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Challenges of Nature and Biology Online Learning for Students with Disabilities: A Mixed Methodology Approach

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Abstract. Nowadays, as Nature and Biology online learning evolves towards Internet technologies, questions arise as to how students with different general intelligence factors cope with online learning and how students with disabilities respond to challenges including adaptation to online learning. A study was conducted to examine the challenges that students with disabilities faced during Nature and Biology online classes. The research was carried out through a combination of quantitative (N=162 students; Grades 5, 6, 7, and 8 of primary school) and qualitative approaches (N=12 teachers). Using the Mann-Whitney U test, it was clearly shown that the g-factor of students' intelligence was not identified as a significant predictor ($p>0.05$) for successful online learning. Furthermore, teachers of students with disabilities were interviewed extensively to identify how students with disabilities respond to the challenges of online learning. Consequently, it has been shown that students with disabilities can progress as well as other students when working in an online environment. Similarly, teachers' responses indicate that while being supported by the environment (involvement from parents and teachers), students with disabilities successfully respond to the challenges of online learning.

Keywords: Biology classes; g-factor; Nature classes; online learning; students with disabilities

1. Introduction

Students with disabilities are those students who show certain developmental difficulties and who are unlikely to reach or maintain a satisfactory level of health and development. Therefore, they need additional support from the environment, education, and care alongside suitable instruction (Bouillet, 2010). There are three categories of students with disabilities in the Croatian education system:

1. students with developmental difficulties

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1.1. students with physical, mental, intellectual, and sensory impairments
1.2. students with a combination of several types of listed impairments and disorders
2. students with learning difficulties, behavioral and emotional problems
3. students with disabilities due to educational, social, economic, cultural, and linguistic factors (MZO, 2021).

The transition to online learning presented a special challenge for all, especially for students with disabilities and their teachers. Online learning differs from f2f instruction in its structure, environment, teaching methods, content presentation, communication, and cooperation among all stakeholders in the educational process (Serdyukov, 2015). Developed digital competence of students and teachers is necessary for successful work in the online environment. In addition to digital competence, other factors are important for the success of online learning, such as the students' g-factor, measured by intelligence tests (Gottfredson, 1998). The general factor of intelligence, the g-factor, stands behind all intellectual tasks (Spearman, 1904) and thus explains the connection between performance on intelligence tests and school success. Gottfredson (1998) states that IQ test results strongly correlate with educational success, so it can be said that intelligence is a major predictor of success (Karbach et al., 2013; Weber et al., 2013). Working with students with disabilities is a challenge for teachers in all areas of education, especially in STEM subjects, and this is the foundation of society's development today. The teacher should help students develop scientific competence and a conceptual understanding of teaching content in the field of science, which is a demanding task in regular f2f teaching, and even more so in the online environment.

Therefore, the purpose of this research was to see whether students with disabilities and with various general g-factors of intelligence can successfully participate in online classes of Nature and Biology. The experiences of the interviewed teachers, who had the chance to monitor the students' work directly through a series of activities in the online environment, also contributed to a better understanding of the researched issue.

This comparative study will hopefully contribute to the limited existing knowledge of challenges faced by students with disabilities in the online learning of Nature and Biology.

2. Literature review

2.1. Students with developmental difficulties in the educational process

Working with students with disabilities is a special challenge for teachers in the classroom, and in recent years in the online environment as well. When adapting to online learning, a supportive environment is extremely important, which includes the support of the family, expert staff, and above all, the support of teachers. An appropriate supportive environment helps students with disabilities to achieve educational outcomes, increases their motivation to work, and raises their self-confidence. Research confirms that students who receive this type of support find it easier to fulfill their school obligations and develop work habits

and organizational skills (Hebebci et al., 2020). In addition to the above modes of support, the intelligence of students proved to be a significant predictor of success in an educational setting. Intelligence is used to denote a standardized set of cognitive abilities as defined by Charles Spearman (Sternberg, 2019). In his Two-Factor Theory of Intelligence, in addition to the general g-factor, Spearman (1904) proposes a specific s-factor of intelligence that refers to a certain area (Sari et al., 2020). The general or g-factor of intelligence, which includes multiple cognitive abilities, describes the ability to think and learn. Almeida et al. (2021) state that research on a sample of Portuguese students (n = 4899) aged 5-12 showed that the general or g-factor of intelligence affects students' school success, with the impact of this decreasing during schooling. Although the g-factor is a predictor of academic performance, other cognitive components can also act as contributors. Other research also shows that a person's intelligence is a predictor of achievement and success, and not vice versa (Deary et al., 2007). General intelligence explains 50–60% of total achievement, and the rest consists of other elements such as self-engagement, motivation, conscientious work, a supportive environment, self-confidence, learning methods, work habits, motivation, and the quality of teaching (Gottschling et al., 2012).

