

Elixir to Schools - 10 years of continuous support for teachers

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Abstract. Elixir to Schools started 10 years ago as a project aimed at improving physics education in the Czech Republic. Four years later it became an independent non-profit organisation. Nowadays it organizes more than 60 regional centres in the whole country for teachers of mainly physics and chemistry but also from primary schools and kindergartens. Currently, almost 3,000 teachers are involved in Elixir to Schools. Thus Elixir makes continuous and long-lasting in-service teachers' training. The paper describes support provided to leaders of the centres, annual conferences of Elixir and specific experience from the project as well as teacher feedback gathered through the annual evaluation.

1. Introduction

Elixir to Schools is a project that focuses on professional support for physics teachers and, in recent years, chemistry teachers and teachers who want to develop their digital competences. For the last ten years, it has been organizing regional centres where teachers can meet once a month to receive methodological and pedagogical support, share their experiences, make tools and do other activities. The centres are run by experienced teachers and are located in schools across the Czech Republic, as shown on the map in Figure 1.

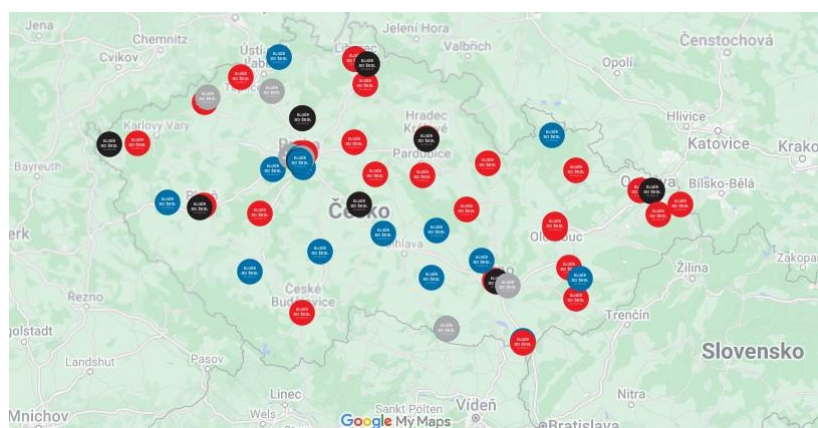


Figure 1. Physical regional centres – red, physical flying centres – blue, Digi centres – black, chemical centres – grey (Note - some labels overlap, web link [1] can be used for better resolution)

On the map of the Czech Republic, the regional physical centres where meetings are held regularly every month are marked in red. The blue circles show centres that we call “flying”, i.e. places where one of the leaders of a nearby regional centre travels several times (about 4-5 times) a year. Centres focused on the development of digital technologies (we call them Digi centres) are black and chemical centres are grey.

2. How it started

The Elixir to Schools project was established in 2013 as one of the projects of the Depositum Bonum Foundation. The Depositum Bonum Foundation was established in 2012 by Česká spořitelna bank. The Foundation was established to support Czech society in the field of science, research, development, and education. Its main goal was to help schools and teachers improve the quality of teaching in technical and science subjects. In 2019, the Depositum Bonum Foundation was merged with the Česká Spořitelna Foundation, which continues to support the Elixir to Schools project.

Since the Heureka project [2] has been operating in the Czech Republic since 1990, focusing on inquiry-based physics education, we were approached to prepare the project in the spring of 2013. We thought about what teachers probably need most, and how we could help them most to improve their physics teaching. Thanks to long-term contacts with teachers we realized that what is most lacking in Czech education is the opportunity to share experiences and problems, to meet in a comfortable and safe environment with colleagues, to simply not be alone.

As part of Heureka’s long-term courses for teachers, we asked experienced teachers in the regions, graduates of Heureka courses, if they would be willing to participate in the newly emerging project. We offered them the opportunity to co-create a platform to support as many physics teachers as possible through space to meet. The intention was that the meetings would provide an opportunity to gain inspiration and ideas for teaching, the production of simple tools, and most importantly the opportunity to share. Many colleagues agreed, and so in September 2013, regional Elixir to Schools centres were established in 15 locations across the country. We chose a model that has worked without major modifications until today. This model will be described in more detail below.

