insulated products in the subject of science and technology

Jure Štokovnik, prof.

Vojnik Primary School, Slovenia

In the fifth grade of Primary school, there are a huge number of possibilities for the introduction of experimental work in the classroom in the subject of science and technology. At the same time, depending on the age and developmental level, students are able to think logically and flexibly, which allows them a greater degree of independent research. The responsibility entrusted to them in this type of activity is an additional motivation. The most important reason for introducing learning through research into lessons is experiential learning, which enables students to gain new knowledge independently and throughout active cooperation with peers. The role of teacher in this is encouraging and guiding. During the Technical day, the students in the fifth grade made a product - a thermally insulated box, a practical product according to a given technological procedure. The product was used as a subject of research; the students tested its thermal conductivity or functionality and tried to explain it. The planning of the research and its implementation were successfully realized. In four-member groups, students developed and perfected a wide range of science skills from observation, asking research questions, measuring, recording, working with data, to reasoning and reflection. The goal of learning through research in this unit was multifaceted, as students have the knowledge of heat transfer or they supported heat flow with evidence - measurement results, graphical illustrations and conclusions. They also developed science literacy using science knowledge and skills and deriving findings based on verified data. As a primary teacher, I am aware of the importance of learning through research, as it additionally motivates students, introduces them to independence and the use of science skills, which are also useful in other subject areas.

Contact information

Jure Štokovnik, prof.
Primary school Vojnik
Slovenia
E-mail: jure.stokovnik@gmail.com

Usability of the cooler bag

Barbara Jančič, prof.
Vojnik Elementary School

There are no limits to the imagination and creativity of students, so I was interested in how successful they will be in researching the cooler bag in the subject of science and technology in the 5th grade of elementary school. I focused my observation mainly on their independence at work, on the need for teacher guidance and on whether an active approach to learning will be interesting to students at all.

The study involved six 5th grade students who are attending additional classes and have themselves expressed a desire for additional research.

The students first did guided research and then had a free open path to explore the cooler bag themselves. So in the second research, the students designed the research questions themselves and planned the research independently, they also divided themselves into groups.

The aim of the research was for the students to use as much knowledge as possible in the second research, which they acquired in the first research, and to apply it to the new case. The aim was to increase their independence, to minimize the need for the presence of a teacher and to keep their active approach interesting.

During the research, students developed cooperation, critical thinking, group work, consolidated the acquired knowledge, learned something new from the obtained results and confirmed their predictions.

References

Jančič, B. (2017). *Spoznavanje lastnosti snovi skozi učenje z raziskovanjem pri predmetu naravoslovje in tehnika: magistrsko delo. Univerza v Ljubljani, Pedagoška fakulteta.*

Contact information

Barbara Jančič, prof.
Elementary School Vojnik
Slovenia
E-mail: barbara.osvojnik@gmail.com

Inquiry Based Learning Example: Double Shadow

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

In usual circumstances an object casts many shadows if it is illuminated by many light sources. The number of shadows is in general equal to the number of light sources. However, if the light is reflected, an interesting phenomenon as presented in the Figure on the right can be observed [1].

In the 3DIPhE project we developed an inquiry based learning unit, where students investigate reasons for appearance of two oppositely oriented shadows. The activity is organised as an open inquiry, developing several inquiry skills; at the same time only basic physics knowledge is required (law of reflection). Materials for experiments, that is, a torch or sunlight, a plane mirror, a small asymmetrical object, and a screen, which could be a wall or a notebook, are available in any household and therefore the activity can be carried out even remotely. Participants are kindly asked to prepare them for experimenting during the workshop, too.

References

[1] Mojca Čepič (2006), Do virtual images cast shadows?, *Phys. Ed.* 41, No 4, 295-297.