A commonly found outcome in all research on traditional and online teaching is that teachers are an important factor (Lathifah et al., 2020). Modern teachers implement integration and inclusion in their work and competence is expected when working with students with disabilities. They contribute to inclusion if they become acquainted in advance with a students' strengths and weaknesses and prepare a supportive classroom atmosphere. High-quality teachers should also possess the skills to work with students with disabilities in the online environment; regularly monitor their online work; intervene, if necessary (Rice & Carter, 2015); implement appropriate individualized educational programs (Marteney & Bernadowski, 2016); help them develop social skills in the online environment; and adapt the curriculum to students with different special characteristics (Crouse & Rice, 2018). Therefore, special attention should be paid to the education of future teachers so that they can support their students with disabilities in the virtual environment.

2.2. Online teaching

The COVID-19 pandemic has changed lives and education around the world, and the need for ICT in education has come to the fore when traditional teaching, with its typical face-to-face (f2f) contact, has moved from the classroom to an online environment in many countries (Basilaia & Kvavadze, 2020; Dozhdikov, 2020). Bozkurt and Sharma (2020) state that online teaching is characterized by "distance in time and/or space" and allows teachers to teach and interact with students. The Carrillo and Flores (2020) study highlighted the need for a pedagogical aspect of online education that integrates ICT as support in teaching and learning. During the COVID-19 pandemic, teachers used ICT support in various ways in online teaching, such as a communication channel, as a teaching aid, and for the evaluation and organization of teaching. Several platforms for working with students have also been designed (Stenhoff et al., 2020) as the introduction of

digital technology in teaching facilitates the learning and teaching process for students and teachers.

Online learning has its advantages and disadvantages (Lapitan et al., 2021). The advantages include access to online classrooms 24 hours a day, the possibility of synchronous and asynchronous communication, and access to Internet information that can be used to help achieve desired educational outcomes (Fatonia et al., 2020). The disadvantages of online learning can be seen in the insufficient digital competence of students or teachers; without computer literacy, posted e-content becomes useless. Technical problems may also occur related to the technology used, such as Internet access, computer availability, and use of certain applications (Yazcayir & Gurgur, 2021; Varela Gonzalez, 2021), as well as students' lack of self-responsibility where responsibility should be taken on (Bulić et al., 2019). Alongside teachers, it is important to involve expert staff in working with students with disabilities in the online environment to achieve students' full potential (Thomson, 2016; Stenhoff et al., 2020), as evidenced by research (Börnert-Ringleb et al., 2021). Solely online teaching can be as successful as traditional teaching and can be used when students for various reasons cannot attend classes (Bulić et al., 2017).

2.3. Teaching Nature and Biology in online environment

Today, the world recognizes the exceptional importance of scientific education because the role of world scientists has been crucial in finding answers to the problems caused by the COVID-19 pandemic. Therefore, it is important to encourage science competence in the STEM area (science, technology, engineering, mathematics) from the earliest age (European Commission, 2020; Nistor et al. 2019). Science is often taught as a single subject that, by integrating the contents of Biology, Chemistry and Physics, helps students to reason logically, think critically (Patonah & Rahardjo, 2021), and understand natural science concepts.

In Croatia, student competence in natural science develops in the school subject Nature and Social Sciences in grades 1-4 of primary school, in Nature in grades 5 and 6, and in Biology, Chemistry, and Physics in grades 7 and 8, when students have two hours per week for each subject. On the subject of Nature, students are introduced to the research and knowledge of nature, and on the subject of Biology, they learn about living beings. A constructivist model with active research learning is important in these classes, along with the proper use of information and communication technologies (ICT). As research shows that students' interest in the natural sciences is declining (Foppoli et al., 2018), it is necessary to find new ways and methods in schools to teach science. Several studies suggest that science education can be improved through the use of technology, personal computers, smartphones, tablets, and various software and mobile applications (Kalogiannakis et al., 2021; Ekici & Erdem, 2020). This is also confirmed by the OECD report on innovation in education (Vincent-Lancrin et al., 2019). This is essential when working with students with disabilities who require special adjustments.

During the COVID 19 pandemic, in an online environment, all Croatian students used computers and accessed the online content which indicates that they had a sufficiently developed digital competence. The research by Bulić and Blažević (2020) indicates the high motivation of primary school students to work in an online environment, confirming that students consider learning Nature and Biology important. Studies on the impact of ICT on students with difficulties (Tassé et al., 2016) show there is a need for research that monitors students with disabilities in their online activities.

