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"COVID-19 SHOCK" AND IDENTIFIED BENEFITS FOR IMPROVED PRE-SERVICE CHEMISTRY TEACHER EDUCATION

Abstract: The global pandemic has forced many people to make significant changes in their work, personal lives, and everyday duties and activities. This metamorphosis has also significantly affected education systems. Implemented research activity in the learning process and emphasised the development of children's cooperation have recently been limited and often unattainable because of learner isolation, prevailing home education, and different countries' COVID-19 quarantine measures. Herein, we investigated and tested the 2020 European spring preparedness, commitment, and erudition of in-service and pre-service teachers and parents in remote education. We profiled the following three paradigm models of successful remote education; specific experience of in-service and pre-service chemistry teachers and the parents of school-age children. Here, we concentrated on sensitive identification of the most common problems, disadvantages, and risks. Prospective teacher training should concentrate more on remote education. It should help develop teachers' didactic competencies and increase their motivation and willingness to participate in this mode of education.

Keywords: online teacher learning, paradigmatic models, pre-service chemistry teacher development, remote education during pandemic conditions, teacher education preparation

Introduction and theoretical background

Global school systems are undergoing a burdensome test of resilience and functionality during this COVID-19 pandemic disruption. There are mentioned, "emergency teaching" or "crisis schooling" [1]. Although this current situation has caused major difficulties, it offers opportunities to adapt education and learning in the education system and triggers future improvement. This is a significant turning point, and we consider that the forced remote education of learners combined with in-class methods could well improve education standards by altered education goals. We also acknowledge the potential educational benefits proffered by this unfortunate occurrence.

Altered sole in-class education has provided incentives for mass remote education and the opportunity to test the positive and negative aspects of the distance-learning concept. Our results reveal the strengths and weaknesses of the readiness of teachers, learners, and parents to effectively apply mass remote education, and this was not previously possible.

Distance education is not a new phenomenon. This concept originated in the 18th century as correspondence courses, and radio and television transmissions in the 20th

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century then gave alternative forms of public distance education through their broadcasts. The first online electronic documents were shared over the Internet in the 1990s and e-learning concepts were coined at the commencement of the millennium. Although mature student loans were approved for this form of education in the second decade of the 21st century, it has not been viewed as a mass education priority for primary and secondary schools; not even by the most erudite Central European universities. Some conference forums have introduced the possibility of virtual conference members, but this has only occurred in the last five years. For middle school science teachers there could be useful to provide mentoring services for scientists and experienced science teachers in an online environment [2, 3], even self-study helps for teachers' personal growth and development [4, 5]. Teachers generally use technology more for preparation and communication. If they felt comfortable with technology, they will use it more often in the classroom when delivering instruction or having students engage in learning activities [6].

There was defined distance learning as 'conducting education through print or electronic media' [7]. The learner is involved in learning at a different place or time to the teacher. There were identified six key elements of distance teaching: separation of teachers and students, the institutionalised influence of the educational organisation, the use of media for teacher-student connection, two-way communication, individualisation of teaching, and teacher influence [8].

Distance learning is still undergoing intensive global investigation, and recent studies have focused on digital 'Teacher Educator Technology Competencies' (TETCs) [9, 10] and their ability to teach in the digital age [11]. There was reported that pre-service teachers appreciate the benefits of synchronous computer-assisted communication in teaching as an excellent learning experience [12], and others considered distance learning a viable educational method [13].

Each country had different input determinants for the introduction of distance education when the corona crisis struck. There have been many education projects implemented in Central Europe over the last twenty years, including informatisation and digitalisation, the introduction of information and communication technology in schools, and the preparation and verification of digital content in individual and mass teacher re-training as part of their lifelong learning. Technology is used in teacher education to create technically literate education professionals, strengthen the practice-theory connection, provide more practice-centered training, and reflect deeply on the scholarship and practice of teaching [14]. However, meaningful use of technology is very important [15].

Many web-based educational portals should make it easier for teachers to choose the processed learning content and forms and methods of teaching a particular subject. However, their number should not be the main criterion in the development of teachers' digital competency. Many of these portals provide forums for solving teachers' current problems and sharing their experiences on counselling sites. While the forms and methods in pre-service teacher training in distance learning are legitimate, they should not dominate because they are still only methods and not the goal of teaching and education. Moreover, they certainly cannot replace the role of a teacher.

The last two years were too exacting for teachers, parents, pupils, and all members of society all over the world. At the same time ministries of education, school headmasters, teachers, etc. faced the problem of how to teach pupils and students with eliminating the

virus spread. Pupils in many countries had a problem with online school communication, with learning without face-to-face help.

