

Changes in the Use of Resources in Teaching Physics Due to the Influence of Distance Learning

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Abstract

As part of the MaTeK project, involving researchers from Slovakia, Czech Republic, Italy, Norway, and Turkey, we carried out research on the use of resources by maths teachers for lesson preparation. The teachers were asked about if there had been any change in their use of resources due to Covid-19 pandemic. We noticed that multiple teachers stated that, due to Covid-19, they had found new resources, so we decided to investigate this topic further. In our research, with the cooperation of teachers in Slovakia and the Czech Republic, we focused not only on maths teaching but also on the teaching of physics. This paper describes the results of this research applied in Slovakia during physics lessons in primary and secondary schools. Our goal was to find out which resources had been used by physics teachers before and after distance learning and which new resources they had found. We were also interested in which resources they still use even now that distance learning is over.

Introduction

At the beginning of 2020, a significant change happened in education. Due to the Covid-19 pandemic the schools in many countries were forced to commence distance learning. Based on the statements of Pokhrel and Chhetri (2021), the closure of schools affected up to 94 % of the world's student population. It was a tremendous challenge for both teachers and students. All participants in the education process had to adapt quickly to the new conditions. The teachers had to adapt to new approaches to teaching, including changing the way they had been planning and preparing for their lessons.

In Slovakia, schools were closed for a quite long time. Based on Hajdúchová (2021), in the period from March 2020 to February 2021 Slovakia was in the list of countries with the schools closed for the longest time within Europe – during this period all children in Slovakia were in school for only 28 days, in a global comparison Slovakia was in 148th place out of 214. Several organizations, such as the Dionýz Ilkovič Foundation, focused on how teachers in Slovakia coped with distance learning. According to the Czech teacher Kubal (Nadácia Dionýza Ilkoviča, 2020a), the biggest problem for Czech teachers was with communication at the beginning of Covid-19 pandemic – it took a long time in some places to find a good way to communicate with students. Slovak teacher Beňuška (Nadácia Dionýza Ilkoviča, 2020b) states that, based on research among natural sciences teachers, 77% out of 570 respondents found that at the beginning of distance learning it took around two weeks to start online learning. As both say, the preparation for teaching was more difficult.

Within the MaTeK project (Projectmatek, 2023), involving researchers from Slovakia, Czech Republic, Italy, Norway, and Turkey, research was carried out focusing on the use of

resources by teachers of maths for lesson preparation and during teaching, in connection with the development of students' reasoning and proving. Because the questionnaire was given to primary and secondary maths teachers shortly after the closing of schools, the results might have been affected by the sudden appearance of new resources. This was underlined by the results of pilot testing (Di Paola & Fazio & Battaglia & Slavíčková, 2022) in which respondents had to answer this question using a six-point Likert scale: *"To what extent did the situation around Covid-19 change the way in which you use resources now?"* The scale lowest value (1) corresponded with *"No change at all."*, while the highest (6) with *"To a great deal."* 108 respondents from all countries participating in the project were involved in the pilot MaTeK testing and based on the collected data the average score was 3.66. We concluded that the teachers felt a certain change. This led us to deal with this topic in more detail.

Methodology

Our research involved teachers in Slovakia and the Czech Republic. We focused not only on the teaching of maths but also on teaching physics in primary and secondary schools. In addition to asking about resources used by teachers before the Covid-19 pandemic, during distance teaching and face-to-face teaching we also inquired about methods chosen by teachers during these time periods (Michal & Kiss, 2022). We decided to deal with these two countries because their education systems are similar, and these two countries also share some history together. Because of this, the results from these two countries should be comparable – this is also stated by Slavíčková and Novotná (2022).

Our research investigated the following research questions:

- RQ1: Which methods did teachers find useful and working for pupils during the lockdown?
- RQ2: What changed in teachers' use of resources during and after the lockdown?
- RQ3: Do teachers still use new methods or approaches from RQ1 now? If so when, why and for what?