Contact information

Dr Ana Gostinčar Blagotinšek
University of Ljubljana, Faculty of Education
Slovenia
E-mail: ana.gostincar@pef.uni-lj.si

Educational Design Research in 3DIPhE: Using case studies to document and learn from our experiences in the 3DIPhE project

James Lovatt[1], Paul Grimes[1], Eilish McLoughlin[2]
[1]*Centre for the Advancement of STEM Teaching & Learning and DCU Institute of Education, Dublin City University,*
[2]*Centre for the Advancement of STEM Teaching & Learning and School of Physical Sciences, Dublin City University*

A challenge of the 3DIPhE project was to develop a way that we could track and measure the impact that the project had on its participants over the course of three years. Educational Design Research is a methodology that allows for adjustments of design so that each adjustment is an opportunity to evaluate impact and generate theory. This presentation will report on the key learning from the 3DIPhE project which was generated through case studies developed by each of the project partners. Case studies provide unique examples of real teachers in real situations, and can portray what it is like to experience a particular situation [1]. Guided by a framework developed using Educational Design Research, project partners were able to systematically collect various types of data throughout the course of the project, and use this data to write case studies to document their own and teachers' experiences, and to report on learning from their work with teachers. We will present a summary of these case studies, including insights from teachers' experiences of the 3DIPhE project, and present initial findings from an evaluation of the project. We will also outline how the EDR framework for the project was developed, a summary of how it guided the implementation of the 3DIPhE project, and how the framework was used to identify key learnings during each cycle of the project.

References

[1] Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education*, 8th Edition. Routledge.

Contact information

Dr James Lovatt
Dublin City University
Ireland
E-mail: james.lovatt@dcu.ie

The Unteachables Project (ERASMUS+)

Ana Gostinčar Blagotinšek
University of Ljubljana Faculty of Education

The consortium of the Unteachables Project consisted from institutions involved in future teachers' education and training from Denmark, Iceland, Italy, Poland (2 partners) and Slovenia, and a quality-assurance partner from Spain. Members of national teams were teachers' educators, students - future teachers and young teachers from lower secondary schools (target group were pupils aged 10-16).

An increasing number of young people might be called "unteachable", but it does not mean that they are not able to learn. On the contrary, many of them are brilliant learners, but the way they learn, does not fit well with the existing education system. The new generations of pupils are challenging the basic axioms of what we know as "education" and "educability".

The project aimed to explore to what extent the new generation can be transformed from "unteachable" not to "teachable" but to "learnable" or "engageable" – without revolutionizing the entire education system. It is important that teacher education and training includes capacity building of the new generation of teachers to manage and tackle such new "learnable" strategies and didactics, going beyond what teacher education and training means today.

Activities within the project systematically analysed what "unteachable" means, from the point of view of pupils, teachers and students - future teachers. On basis of this profiling, the key challenges to traditional educational didactics were identified and some strategies to overcoming them designed and will be presented. Some experimentation with suggested strategies were also planned, but not implemented due to pandemic.

Contact information

Dr Ana Gostinčar Blagotinšek
University of Ljubljana Faculty of Education
Slovenia
E-mail: ana.gostincar@pef.uni-lj.si

Erasmus+ project ARphymedes

Jerneja Pavlin
Faculty of Education, University of Ljubljana, Ljubljana, Slovenia

The project ERASMUS+ KA201 entitled *AR Physics made for students* (acronym: *ARphymedes*) with partners from UNIVERZITA SV. CYRILA A METODA V TRAVNE (Slovakia, applicant), SLOVENSKA TECHNICKA UNIVERZITA V BRATISLAVE (Slovakia), TALLINNA TEHNIKAULIKOOL (Estonia), UNIVERZA V LJUBLJANI (Slovenia), VITALE TECNOLOGIE COMUNICAZIONE - VITECO SRL (Italy), DIADRASIS (Greece) and UNIVERSITATEA TEHNICA GHEORGHE ASACHI DIN IASI (Romania) was approved in August 2020. The project will start in September 2020 and will last 3 years.