Chemistry and science education are specific in activities that are typical for these lessons with labs, modelling, and lots of symbolic and microscopic representations [16] and for different approaches and methods, e.g. [17-20]. The challenge for chemistry teachers around the world was how to bring chemistry to households via online education [21]. The situation affected general educational activities, particularly chemistry teaching. Laboratory education during COVID-19 was in many cases stopped. This led to a lack of hands-on laboratory experience [22]. On the other hand in China, there has been proposed an effective online teaching method for chemistry experiments [23]. In Australia, George-Williams et al. [24] proceeded with specific tools and techniques, and the range of modes in which they taught, including lectures, tutorials, and laboratories. In West Java teachers, students, and school managers were unprepared for the online system in education [25].

The major aim of our research is to improve the quality of pre-service chemistry teacher training by examining the course, results, and risks in the ground-breaking massive introduction of distance education in Slovakia during the COVID-19 crisis.

Methodology

Research questions

- What is the experience of in-service chemistry teachers with the massive introduction of distance forms of education during the COVID-19 crisis?
- What is the experience of pre-service chemistry teachers with the massive introduction of distance forms of education during the COVID-19 crisis?
- What is the experience of parents with the massive introduction of distance forms of education during the COVID-19 crisis?

Methods employed in implementing the research

We used a structured interview (see the Supplementary Material) in our research. This choice resulted from our intention to map the respondents' experience with the character, relationships, and opinions on the massive application of remote education in Slovak schools during the COVID-19 crisis as comprehensively as possible. The interview focused mainly on the following aspects: the method of distance education, the nature and sources of difficulties, problems with the start of this education, conditions of preparation and implementation of such education, aspects of the procedural elements of education, and respondents' attitudes and self-assessment concerning the related issues. The questions were open-ended in the range 32-37 (some of them in each group of participants are added as Supplementary Material).

The interviews were recorded, then processed and analysed by the principles and procedures of qualitative research. Subsequently, paradigmatic models of the view of individual cohorts of respondents on the practice of distance education during the COVID-19 crisis were devised through open, axial, and selective coding.

The research sample consisted of three respondent cohorts.

The first included 12 chemistry in-service teachers aged between 30 to 55 with different lengths of teaching experience and different combinations of subjects taught.

The ultimate aim of our research was to optimise pre-service teacher training and we, therefore, chose a group of university students; future chemistry teachers who also switched to remote education during the pandemic. This choice provided an insider's view of the problem in question. The group comprised prospective teachers and master's degree students studying a combination of science subjects with chemistry. At the time of the research, they had completed pedagogical, psychological preparation, and introduction to didactics. This cohort had 17 respondents.

The final cohort included parents of children who participated in distance learning so that the view on the implementation of remote education during the corona crisis was more comprehensive. This group consisted of 10 parents aged between 36 and 46.

The data was collected at the turn of May and June 2020.

Table 1

Information about the groups of participants in the survey

Name of group	Number of participants	Age	Questions
In-service teachers	12	30-55	32
Pre-service teachers	17	22-24	32
Parents	10	36-46	37

Results, analysis, and data interpretation

In-service chemistry teachers

We found that the teachers used a wide range of available online education options. These ranged from telephone communication to instructions and guidelines through social networks and e-mails and finally to specialised software which enabled online meetings and material sharing. While all teachers applied several methods and the frequency of their use was different, specialised software for online teaching and meetings produced by various manufacturers prevailed in all of them. In principle, the use of potential options varied, but it was accompanied by effective use of the positive aspects of individual options and the actual and available possibilities.

The introduction of online teaching at the beginning of the pandemic encountered several problems due to the unanchored distance education in Slovakia. The teachers identified the three most common problem areas:

1. The need to reorient "didactic" thinking and actions by the change like online education as opposed to in-class education. The teachers felt some limitations in the preparation to motivate students in this form of education, in formulating questions and tasks ensuring the activities of students or the overall management of individual didactic sequences. The teachers considered that difficulties arising from the feedback and assessment of learners' work were a permanent source of problems. This signals the deep entrenchment of these issues in in-class education. Finally, the teachers experienced serious problems in trying to change learners' perception of computer use to systematic work associated with education, and the lack of emphasis on learners' independent work proved to hurt distance education.
2. Respondents considered that weaker teacher and students digital competencies created fewer problems than anticipated. Teachers reported approximately two weeks to initially suppress the difficulties arising from this aspect and to start online education at least at the basal level.