Data collection took place from July 2022 to November 2022. Data were collected with the use of a questionnaire which was sent via email to maths and/or physics teachers. Our research was conducted in accordance with ethical principles and approved by the ethics commission at our faculty. The questionnaire consisted of open-ended, semi-opened and closed questions. The questionnaire was divided into two parts: in the first part, respondents answered a question about which subject they taught in school. If a given respondent was a maths teacher and a physics teacher at the same time, the respondent filled the questionnaire separately for each subject. The respondents were firstly asked about what resources they used primarily (the most often) before the Covid-19 pandemic. The question of what resources used and tried during distance teaching followed. We were also interested in what resources the respondent had tried but did not use any further during distance teaching. Finally questions about face-to-face teaching were asked. We were interested in which resources respondents discovered during distance learning and still use them in lessons during face-to-face teaching, or no longer use them from some reason at present. Respondents were able to select resources from the list provided for given periods of time; they were also allowed to write down their own. Respondents were also asked to provide a statement regarding what way they used the given resources: how often, in what part of the lesson and with what goal. In the following part, we asked about methods used in the same manner. The

second part of the questionnaire included demographic questions: we asked about gender, age, years of experience, place, and type of school they worked in. At the end of the questionnaire, respondents were given an option to sign up for an interview in which we asked further about the resources they used.

This paper is reporting on only a subset of these results; we are presenting only the use of resources in teaching physics in primary and secondary schools in Slovakia. Within this report we will state what resources the teachers of physics used before distance teaching, what new resources they used during online lessons and what resources are used even after the Covid-19 pandemic.

Questionnaire characteristics

Our questionnaire was sent to the teachers from primary and secondary schools. 156 teachers teaching maths and/or physics from Slovakia and the Czech Republic were involved in this research.

In the following parts we will be dealing only with the physics teachers from Slovakia—61 respondents in total. Among respondents there were 11 male teachers and 50 female teachers. Their age and experience is shown in the figures below (Figure 1 and 2).

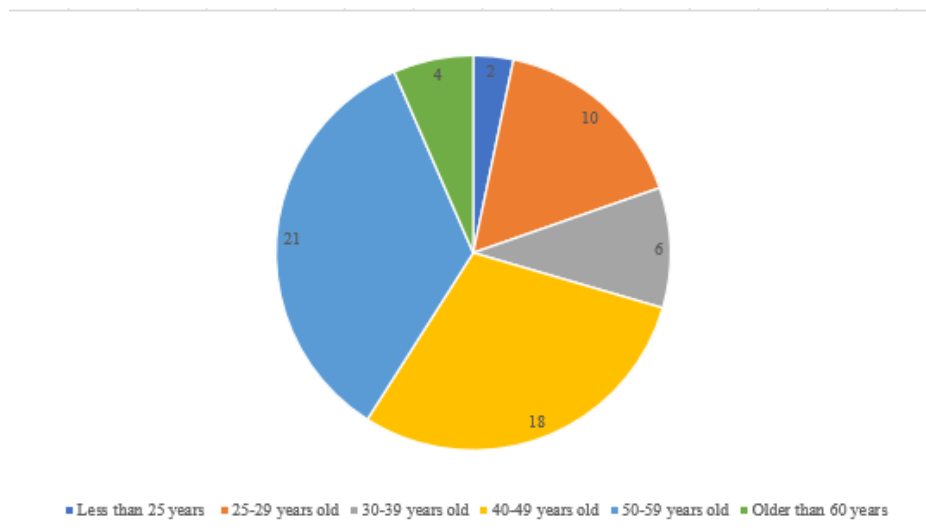


Figure 1: Distribution of physics teachers involved in the research from Slovakia according to their age

