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Research Article

The effect of tools on the biological word association performance of students with mild intellectual disabilities

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ABSTRACT

In our research, we used the word association test to assess the biology knowledge of seventh-grade pupils with (N = 34) and without mild intellectual disabilities (N = 40) in the context of the use of tools. The use of the word association test is quite common among typically developing pupils, however, it is not yet widely used for pupils with mild intellectual disabilities. Furthermore, pupils with mild intellectual disabilities learn by using other tools, which may lead to different results. The first section of the research included a self-composed questionnaire, and this was followed by the word association test where the pupils had one minute to give answers to the stimulus words. For the analysis we used the SPSS statistical program and ANOVA. The results of the two groups of pupils were different because pupils with mild intellectual disabilities reported more misconceptions in the same amount of time (7.63 and 12.38). Furthermore, more frequent tool use by pupils with mild intellectual disabilities was correlated with the proportion of misconceptions (low used 11.47; high used 13.53; p = 0.004). In addition, the examination highlighted the different risk factors of using various tools in biology class.

Keywords: word association, biology, mild intellectual disabilities

INTRODUCTION

A wide range of studies is currently available on different examinations of student achievement, both in Hungary and internationally (Hegedűs, 2022). The main aim of our research is to explore the scientific knowledge of pupils with and without mild intellectual disability using the word association method. The diagnostic criteria for ICD-10: F70 in Hungary align with international guidelines; therefore, we included in the study only those children who met these uniform criteria. A further aim is to shed light on whether there are similarities and differences in misconceptions between the two groups of pupils.

However, there is a lack of comparative studies for these groups of learners (Hegedűs, 2020; Szabó, 2016), and a comparison of word association capacity has not been done before, which may be due to the fact that pupils with mild intellectual disabilities are tested by different professionals and with different tools (Zentai et al., 2013). The study is important for the two groups of pupils because they can be educated together in integrated education (Hegedűs, 2023a; Mező & Mező, 2022), and teachers have similar expectations of them. Also, these tests often only cover basic skills. For this reason, this research is relevant and important.

Moreover, information and communication technology (ICT) tools are increasingly important nowadays as children are socialized to use them (Végh & Pusztafalvi, 2019). Furthermore, the positive impact of using ICT tools on learning is also frequent (Karma et al., 2024; Langoi & Deogratias, 2024). Teachers should do their

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best to transfer knowledge better, as children find it difficult to visualize certain things and may have misconceptions, which these tools can help with. In this study, we examined those ICT tools that facilitate active learning and interaction. Our analysis included the following: videos, audio materials, textbooks and workbooks, models, microscopes, experiments, maps, and other interactive tools.

For children with mild intellectual disabilities, their thinking is too rigid, and experiential learning is essential; they need more practical/experimental tasks to understand contexts and learn correctly. This means that the textbook itself is not enough; more tools and methods are needed to support successful learning. The use of ICT tools in both the teaching process and the organization of learning can play a relevant role in the education of pupils with mild intellectual disabilities (Vágó-Kürti & Virányi, 2023).

Our research aims to contribute to the extent to which ICT tools and classroom tools support the integration of new knowledge as accurately as possible. On the other hand, we also try to focus on the impact of the use of these tools on the two groups of pupils, and in the case of integrated learning, the teachers should change their methods.

Research Trends in Word Association Studies Among Pupils with and without Mild Intellectual Disability

The word association method is widely used, with many results available from various research studies. It is frequent and widespread in science topics, from kindergartners (Daru & Tóth, 2013) through elementary and high school pupils (Sója-Gajdos & Tóth, 2017) to university students (Kurt et al., 2013). In contrast, there is not as much study among pupils with mild intellectual disabilities on this topic. Besides, comparative studies are rare and focus mainly on typically developing pupils.

