Article
The Impact and Evaluation of the COVID-19 Pandemic on the Teaching of Biology from the Perspective of Slovak School Teachers

Ramona Babosová 1, Alexandra Bartková 1,2,*، Vladimír Langraf 1، Mária Vondráková 1 and Anna Sandanusová 1

1 Department of Zoology and Anthropology، Constantine the Philosopher University in Nitra، 94974 Nitra، Slovakia; rbabosova@ukf.sk (R.B.); vlangraf@ukf.sk (V.L.); mvondrakova@ukf.sk (M.V.); asandanusova@ukf.sk (A.S.)
2 Laboratory of Developmental Biology، Institute of Animal Physiology، Genetics of the Czech Academy of Sciences، 27721 Libechov، Czech Republic
* Correspondence: abartkova2@ukf.sk

Abstract: The closing of schools due to COVID-19 was a critical incident that should have caused a rethinking of education in our country. Among the many changes that this crisis has brought، one is fully remote teaching. Our research focuses on a comparison of the changes between on-site and remote forms of biology teaching، the opinions and feelings of teaching staff across all the institutional levels، and their opinions regarding the usage of online teaching tools in the future. The research shows that teachers have used both time-tested teaching aids and modern technology to generate an environment that would be as close to on-site teaching as possible. Similarly، the teachers with longer teaching experience had felt a greater degree of stress during the remote teaching period. Teachers of primary and tertiary schools agree that they can imagine having a combined form of education in the future but that the practical classes of biology must be completed on-site. On the other hand، most secondary school teachers want to preserve only the on-site form of teaching. Our study provides information on the current state of coping with the pandemic situation in Slovakia from teachers’ perspectives.

Keywords: COVID-19، remote education، biology، teacher، primary school، secondary school، tertiary school

1. Introduction
COVID-19 viral infection، which has been present since the end of 2019، can be characterized as a highly contagious disease caused by coronavirus 2 (SARS-CoV-2) which has spread from China across the whole world [1–4]. This disease is characterized by transmission through air via droplets and aerosols، a short incubation period and a high transmission rate [5–8]. As opposed to other similar diseases، in a relatively high percentage of cases، COVID-19 creates complications that require specialized treatment and has a generally higher mortality rate، especially if such treatment is absent. These abovementioned characteristics led to an explosive spread of the infection، a sudden rise in mortality rates، and often placed a disproportionate strain on the health infrastructure in some areas [8–10]. For that reason، governments of most countries were forced to adopt a wide range of measures to limit the spread of the disease [1،11]. Those measures were of different kinds and intensities and although attempts were made to limit them to only certain areas less critical for the functioning of society، the swift development of the pandemic led to restrictions even in the more critical areas، such as health services or education. The emergence of subsequent new mutations of the disease also caused these measures to be in effect for a longer period [12،13].

From 2019، the burgeoning pandemic of COVID-19 has created an emergency state in many areas throughout the world. It has affected many societal sectors، especially in...
health, other services, and education. In most countries, schools and other educational institutions were closed to prevent the spread of the virus [14,15]. According to UNESCO, 186 countries had introduced the closure of schools before the end of April 2020 and it affected approximately 73.3% of students [16]. Slovakia was no different, and as such, the closure of schools required a transition from on-site to online teaching. Education thus had to be realized through the digitalization of educational strategies focused primarily on the continuous education of students. Practically speaking, it was not that simple, especially due to the scope and complexity of the education process. Anti-pandemic measures thus led to new and unanticipated challenges such as a fast reorganization of education methods and the creation of remote support tools for students. Before the lock-down, teaching was always focused on teacher–student contact whereas due to the restrictions related to COVID-19, most teachers needed to change their approach to multiple aspects of their work basically overnight [17]. According to the HundrED survey, a lack of digitization and the unpreparedness of European schools constituted the biggest issues of remote education. UNESCO noted that only 20% of countries were equipped with online education programs and the pandemic remains a transformative and adaptational challenge with no successful solution for almost all teachers. Strict measures have disrupted the standard mode of functioning of schools and universities [18] and because of the extensive nature of those measures and with the expectation of them being continued, alternative methods of teaching were devised. Even today, educational institutions are working on alternative methods so that they can continue to teach at the time of on-site education not being possible and devise methods that enable them to work in a safe environment. Even though direct teacher–student contact as the highest form of educational interaction cannot be suitably replaced by anything else, remote teaching can form a useful complement to traditional education methods.

Online teaching, or e-learning, can be characterized as transferring information and experience using various electronic equipment (such as personal computers, laptops, smartphones, etc.) with internet access in synchronous and asynchronous environments. Online e-learning is a platform that helps implement creative and flexible educational processes focused on the independent work of the students [19,20]. In Slovakian schools, however, this form of education is relatively rare. Before the COVID-19 pandemic, online education had only an auxiliary role and was mostly used by universities [21]. In times before the pandemic, e-learning courses constituted a popular, albeit complementary, form of informal education; however, the anti-pandemic measures have transformed them into a formal style of the education system [22]. Compulsory quarantine measures are used even in primary and secondary education [23] and online education has generally more positive than negative effects, e.g., low costs and ease with which the study materials can be provided to students in rural or remote areas [24]. Although, according to Muthuprasad et al. [25], it does not provide sufficient interaction or motivation for students. Multiple Slovakian schools have implemented various creative strategies to combat the crisis using multiple applications and software such as Google Classroom, Zoom, or Microsoft Teams.

Biology is a science of life, which, after all, is implied by the word itself, as it is derived from the Greek words, “bios” (which means life) and “logos” (which means study). Generally speaking, it is possible to say that biology concerns the study of the origins, development, and functions of living organisms and, consequently, biology as a subject is important to understanding the basic functions and interactions in nature. Its teaching is based mainly on the experimental demonstration of a broad spectrum of biological processes [26]. Multiple authors have defined the remote teaching of practical subjects as being limiting, regarding aspects such as insufficient feedback, lower discipline and especially the impossibility of transferring the required practical skills [27]. Because of this, online education posed an even greater challenge for biology teachers.