At the end of 2017, a separate organization, Elixir to Schools, was established to further expand Elixir’s work.

3. Aim and focus of Elixir to Schools

The vision of the project is for children to learn to the full potential and with joy. Elixir supports this and the development of children’s science and digital literacy through teacher training.

The main mission of Elixir to Schools is:

- help develop teachers’ skills, knowledge, and competences to improve their classroom teaching,
- encourage teachers to reflect on why, what, and how they teach, to share and learn from each other,
- develop awareness of functional teaching approaches, forms, and methods, show examples of good practice, and guide teachers to use these approaches in their teaching.

The aim of Elixir is therefore to build a professional network of motivated and confident teachers whose skills, knowledge, competences, and attitudes guarantee meaningful teaching, especially of science subjects. We want every teacher in the Elixir network to experience success in their teaching, and for their students to experience success as a result.

The importance and effectiveness of this type of work at school and of teacher education is confirmed, for example, by a study of European Commission [3]: *“A reversal of school science-teaching pedagogy from mainly deductive to inquiry-based methods provides the means to increase interest in science. Teachers are key players in the renewal of science education. Among other methods, being part of a network allows them to improve the quality of their teaching and supports their motivation.”*

4. The Elixir has set 3 directions to achieve this goal:

A. Experiment as a means of learning

Through teachers' experience with the experiments, we create space for the development of their knowledge, skills and empowerment. This involves, for example: planning, patience, diligence; understanding problems; formulating and testing hypotheses; finding solutions; working with error; developing critical thinking, etc. The importance of experimentation in working with students and teachers is described in more detail in [4].

B. Reflection as a natural part of the learning process

We try to guide all participants to answer questions like: why are we doing this? Where are we going? What's going well? What do I still need to learn? What are the risks and strengths? What will we keep for next time and what will we do differently?

C. Digital competences as an integral part of learning

We consider digital literacy important for teachers and students and see them as an integral part of meaningful learning where they add value. We do not want to replace experiments with real tools with virtual reality. We teach pupils to work with real tools wherever possible and to use digital technologies when they make sense. For example, we supplement measurements using analogue measuring instruments with measurements using digital instruments and compare the accuracy of the measurements. Or we show teachers that it is important to build pupils' graphing skills with pencil and ruler first, so that pupils understand the principle of graphing, and then move on to computer processing.

5. How Elixir Centres work

The regional **physical centre** leaders, who are physics teachers in junior and higher secondary schools, organise two-hour meetings with other physics teachers once a month in the afternoon at their school to offer inspiring ideas for teaching physics and to create a space for joint discussion about teaching. The centre also offers teachers free loan of some modern tools (e.g. digital thermometer, digital microscope) that individual schools would otherwise either not be able to afford or that teachers do not yet have experience with.

The topics covered by the centres are diverse, here are the topics covered by one of the centres in the school year 2022/23:

Crystals and the polarization of light; Leonardo da Vinci's machines; Electrical circuits at primary school; Christmas meeting; Making an electric charge detector; Rainbow world and spectrometer making; Optics in experiments; 3D printing and how to do it; Nuclear physics; Physics in the works of Jules Verne.

For comparison, other centre topics in the same period: Electrostatics; Acoustics actively; Newton's laws; Games and toys for the pre-Christmas lesson; Electromagnetism; Microworld; Pressure; Formative assessment practically; Why does a candle burn?; Let us solder!

Chemistry centres work similarly to physics centres, only instead of in the classroom they meet in the chemistry laboratory, which limits the possible number of participants.

Examples of topics from one chemistry centre: Chemistry and candy; Electrolysis; Crystals and the polarization of light; Home lab; Staining of biological preparations; Physical or chemical process?; Radioactivity; Chemical experiments with Vernier sensors; Polydensity bottle.

Centres focused on using digital technologies in schools (Digi centres) help teachers develop their digital competences. They offer them ideas on how to use digital technologies meaningfully in their teaching. Most of the centres are hybrid or online, so even teachers from more distant places can attend them.