3. Teachers identified the following external sources of problems; limitations caused by different technical and economic backgrounds of learners' families, the schools and school management support for their teachers, and the parents' approach to supporting their children in online education.

However, there were no "internal" teacher problems, and we recorded no significantly negative teacher problems in mastering the specific software required for online education. It was a pleasant surprise that this was true for all interviewed teachers regardless of their age, and although the older teacher generation initially felt unsure and less confident, school management support ensured a smooth transition.

We also noted teachers' opinions concerning the time-consuming preparation for online teaching. Respondents reported that online preparation took twice the time of in-class lessons. Although the teachers consider that the daily number of online units should be cut in half, they differ in the perceived extent of a suitable teaching obligation for each teacher. The following teaching loads were recommended: "from teachers for International Standard Classification of Education levels from 1 to 3A (from ISCED 1 to ISCED 3A), the teaching obligation should increase by approximately three teaching units for each level of education. Thus, for ISCED 3A teachers, this should be approximately two-thirds of the teaching obligation applied in in-class teaching".

We were also interested in how teachers perceived the work of their learners during online education, and we found that the teachers' experiences were diverse. While some learners reacted to work in online teaching by initial great activity to gradual attenuation, many entered work pace gradually until reaching a stable optimal level of work, and a significant percentage of learners did not adapt to a sufficient work pace at all. Moreover, some learners worked only under constant pressure from the teacher. One group focused all activity on finding weaknesses in online education and used these to escape work and others transparently expressed ignorance of the necessity to fulfill work duties. Such a wide array of teachers' experience with learners' work suggests that neither the positive nor negative features of distance education dominated and that learners' work was most likely conditioned by the entire spectrum of factors and characteristics encountered in in-class teaching.

Re-orientation to the specific needs of online teaching was not insoluble for the teachers because the number and variety of teaching methods they used were not significantly different from those in in-class teaching. For example, the resources that teachers prepared for individual topics particularly included worksheets, videos, power-point presentations, electronic textbooks and scanned available materials. The teachers also developed tests that subsequently provided feedback on the results of their teaching. However, they mostly felt the need for specific preparation or adaptation to successfully apply the teaching methods and resources in this more specific online teaching environment and stated that their pre-service teacher training should have included preparation for dealing with such situations.

In contrast, in-service teachers adapted more easily to this online education because they were younger and computer-knowledgeable. This especially applied to the humanities teachers who reported little difficulty in the educational switch.

However, most respondents were unfamiliar with distance education before the crisis because they had never used it or considered it carefully. In addition, they had a distinctly negative attitude towards it, and personal experience with the use of online education has not made any significant change in their scepticism. Moreover, the teachers consider the

main disadvantage of distance education is that it is a poor substitute for in-class teaching. They lack personal contact with students, and problems with feedback and testing exacerbate their negative feelings.

The broader context of teacher reactions is both negative and positive.

Their dissatisfaction includes the following; teachers sense societal lack of preparedness for this education re-organisation; technical complexity problems; loss of social contact; a lack of approval in the social climate and problems with feedback and assessment objectivity in this education method. Finally, they also list the risks involved with the frequent inconsistency observed in most learners.

Teacher's positive observations are that distance learning help solve the following societal and individual situations; student illness and long-term absence; its suitability for motivated students and especially those in higher classes; temporal flexibility for both teachers and students enables both individual approach and pace; teachers appreciate harmonisation with modern technology in both the school and society; they register the positive experience of improving the work of even weaker students and they appreciate the support of a large number of parents. Finally, teachers like the idea of distance education enhancing student independence.

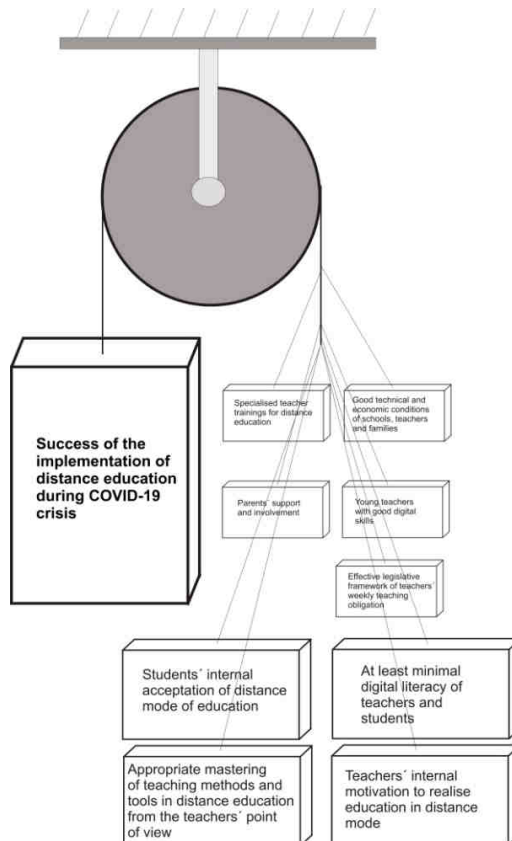


Fig. 1. The success of implementing remote education from the perspective of in-service teachers (Paradigmatic model)