Due to the current relevance of the topic, this work aims to judge and compare the effects of changing the methods of teaching the natural sciences, concretely biology, from the perspective of Slovakian teachers of primary, secondary, and tertiary schools during the
COVID-19 quarantine. We endeavored to find the answers pertaining to the three most important areas: (1) what are the differences between on-site and remote biology teaching at different levels of education?; (2) what is the opinion of the teachers regarding the remote teaching of biology?; and (3) what is the opinion of teachers on using remote teaching of biology in the future based on the experience gathered during the COVID-19 pandemic?

We expect that our results will describe the current state and help to improve and optimize teaching in Slovakian schools.

2. Materials and Methods

The study’s goal was to identify the views of primary, secondary and tertiary schoolteachers regarding the effects of the remote teaching of biology. We used questionnaires for the purposes of gathering data. The questionnaire was prepared in Google Forms and contained 14 questions combining open and closed questions, as presented in Table 1. The majority of those questions were multiple choices. Respondents also had an option of including a short answer to each question.

Table 1. List of the questionnaire’s open and closed questions.

| Questions                                                                 | Characteristic       |
|---------------------------------------------------------------------------|----------------------|
| You are a teaching staff at:                                             | closed-ended question|
| Your teaching practice is:                                                | open-ended question  |
| What tools do you use in remote biology teaching?                         | closed-ended question|
| What tools do you use in full-time biology teaching?                      | closed-ended question|
| How many hours a day do you spend preparing for biology lessons in the full-time form of education? | open-ended question |
| How many hours a day do you spend preparing for biology lessons in the remote form of education? | open-ended question |
| Which resources had you used during the remote teaching of biology?       | open-ended question  |
| How did you distribute study materials among the students?                | closed-ended question|
| How did you teach practical lessons during remote study of biology?       | closed-ended question|
| What positive aspects of remote teaching have you felt as a teacher?      | closed-ended question|
| What negative aspects of remote teaching have you felt as a teacher?      | closed-ended question|
| As for you, remote teaching was:                                          | closed-ended question|
| Will you be using the material prepared during remote teaching also for on-site teaching? | closed-ended question|
| Can you imagine teaching biology in combined form (on-site and remote) in the future? | closed-ended question|

The questionnaire was shared with the teachers using school e-mail. In its introductory part, the teachers were informed about the aim of the study with the emphasis on its importance and the method of preparation according to the ethical norms of Constantine the Philosopher University in Nitra.

In the first part, two questions focused on gathering demographic information (type of school, length of experience in teaching biology). In the second part, there were questions pertaining to the research topic focused on the aspects and differences between on-site and remote teaching, focusing on the demands for preparation, tools, forms of the practical part of the subject, and common positive and adverse effects. The questionnaire was anonymous, and its completion took up to 8 min.

In total, 368 teachers from Slovak public schools participated in the study. Primary school teachers were the most numerous, and the predominant group in terms of experience were teachers with 21 to 25 years of experience. Demographic information pertaining to the teachers is shown in Table 2.
Table 2. Demographic information.

| Variable | N ¹ | % ² ³ | SD ² |
|----------|-----|------|------|
| Teachers |     |      |      |
| Primary  | 295 | 86.94|      |
| Secondary|  60 | 11.79| 151  |
| Tertiary |  13 |  1.28|      |
| Teaching experience |     |      |      |
| <5 years |  64 | 17.39|      |
| 5 to 10 years |  48 | 13.04|      |
| 11 to 15 years |  43 | 11.68|      |
| 16 to 20 years |  61 | 16.58| 19.44|
| 21 to 25 years |  86 | 23.37|      |
| 26 to 30 years |  39 | 10.6 |      |
| >30 years |  27 |  7.34|      |

¹ number of teachers; ² standard deviation.

Gathered data were transferred from Google forms to the MS Excel program. Afterward, the data were processed using inductive statistical methods. The short answers were processed using open coding and the consequent categorization of answers [28]. General terms were first identified in the answers so that they could be grouped into categories of similar focus [29]. Two scientists analyzed the answers. First, the different categories were compared to improve the reliability. The statistical analysis of answers was evaluated in R program ver. 3.6.3 (2020) using Pearson’s chi-square test, testing of the normal distribution of data (Kolmogorov–Smirnov (KS) test), and Spearman’s correlation coefficient.

3. Results

The main aim of the research was to explore the differences between remote and full-time education and examine the perception of primary, secondary and tertiary school biology teachers during the coronavirus pandemic. In evaluating the questionnaire, we have reached the following findings.

3.1. Differences in On-Site and Remote Teaching of Biology

Lessons of biology frequently rely on the use of various teaching aids. It is not possible to present the study material to the students merely by verbal or written methods. Teaching aids often enable the students to see phenomena they had not met previously. When analyzing the usage of teaching aids during biology lessons of primary and secondary school teachers, we confirmed, using the Pearson’s chi-square test, a statistically significant difference between on-site and remote teaching (p = 0.00022 for primary school teachers, p = 0.000022 for secondary school teachers). On the other hand, tertiary school teachers did not confirm this effect (p = 0.5741). Similarly, we also confirmed a statistically significant difference in the time required for the preparation of on-site and remote lessons of biology by primary school teachers (p = 0.0022) and secondary school teachers (p = 0.001773). The tertiary school teachers did not confirm this difference (p = 0.4233). The results are shown in Table 3.

Table 3. Results of analysis (Pearson’s chi-square test) of using teaching aids and preparation of lessons during the remote and on-site form of teaching.

| Using Teaching Aids | Preparation of Lessons |
|---------------------|------------------------|
|                     | Primary School | Secondary School | Tertiary School | Primary School | Secondary School | Tertiary School |
| X-squared           | 1690            | 183.91           | 3.83           | 93.479         | 17.193           | 1.7193          |
| df                  | 13              | 9                | 5              | 4              | 4                | 2               |
| p-value             | 0.000022        | 0.00022          | 0.5741         | 0.0022         | 0.001773         | 0.4233          |

The most common aid used by primary school teachers during on-site teaching is a textbook (14.98%) and videos during remote teaching (29.49%). Secondary school teachers
mostly use their presentations during on-site (15.94%) and remote classes (24.12%). Tertiary school teachers mostly use presentations on-site (32.14%) and videos during remote classes (40.63%).