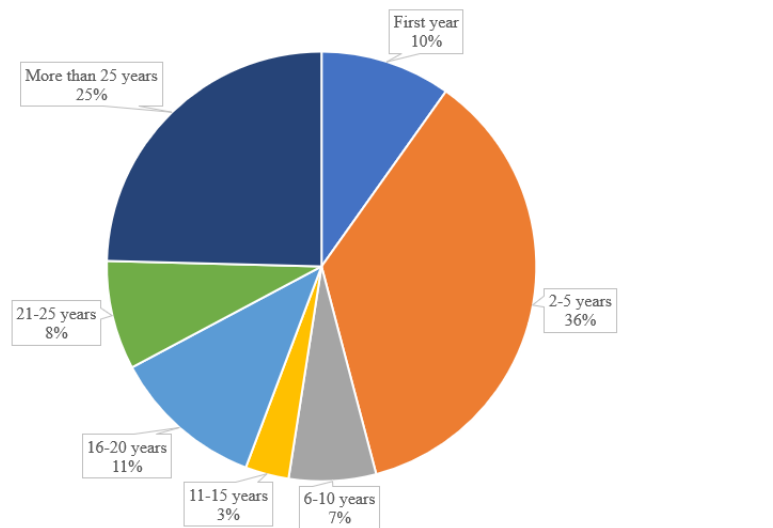


Figure 2: Distribution of physics teachers involved in the research from Slovakia according to their experience

Based on these figures we may notice that more experienced physics teachers from Slovakia were involved in our research. The last demographic information we were looking for was the type of school in which given physics teachers work. These data are shown in the figures below (Figure 3 and 4).

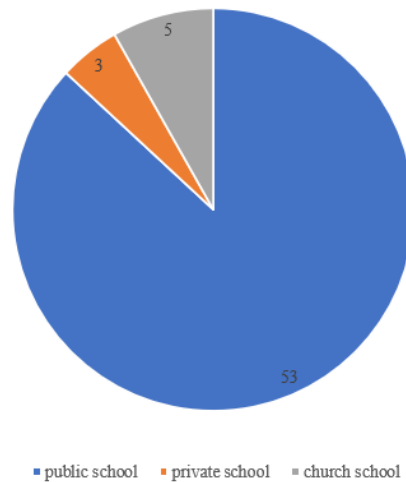


Figure 3: Distribution of physics teachers involved in the research from Slovakia according to the type of school they worked at in the academic year of 2021/2022 (1)

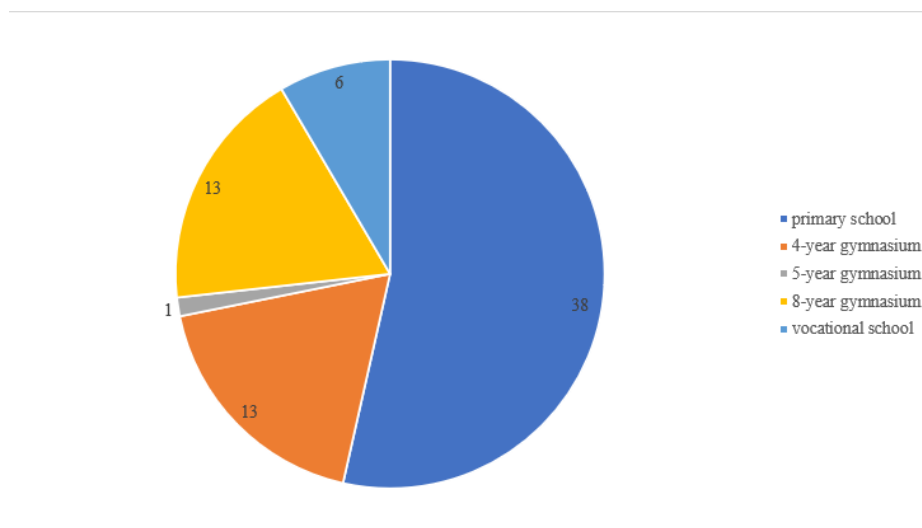


Figure 4: Distribution of physics teachers involved in the research from Slovakia according to the type of school they worked at in the academic year of 2021/2022 (2)

The figures show that from involved teachers of physics only 8 teachers were not working in a public school – 3 teachers were from private schools, 5 teachers were from church schools. The involved physics teachers were mainly working within lower levels of education.