The aim of the project is to raise the level of achievement and interest in physics through innovative practices in a digital age. During the project an educational tool will be developed that combines the use of books and, AR through a smartphone application, tells the story of important historical milestones in physics and examples of direct applications of principles of physics in technology. By combining the convenient hardcover format of a book, which provides a tangible pleasure and a source of information for deep learning, with an AR application that is capable of attracting and retaining attention, we will build a bridge between traditional and digital learning. The introduction of the tool will be supported by the development of curriculum materials for teachers that explain the use and implementation of the tool in the educational process. We will then organize training sessions for teachers and conduct a case study in test classes to observe the impact of the tool. We will also organize workshop days in schools where students and teachers will have the opportunity to test the tool.

Contact information

Dr Jerneja Pavlin
University of Ljubljana, Faculty of Education
Slovenia
E-mail: jerneja.pavlin@pef.uni-lj.si

Parallel and New Horizons: The STAMPEd Project

Paul Grimes[1], Eilish McLoughlin[2]

[1]*Centre for the Advancement of STEM Teaching & Learning and DCU Institute of Education, Dublin City University,*

[2]*Centre for the Advancement of STEM Teaching & Learning and School of Physical Sciences, Dublin City University*

During this presentation we will outline details of a new three-year project, titled Supporting Transitions Across Mathematics and Physics Education (STAMPEd). The project has been funded as part of the Erasmus+ KA201 programme, and will begin in September 2020.

Transitions in education can provide several challenges for both students and teachers. Between the ages of 10 and 16 students undertake several transitions in their school lives. These include transitions across school systems (e.g. primary level to second level), transitions between different teachers, transitions across subjects (for example from general/broad science curriculum to a specialised physics curriculum and transitions across maths and physics) and several other social transitions. These challenges can be particularly prevalent in Mathematics and Physics, as from the ages of 10 upwards, students can begin to have specialist teachers in these subjects, and links start being made between the two subjects.

The main aim of the STAMPEd project is to develop ways that both pupils and teachers can be supported in these transitions. The project will aim to build on the work already done in the Erasmus+ funded 3DIPhE (Three Dimensions of Inquiry in Physics Education) Project. In particular, this project aims to use the learning experiences of 3DIPhE in the area of supporting teachers to carry out Practitioner Inquiry (PI), and forming Professional Learning Communities (PLCs) of teachers.

We aim to have 4 main outputs for the project:

1. A collection of rich classroom tasks in both mathematics and physics that support student learning in transitions
2. Creation of sustainable Professional Learning Communities within and between schools
3. A collection of teachers' experiences (practitioner inquiries and teachers' reflections to accompany these) of working within and across transitions
4. Evidence informed recommendations for supporting students and teachers in transition.

Contact information
Dr Paul Grimes
Dublin City University
Ireland
E-mail: paul.grimes@dcu.ie

Round table: Levels of inquiry

Mojca Čepič and partners of 3DIPhE project

Inquiry is a difficult word especially as in many partners' languages an accurate translation does not even exist. Its meaning in education varies from investigating, research, experimenting, literature search etc. In 3DIPhE project its meaning was exclusively used for the following sequence of actions

- Gain or review experience and define the inquiry problem
- Plan the inquiry (the action and the circumstances, materials, timing, collecting data, etc.)
- Analyse collected data
- Draw conclusions based on collected data

but also

- Discuss your inquiry with other students/practitioners
- Present/report your inquiry to the others
- Reflect on results

However, when one gets used to this set of actions, they are applicable everywhere. They are the essence of Inquiry Based Learning approach; they are the basis of Practitioners' Inquiry, that is, of inspections of practitioner's own work in the school and elsewhere. In 3DIPhE project we used the same approach for inspection of our coaching of professional learning communities and of all the processes in the project.

The Round table will focus on inquiry as discussed above as an everyday approach to every problem one faces and will also include a review and applicability of 3DIPhE results.

References

[1] Mojca Čepič et al. (2017) Three Dimensions of Inquiry in Physics Education, project proposal.

Contact information

Dr Mojca Čepič
University of Ljubljana, Faculty of Education
Slovenia
E-mail: mojca.cepic@pef.uni-ljsi