Examples of topics from one Digi centre: Work with data; Creating a mobile application; 3D glasses and sharing good practice; Activities without a computer (unplugged); Tips for working with images.

The last type of centre in Elixir to schools is the online centre, which we will talk about later.

Participation in all centres is completely voluntary; teachers can attend any centre and are not restricted in any way. Similarly, the leaders of each centre have the freedom to design the programme of each meeting - they prepare the programme based on the demand of the teachers attending the centre and their own experience. Gradually, they try to involve other teachers in the program of the centres. The project has thus emerged and developed from below and responds to the real needs of teachers.

6. Main characteristics of the work with teachers in the Elixir to Schools project

6.1. Active work

We are convinced (and many studies confirm this e.g. [5], [6]) that the active work of pupils is one of the most effective ways of teaching in school, and therefore we use it as much as possible in our work with teachers. Teachers in Elixir to Schools centres make simple tools, solve problems, discuss appropriate teaching methods, learn about new physics, etc.

Meetings may be supplemented by excursions to science centres and specialist departments. An external lecturer can also be invited to the meeting.

6.2. Creating a community

Because the centres have been working with teachers for a long time, and the group of participants changes only slightly, a community of teachers forms around each centre, supporting each other, meeting also outside the official centre meetings and often visiting each other in schools. We consider it unique that the fifteen centres that started their activities in September 2013 celebrate their 100th meeting in June 2023. The opportunity to share the joys and sorrows of teaching life is also what teachers value most in the feedback.

6.3. Voluntariness

As already mentioned, the teachers come to the centre meetings in the afternoon, in their free time. They are therefore not constrained by having to take time off from teaching. However, voluntary attendance at the centre is also proof to the centre manager that he is preparing an interesting programme. If the programme was not interesting to the teachers, they would have no reason to attend the meetings and the centre would soon close.

However, voluntariness also applies to centre leaders. In case they no longer want to lead a centre for family, work or other reasons, the project management will agree with them to end their cooperation. However, the person concerned can continue to participate in Elixir events and is not considered a “black sheep”.

6.4. Longevity

It takes quite a long time to change your approach to teaching, and therefore to change your mindset as a teacher. We know from the evaluation of the project that the biggest transformation in teaching occurs during the third year of attending Elixir to Schools meetings. That is why we encourage teachers to participate in the meetings over the long term. We are pleased that most participants attend their centre’s meetings regularly and declare that they have changed their teaching thanks to Elixir. We will describe the impact of the Elixir centres in more detail below.

6.5. A widely developing project

As mentioned above, in 2013 Elixir to Schools started with 15 regional centres across the Czech Republic. Gradually, the number has increased and by 2022 we have 47 physics-focused centres. In

addition to physics, from 2018 Elixir started to establish centres focused on the development of digital technologies in science subjects, and from 2022 chemistry centres are also part of Elixir.

The progressive development of the project is summarized in Table 1.

Table 1. Numbers of Elixir to Schools centres

School year starting	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Physical centres	15	21	21	21	22	30	36	38	43	47
Digi centres						2	5	8	10	9
Chemical centres										10

The map in Figure 1 shows that the Elixir to Schools centres do indeed cover a large part of the country, and that there are few places from which teachers find it difficult to commute to one of the centres.

Teachers from all types of schools for age groups 12-19, but also younger ages (see below), come to Elixir meetings in schools. These are both experienced teachers who can offer their ideas and opinions to others and those who have no formal physics training but still teach physics in their schools.

Since 2018, Elixir to Schools has started to target another group of teachers, in addition to junior and higher secondary school physics teachers, which are first-grade and kindergarten teachers (ages of children 3-12). This group has been growing steadily over the last few years, and it is clear that there is a growing interest in science education among these teachers. It is very interesting to see how these teachers are happy to transfer physical and chemical experiments into their work with children, and how they are creative in developing and improving them.

6.6. Support

Naturally, centre leaders need support for their work. In addition to sharing with each other on an ongoing basis, solving current problems, informing about interesting experiments, etc. via social networks, we also offer personal meetings to the centre leaders. Three times a year during the school year, we organise weekend meetings for them (the so-called Elixir Academy), during which they receive up-to-date information about the operation of Elixir, we discuss with them various problems that arise in the project, but we also invite interesting guests who introduce them to various topics (e.g. voice work, teacher-assistant collaboration). These meetings always include one or two workshops in which one of the leaders shows the others what interesting things they have done with the participants in their centre, as well as an exchange of ideas for different experiments and tools.