Results

Within our questionnaire, we were interested in three periods of time: the period **before** the Covid-19 pandemic, the period of **online** teaching, and the period **after** the Covid-19 pandemic – the period after the resumption of in-person teaching. We asked the addressed teachers to share which resources they were using most often, which least often, and we were also interested in the resources they tried and used regularly, or the resources they tried, but did not use regularly. The acquired results are stated according to the individual periods of time.

Using resources before the Covid-19 pandemic:

As seen in Table 1, physics teachers from Slovakia that participated in our research, primarily used the following resources before the Covid-19 pandemic:

- textbooks,
- national curriculum and
- own materials prepared in the past.

The least used primary resources were:

- social media (e.g. Facebook groups of physics teachers),
- online professional platforms/libraries for physics or teaching physics and
- professional periodicals (journals) for teaching physics.

As far as online resources are concerned, based on the results of the questionnaire, the physics teachers preferably used *online databases or websites for sharing resources created by teachers or online video platforms such as YouTube*, and less *online professional platforms/libraries for physics or teaching physics or social media such as Facebook group of physics teachers*.

Table 1: Use of the resources before the Covid-19 pandemic and during distance teaching

Resource	Before	During	The change in resource
Textbooks	54	46	-8
National curriculum	45	28	-17
Own materials prepared in the past	39	47	8
Books related to physics or teaching physics (other than textbooks)	38	33	-5
Online databases or websites for sharing resources created by teachers	36	45	9
Online video platforms (e.g. YouTube)	35	51	16
Consultation with physics teachers in my school	33	24	-9
Internet image search engines or image libraries	30	36	6
Teacher guides or textbook teacher editions	25	19	-6
Digital physics apps/virtual manipulatives (e.g. WolframAlpha, GeoGebra, PhET)	20	24	4
General information websites (e.g. Wikipedia, blogs)	19	26	7
Professional periodicals (journals) for teaching physics	17	10	-7
Online professional platforms/libraries for physics or teaching physics	12	20	8
Social media (e.g. Facebook group of physics teachers)	7	26	19

Using resources during distance teaching:

As for the resources **tried and regularly used** by physics teachers during distance teaching, as shown in the Table 1, in comparison with the resources used by the teachers as primary ones before the Covid-19 pandemic, there is only one change in the first three places (and another change in order of the resources). During this period the physics teachers used *online video platforms such as YouTube* the most, and then, comparably to the period before the Covid-19 pandemic, their *own materials prepared in the past* and *textbooks*.

If we look at the resources used regularly by physics teachers during distance teaching, in comparison with the resources used by the teachers before the Covid-19 pandemic, there are the two resources which remained in the last three places - *online professional platforms/libraries for physics or teaching physics* and *professional periodicals (journals) for teaching physics*. The *social media* resource, such as *Facebook group of physics teachers*, moved upwards in the order which means that the physics teachers used this resource more often within online teaching.

As for the use of online resources during distance teaching, we can notice that online resources—mainly *online video platforms, such as YouTube*—moved upwards in the order. This fact, however, is not surprising, since it was to be expected that during distance teaching the teachers would use online resources more frequently.

Within one of the questions, we asked the physics teachers which resources **they tried, but did not use regularly** for whatever reason during distance teaching. The order of the resources is stated in the following chart (Table 2).