The integration of students with disabilities into regular classes takes place through cooperation between teachers and expert staff in the educational-rehabilitation profile. To investigate the factors that affect e-inclusion, the University of Genoa (Italy) designed a qualitative study involving 785 teachers. Effective e-inclusion has been shown to depend on technology, family-teacher collaboration, online teaching strategies, and individualization of working with students with disabilities (Parmigiani et al., 2021). The results of the Indonesian survey on working with students with disabilities, conducted among teachers of educational and rehabilitation profiles, parents, and students, indicate the challenges encountered in online teaching. Parents were hampered by a lack of coordination and communication and limited time in which to monitor students. Students point out boredom and a lack of their own abilities. Teachers mention difficulties in adapting materials, evaluating student progress, and a lack of school support (Supratiwi et al., 2021). The results of a study by Schuck et al. (2021) conducted among the expert staff of the educational-rehabilitation profile also emphasize the importance of partnership between the school and family. The partnership is manifested in mutual socio-emotional support, the provision of feedback to parents, the implementation of educational content, and the importance of mutual understanding.

3. The present study

The present study aims to provide and integrate quantitative and qualitative approaches to investigate how students with disabilities respond to online learning challenges. To achieve this, a g-factor of intelligence was determined for 162 students who took part in traditional and fully online classes in Nature and Biology, while their success in achieving educational outcomes was monitored.
It was hypothesized that there was no statistically significant difference in the achievement of educational outcomes concerning the g-factor of student intelligence and the applied methods of teaching both traditional and online classes.

Twelve teachers of Nature and Biology were interviewed, who shared their experiences of working with students with disabilities in the online environment. In a semi-structured interview with teachers, the four research questions were asked:

1. How have students with disabilities adapted to Nature and Biology classes in an online environment, with respect to their age, gender, and school success?
2. How much has the supportive environment affected students' school success?

3. How much have the work habits and organizational skills of students with disabilities changed during online classes?
4. How have online classes affected students' self-confidence and motivation?

A mixed-method approach is used to answer the research questions.

4. Methodology

4.1. Quantitative part of the research

4.1.1. Sample of respondents

A total of 162 students in grades 5-8 of the primary school participated in the quantitative part of the research.

Table 1: Sample of respondents

Grade	Total number of students
5	38
6	42
7	44
8	38
Total	162

4.1.2. Sample of instruments

To realize the quantitative part of the research and obtain answers to the posed hypothesis, the following instruments were used: *pretest of knowledge, a written test of knowledge I, a written test of knowledge II, and Standard Progressive Matrices*.

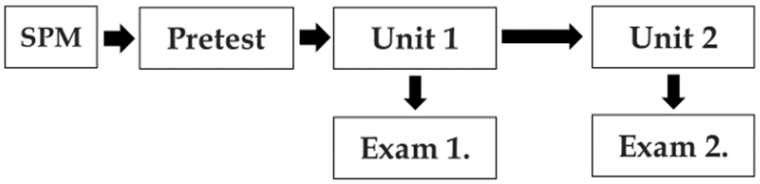

Figure 1. Research course

A pretest was given to all students to establish the initial level of their knowledge on selected topics in Nature and Biology and to determine student success after traditional and online learning. The research (the present study) was conducted by working on two lessons, and a total of eight lessons were uploaded on the Moodle learning platform. After the first unit, students wrote the *written test of knowledge I*, and after the second unit, they wrote the *written test of knowledge II*, and eight different written tests were posted on Moodle. Tasks in written tests were formulated in such a way as to examine the required educational outcomes of these lessons. Crooks (1988) distinguishes three levels of cognitive achievement: 1st level – reproductive knowledge; 2nd level – understanding and application; and 3rd level – problem-solving. Therefore, these written tests of

knowledge included questions of all cognitive levels. During online classes, students wrote tests in an e-form in the IT classroom, and during traditional classes in the regular classroom.

The *Standard Progressive Matrices (SPM)* or Raven's Progressive Matrices is the name of a test designed by John Raven (Raven et al., 1994). SPM is considered one of the best measures of g-factor or general intellectual ability factor (Gardner et al., 1999). For children aged 6 to 17, *Standard Progressive Matrices (SPM)* are used, which contain tasks progressively grouped by difficulty, hence their name. The SPM results are most often presented in centiles. The scale consists of 60 tasks, where problems are divided into five series (A, B, C, D, and E) and each series contains 12 problems (one part is missing, and the respondent needs to find the right part among several offered parts). The five series also provide five options for capturing the ways of thinking needed to solve the problems posed and to provide five progressive measurements of the respondent's ability for intellectual activity. To keep the interest of the respondents at the required level and to avoid exhaustion during the test, each problem is printed on the page in bolded letters, which are precisely drawn and pleasant to observe (Raven et al., 1994).