Although teachers had not felt ready for such a new situation, their reported self-assessment confirmed satisfaction in managing their needs, demands, activities, and results. However, they still maintained that they did not like this way of teaching because of a lack of personal contact and direct social ties. Overall, the in-service teachers consider that the professional activity is both challenging and instructive, and they feel particularly satisfied with their improved ICT skills and their ability to organise their work.

Qualitative research enabled the development of a paradigmatic model for teachers. This described the effects of factors that determined improved implementation of remote education during the COVID-19 crisis (Fig. 1).

The paradigmatic model analyses teachers' attitudes and opinions and expresses how the identified factors increase success in distance education. We identified 9 factors and considered that the 4 shown in the larger blocks are the most dominant.

Pre-service chemistry teachers

The following findings are summarised from interviews with teacher training program students who communicated with their university teachers in several ways. Online teaching was mostly conducted through online meetings such as lectures, interactive seminars, and online tests. This was accompanied by an e-mail lesson dispatch and completed assignment submission. There was also material mediation through websites, phones, and social networking. In all cases, there was a variety of online teaching methods implemented.

Students identified the following issues that they struggled with at the commencement of distance learning:

1. The first major group of problems students encountered was managing their learning time at home and also their concentration and assignment return. They reported slight improvement after teachers introduced a two-week course in online lectures and seminars. This type of education was not available in many subjects, so this learning organisation became a student's responsibility.
2. The second large group of difficulties was communication with teachers. When introducing distance learning, the teachers shifted greater responsibility for acquiring knowledge and skills onto students. They assumed that students could obtain the most required information by self-study from literary and electronic sources. However, the students found this discouraging because it required more time and they also lacked sufficient study material. The use of various software for online communication was also a problem because teachers used different systems and the students had to work with the teachers' choice of software.
3. A minor issue then concerned student experience with low-quality and unstable Internet connections and conflicts with sibling students.

Most student respondents perceived remote education as unimaginable before the COVID-19 crisis and had a neutral attitude towards it. Some mentioned the possibility of future use of distance learning but realised it could not completely replace in-class teaching. However, the experience of implementing distance learning brought a slight shift in students' positive views of this education, and the students rapidly gained greater insight into distance education possibilities than their teachers.

The most significant negatives perceived by the students were a lack of social contact with classmates and teachers, limited opportunities for feedback and objective assessment, and limited opportunities for 'prac-teaching'. Other disadvantages stemmed from the unpreparedness of our education system for this type of teaching. This involved the lack of

online materials and sufficient experience with online software or other programs adapted for distance education. Negative perceptions also included the long periods spent on the computer and a lack of physical activity from quarantine measures.

Student positives came from being in the home environment because they were less stressed and avoided travel time and expenses and wardrobe choices. Individual work pace and the possibility of recording lectures and replaying them were especially advantageous.

All respondents considered distance education a good alternative when either student or teacher experienced long-term absence due to illness or maternity leave, and the learner respondents claimed that distance learning is more suitable for upper secondary schools and universities and a wide range of subjects. The major drawback was the loss of practical teaching. The learners who benefited most from distance learning were those who prefer an individual approach, find company disturbing and distracting, and those who may have long illnesses. In contrast, learners who felt particularly handicapped were those with inadequate technical equipment and those from socially weaker families or with learning disabilities and therefore require more teacher attention.

Pre-service teachers considered that it would be ideal to have one online lesson a day at the first stage of primary school, one to three lessons at the second stage, and between two to four online lessons each day at secondary schools. They justified this estimation by claiming that online teaching was also exhausting for them and the younger learners would not be able to manage as many distance hours as in in-class teaching.

The students also report that teachers' attitudes often changed in many ways during this period. Some were more lenient with tasks, reducing the curriculum and emphasising only selected parts, while others recommended self-study and required even more work than usual. In addition, some teachers were willing to introduce online lectures and seminars, but others communicated reluctantly or ignored students' requests for online lectures.