In the case of typically developing pupils, it is particularly important to review their traits as described by different studies in order to analyze the data and base our conclusions. First of all, it should be noted that a study used the word association method with 6th-grade and 7th-grade pupils, and the researchers examined the pupils' cognitive structure in science at the beginning and end of a project (Armağan, 2015). Similar to other studies (Arslan, 2023; Kostova & Radoynovska, 2008), the researchers suggest the use of a word association test at the beginning of a lesson to explore students' knowledge so far (Armağan, 2015). In addition, a word association test was used to assess 9th grade biology students' knowledge of living organisms. In this study, the students drew on their experiences and daily lives (e.g., vitamins and fruits, salt and meals, etc.), but there were also some unscientific associations. According to the researchers, biology education should use methods and techniques that deal with misconceptions, and the researchers also suggest teaching through experimentation (Özerslan & Çetin, 2018). Word association tests have also been used with prospective science teachers to map their cognitive structure (Yilmaz, 2019) and also their knowledge about the topic of genes (Dikmenli et al., 2011).

However, not as much research can be found in this topic by pupils with mild intellectual disabilities. In Hungary, the concept of mild intellectual disability was introduced in the 20th century, in which case the student can be classified as mildly mentally handicapped on the basis of IQ (between 50 and 69) (Mesterházi & Szekeres, 2019). Pupils with mild intellectual disabilities lag behind in several areas of typical developmental peers, including cognitive abilities, perception, cognition, attention, memory, and thinking functions (Rottmayer, 2006). Rigidity is related to reduced cognitive flexibility and difficulties with abstraction. As a result, the formation of more distant associations may also be limited, which can affect vocabulary development (Mesterházi & Szekeres, 2019). Their limited working memory is also a problematic area, as it affects speech comprehension, speech production, attention, and so on (Fazekasné Fenyvesi et al., 2019). Many studies have analyzed the vocabulary of pupils with mild intellectual disabilities and the factors that influence it (Macher, 2016; Wang et al., 2023).

Misconceptions represent a significant challenge in the acquisition of knowledge, not only for typically developing students but also for those with mild intellectual disabilities. As Korom (2002) notes, misconceptions are persistent, deeply rooted ideas that conflict with currently accepted scientific views and often resist traditional teaching methods (Mády & Hegedűs, 2023).

As the skills of the two groups of pupils are different, so are their teaching methods and their use of tools. Learning from textbooks is far from enough for pupils with mild intellectual disabilities because, besides, they need other ways to absorb the new information (Juhos & Hegedűs, 2023; Mező, 2023). Currently, there are a wide variety of tools that can support the teaching process in different lessons, especially ICT tools.

Using Different Tools in Lessons with a Focus on ICT Tools

At present, the use of ICT tools is becoming increasingly important, so the use of ICT in education is also becoming more frequent (Anil & Ozer, 2012; Eren & Kurt, 2011; Ollé & Csekő, 2004, cited in Végh & Pusztafalvi, 2019). The use of ICT in education raises a number of questions, for example, about the willingness of teachers to use ICT tools (Buda, 2017) or their skills. However, during the COVID-19 epidemic, many institutions were forced to provide online education for their students. In the initial period, the negative effects of this were more in focus, such as the lack of ICT skills of teachers, the short transition time, and the difficulties of disadvantaged institutions and families because not everyone had the tools at their disposal (Fekete, 2020). Regarding teachers' use of ICT, they are currently much more open to integrating these tools into their teaching practice (Bartal & Kolacsek, 2021). However, according to a previous survey (Tóth et al., 2011), the equipment in schools was far from satisfactory, with the number and obsolescence of equipment being a problem. Furthermore, there was no apparent tendency for larger schools to have more ICT equipment; it can be said that schools had similar chances of tendering for devices (Tóth et al., 2011).

The following section explores the impact of these tools on student achievement. Several studies have examined the impact of ICT on student achievement, such as a study in Turkey investigating the positive correlation between computer use and achievement in science among 15-year-old students (Anil & Ozer, 2012). In another study, researchers found that ICT use at home has a more positive impact on achievement in math and science, possibly because ICT is not or only less integrated into school education (Delen & Bulut, 2011). Furthermore, pupils who are more proficient in ICT tend to perform better in their school studies (Eskil et al., 2010 cited in Delen & Bulut, 2011). It should be noted that other research has also reported on the impact of home ICT use on mathematics learning in the context of the social background of the pupils (Vincze, 2018). The correlation between home ICT use and achievement in science is also discussed in another study in which home ICT use was found to be more influential than school-based ICT use (Spiezia, 2011 cited in Vincze, 2018).