In terms of the preparation of lessons, 1–2 h per day were spent preparing lessons by 62.71% of primary school teachers and 48.33% by secondary school teachers during on-site teaching. For remote teaching, 3–4 h per day were needed by primary school teachers (47.80%) and secondary school teachers (38.33%). Tertiary school teachers mainly needed 1–2 h per day for on-site (69.23%) and remote teaching (76.92%).

Regarding the question of what resources the teachers used during the remote study, we detected by the chi-square test a significant difference between the answers of the primary (\( p = 0.000022 \)), secondary (\( p = 0.002884 \)) and tertiary (\( p = 0.01128 \)) school teachers (Table 4). The most commonly used resources for the tertiary school teachers were their own presentations (40.63%) and YouTube (27.27%), their own presentations for the secondary school teachers (22.59%), and YouTube for the primary school teachers (21.46%).

| Which resources had you used during the remote teaching of biology? | Primary School | Secondary School | Tertiary School |
|---------------------------------------------------------------|----------------|-----------------|----------------|
| X-squared          | 1167.3         | 48.433          | 13             |
| df                | 9              | 5               | 4              |
| p-value            | 0.000022       | 0.002884        | 0.01128        |

| How did you distribute study materials among the students? | Primary School | Secondary School | Tertiary School |
|----------------------------------------------------------|----------------|-----------------|----------------|
| X-squared       | 663.5          | 142             | 6              |
| df             | 7              | 7               | 3              |
| p-value         | 0.0022         | 0.000223        | 0.1116         |

| How did you teach practical lessons during remote study of biology? | Primary School | Secondary School | Tertiary School |
|-----------------------------------------------------------------|----------------|-----------------|----------------|
| X-squared          | 114.54         | 19.833          | 2.7692         |
| df                | 4              | 4               | 4              |
| p-value            | 0.000022       | 0.0005387       | 0.5972         |

Pertaining to the questions about what form the study materials were provided to students, we saw a significant difference among the primary school teachers (\( p = 0.0022 \)) and secondary school teachers (\( p = 0.00022 \)). This effect was not confirmed among the tertiary school teachers (\( p = 0.1116 \)) (Table 4).

The most common reply given by the primary (45.91%) and secondary (44.34%) school teachers was “using EduPage”. Most of the tertiary school teachers (77.78%) gave “to e-mail addresses of the students” as the most common reply. High numbers were also detected for the reply “using MS Teams” for the primary (23.15%) and secondary school students (28.3%).

Using the chi-square test, we detected a significant difference between the answers to the question of how the practical biology classes were conducted during the remote form among the primary school teachers (\( p = 0.000022 \)) and secondary school teachers (\( p = 0.0005387 \)). We did not see this difference among the tertiary school teachers (\( p = 0.5972 \)) (Table 3). The most common answer in all cases was “students were working on practical classes independently in the form of projects or special home assignments, worksheets”, namely, primary (41.36%), secondary (36.66%) and tertiary (30.77%).

### 3.2. Opinions of the Teachers Regarding the Remote Teaching of Biology

When analyzing the questionnaire, we focused both on the positive and negative impacts of remote education from the perspective of biology teachers. Online learning in Slovakian schools had multiple positive effects. Most of the teachers appreciated flexibility as the greatest advantage of online education. Using the chi-square test, we detected a statistically significant difference in perceiving the positive effects of remote education among the primary (\( p = 0.0022 \)), secondary (\( p = 0.00022 \)) and tertiary (\( p = 0.04304 \)) school teachers (Table 5).
Table 5. Results of chi-square test analysis of respondents’ answers on remote teaching.

| | Primary School | Secondary School | Tertiary School |
|---|---|---|---|
| What positive aspects of remote teaching have you felt as a teacher? | X-squared | 415.82 | 121.65 | 13 |
| df | 7 | 8 | 6 |
| p-value | 0.0022 | 0.00022 | 0.04304 |
| What negative aspects of remote teaching have you felt as a teacher? | X-squared | 786.26 | 162.41 | 26.8 |
| df | 13 | 13 | 11 |
| p-value | 0.00022 | 0.022 | 0.004926 |

The most positive effect among the tertiary school teachers was an absence of early rising and traveling to work (34.48%). The advantage of self-development in ICT was mentioned mostly by the secondary (29.75%) and primary school teachers (29.49%).

The second aspect was the evaluation of negative effects. Using the chi-square test, we noticed a statistically significant difference in the perceived negative effects of remote education among primary ($p = 0.00022$), secondary ($p = 0.022$) and tertiary ($p = 0.004926$) school teachers (Table 5). The most cited negative effect among the tertiary (16.13%) and secondary school teachers (13.73%) was the absence of personal contact with students, and the primary school teachers noted problems with an internet connection (13.49%).

In the question, “As for you, remote teaching was:”, the teachers were asked to project their experience during the pandemic into pictures. The teachers had the possible choice of five images showing people working on a computer, which represented feelings of stress, difficulties, boredom, relaxation, and interest (Figure 1).

We confirmed the assumption of the disruption of normal distribution data by the Kolmogorov–Smirnov (KS) test ($p$-value = 0.0001).

Based on the disruption of normal distribution of data, we used the non-parametric Spearman’s correlation coefficient to represent the relationship between teaching experience and the total impression of remote education. We detected a slight inverse relationship among the tertiary ($r = -0.3966$) (Figure 2) and secondary school teachers ($r = -0.168$) (Figure 3). The reliability coefficient for the tertiary school teachers was $r^2 = 0.7841$ and for the secondary school teachers it was $r^2 = 0.7541$. 