The methods and tools employed during online teaching differed depending on the teacher, with most presentations, scanned materials, and videos, but also online textbooks, worksheets, and tests. The pre-service teachers considered that online teaching by younger teachers with good technical skills was generally easy to adapt to, but some older teachers also demonstrated no problems with online teaching. The student teachers also considered that both preparations for distance learning lessons and the number of lessons required to be delivered are more time-consuming than in in-class teaching. Moreover, most think that the teaching load should be a maximum of half the lessons given in in-class teaching.

The vast majority of pre-service teachers report insufficient preparedness for distance education, but still, feel comfortable in mastering it during the COVID-19 crisis. Although a small percentage feel that they were prepared for distance education, but dissatisfied with implementation methods, most consider distance learning unsuitable and they would be unwilling to exchange it for in-class teaching. The main reasons they gave are the lack of social contacts, difficulty in separating personal and educational time, and unrealistic opportunities to complete practical teaching duties.

While the students mostly evaluated the pre-COVID period positively as an extremely satisfying experience, they also found it very demanding, exhausting, and stressful with so much to learn in such a short time. Preparation time for in-class and distance learning varies greatly from student to student. Respondents were divided into two equally represented groups; one group reported that they spent more time preparing for distance learning and the other one less. This depended on the teachers' methods and tools.

In addition, students report that their skills have improved through the use of ICT which aided information retrieval and time management. However, they then recorded regression in motivation to learn and also decreased practical skills. Although their opinion on individual subjects changed very little during the corona crisis, their attitude was influenced by the teacher’s approach and the amount of material to be completed and submitted. Students were also engaged in self-assessment, and here they stated that escape strategies in online teaching were greater than in in-class teaching. Most often, they turned off the camera and microphone during lectures if there were many participants and individual presence was only passive receipt of information.

Therefore, we devised a paradigmatic model for a group of pre-service teachers describing the effect of factors that determined improved remote education implementation in the COVID-19 crisis. This is set out in Figure 2.

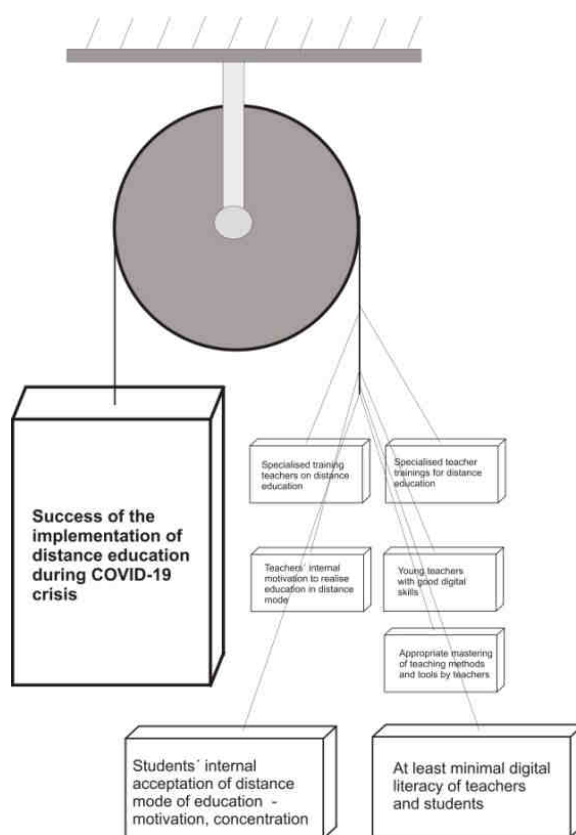


Fig. 2. The success of the implementation of remote education from the perspective of pre-service teachers (Paradigmatic model)

The paradigmatic model illustrates the dominant factors affecting the successful implementation of distance education from the student/pre-service-teacher perspective. The students considered their internal adaptation to distance education as the most

important factor, and this is especially related to motivation and concentration. The next important factor appeared to be student and teacher digital literacy.

Parents

We also canvassed the opinions of parents on remote education. All of them provided a "child service" with a laptop, tablet, and internet connection. They took the assignment from the teacher by e-mail or school portal. The child completed the lesson and sent the completed assignment to the teacher. Parents also participated in the control of explanations, interpretations, and completed assignments. Although it was generally expected that older children would mostly manage distance education themselves, no parent reported a lack of participation and help in their children's distance learning. They were there to help the children with all problems associated with lesson downloading and subsequent submission.