"All respondents, regardless of their age, are given the same series of problems, in the same order, and they are told to work at their speed, without interruption, from the beginning to the end of the scale. The overall result of the respondents is an indicator of her/his intellectual ability" (Raven et al., 1994). During the SPM test, there is a psychologist in the room with the students where they work quietly and individually. In the introductory section, the psychologist provides instructions and explains that one part of the illustration is cut, and that each of the patterns fits into the space, but only one offers the correct solution. A psychologist then shows participants the exact part and solves the first 5 patterns together with the respondents. If the respondent is unable to solve these first 5 patterns, the test is stopped. If the respondent solves the first five tasks, they continue to solve 60 tasks in silence for 60 minutes. In the case of this research, the overall SPM testing procedure lasted 16 hours. The tests were reviewed by a school psychologist who tested the students. She distributed, corrected, and interpreted the tests. The test had a total of 60 points, with one point for each task. Then she grouped the students according to the test results into one of the following categories: intellectually superior, clearly above-average intellectual abilities, average intelligence, clearly below-average intellectual abilities, and reduced intelligence (Table 2). Two students with an individualized approach were assisted at all stages of the research.

Table 2: Groups of students according to the SPM test results

Degree	Intellectual abilities	Result
I	Intellectually superior	95 centiles and above
II	Clearly above-average intellectual abilities	75 centiles and above
III	Average intelligence	Between 25 and 74 centiles

IV	Clearly below-average intellectual abilities	24 centiles and below
V	Reduced intelligence	5 centiles and below

Centiles indicate the position of an individual test result on the normal distribution curve (Gaussian curve)

Degree I or "Intellectually superior" if the result is positioned in 95 centiles and above for persons from the same age group.
Degree II or "Clearly above-average intellectual abilities" if the result is positioned in 75 centiles and above.
Degree III or "Average intelligence" if the result is between 25 and 74 centiles.
Degree IV or "Clearly below-average intellectual abilities" if the result is positioned in 24 centiles and below.
Degree V or "Reduced intelligence" if the result is positioned in 5 centiles and below (Raven et al., 1994).

4.1.3. Description of the experimental procedure

In the context of the quantitative section of the research, which was conducted before the COVID-19 pandemic, the g-factor of intelligence was determined for 162 students in higher grades of primary school (subject teaching). According to the g-factor of intelligence, students were divided into 5 qualitative groups: intellectually superior, clearly above-average intellectual abilities, average intelligence, clearly below-average intellectual abilities, reduced intelligence. Students of each class learned one lesson traditionally in a classroom with a teacher, and the other unit, Nature and Biology, was carried out online, without face-to-face contact with a teacher. After each unit, the students wrote an exam. Prior to the quantitative part of the research that used the ADDIE model of instructional design, teaching contents of the teaching units were designed, developed, and implemented/posted on the Moodle platform. All the necessary research measurement instruments and lesson plans for each individual lesson and each teaching unit in all grades were made. With the aim of testing the measurement instruments, a pilot study was conducted in two classes, which showed that the instruments are reliable and valid. During the online classes, the students followed the lessons of Nature and Biology in an IT classroom and did not have face-to-face (f2f) contact with a teacher. The students accessed the teaching contents posted on Moodle, both in school and at home, when and for how long they wanted. They created passwords and were instructed on the basics of working in Moodle for two school hours for each class group, which lasted for 16 school hours in total. Throughout the research, students were able to contact the teacher by email, Moodle messages, or by asking questions on the Forum.

4.1.4. Research data processing methods

The students were divided into 5 groups according to the g-factor of intelligence measured by the SPM test. Intellectually superior students and students with clearly above-average intellectual abilities were considered as one group (ABVAVRG) while students with clearly below-average intellectual abilities, students with reduced intelligence, and students with average intelligence were in another group (BLWAAVRG). We calculated the variable of difference between

the results of the respondent as a member of the control group (when participating in traditional classroom teaching) and the results of the respondent as a member of the experimental group (when participating in fully online classes) in the written test. Using the Mann-Whitney U test, we examined the difference between the defined groups of respondents in the calculated variable of differences. The analysis was carried out separately for grades 5, 6, 7, and 8. The data were considered significant if $p<0.05$. All results were calculated using Statistica 12.0 software (StatSoft, Tulsa, Oklahoma, USA).