Figure 1. Questionnaire images for expressing impressions of remote teaching.

As for you, remote teaching was:
Figure 2. Representation of relationship between impressions and teaching experience among tertiary school teachers. Note: 1—stress; 2—difficulties; 3—boredom; 4—relaxation; 5—interest.

Figure 3. Representation of relationship between impressions and teaching experience among secondary school teachers. Note: 1—stress; 2—difficulties; 3—boredom; 4—relaxation; 5—interest.

A trivial positive relationship was found among the primary school teachers ($r = 0.0636$) (Figure 4), and the reliability coefficient was $r^2 = 0.8112$. Our results imply that tertiary and secondary school biology teachers with a longer teaching experience felt more stress during remote teaching.

Figure 4. Representation of relationship between impressions and teaching experience among primary school teachers. Note: 1—stress; 2—difficulties; 3—boredom; 4—relaxation; 5—interest.
3.3. Using the Remote Teaching of Biology in the Future

By means of the aforementioned questionnaire, we concluded that teachers of primary and secondary schools that created new teaching materials were able to use them effectively even in on-site education. When analyzing the question of whether the teachers plan to use the material prepared for remote teaching after the pandemic ends, we detected, using the chi-square test, a significant difference among the primary \((p = 0.001422)\) and secondary \((p = 0.009306)\) teachers. This difference was not present among the tertiary school teachers \((p = 0.2089)\) (Table 6). In all cases, the most common reply was “yes, majority of the material is appropriate for on-site teaching as well” (primary 71.53%, secondary 81.67%, and tertiary 53.85%).

| Table 6. Results of chi-square analysis of respondents’ answers on remote teaching in the future. |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Will you be using the material prepared during remote teaching also for on-site teaching? | X-squared | Primary School | Secondary School | Tertiary School |
| df | 1 | 1 | 1 |
| p-value | 0.001422 | 0.009306 | 0.2089 |
| Can you imagine teaching biology in combined form (on-site and remote) in the future? | X-squared | Primary School | Secondary School | Tertiary School |
| df | 3 | 3 | 3 |
| p-value | 0.02945 | 0.02097 | 0.2089 |

Lastly, we investigated if the teachers could imagine teaching biology using a combined approach (standard on-site and online teaching) in the future. Using the chi-square test, we found a significant difference in the answers among the primary school teachers \((p = 0.02945)\) and secondary school teachers \((p = 0.02097)\). This difference, once again, was not confirmed among the tertiary school teachers \((p = 0.2089)\) (Table 5). The most common reply among the primary (32.54%) and tertiary (46.15%) teachers was “yes, but practical lessons must be done on-site”, and secondary school teachers noted “no, better teach it on-site only” (36.67%). In the study, some primary school teachers thought that remote teaching was not workable for teaching biology due to insufficient laboratory courses, insufficient practical applications or insufficient excursions and observations, and an overall absence of student–teacher interactions. Aside from that, those teachers stated that they did not want to implement remote education for biology lessons in the future.

4. Discussion

The transition to online teaching created various challenges not only for students but also for teachers who had to adjust the content and curriculum for the education and participation of students and, correspondingly, the remote teaching of biology is more difficult due to the experimental nature of the subject.

4.1. Differences in the On-Site and Remote Teaching of Biology

The success in remote learning is, aside from the discipline of the students to a certain degree, determined by the quality and interactive nature of the study materials that substitute the direct student–teacher interaction [29]. These are primarily teaching aids—texts adjusted for self-study, audio and video programs, computer programs and interactive teaching programs that combine the essence of all previous materials [30]. Xie and Yang [31] hold the opinion that the study materials for remote forms of study should be prepared in such a way to help the teachers during the lessons, to save time, and to help develop the autonomic learning of the students as much as possible. According to these results, it is possible to say that the biology teachers used different teaching methods and techniques when teaching remotely during the COVID-19 pandemic; however, they strove to preserve as many of the methods of on-site teaching as possible. Based on our results,
we can say that the tertiary school biology teachers tried to use the same videos to give
students the best possible ideas about the practical work in the laboratory.

The average time teachers needed for the preparation of a lesson varied. Of course,
this depended on their experience, the number of classes to teach during the quarantine
period, the number of study groups and the form of the classes. Among the respondents,
some teachers spent significant time preparing various materials for their students. They
also were willing and able to teach online and synchronously through applications almost
daily. As the curriculum in Slovakia was not designed for remote learning, it was necessary
to forgo many subjects and similarly, some topics had to be excluded from some subjects
due to insufficient time in the online environment.

Similarly, effective teaching requires developing an understanding of how to modify
the teaching material using different technologies and teachers must understand which
technology is best for a particular subject and how the content determines which concrete
technologies can be used and vice versa [32]. YouTube, for example, can be seen as an
informal teaching medium [33]. Tan shows that informal educational interactions are
pleasant for students, support their learning and widen their mutual activity and social in-
teraction [34]. In accordance with our findings, Juanda et al. [35] state that 66.5% of biology
teachers in Turkey used YouTube or PowerPoint presentations during remote lessons.

In remote teaching, study materials were predominantly provided to students through
the EduPage webpage. Csachová and Jurečková also cited that for primary school mathe-
matics teachers, www.edupage.sk (accessed on 15 April 2021) was the most used application
for communication with students, while students’ e-mail addresses were the second most
common [23]. The authors presume that this is connected with the directives of individ-
ual schools, which used the aforementioned web page for communication with students.
During the analysis of the replies, we also encountered teachers who did not use such
communication or interaction with students at all. Seven primary school teachers stated
that they had not used any internet-based resources, as they teach students from socially
disadvantaged families who do not have internet access. In these cases, the teachers dis-
tributed printed materials to students by post. Similar results are shown by Csachová
and Jurečková, who mention that not all students had subsequently returned their given
worksheets (either they had lost them or did not do the assignments at all). Therefore,
the teachers did not obtain any feedback regarding what their students knew (or did not
know), or if they had worked on their assignments [23].