Parents observed the following problems with teaching protocol, materials, and technical equipment:

- a) *schools*: the material equipment in families was not assessed by the school, although some schools lent laptops to their learners;
- b) *teachers*: not all teachers' home environment is equipped with appropriate technical equipment for online teaching;
- c) *children*: the technical equipment of the household with several computers and tablets was demanding because online lessons took place for all siblings at the same time.

Parents recognised problems in the following areas; introducing distance education; setting up this system; ensuring a regular regime; harmonising activities so that children could be educated at home; preventing distractions wherever possible; allocating free time, and avoiding the perception that the children "were on holidays" and ensuring family time together.

Many respondents considered that the children were abruptly given too many tasks, and parents themselves did not have sufficient time for psychological adaptation and relaxation. Most parents assessed the introduction of distance education as straightforward, but they quickly realised the problems and material costs involved in multi-children families. This revolved around PC equipment, headphones, microphones, and webcams. When problems with connection to online teaching occurred, the parents first tried to reconnect the child with the teacher through re-login, re-start, or connection by mobile phone. They then informed the teacher of their problem by e-mail or through the school portal, and either excused the child's absence from online lessons or rapidly helped the child catch up with teacher support. The teachers also sent further curricular information to help with online class attendance or assigned tasks.

All parents agreed that remote education was the best possible solution in pandemic conditions. They considered that teacher-child interaction through technical equipment was valuable in receiving and returning assignments, but expected more lesson explanation and feedback. They also understood the greater effort required, and that the learning results differed depending on the distance methods employed by individual teachers.

In addition, the parents considered the following major disadvantage of distance education; their child's lack of social contact with peers, impersonal teacher contact; time-consuming preparation and education; the lengthy time the child must spend in front of the computer, and the consequent loss of play and exercise. Some respondents added that

there was insufficient feedback, a lack of educational subjects and group and systematic work, and finally, too many subjects concentrated on taking notes from textbooks.

While parent respondents appreciated the difficult work of teachers during the pandemic, they also offered criticism. Although they acknowledged that some teachers took the new situation very seriously, they held the following views; the teachers did not consider learners' home situations and technical problems; some did not even contact their learners; some wrote: "find five sentences on the Internet and determine the tense they are written in"; therefore, students who had adapted to their new activities continued to work creatively, while the rest remained inactive; some teachers focused entirely on essential subjects and the student was left to 'self-study' other subjects and some teachers initially "went overboard" with an amazing number of assignments, tasks, and projects delivered and required, but this stabilised over time until a satisfactory compromise was finally contrived. In contrast, many teachers were academically active and creative, and some were very proactive and utilised these attributes admirably in distance teaching and learning.

Parents also gave their opinions on teaching loads: teachers should be able to teach two to four online lessons daily, and ideally with a group of 10-15 students; parents aware of the time-consuming preparation of online lessons expected two lessons daily, and these appreciated teacher-time spent in material and assignment collection and adaptation, task-checking, feedback distribution and verbal assessment of learner product.

Their views on parent responsibility were also recorded; parent participation in preparing their child for school work should last from one to four hours; depending on the number of school-age children, the demands and division of family work duties, demands on home office performance, and the quality of teacher performance. Parents admitted that they spent much more time with their children. They reported that their 5-12 hours week participation is optimal for teaching first-stage learners in primary schools, 6-20 hours a week for primary school second-stage learners, and 10-25 hours a week for secondary school students. This generally complies with the 1-2-3 hours a day model.

Parents participated in the remote education of their offspring by mail, material and data equipment, and particularly in their time and money contributions. At the end of the school year, they claimed that they had managed this form of education and were satisfied with their role in it. They recorded that the most serious and longest-lasting problems involved setting the children's daily routine, with time set for learning preparation, learning and rest, and recreation. Before remote education during the pandemic, these problems had usually been solved in the first days of school. Respondents summarised the disadvantages of distance education as follows: the child's insufficient social contacts; impersonal contact with the teacher; more time-consuming preparation and education; unreasonably long time on the computer, mobile, or tablet; unsystematic access to the curriculum and biased examination of knowledge. However, they welcomed this form of education temporarily, but only as a future supplement to in-class learning.

Our parental respondents see the following distance education advantages: strengthening digital/computer literacy; developing child independence; flexibility; children taking responsibility for their learning; better understanding of the teaching profession; support for the child's workplace; individualised/personalised teaching; freedom in organising the entire family's day; less time the child had to spend on school responsibilities; absence of exams and tests; the ability to choose subject allocation and order; communication between teacher and classmates was welcome and made the learners

feel as if they were actually in class and, finally, the learners began understanding new curriculum chapters faster and more easily than in self-study.