4.2. Qualitative part of the research

4.2.1. Sample of respondents

For the qualitative section of the research, 12 Nature and Biology teachers of primary school students with disabilities were selected. The research was conducted in accordance with the Declaration of Helsinki. All parents were informed about the research and signed an agreement that the child was able to stop participating in the research if required, without consequences.
Equally, each teacher who participated in the qualitative section of the research signed the participation agreement.

4.2.2. Sample of instruments

The data collection technique in the qualitative section included a semi-structured interview with 12 randomly selected teachers from different primary schools in the Republic of Croatia during distance learning in 2020. An interview is a structured and purposeful conversation in which the researcher collects data for further analysis and interpretation (Kvale & Brinkmann, 2009). Yin (2016) argues that a qualitative interview can be semi-structured or unstructured. The researcher only determines in advance the topics or issues to be discussed to get a detailed respondents' perspective.The interviewing technique was chosen to obtain the data appropriate to the research questions. The data collected by the interview served as the material for the analysis based on which the conclusions were made. After listening to recorded interviews, word-for-word transcripts were made and prepared for the data analysis. Next, the transcript was read to thoroughly ascertain the teachers' comments. This was followed by open coding of the transcript and the organization of a formal database – the transcribed data from the interview were divided into four categories, each of which related to one research question. The analysis of the collected material helped determine the connections and relationships between the obtained data.

4.2.3. Description of the procedure

In the context of the qualitative section of the research, individual interviews were arranged with twelve teachers of Nature and Biology employed in primary schools in Croatia. The interview with the teachers was conducted at the faculty. For the purposes of the semi-structured interview, questions were prepared in accordance with the research questions. The interviews were recorded and lasted an average of 60 minutes per participant.

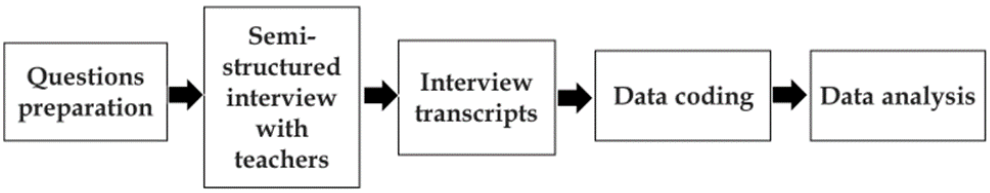

Figure 2. Course of the qualitative part of the research

4.2.4. Research data processing methods

Transcripts of interviews were made for the qualitative part of the research. In the conducted research, open coding of data was used through the organization of a formal database and the division of data according to the research questions.

5. Results and discussion

In the quantitative section of the research, the final Nature and Biology grades of 162 participants were analyzed. It was established that 35.2% of students achieved excellent success, 36.4% very good, 23.5% good, and 4.9% sufficient. None of the students had an insufficient final grade in these subjects. Students with an individualized approach due to various difficulties in work also achieved satisfactory success in Nature and Biology.

The research aimed to check whether there is a statistically significant difference in the achievement of educational outcomes regarding the g-factor and applied teaching procedures, and whether all students can progress in an online environment. Using the Mann-Whitney U test, the difference between the defined groups of respondents in the calculated variable of differences was investigated. The analysis was carried out separately for grades 5, 6, 7, and 8. Table 3 shows the results of descriptive statistics of the variable of differences in student performance when participating in traditional teaching and online learning in grades 5, 6, 7, and 8, along with the results of the Mann-Whitney U test of comparison of two student groups in the difference variable. It was to be expected that the students of the ABVAVRG group (intellectually superior and students with clearly above-average intellectual abilities) would cope better in the new situation compared to the BLWAAVRG group. However, the results of their written tests show that online learning in grades 5 and 6 is also suitable for students of average and reduced intelligence, because they also show progress. Very similar results were obtained with students in grades 7 and 8 because students of both groups progressed or regressed equally; it can be said that all students achieved equally well in online classes.

Table 3: Results of descriptive statistics and Mann-Whitney U test for the variable of differences in the results of the student as a member of the control group and as a member of the experimental group for all grades

Grade	Group	Descriptive indicators				Mann-Whitney U test		
		AS	med	min	max	U	Z	p
5	ABVAVRG	1.06	1.00	-1.00	3.00	158.50	0.50	0.62
	BLWAAVRG	0.86	1.00	-1.00	2.00			
6	ABVAVRG	1.09	1.00	-1.00	3.00	168.50	0.04	0.97
	BLWAAVRG	1.07	1.00	-1.00	4.00			
7	ABVAVRG	0.30	0.00	-2.00	2.00	162.00	-0.21	0.83
	BLWAAVRG	0.44	0.50	-1.00	3.00			
8	ABVAVRG	0.30	0.50	-2.00	2.00	110.00	0.98	0.33
	BLWAAVRG	-0.14	0.00	-2.00	2.00			

Index of variables: ABVAVRG (intellectually superior students and students with clearly above-average intellectual abilities); BLWAAVRG (students with reduced intelligence, students with clearly below-average intellectual abilities, and students with average intelligence).