Teaching biology also requires that students have good laboratory skills, but such
activity is difficult to implement during online learning [36,37]; although, presently there
exists a lot of established online methods of teaching experimental design and data analysis
in science. We believe that nothing can replace the tactile experience of working in a
laboratory or the field. Similarly, Frey [38] also mentions that practical classes cannot be
fully implemented during online learning, so the teachers must choose the correct teaching
methodology and technology to substitute laboratory work. Babinčáková and Bernard [39]
have published similar results. Their study focused on experimental teaching methods
of chemistry, with the predominant use of presentations, video sharing, and at-home
experiments adjusted for the home environment.

4.2. Opinions of the Teachers Regarding the Remote Teaching of Biology

Online learning in Slovakian schools had multiple positive and negative effects. Ac-
cording to the teachers, flexibility was the most significant positive advantage of remote
education. Similarly, Rapanta et al. [40] also noted that teaching flexibility was an advan-
tage. Self-development in ICT was mentioned mostly by primary and secondary school
teachers. We suppose that this result is related to the methods used during on-site teaching.
Although primary and secondary school teachers mostly rely on textbooks for their classes,
tertiary school teachers work with PowerPoint presentations and ICT [41].

Others have mentioned that teachers were not quite happy with e-learning as a new
teaching method, attributing this to numerous factors such as technological challenges,
difficult interactions and discussions with students, inadequate internet connections and a preference for personal teaching [42,43]. Van der Spoel et al. [41] noted that the absence of interaction is the main negative aspect of remote teaching. The perception of transactional distance weakens communication between the teacher and student in various environments and creates a psychological divide [44], while Amhag et al. [45] concluded that the absence of direct interaction has helped integrate introverted students into the learning process in more significant ways compared to the standard teaching style. A second major drawback was technical issues caused by an insufficient, or unstable, internet connection. Other studies similarly note as the biggest drawbacks an insufficient/unstable internet connection, unsatisfactory computer classrooms, an insufficient number of computers/laptops and technical issues related to adjusting to online teaching [46–48].

We suppose that the increase of negative feelings could be caused not only by the academic context but also by the new measures that had to be issued by educational institutions without the necessary material and human support. Excessive stress could have generated emotional exhaustion, which is the first and most important symptom of occupational burnout and which is also a common negative consequence of the acute increase of work-related stress characterized by chronic tiredness and exhaustion [49–51]. As a consequence, sudden changes in the teaching methodology due to an outbreak of COVID-19 could trigger threats related to work and, thus, increase the emotional exhaustion of teachers. Our results also correlated with studies confirming the negative state-of-mind of teachers [52,53]. Considering the length of teaching experience, we observed that pertaining to tertiary and secondary education, remote teaching was stressful for teachers with a longer teaching experience. Identical results were achieved by Ozamiz-Extebarria et al. [54]; however, Gorrochategi et al. observed that a greater degree of stress could be present in younger teachers [55]. We agree with the supposition by Corbin et al. that the increase of stress could be related to occupational burnout and low levels of ICT skills [56]. Meanwhile, Kini and Podolsky [57] confirmed that although the length of teaching experience is related to the efficiency of a teacher’s preparation, it does not always positively affect their competency. The differences pertaining to the length of teaching experience and feelings about remote teaching discovered by us, could also be attributed to changes in conditions such as differences in the total number of lessons, the complexity of individual topics, the number of students, etc.

4.3. Using Remote Teaching of Biology in the Future

Goos [58] and Van der Spoel et al. [41] confirmed that teachers plan to integrate technology into teaching to a greater degree after teaching modes return back to their original, on-site form. Studies focused on utilizing innovations in education also confirm the positive effects of using technology on teaching efficiency and the motivation of students [59,60]. Similarly, Csachová and Jurečková [23] also detected the willingness of the teachers of mathematics to continue using different types of materials (presentations, videos, worksheets) that were prepared during the COVID-19 pandemic, even after the return to on-site teaching.

In accordance with our findings pertaining to secondary and tertiary school teachers, Karakaya et al. [61] found that biology teachers in Turkey believed that remote teaching should continue in the future but that it should be implemented to complement the shortcomings of on-site teaching. Some teachers were of the opinion that if the teaching process contained a sufficient number of visual demonstrations (animations, videos), then remote teaching could be an appropriate form even for teaching biology, while others believed remote teaching was applicable only to the theoretical topics of biology. Laboratory applications will not be workable for remote teaching because biology is learned through practical experience.
4.4. Limitation of Study

The first limitation of our research is the absence of questions on gender, age, and region. We can assume that these factors could affect the number of hours of preparation for teaching or the willingness to use new applications for distance learning.

Another limitation was the low return rate of the questionnaires. Some teachers who did not fill in the questionnaire wrote to us that they did not want to express themselves on the given topic, that they have a lot of work involved with remote teaching, or that education was interrupted at their school.

We endeavored to create questions suitable for biology teachers at all school levels; however, this was not always possible. The teachers at the tertiary school level had difficulty answering some questions where the teaching of biology, and especially the practical exercises, is more intensive than in primary or secondary schools. Although few tertiary teachers participated in the research, our findings sufficiently revealed how those teachers worked and what was different in their work during the pandemic period. The most important result of our study was that despite the disadvantages related to remote education during the pandemic period (e.g., no contact with some students, limited opportunities for motivation and support), most teachers (71.53%, secondary 81.67%, and tertiary 53.85%) reported a willingness to integrate technology into their teaching to a greater degree after teaching returns to its original, on-site form. It appears that new experiences in the pandemic era could lead to a positive change in the education system.

Despite the limitations in our study, we believe it provides some guidelines that provide a direction for future research.