The final and most telling results of parent responses included their acknowledgment of some teachers' enormous efforts to cope with the situation; they felt completely satisfied with the teachers' performance. The parents were also happy to "try out the role of a teacher", and many gained complete confidence in monitoring the fulfilment of their children's school duties.

The parent responses were very enlightening, and therefore we devised a paradigmatic model for a group of parents describing the effect of factors that determined the improved implementation of remote education during the COVID-19 crisis (Fig. 3).

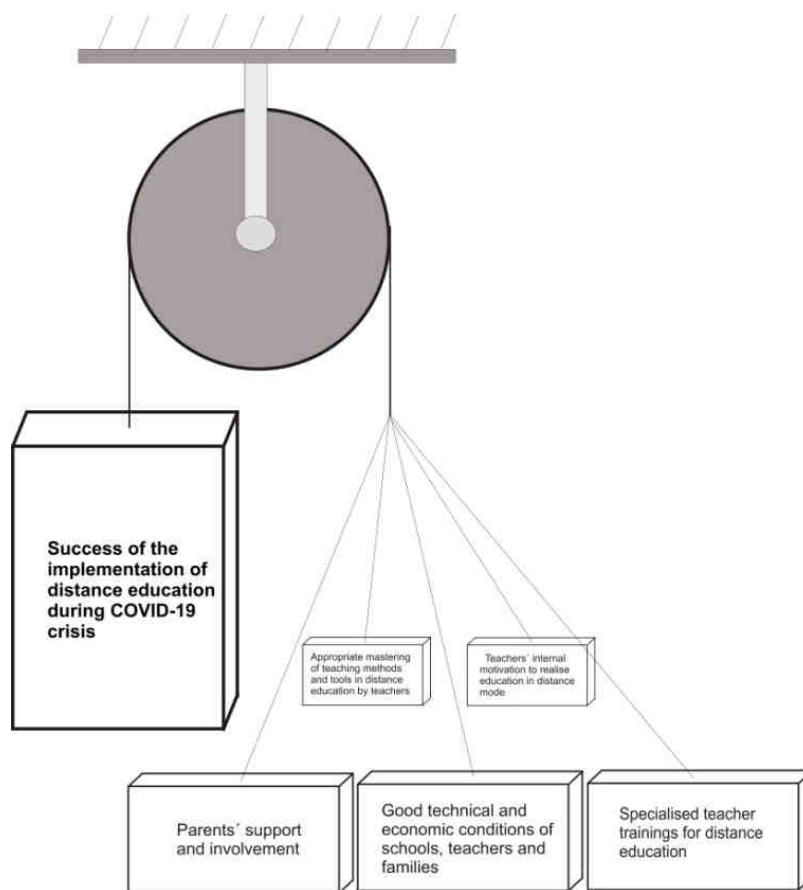


Fig. 3. The success of the implementation of remote education from the parents' perspective (Paradigmatic model)

The paradigmatic model was created by analysing parents' attitudes and opinions on research issues, and it highlights the key factors that influenced distance education success during the corona crisis. These were especially the parents' support and involvement, the good technical and economic conditions of the schools, teachers, and families, and, finally,

the specialised teacher training for this education. These factors elucidate the parent-teacher-school interaction which benefited young learner education.

The parents found the teachers' adequate mastery of methods and resources and their motivation to implement distance education most significant. They held the clear opinion that 21st-century education remains primarily in the hands of teachers, aided by the technical advances available from the rapid development of cutting-edge technology.

Parents did not regard the minimum digital literacy of teachers and pupils significant, nor consider a legislated teaching workload necessary. They did, however, express their solid opinion on an appropriate number of teaching units for primary and secondary school learners. Encouragingly, and most validly, parents did not rate teacher age as a factor that determined successful distance education.

Discussion and conclusion

Several research studies about education in Slovakia during the coronavirus pandemic were focused on the education of pupils with specific needs, and pupils without them, on parents' views on this problem [26], and on pupils from socially disadvantaged backgrounds [27]. School plans all around the world in different schools were not adapted to online education and several topics and school subjects were not provided while distance learning. The main pupils' problems were different approaches (pupils from socially disadvantaged backgrounds, parents refusing communication via social media), different pupils' communication competencies, and technical and individual barriers with PC and the internet (pupils on online education at the same time as parents on the home office) [28].