Table 2: Irregular use of the resources during distance teaching

Resources	Number
Social media (e.g. Facebook group of physics teachers)	15
Online professional platforms/libraries for physics or teaching physics	14
Professional periodicals (journals) for teaching physics	13
Online databases or websites for sharing resources created by teachers	12
Books related to physics or teaching physics (other than textbooks)	12
National curriculum	12
Digital physics apps/virtual manipulatives (e.g. WolframAlpha, GeoGebra, PhET)	12
Online video platforms (e.g. YouTube)	9
Textbooks	9
General information websites (e.g. Wikipedia, blogs)	9
Consultation with physics teachers in my school	8
Teacher guides or textbook teacher editions	8
Internet image search engines or image libraries	6
Own materials prepared in the past	4

In the Figure 5, marked by blue colour, we can see the resources that teachers tried and used frequently during the pandemic and marked by yellow colour, the resources they tried but did not use frequently during the pandemic.

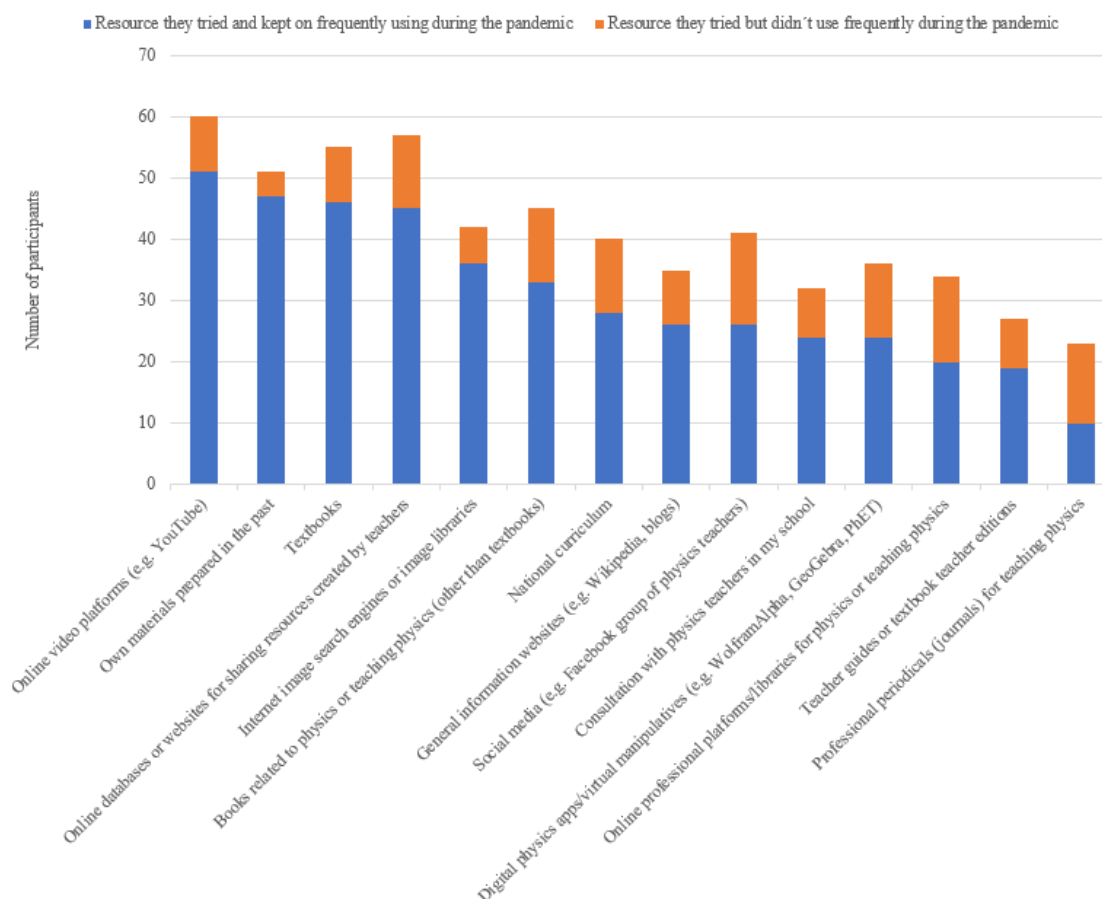


Figure 5: Regular and irregular use of the resources during online teaching

We can notice that out of those physics teachers that used *online video platforms such as YouTube*, only 15% of them did not use these resources regularly. In the case of *online databases or websites for sharing resources created by teachers* it is 20%. If we take a look at *digital physics apps/virtual manipulatives, for example WolframAlpha, GeoGebra, PhET*, we can see that out of those physics teachers that used this resource, one third of them did not use it regularly.