5. Conclusions

Restrictions and measures attempting to prevent the coronavirus from spreading have led to changes in the education system in which online teaching has become a primary means of education. Such a transition to online teaching has created various challenges not only for students but also for teachers who had to adjust the content and curriculum with respect to the education and activity of students. Additionally, remote teaching in biology is more difficult due to the experimental nature of the subject. This study researched how primary, secondary and tertiary school teachers perceived the outbreak of COVID-19 during the closure of schools and how they managed to adapt to the new teaching routines and activities necessary due to remote teaching. Although these challenges arose in a unique context, which, hopefully, will not last, we can say that as far as possible, the teachers did create multiple innovations virtually overnight. The results of our research have provided us with information about the current state of coping with the pandemic state and have provided us with information necessary for creating more appropriate educational forms of practical biology lessons. These findings shed light on the limiting factors of remote teaching and teachers’ emotional exhaustion during the COVID-19 pandemic while implementing remote education practices. They also serve as an encouraging look to the future of education and increases in the efficiency of natural science education.

Author Contributions: Conceptualization, R.B., A.B. and A.S.; methodology, R.B., A.B. and A.S.; software, V.L.; validation, R.B., A.B. and V.L.; formal analysis, R.B., A.B. and V.L.; resources, R.B., A.B.; data curation, V.L.; writing—original draft preparation, R.B., A.B.; writing—review and editing, V.L., A.S. and M.V.; visualization, R.B., A.B.; supervision, R.B., A.B.; project administration, R.B. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the grant KEGA 039UKF-4/2021.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.
Acknowledgments: We would like to thank all the biology teachers who took part in the questionnaire survey and provided us with information about how they taught during the COVID-19 pandemic.

Conflicts of Interest: The authors declare no conflict of interest.

References
1. Remuzzi, A.; Remuzzi, G. COVID-19 and Italy: What next? Lancet 2020, 395, 1225–1228. [CrossRef]
2. Zhu, H.; Wei, L.; Niu, P. The novel coronavirus outbreak in Wuhan, China. Glob. Health Res. Policy 2020, 5, 6. [CrossRef] [PubMed]
3. Tan, W.; Zhao, X.; Ma, X.; Wang, W.; Niu, P.; Xu, W.; Gao, G.F.; Wu, G. A Novel Coronavirus Genome Identified in a Cluster of Pneumonia Cases—Wuhan, China 2019–2020. China CDC Wkly. 2020, 2, 61–62. [CrossRef] [PubMed]
4. Yu, X.; Li, N. Understanding the beginning of a pandemic: China’s response to the emergence of COVID-19. J. Infect. Public Health 2020, 14, 347–352. [CrossRef] [PubMed]
5. Liu, J.; Zheng, X.; Tong, Q.; Li, W.; Wang, B.; Sutter, K.; Trilling, M.; Lu, M.; Dittmer, U.; Yang, D. Overlapping and discrete aspects of the pathology and pathogenesis of the emerging human pathogenic coronaviruses SARS-CoV, MERS-CoV, and 2019-nCoV. J. Med. Virol. 2020, 92, 491–494. [CrossRef] [PubMed]
6. Pascarella, G.; Strumia, A.; Pliego, C.; Bruno, F.; Del Buono, R.; Costa, F.; Scarlata, S.; Agrò, F.E. COVID-19 diagnosis and management: a comprehensive review. J. Intern. Med. 2020, 288, 192–206. [CrossRef] [PubMed]
7. Sender, R.; Bar-On, S.Y.; Gleizer, S.; Berrishein, B.; Flamholz, A.; Phillips, R.; Milo, R. The total number and mass of SARS-CoV-2 virions. Proc. Natl. Acad. Sci. USA 2021, 118, e2024815118. [CrossRef] [PubMed]
8. Cascella, M.; Rajnik, M.; Aleem, A.; Dulebohn, S.C.; Di Napoli, R. Features, Evaluation, and Treatment of Coronavirus (COVID-19). In StatPearls; StatPearls Publishing: Treasure Island, FL, USA, 2022. Available online: https://www.ncbi.nlm.nih.gov/books/NBK554776/ (accessed on 3 April 2021).
9. Huang, J.; Zhang, L.; Liu, X.; Wei, Y.; Liu, C.; Lian, X.; Huang, Z.; Chou, J.; Liu, X.; Li, X.; et al. Global prediction system for COVID-19 pandemic. Sci. Bull. 2020, 65, 1884–1887. [CrossRef]
10. Wang, H.; Paulson, K.R.; Pease, S.A.; Watson, S.; Comfort, H.; Zheng, P.; Aravkin, A.Y.; Bisignano, C.; Barber, R.M.; Alam, T.; et al. Estimating excess mortality due to the COVID-19 pandemic: A systematic analysis of COVID-19-related mortality, 2020–2021. Lancet 2022, 399, 1513–1536. [CrossRef]
11. Bernard, S.S.; Rolland, P.; Silve, Y.; Mailles, A.; Campese, C.; Simonond, A.; Mechin, M.; Meurice, L.; Nguyen, M.; Bassi, C.; et al. First cases of coronavirus disease 2019 (COVID-19) in France: Surveillance, investigations and control measures. Eurosurveillance 2020, 25, 200094. [CrossRef]
12. Zhou, W.; Wang, W. Fast-spreading SARS-CoV-2 variants: Challenges to and new design strategies of COVID-19 vaccines. Signal Trans. Target. Ther. 2021, 6, 226. [CrossRef]
13. Zhao, Y.; Huang, J.; Zhang, L.; Chen, S.; Gao, J.; Jiao, H. The global transmission of new coronavirus variants. Environ. Res. 2022, 206, 112240. [CrossRef] [PubMed]
14. Crawford, J.; Butler-Henderson, K.; Rudolph, J.; Malikwi, B.; Glowatz, M.; Burton, R.; Magni, P.; Lam, S. COVID-19: 20 countries’ higher education intra-period digital pedagogy responses. J. Appl. Learn. Teach. 2020, 3, 1–20. [CrossRef]
15. Almendingen, K.; Morseth, M.S.; Gjølstad, E.; Brevik, A.; Tørris, C. Student’s experiences with online teaching following COVID-19 lockdown: A mixed methods explorative study. PLoS ONE 2021, 16, e0250378. [CrossRef] [PubMed]
16. Education: From Disruption to Recovery. (n.d.). Available online: https://en.unesco.org/covid19/educationresponse/ (accessed on 16 February 2021).
17. Sanger, C.S. Inclusive Pedagogy and Universal Design Approaches for Diverse Learning Environments. In Diversity and Inclusion in Global Higher Education: Lessons from across Asia; Springer: Singapore, 2020.
18. Pratama, H.; Azman, M.N.A.; Kassymyova, G.K.; Duisenbayeva, S.S. The Trend in Using Online Meeting Applications for Learning During the Period of Pandemic COVID-19: A Literature Review. J. Innov. Educ. Cult. Res. 2020, 1, 58–68. [CrossRef]
19. Singh, V.; Thurman, A. How many ways can we define online learning? A systematic literature review of definitions of online learning (1988–2018). Am. J. Distance Educ. 2019, 33, 289–306. [CrossRef]
20. Sadikin, A.; Hamidah, A. Pembelajaran Daring di Tengah Wabah COVID-19. Biodik. J. Ilm. Pendidik. Biol. 2020, 6, 109–119. [CrossRef]
21. Kundrátová, M.; Hrmo, R.; Miština, J. Implementing multimedia into pedagogical study of university teachers at the Slovak University of Technology. In Using Technology in Open and Distance Learning: Proceedings of the 2nd International DETECH Workshop; Univerza v Mariboru: Maribor, Slovenia, 2001; pp. 123–128.
22. Mishra, A.K.; Sahu, K.K.; Lal, A.; Sargent, J. Patterns of heart injury in COVID-19 and relation to outcome. J. Med. Virol. 2020, 92, 1747. [CrossRef]
23. Csachová, L.; Jurečková, M. Mathematics teaching in Slovakia during COVID-19 quarantine season in spring of 2020. Open Educ. Stud. 2020, 2, 285–294. [CrossRef]
24. Kaur, N.; Dwivedi, D.; Arora, J.; Gandhi, A. Study of the effectiveness of e-learning to conventional teaching in medical undergraduates amid COVID-19 pandemic. Natl. J. Physiol Pharmaco. 2020, 10, 563–567. [CrossRef]
25. Muthuprasad, T.; Aiswarya, S.; Aditya, K.S.; Jha, G.K. Students’ perception and preference for online education in India during COVID 19 pandemic. Soc. Sci. Humanit. Open 2021, 3, 100101. [CrossRef] [PubMed]
26. Hillis, D.M.; Heller, H.C.; Hacker, S.D.; Laskowski, M.J.; Sadava, D.E. Studying life. In *Life: The Science of Biology*, 12th ed.; Freeman, W.H., Ed.; Sinauer Associates, Inc.: Sunderland, MA, USA, 2020; ISBN 9781319017644.