Interactive whiteboards have been used in classrooms for several years and have had a positive impact by increasing pupils' motivation to learn (Végh & Pusztafalvi, 2019). Végh and Pusztafalvi (2019) highlighted the positive benefits of using the interactive whiteboard and how the tool helps to introduce curriculum content and develop knowledge and skills, as well as the interaction between teacher and student. In addition, drawing on previous literature, they confirm a positive attitude towards the interactive whiteboard in biology lessons and that the tool facilitates and accelerates the understanding of the subject (Karakoyun & Yapici, 2016 cited in Végh & Pusztafalvi, 2019).

Several studies focus on the use of ICT in the teaching and learning of math and science (Langoi & Deogratias, 2024; Karma et al., 2024). Langoi and Deogratias (2024) point out that among science teachers, biology teachers (N = 25) are the most common users of ICT in their lessons mostly for illustration (graphs, pictures, diagrams, charts, etc.). Teachers' perceptions and results showed that students' learning and thinking abilities are both improved after using ICT tools (Langoi & Deogratias, 2024). Another study shows that the use of ICT tools has a positive impact on the achievement of 7th-grade students (Karma et al., 2024). The researchers recommend the integration of ICT tools in teaching, and the 7th-grade students in the study are also encouraged to use ICT tools in class (including science lessons) because it contributes to an easier understanding of the curriculum (Karma et al., 2024).

There are several tools that teachers can use to support students' learning, and ICT devices are currently becoming a key element. Moreover, using technology in science would help students in several ways, such as gaining practical knowledge (Soyikwa & Boateng, 2024). In our research, the use of ICT tools was the second most common tool after textbooks. In the following, we will compare the use of different tools with pupils' word association activities in biology.

The Aims and Questions of the Research

The aim of the research is to examine the pupils' knowledge of biology through their word association capacity and to assess the extent to which the tools used in the lessons influence word association ability.

Table 1. How common is the use of the following tools in biology lessons? Give your answer on a scale of 1 to 4 (1–least common, 4–most common)

ICT tools	Scale			
	1	2	3	4
Audio				
Experiments				
Interactive device				
Map				
Microscope				
Model				
Textbook and workbook				
Video				
Wall table				

1. Do pupils with mild intellectual disabilities produce more misconceptions in the same amount of time?
2. Is the use of several tools (ICT, video, audio, textbook, workbook, model, map, and experiments) having a stronger impact on the word association achievement of pupils with mild intellectual disabilities?

METHODS

The data were collected at the end of the spring semester 2022 with 40 typical developing pupils and 34 pupils with mild intellectual disabilities (IQ less than 70, ICD-10: F70, DSM 317) in 7th grade. In the study, we aimed to obtain a sample with a nearly equal number of elements. However, since all the participants were from the same grade level, it should be noted that pupils with mild intellectual disabilities may starts school later and have a higher chance of academic failure. In terms of age, the participants differed by an average of about two years (and occasionally more); however, since their cognitive abilities vary, age cannot be considered a reliable indicator. During the survey, we visited almost all the unified methodological special education institutions in Szabolcs-Szatmár-Bereg County, where children with mild intellectual disabilities receive special education and learn based on a different curriculum. In their case, to increase the number of participants, we visited institutions in Hajdú-Bihar County too, but there was an institution that completely rejected to participate in the research. In order to make a comparison, we selected two classes from majority institutions.

In the first part of the research, we took a self-administered questionnaire in person with the pupils. The questionnaire was preceded by parental consent, which allowed children to participate in the research. During the development of the questionnaire, we adapted to age and cognitive characteristics. The questionnaire included, among other things, information on demographic background, the contact with nature, as well as the pupils' preferences and achievements in biology, and last but not least, the quality of the lessons (e.g., for the current analysis in **Table 1**). The value of Cronbach's alpha among the variables is 0.805, based on which the question block is reliable. So this block is very useful for analysis.