One of the respondents stated that GeoGebra, for example, was not used because of the need to show the students such an application in which they would see directly how to manipulate with a ruler and a goniometer:

During distance learning GeoGebra turned out not to be the tool I needed. Pupils need to observe the way in which to use goniometer and ruler. Thus, I eventually started using simple software for an interactive board in its place, where I could work with these instruments.

Using resources after the Covid-19 pandemic:

In the last part of our questionnaire, we were interested in which resources physics teachers discovered during the pandemic, and which of these they still use, or, for whatever reason, they do not use anymore. The results are stated in the following table (Table 3).

Table 3: Use of the resources after the Covid-19 pandemic

	Resource they discovered during the pandemic and still use	Resource they discovered during the pandemic but do not use anymore
Online video platforms (e.g. YouTube)	30	6
Digital physics apps/virtual manipulatives (e.g. WolframAlpha, GeoGebra, PhET)	19	9
Online professional platforms/libraries for physics or teaching physics	17	11
Online databases or websites for sharing resources created by teachers	13	9
Social media (e.g. Facebook group of physics teachers)	12	16
Internet image search engines or image libraries	12	1
General information websites (e.g. Wikipedia, blogs)	10	6
Books related to physics or teaching physics (other than textbooks)	8	3
Own materials prepared in the past	8	3
Textbooks	6	3
Consultation with physics teachers in my school	5	2
National curriculum	4	2
Professional periodicals (journals) for teaching physics	3	4
Teacher guides or textbook teacher editions	2	0

Looking at online resources, we can see for 5 resources (marked in bold) that between 60% and 80% of the teachers that used the given resource during the pandemic still use them. We can also see that online video platforms are still considerably used. Several physics teachers reported that they still use the videos even during face-to-face teaching. Some physics teachers use the videos in the motivational part of the lesson and to explain some concepts and phenomena. Some teachers use the videos as the means of distributing homework for the students and elaborating laboratory protocol:

Before the pandemic, we did experiments with pupils in the classroom, and thanks to them we often created a problem situation. Sometimes it happened that for various reasons it was not possible to carry out the experiment in school conditions, so I resorted to video or animation of the phenomenon under study. During the pandemic-related online classes, we used video demonstrations and various applets much more often in the classroom, so that I could create a problem situation or attract the attention of the pupils. Also, pupils carried out various physics measurements via applets, in case the home conditions were not sufficient to carry out the real experiment and the measurement associated with it. After returning to the school, I opted for the use of a short video in the lessons to demonstrate and arouse the interest of the pupils with greater frequency. Also, some of the measurements that the pupils did during the online lessons I later chose to do again in this

form during the school lessons, as it was more illustrative, and every pupil could do the measurement.

Analysis

Within this report we were dealing with what resources sampled teachers of physics from Slovakia used before pandemic, which resources they tried and used (or did not try or use for some reason) during distance teaching and finally we were looking at what resources they found and are still using up to date.