Branikovicova and Lastincova [27] administered an online questionnaire focused specifically on primary school teachers' attitudes to work with students from socially disadvantaged backgrounds during a coronavirus pandemic. They focused on didactic methods of teachers, activities, and feedback of students from socially disadvantaged backgrounds during distance education. While 31.8 % of participants were without internet access, 41.9 % could not fully participate in teaching compared to other students, although some schools used field social workers or personal contact to communicate with them. The risk deepened the social isolation and exclusion of these students.

Huang [23] found out that teachers in China became familiar with internet-based technologies and online teaching tools, adjusted their teaching plans and teaching methods, and quickly adapted to the new situation. Teachers also needed to improve their teacher-student interaction and maintain student interest and engagement during online teaching. To become successful online learners, students needed to be more proactive and self-disciplined. In comparison with our research teachers, parent, and pupils faced similar problems and difficulties and did not consider them so easy to solve.

Comparing the research provided in India and USA students considered internet issues as a major challenge they faced and reported a financial burden as a major challenge met during the pandemic. Only a minority of the students rated the level of chemistry learned during the crisis as exceptional [29].

In another research (in Southeastern Asia, West Jawa) chemistry teachers answered 10 open questions about chemistry learning and practicum in the COVID-19 pandemic. Participants tried to utilise various technology platforms in conducting learning. Most of them faced difficulty to arrange the lab-work activities and did nothing. Some teachers try to find lab-work multimedia instead of real activities [25]. Teachers encountered difficulties

and needs during the COVID-19 pandemic, they shared their knowledge, materials, and teaching strategies for online teaching.

The respondents in the individual cohorts in our research had much in common, despite holding different positions during the corona crisis and being expected to express different opinions on distance learning. Teaching through online meetings and e-mail material mediation successfully prevailed in all cohorts and alternative distance education methods were only supplementary and rarely used. In addition, all cohorts held the view that technical equipment is not essential, but it is important enough to disadvantage learners from socially weaker families or large families with many children. A further common problem was the re-orientation to distance teaching and learning. Teachers use this to motivate students and get feedback, students employ it to organise time and focus on learning at home and parents need it to set their child's daily regime and concentration on school duties.

Most importantly, all cohorts agreed that although distance learning is an acceptable, but not equivalent, alternative to in-class teaching, its utility is only preferable for learners who have long-term illnesses and those unable to attend school in circumstances such as long-distance commuting. The respondents also highlighted that the lack of social contact between learners and between learners and teachers is the main negative encountered in distance learning and everyone contended that it is almost impossible to develop student teamwork and communication or practical skills in science and technology. Moreover, common opinion decreed that distance education is most suitable for younger teachers of subjects such as computer science and mathematics.

We also recorded differences in the individual cohort's assessment of the importance of teachers' digital competencies. While both in-service and pre-service teachers identified this as a key factor in successfully implementing distance learning, parents considered it less important. This was most likely because parents take teachers' digital skills for granted, and nothing happened to change this opinion. There was a similar difference attached to the importance of teachers' internal motivation in distance teaching and parents' support and involvement. While the former is considered extremely important only by in-service teachers and the latter only by parents, the pre-service teachers did not consider that parental support was an important influence for the successful implementation of distance education. The cohorts had similar attitudes to both pre-service teachers and learners using lesson-escape strategies, but they all considered that the older learners' reason was immersion in self-study.

We implemented this research to use the resultant knowledge to adjust pre-service teacher training in our faculty. Analysis of the results suggests that prospective teacher training should concentrate more on distance education. This adjustment should help develop teachers' didactic competencies and increase their motivation and willingness to participate in this mode of education. Teacher training should therefore stress information that helps these students verify the characteristics, benefits, and limitations in their future choices of methods, forms, and instruments in imparting distance education. Moreover, education itself demands that prospective teachers have personal experience with distance learning, and teacher training must instill insight into the problems and solutions which can arise in this important undertaking. Therefore, it is imperative that pre-service teacher training includes theory and practice in distance education. Further, this theory and practice must not concentrate just on the benefits and shortcomings of different internet technology because most students today already have great awareness of "what works".

This implementation in teacher training courses must target lifelong education and the continual adjustments teachers must make to satisfy their pupils' needs in this rapidly changing world. Finally, some pre-service lessons should also cover specialised didactic subjects focused on practical testing in this distance mode of education.

In conclusion, although we do not wish to overestimate the knowledge and results gained in this research, we realise that they are much more than just fragments of future teacher education, and also that these will contribute to a more comprehensive view of appropriate theory and practice in pre-service teacher training in the wider global setting.

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