From Table 3, it can be seen that the level of significance (p-level) for all grades is higher than 0.05 ($p > 0.05$), which indicates that there is no statistically significant difference in the progress of students in the ABVAVRG group compared to the BLWAAVRG group, and they progressed or regressed equally. It can be said that online learning of Nature and Biology provides all students an equal opportunity to progress in their work and achieve the educational outcomes clearly stated in the subject curriculum. The results of the research showed that students of a lower g-factor (categories of reduced intelligence and below-average intelligence) and students of average intelligence can progress as well as intellectually superior and clearly above-average intelligent students upon full participation in online classes of Nature and Biology.

The results of the research showed that students with different g-factors can successfully complete online tasks in a virtual environment if they have the support of teachers who apply an appropriate individualized approach in the online environment, as was the case in this research. Students with appropriate content adjustments and an individualized program in traditional classes were offered the same individualized program in online classes along with constant support from teachers and parents. The obtained results also correlate with research that indicates that a person's intelligence is a predictor for success and achievement (Deary et al., 2007).

This aligns with the requirements of the school, so it is quite understandable that IQ is positively correlated with school success (Almeida et al., 2021). However,

intelligence is only one of the factors influencing school success. This research also shows that the impact of students' characteristics is important because some students, despite being of average intelligence, achieve excellent success due to conscientious and regular work on tasks and supportive parents. Putri et al. (2020) emphasize that the attitude of parents is an important prerequisite for the success of online learning (Lathifah et al., 2020), which proved important in this study as parents of students in all eight grades were thoroughly acquainted with the planned research and the expectations placed upon students. They provided help and support to their children. Contrary to this, research has shown that there are students with above-average intelligence who achieve minimal educational outcomes because they do not work hard, do not complete homework, are often careless during class. Bao (2020) believes the possible lack of digital literacy is a negative effect of online learning. As such, this research was preceded by detailed two-hour instructions for all students that taught how to work effectively in Moodle. For students with disabilities, all instructions for working in the Moodle system were written in detail. We can thus stress the importance of the organization of teaching, which should enable the progress of all students in accordance with their abilities. Research by Latifah et al. (2020) shows that teachers are an important factor in traditional and online teaching and that they need to train students for independent work and the active acquisition of knowledge. The teacher formulates different types of tasks for all students, especially for those with individualized approaches, creates different types of tasks, monitors their progress, helps them if they encounter ambiguities by providing them with the necessary assistance and support in their work, and provides regular and timely information on their work and progress (Bulić & Kostović Vranješ, 2019).

Moreover, we integrated a qualitative approach to determine how students with disabilities respond to the challenges of online classes of Nature and Biology. We therefore conducted a semi-structured interview with teachers about their experiences during online learning.

Following the research questions, four thematic categories based on the obtained data were studied: a) the impact of age, gender, and school success of students with disabilities on adaptation to the online environment of Nature and Biology classes, b) the impact of a supportive environment on the success of students with disabilities in an online environment, c) work habits and organizational skills of students with disabilities in an online environment, d) self-confidence and motivation of students with disabilities in an online environment.

The impact of age, gender, and school success of students with disabilities on adaptation to Nature and Biology online classes

Regarding student ***age***, the analysis of the obtained data on the adaptation of students with disabilities shows how eight teachers stated that older students (in grades 7 and 8) adapted to online learning better than younger students (in grades 5 and 6). Teachers see the reason for better adaptation in "... more developed digital competences of older students compared to younger ones." Other teachers did not notice any differences. Regarding ***gender***, seven teachers believe that there is no difference in the adaptation to online learning of students with disabilities,