Another meeting of the Elixir Academy takes place during the summer holidays in some place outside Prague. This stay is free for participants and we take it partly as a reward for their work. Also for these summer meetings we try to prepare an interesting program to help the leaders in their demanding work.

Of course, the project also needs financial support. Currently, it is significantly supported by the Česká Spořitelna Foundation, which is the founder of Elixir to Schools, but it is also succeeding in reaching out to other donors, both from the civil service and companies.

7. Other Elixir to schools activities

7.1. Elixir to Schools Conference

In addition to attending meetings at regional centres, teachers have the opportunity to attend the Elixir to Schools weekend conference once a year. The conference programme consists of both lectures, to which we invite interesting guests, and workshops prepared by centre leaders or teachers themselves. More than 250 teachers attend the event and the feedback is always very good. A report from the conference held in 2019 can be seen in the video [7], where at the end the students of the Pilsen gymnasium play the Czech national anthem on glasses of water.

In 2023, the 9th Elixir to Schools conference [8] took place (of which the 2020 and 2021 conferences were online due to covid). In 2022, this event was not held as Elixir into Schools was the main organiser of the Science on Stage festival (see below).

7.2. Elixir Proceedings

Every year, dozens of interesting experiments and teaching topics appear in the Elixir centres. To make sure that these ideas don't get lost and can reach other teachers who were not at that particular meeting, the idea occurred to prepare a collection of Elixir ideas, a kind of proceedings. The first one was published in 2021 with the title "Inspiration from the Elixir to Schools for All Seasons". The following year, the compendium was published under the title "Inspiration from Science on Stage 2022" and in 2023 with the subtitle "10 years in 10 months". These proceedings are freely downloadable on the Elixir website.

7.3. Festival Science on Stage

A special event for Elixir to Schools was the international festival Science on Stage [9]. This festival took place for the first time in the Czech Republic in 2022 in Prague and Elixir was its promoter. The event attracted 335 nominated participants from more than 30 countries in Europe and Canada. There were 215 exhibition stands, 24 workshops in English and 14 in Czech. Lectures and stage performances as well as a cultural and social programme were also held during the festival. Open day (March 26) was attended by 217 teachers, mostly from the Czech Republic.

On the occasion of the festival, a 30-page brochure called "Paper science" was published, offering teachers, pupils, but also parents and grandparents the opportunity to enjoy making paper toys and then having a lot of fun playing with them. The booklet is available in English at [10].

7.4. Cooperation with partners

Cooperation with other organizations is an important part of Elixir to Schools. These include universities (Faculty of Mathematics and Physics, Faculty of Science, Charles University), as well as state authorities at the highest or regional level, companies or other entities. Currently, Elixir cooperates with more than 45 partners.

8. Functioning under Covid

During the time of the covid restrictions, direct activities with teachers were of course severely restricted or outright banned. However, at least some of Elixir's activities have been transferred to the online environment. Even at this time, we managed to maintain the basic principles of Elixir (active work, community building, long-term) at the regional centre meetings. The participants in the meetings prepared tools at home, a list of which they received in advance, and experimented together with the centre leader during the online posting. Our experiences from this time, including teacher feedback, are described in the article "What Covid gave and took away from physics teachers" [11].

From this time, we have retained the online centre, which has no headquarters and is open to teachers from all over the country. However, the other characteristics of the centre remain the same - teachers prepare the tools in advance and then experiment together with the leader once a month in the afternoon.

9. Project evaluation

Evaluation is an integral part of the project for the entire duration of the project. This is carried out on two levels. At the elementary level, we determine the impact of our work by interviewing participants at the centres or at the conference.