61 physics teachers from Slovakia were involved in our research. The majority of them taught in public schools. Before the Covid-19 pandemic, these teachers used *textbooks* as the primary resource, while *social media resources, such as Facebook group of physics teachers*, were used the least. As for the resources which the teachers tried and used regularly during distance teaching, in first place there were *online video platforms such as YouTube*, followed, comparably to the period before the pandemic, by *own materials prepared in the past and textbooks*. We can notice that out of those physics teachers that used *online video platforms such as YouTube*, only 15% of them did not use these resources regularly. On YouTube, Slovak teachers participating in our research most searched for videos featuring experiments related to the topic they were currently teaching. Videos focusing on specific physics topics were also sought after. Teachers used these videos as supplementary materials during physics classes. One specific author mentioned by teachers as frequently searched on YouTube was Jozef Beňuška (<https://www.youtube.com/@JozefBenuska/videos>). There was an interesting finding that *textbooks* were in the first place of the used resources before the Covid-19 pandemic and during distance teaching. We assume that it was like this during distance teaching because multiple publishers allowed the teachers to access electronic versions of the textbooks.

Discussion

Regarding the use of resources after the end of distance teaching, we can state that online resources have remained among the everyday resources used by physics teachers. According to schoolteacher Libor Klubal, teachers have not given up on online teaching even after the end of pandemic (Nadácia Dionýza Ilkoviča, 2020a). Quite the opposite, they have developed it and used it further in classic teaching. Klubal also noticed the importance of supporting online teaching (Nadácia Dionýza Ilkoviča, 2020a). The most significant advantages are seen in the fact that, even students who could not attend a lesson or missed noting everything during the given lesson, are able to return to it at any time. He also sees the use in activating students during the review of the material – with the use of digital support, he can ensure that everyone works at the same time and receives feedback from each student in the lesson. Also referring to Klubal, during distance teaching the teachers were using a more constructivist approach to teaching, because students were only given instructions based on which they were supposed to proceed and seek various information (Nadácia Dionýza Ilkoviča, 2020a). According to him, teachers should continue this approach even after pandemic.

As schoolteacher Jozef Beňuška states (Nadácia Dionýza Ilkoviča, 2020b), for online learning the educational materials in digital form are needed. Within the research, which was carried out by Dionýz Ilkovič Foundation (Nadácia Dionýza Ilkoviča, 2020c), 90% of respondents (570 teachers of maths, physics, informatics, and chemistry) was creating their content by themselves. This was because for various reasons – such as quality of materials –

they could not use the materials found on the internet. Based on the outcomes of our research, the physics teachers often used the materials from various online resources. Because of this it would be beneficial to create more materials which could be used by teachers primarily within distance learning, but also during face-to-face lessons. However, it is important to pay attention to the professional and didactic correctness and quality of these materials. Here we see the possibility of implementation by students of physics teaching in collaboration with experts in didactics of physics.

During distance teaching, Beňuška (Nadácia Dionýza Ilkoviča, 2020b) missed physical experiments the most. Due to this very reason he started to prepare videos with experiments which were provided to the teachers. These videos were used by multiple respondents from our research. Speaking of experiment videos, during distance teaching they helped the teachers a lot because they could demonstrate various physical phenomena even without being at school and without working with needed equipment. However, we do not have to forget about different videos that represent different physical phenomena even nowadays during face-to-face teaching. Authors Gorčáková and Velmovská (2022) are dealing with the use of silent videos in the lessons of physics. In their work, they mention the use of silent videos both in distance and face-to-face teaching. Authors Jose, Kochandra and Daniel (2021) focused on videos of the screencast and lightboard types from the perspective of conceptual understanding and self-efficacy, not only during the pandemic Covid-19.

Based on the research carried out by Dionýz Ilkovič Foundation, we may further notice that 60% of asked teachers do not see a difference between effectivity of online teaching and classic lessons. They consider the expanse of online education even after pandemic important. In the compliance with Klubal they also see the importance of this for the students who cannot attend lessons for various reasons. The interesting fact is that 90% of asked teachers think that online education should be used in the upcoming university education process for future teachers.

Based on the results, we believe that future physics teachers should also be prepared for the use of online resources in teaching physics. There is also an opportunity to create additional materials for practicing teachers, also online, that are of high quality.

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