and others indicate that girls have adapted better than boys because "... girls are more successful, more regular and more specific, and boys generally do not follow given instructions." Teachers' observations are also confirmed by studies that reveal how female students achieve better results than male students in the field of digital literacy (Gebhardt et al., 2019; Fraillon et al., 2020). In addition to age and gender, it was important to examine how students with disabilities and with different ***school success*** adapted to the online environment. In working with such students, it is important to know the individual differences that led to difficulties in the digital environment (Rocha et al., 2012). Seven teachers state that the school success of most students with disabilities was better than in classes where they had f2f contact due to "... the recommendation of the Ministry of Science and Education that students be not examined in writing but only orally in addition to evaluation of student activities and projects." During the oral examination, the teachers did not see any differences in school success because "... students answer via video call..." so the grades remained the same. Teachers who conducted written tests, however, state that "…written tests in the form of a quiz yielded much better results than the written knowledge tests in regular school environment...", but some teachers point out that the success was "unrealistically better because the parents helped them, but for the wrong reasons..." so the students "…. copied or solved tasks, which could be seen from the handwriting, but also wrote projects and essays, which is evident from vocabulary that was not appropriate for students of this age." Teachers' perceptions are consistent with research showing that ICT improves school performance if used properly to support active learning (Kalamković et al., 2013).

The impact of a supportive environment on the success of students with disabilities in the online environment

The supportive environment during the online classes was related to family support during learning, as well as support by expert staff and teachers. Many scientists highlight the importance of cooperation between ***family*** and school for student success, especially when it comes to students with disabilities (Vrkić Dimić et al., 2017), and particularly in an online environment (Börnert-Ringleb et al., 2021). Ten participants in the study stated that parental support at home had a great impact on the work and success of students with disabilities because "... parents often asked for an explanation of work instructions when they were not clear to their children..." but added that sometimes it was inappropriate because "...according to the formation of sentences and the structure of the papers, I conclude that parents did homework instead of students." Two teachers point out that "...some parents did not support students in working in an online environment, so such students joined virtual classes very rarely." On the other hand, research by Kolak et al. (2021) shows how parents are satisfied with online learning, but that their involvement is higher with younger students and in the case of more children in the family, although more children in the family leads to a greater independence of students (Hebebci et al., 2020). The teachers also state that "Students who could not attend distance learning because they could not cope with it, visited a school speech therapist who helped them with the necessary tasks." However, it is worrying when teachers say that they did not have the support of the ***expert staff*** in adapting their classes to the online environment for students with disabilities. The support of expert staff in working with students

with disabilities in the online environment is important, as well as students' education (Börnert-Ringleb et al., 2021) and cooperation between educational workers and family (Stenhoff et al., 2020; Thompson, 2016). This places additional demands on ***teachers*** to adapt to the online environment, especially when adapting materials at the level of the needs and cognitive abilities of students with disabilities (Varela Gonzalez, 2021). Adjustments require additional time and commitment on the part of teachers (Sablić et al., 2020), and those teachers who had a higher level of technical knowledge were able to provide more effective individual support to their students (Aarnos et al., 2021). The teachers interviewed expressed their support for students with disabilities in different ways: "... using digital tools, video lessons, recording experiments, quizzes, worksheets with fewer questions, PPT presentations, adjusted practical motivating works .... "; "... additional time out of class to further clarify unclear content (via ZOOM, with parental agreement), extended time for writing a test, giving instructions via WhatsApp..."; "... more frequent use of the drawing method than the writing method, introducing work in pairs, joining the student with his/her better peer (so-called instructional work) who lives near or in a virtual environment – depending on the situation." They also state that students rarely asked for additional help from teachers as they were provided with clear instructions. Students only mention asking for help related to the use of technology: "... how to join online classes via ZOOM ..." or "... how to hand in a task, for example." Research participants cited a number of technology-related problems, which correlates with other studies on disruptive factors in the implementation of online teaching (Varela Gonzalez, 2021; Yazcayir & Gurgur, 2021). All the above requires teachers to have a developed digital competence, as Batarelo Kokić (2020) points out, stating that the COVID-19 crisis has developed new perspectives for teacher training.

Work habits and organizational skills of students with disabilities in an online environment

According to teachers, the impact of online learning on the development of work habits and organizational skills of students with disabilities was different. Some students who were active during traditional classes remained active in the online environment, some became more regular, while others became less regular. The teachers state that there were also "... students who were left to fend for themselves, so it was necessary to invite them many times in private to complete the task and seek the help of homeroom teachers and pedagogues." Here, we can see the importance of engaging parents in helping with homework writing (Vrkić Dimić et al., 2017). They also assume that the students were more persistent because they received a grade for class attendance and accuracy but note that "...their work habits were better, but I hope this refers to the students, not the parents...". The students' organizational skills also improved in different ways: "... some were encouraged by distance learning to work more regularly, motivated by grades for activities", while others point out that "... some of them were really on vacation, happy to have parental help they can rely on in learning." In order to further motivate students to complete their homework, especially in the online environment, it is important that teachers help students with external control difficulties given that they lack the "living word" of teachers in online

classes (Aarnos et al., 2021). The guidance and support of teachers is vital in the education of students with special needs (Yazcayir & Gurgur, 2021).