A much more sophisticated form is a survey of participants in the form of a questionnaire, conducted since 2017. In particular, it must be said that it does not have a fixed form. Since 2018, the questionnaire has been more or less modified every year according to the current needs and experience of the organization. It is uniform for all types of centres. It contains both reflexive questions focused

on the annual evaluation of the organization and its activities, as well as questions reflecting the personal and professional benefits of Elixir for teachers and, by implication, the impact on the form of their teaching and the response of pupils. In the questionnaire, we use a combination of closed, semi-closed and completely open questions, the answers to which we then categorize.

In 2022, Elixir to Schools recorded almost 3,000 unique (registered and unregistered) participants in one of 47 physics, 9 digital and 10 chemistry centres. This is a figure that corresponds with the facts that the number of physical and digital centres operating and chemistry centres starting up have increased again year-on-year, while the number of people attending the online format of centre meetings has also increased. Distribution of the questionnaire was done electronically in early January 2023, with the questionnaire distributed to all unique participants. A total of 1,445 respondents completed the questionnaire, including 1,388 teachers.

9.1. Main results

Unsurprisingly, physics (51%) and mathematics (46%) teachers were still the most prevalent among centre participants in 2022. Physics - mathematics was also the most common combination of subjects taught (31% of the total sample). As for computer science teachers, they were represented by 34%. A combination of both subjects, i.e. physics and computer science, was then taught by 15% of the respondents. Chemistry was taught by 24% of respondents, while other subjects were significantly less represented.

More than 90% of the respondents say that the biggest motivation for them to visit the centre is to get inspiration for specific experiments or manufactured tools together with an interesting programme. Compared to last year, the importance of incorporating technology into distance learning has declined somewhat among “physicists”, but it is still an important topic along with pedagogy in general.

Strong motivating factors are meeting others and sharing practice experiences together (reported by 84% of respondents), the need to relax and recharge (over 75% of respondents) and the personality of the centre managers (over 60% of respondents). Around 40% of respondents declare that they can no longer imagine their professional life without Elixir.

This supports our long-term experience that Elixir contributes to maintaining teachers’ work motivation and well-being. Inquiry-based learning is also a new factor, as is the need for Digi centre teachers to expand their knowledge in developing students’ digital competences. On the other hand, formal reasons, or the fact that the meetings are free of charge have rather little influence. Only a minimum of participants came to the centre based on the request of the school management.

Thus, the evaluation confirms that teachers' participation in Elixir centres is overwhelmingly driven by their intrinsic motivation. We consider this to be an important feature of our activities. (The importance of intrinsic motivation for teachers' participation in professional development is also highlighted, for example, in reference [12].)

The functioning of the centres in 2022 got a grade 1 from 83% of teachers, with an average grade of 1.2 (in the Czech Republic, 1 is the best grade on a five-point scale). In principle, teachers do not want to change anything about the current organisation of meetings; they believe that the centres are working well. Isolated suggestions for modifications were related to the wish to meet more often, to be able to connect online or to expand the current network of chemistry centres.

9.2. What teachers appreciate

Personally, teachers at Elixir last year most often appreciated the great atmosphere and time spent together with like-minded colleagues and the presence of “enthusiastic” and “great” centre leaders. Also, crucial for them was the support and sharing of practical experience in the safe environment of the centres and the abundance of inspiration and teaching aids.

As in previous years, the most important centre programmes for teachers in 2022 were those focused on hands-on demonstrations (98%), conducting experiments/activities so that pupils can ‘touch’ physics/chemistry/informatics, think and discover for themselves (96%), sharing experiences

(96%) and making tools (94%). A significant number of teachers considered important topics such as developing pupils' digital competence (65%) and developing pupils' computational thinking (68%).

What teachers personally value about Elixir (examples of answers):

"Making physics accessible to me and my first graders. It's a beautiful science."

"The Elixir forced me to step out of my old stereotypes and start trying new things in my teaching again."

"That it supports teachers and gives them the energy to keep going. Especially in vocational subjects, contact between people in the same field is important. A teacher at a lower secondary school, who is often alone in the school for a particular subject, simply doesn't have that opportunity. The district methodologists that used to exist no longer exist."

"Friendly treatment. Both knowledge and "psychological" support. Thanks a lot :-)"

"Everything is ready for us, we can borrow material, we support each other, we motivate each other, we transfer experience. If I need something for my school, there is always someone who knows exactly where to buy it."