27. Mukhtar, K.; Javed, K.; Arooj, M.; Sethi, A. Advantages, Limitations and Recommendations for online learning during COVID-19 pandemic era. *Pak. J. Med. Sci.* 2020, 36, 27–31. [CrossRef] [PubMed]

28. Hendi, J. *Koalitivní Výzkum—Základní Teorie, Metody a Aplikace* [Qualitative Research—Basic Theories, Methods and Applications]; Portál: Prague, Czech Republic, 2016; p. 437. ISBN 978-80-262-0982-9.

29. Švaříček, R.; Šedová, K.; Janík, T.; Kaščák, O.; Miková, M.; Nědbálová, K.; Novotný, P.; Sedláček, M.; Zounek, J. *Koalitivní Výzkum v Pedagogických Vědách* [Qualitative Research in Pedagogical Sciences]; Portál: Prague, Czech Republic, 2014; 384p. ISBN 978-80-262-0644-6.

30. Kotbra, T.; Lacina, L. *Práctické Využití Aktivizačních Metod ve Výuce* [Practical Use of Activation Methods in Teaching]; Barrister & Principal: Brno, Czech Republic, 2007; 187p. ISBN 978-80-87029-12-1.

31. Xie, Z.; Yang, J. Autonomous learning of elementary students at home during the COVID-19 epidemic: A case study of the second elementary school in Daxie, Ningbo, Zhejiang Province, China. *Best Evid. Chin. Educ.* 2020, 4, 535–541. [CrossRef]

32. Harris, J.; Mishra, P.; Koehler, M. Teachers’ technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *J. Res. Technol. Educ.* 2009, 41, 393–416. [CrossRef]

33. Moghavvemi, S.; Sulaiman, A.; Jaafar, N.I.; Kasem, N. Social media as a complementary learning tool for teaching and learning: The case of youtube. *Int. J. Manag. Educ.* 2018, 16, 37–42. [CrossRef]

34. Tan, E. Informal learning on YouTube: Exploring digital literacy in independent online learning. *Learn. Media Technol.* 2013, 38, 463–477. [CrossRef]

35. Juanda, A.; Shidiq, A.S.; Nasrudin, D. Teacher learning management: Investigating biology teachers’ tpack to conduct learning during the COVID-19 outbreak. *J. Pendidik. IPA Indonesia*. 2021, 10, 48–59. [CrossRef]

36. Ekwueme, C.O.; Ekon, E.E.; Ezenwa-Nebife, C.D. The Impact of Hands-On-Approach on Student Academic Performance in Basic Science and Mathematics. *High. Educ. Stud.* 2015, 5, 47–51. [CrossRef]

37. Daba, T.M.; Anbassa, B.; Oda, B.K.; Degefa, I. Status of Biology Laboratory and Practical Activities in some Selected Secondary and Preparatory Schools of Borena Zone, South Ethiopia. *Educ. Res. Rev.* 2016, 11, 1709–1718. [CrossRef]

38. Frey, T. Determining the impact of online practicum facilitation for inservice teachers. *J. Technol. Teach. Educ.* 2008, 16, 181–210. [CrossRef]