Self-confidence and motivation of students with disabilities in an online environment

The motivation and self-confidence of students with disabilities in an online environment are essential for a smoother adjustment to the teaching process. The use of ICT will help the students increase their self-confidence and motivation if technology is adapted to the students, but other research suggests that an inappropriate use of ICT can cause countereffects (Saad et al., 2015). Primary school students show a high motivation to work in an online environment and consider learning Nature and Biology as important (Bulić & Blažević, 2020). Some teachers state that students were more motivated because of their teaching methods, and some of them think that they were less motivated because they had a hard time coping with learning in an online environment, but also because "… with this kind of work students are quickly satiated". They state that some students "... got the impression that online learning is a game without rules, obligations, and consequences and this makes them more relaxed in the implementation...". However, the following answer is certainly encouraging: "... better teacher-student communication created a closer relationship and that therefore students do not have brakes, which reduces the uncertainty and fear of mistakes." To further motivate students with disabilities, it is recommended to use as many materials that stimulate the senses such as image, sound, and video, as well as computer games (Matijević, 2017). The online environment has affected the self-confidence of students with disabilities in different ways. Half of the teachers think that it has increased students' self-confidence, some believe that it has remained the same, and some do not notice the differences. They see an increase in self-confidence in "... self-effacing and insecure students in the classroom, who pleasantly surprised them with more open communication, regularity, and work habits in online learning, which resulted in a successful grade and higher self-confidence." They see the reason for lower self-confidence in insufficiently developed digital competences, i.e., "...failure in coping with the digital surrounding."

6. Conclusion

Students with lower g-factor (category of reduced intelligence and below-average intelligence) and students with average intelligence equally progress and regress in online classes in Nature and Biology compared to intellectually superior students and those with above-average intelligence. It can be concluded that online classes provide equal opportunities to all students, regardless of their level of intelligence, allowing room for improvement for students of lower intelligence.

The experience of teachers who taught online Nature and Biology to students with disabilities shows that older students fared better due to better digital competences, as well as girls compared to boys. They note that the academic performance of some students with disabilities has improved mainly due to oral examinations and assessments of student activity, and even point to unrealistically high grades as parents completed homework instead of students.

However, it can also be seen that a supportive environment facilitated by family and teachers ultimately played a key role in students' adaptation to online learning. Teachers implemented individualization and content adjustments in different ways using different teaching methods and strategies. The result of such an approach was manifested in good organizational skills as well as the appropriate work habits of students with disabilities in the online environment. All the above motivated the students to perform their duties, and some even developed a stronger self-confidence.

There are multiple implications of the research as the results obtained can be used to improve future work surrounding students with disabilities in the online environment. Based on the obtained results, teacher practitioners gained insight into the importance of a supportive environment for working with students with disabilities, cooperation with expert staff, and having well-designed didactic-methodological individualized materials for students. In addition to a supportive environment, it is important to find different methods and strategies enriched with different sources of knowledge to enable students to achieve learning outcomes. Although family support in the online environment is essential, parents should be made aware of the differentiation between helping students with disabilities with their homework and completing students' homework on their behalf. When completing work on behalf of children, parents ultimately reduce a child's learning opportunity, despite believing this may be of help. This presents a challenge for teachers as they need to develop evaluation competencies in the online environment in order to objectively assess what students have actually done; overinvolvement from parents in this manner undermines the teaching structure.

The advantage of the research is that teachers and scholars have received a better introduction to the state of educational practice in working with students with disabilities in the online environment. The advantage is that as the g-factor of intelligence was determined for all students before the research, there is additional objectivity to the research results. The quantitative and qualitative sections also provided a better insight into the researched issues. An additional advantage is that students and teachers participated in the research, and the topic of online learning of Nature and Biology was viewed from both perspectives. A characteristic of this research is that all the teaching contents posted to Moodle were designed by a biology teacher and followed the curriculum and the required educational learning outcomes.

It should be noted that there are some limitations to this study. A limitation of the research, and what also acts as a recommendation, is that parents could be included in the survey to allow for an analysis of their perspectives on the work of students with disabilities in the online environment. Expert staff should also be included due to their role in working with students with disabilities, and it should be investigated how they provided help and support to these students during online teaching. It is recommended that similar research be conducted in areas other than science to assess what impact the s-factor of intelligence has on student outcomes in the online environment.

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