"I especially appreciate the contacts with other teachers. And a bunch of ideas for teaching and also the opportunity to ask if something doesn't work in class. Such a nice collegial support."

"Knowing that there are still plenty of people who are interested in how the world around them works, trying to understand it, and want to enthusiastically pass that knowledge on to children. It's an increasingly rare phenomenon in the field of physics."

"The personality of the lecturer, her enthusiasm, which is a great support for my teaching."

"Getting to know new colleagues from other schools, continuous personal development in computer science. The feeling that I am not alone."

"Friendly atmosphere, willingness of the leader to answer questions and accommodate the participants' lack of knowledge in chemistry."

9.3. Identifying the impact of Elixir centres

The overall impact of the centres' activities on pupils and students in the Czech Republic continues to increase year-on-year. In 2022, Elixir teachers (physics, chemistry and digi) taught approximately 365 thousand students, which is about 60 thousand more than the previous year.

If we consider the primary impact of the centres' activities to be a change in teaching methods, we can say that the majority of respondents observe this change: 62% say they have changed their teaching methods somewhat, 11% significantly. Only 9% of the teachers do not feel the impact at all, 18% have changed their teaching methods minimally.

How the teachers themselves perceived the change in teaching to have affected their lessons and pupils' performance is summarised in the graph in Figure 2:

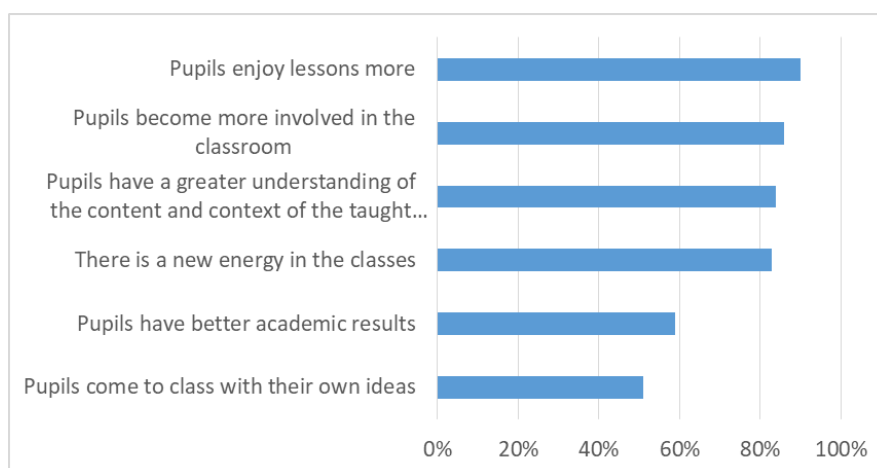


Figure 2. Impact of the change in teaching on pupils

From the programme of the centres, the most common themes used by teachers in lessons last year were various physical and chemical experiments and the tools they had built in the centres. They also made extensive use of the recommended applications in computer science, worksheets, 3D printing, programming, board games, robotic tools, and escape games and physics kits.

Almost half of the teachers say that the changes they have made in the way they teach have increased their pupils' interest in studying at science, computing or technical schools. More than half of the teachers have already thought of looking among their pupils for possible future teachers of their subjects, 77% of them already have or have had someone like this in their class.

The vast majority of teachers (90%) also share their knowledge and experience with other teachers, not only in their school but also outside it. A further 5% are considering sharing in the future, while the same proportion of respondents do not feel the need or have not thought of it. Sharing usually takes place individually or in small groups (on average 4 colleagues), but in some cases also within a larger teaching team. 37% of teachers also inform the pupils themselves about their participation in the centres.

Of course, the evaluation provides us with a lot of additional information, but due to the limited scope of this article, we have included only the basic ones.

10. Conclusion

According to feedback from teachers in the Czech Republic and abroad, it seems that Elixir to Schools is a rather unique project to support teachers. If you are interested in learning more about the project, please contact us and we will be happy to share our experience. (Naturally, because sharing experience is one of the main characteristics of our project.)

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