39. Babinčák, M.; Bernard, P. Online Experimentation during COVID-19 Secondary School Closures: Teaching Methods and Student Perceptions. *J. Chem. Educ.* 2020, 97, 3295–3300. [CrossRef] [PubMed]

40. Rapanta, C.; Botturi, L.; Goodyear, P.; Guárdia, L.; Koole, M. Online University Teaching during and after the COVID-19 Crisis: Refocusing Teacher Presence and Learning Activity. *Postdigit. Sci. Educ.* 2020, 2, 923–945. [CrossRef]

41. Van der Spoel, I.; Noroozi, O.; Schuurink, E.; van Ginkel, S. Teachers’ online teaching expectations and experiences during the Covid19-pandemic in the Netherlands. *Eur. J. Teach. Educ.* 2020, 43, 623–638. [CrossRef]

42. Poon, W.C.; Low, L.T.; Yong, G.F. A study of Web-based learning (WBL) environment in Malaysia. *Int. J. Educ. Manag.* 2004, 18, 374–385. [CrossRef]

43. Hong, K.S.; Lai, K.W.; Holton, D. Students’ satisfaction and perceived learning with a Web based course. *J. Educ. Technol. Soc.* 2003, 6, 116–124. [CrossRef]

44. Moore, M.G.; Kearsley, G. *Distance Education: A Systems View of Online Learning*, 3rd ed.; Wadsworth Cengage Learning: Belmont, CA, USA, 2012.

45. Amhag, L.; Hellström, L.; Stigmar, M. Teacher Educators’ Use of Digital Tools and Needs for Digital Competence in Higher Education. *J. Digit. Learn. Teach. Educ.* 2019, 35, 203–220. [CrossRef]

46. Luo, N.; Zhang, M.; ve Qi, D. Effects of different interactions on students’ sense of community in e-learning environment. *Comput. Educ.* 2017, 115, 153–160. [CrossRef]

47. Dhwani, S. Online Learning: A Panacea in the time of COVID-19 Crisis. *J. Educ. Technol. Syst.* 2020, 49, 5–22. [CrossRef]

48. Lesiyianawati, R.; Widyanarto, A. Strategies and Problems Faced by Indonesian Teachers in Conducting E-Learning System During COVID-19 Outbreak. *Cult. Lit. Linguist. Engl. Teach.* 2020, 2, 71–82. [CrossRef]

49. Maslach, C. Job burnout: New directions in Research and Intervention. *Am. J. Geriatr. Psychiatry* 2020, 28, 993–998. [CrossRef] [PubMed]

50. Maslach, C.; Jackson, S.E. The measurement of experienced burnout. *J. Organ. Behav.* 1981, 2, 99–113. [CrossRef]

51. Skaalvik, E.; Skaalvik, S. Teacher Stress and Teacher Self-Efficacy as Predictors of Engagement, Emotional Exhaustion, and Motivation to Leave the Teaching Profession. *Creat. Educ.* 2016, 7, 1785–1799. [CrossRef]

52. Aperribai, L.; Cortabarría, L.; Aguirre, T.; Verche, E. Teacher’s Physical Activity and Mental Health During Lockdown Due to the COVID-19 Pandemic. *Front. Psychol.* 2021, 12, 2673. [CrossRef] [PubMed]

53. Besser, A.; Lotem, S.; Zeigler-Hill, V. Psychological Stress and Vocal Symptoms Among University Professors in Israel: Implications of the Shift to Online Synchronous Teaching During the COVID-19 Pandemic. *J. Voice Off. J. Voice Foundat.* 2020, S0892-1997, 30190–30199. [CrossRef] [PubMed]

54. Ozamiz-Etxebarria, N.; Berasategi Santxo, N.; Idola Mondragon, N.; Santamaria, D.M. The Psychological State of Teachers During the COVID-19 Crisis: The Challenge of Returning to Face-to-Face Teaching. *Front. Psychol.* 2021, 21, 3861. [CrossRef] [PubMed]

55. Gorrochategi, M.P.; Munitis, A.E.; Santamaria, M.D.; Ozamiz-Etxebarria, N. Stress, Anxiety, and Depression in People Aged Over 60 in the COVID-19 Outbreak in a Sample Collected in Northern Spain. *Am. J. Geriatr. Psychiatry* 2020, 28, 993–998. [CrossRef] [PubMed]
56. Corbin, C.M.; Alamos, P.; Lowenstein, A.E.; Downer, J.T.; Brown, J.L. The role of teacher-student relationships in predicting teachers’ personal accomplishment and emotional exhaustion. *J. Sch. Psychol.* 2019, 77, 1–12. [CrossRef] [PubMed]

57. Kini, T.; Podolsky, A. Does Teaching Experience Increase Teacher Activeness? A Review of the Research; Learning Policy Institute: Palo Alto, CA, USA, 2016; Available online: https://learningpolicyinstitute.org/sites/default/files/product-files/Teaching_Experience_Report_June_2016.pdf (accessed on 21 December 2020).

58. Goos, M. Technology Integration in Secondary Mathematics: Enhancing the Professionalisation of Prospective Teachers. In *Constructing Knowledge for Teaching Secondary Mathematics*; Sullivan, P., Zaslavsky, O., Eds.; Springer: Boston, MA, USA, 2011; pp. 209–225.

59. Sosin, K.; Lecha, B.J.; Agarwal, R.; Bartlett, R.L.; Daniel, J.I. Efficiency in the Use of Technology in Economic Education: Some Preliminary Results. *Am. Econ. Rev.* 2004, 94, 253–258. [CrossRef]

60. Higgins, K.; Huscroft-D’Angelo, J.; Crawford, L. Effects of technology in mathematics on achievement, motivation, and attitude: A meta-analysis. *J. Educ. Comput. Res.* 2019, 57, 283–319. [CrossRef]

61. Karakaya, F.; Arik, S.; Cimen, O.; Yilmaz, M. Investigation of the views of biology teachers on distance education during the COVID-19 pandemic. *J. Educ. Sci. Environ. Health* 2020, 6, 246–258. [CrossRef]