The questionnaire was followed by the word association test, where the answers were recorded as audio files in a personal situation. It was important that the test not be written, both to avoid time constraints and to avoid any potential writing problems. The pupils associated eight catchwords on the topic of plants, fungi, and animals (flowering seed plants, non-flowering plants, evergreens, fungi, mammals, reptiles, amphibians, and bugs). Both groups of students study the following biological concepts as part of their biology curriculum.

About the participants in the sample categories were decided by two independent people and controversial cases were discussed. The responses were classified into three categories, which were also used for the catchwords: proportion of all associations, proportions of misconceptions, and a third category, which also seemed necessary, as there were responses that were not misconceptions but also not closely related to science. The data obtained were analyzed using SPSS, two and multivariate ANOVA. In the analysis, significance levels were calculated. In addition, ANOVA was used, for example, in the part where we compared the proportion of students' responses to the stimulus words in the context of the use of the tools in biology lessons. Correlation tests were performed between the variables, which were not normally distributed, so Spearman correlation was used. For the analysis, variables (e.g., based on the use of tools) were created by aggregating data.

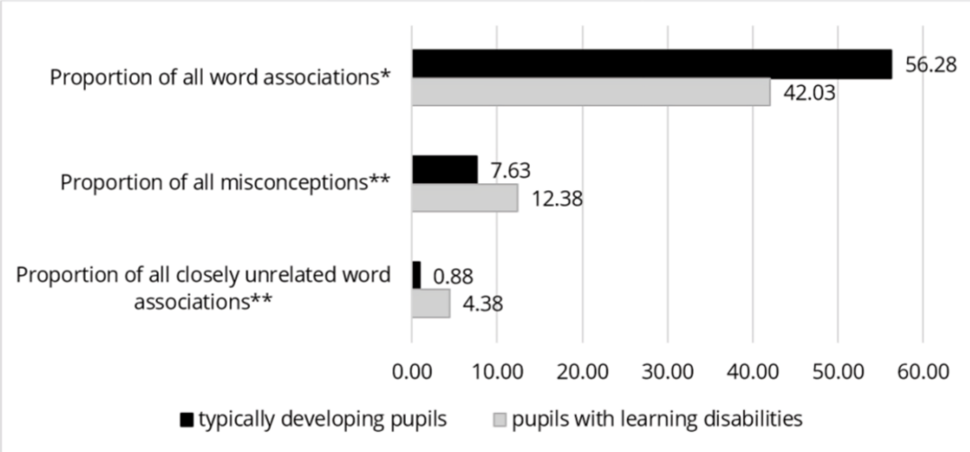

Figure 1. Proportion of pupils' answers to the catchwords (N = 74; ***< 0.001; **0.001-0.01; & *0.01-0.05) (the authors' own edit)

Table 2. Average number of pupils' responses to catchwords in the topic of plants and fungi

Catchword	Category	Typically developing pupils	Pupils with mild intellectual disabilities	Sig.
Flowering seed plants	Proportion of all word associations**	8.75	5.65	0.001
	Proportion of all closely unrelated word associations*	0.08	0.59	0.012
Non-flowering plants	Proportion of all closely unrelated word associations**	0.03	0.94	0.001
Evergreens	Proportion of all misconceptions*	0.65	1.26	0.012
	Proportion of all closely unrelated word associations*	0.28	1.35	0.029
Fungi	Proportion of all word associations***	9.15	5.12	0.000

Note. N = 74; ***<0.001; **0.001-0.01; & *0.01-0.05

FINDINGS

The difference between the two groups of pupils is clearly seen, as students with mild intellectual disabilities mostly listed examples and features related to the stimulus words, whereas for pupils without mild intellectual disabilities, the emphasis was more on the knowledge acquired in class and the content of the curriculum. There were significant differences in the main categories, as pupils with mild intellectual disabilities produce fewer word associations than pupils without mild intellectual disabilities (p = 0.017). However, pupils with mild intellectual disabilities produce more misconceptions (p = 0.004) and closely unrelated word associations (p = 0.002) in the same amount of time (**Figure 1**). The attention of pupils with mild intellectual disabilities was often distracted during the examination. In addition, some answers were questionable as to how they related to the topic, but these were not classified as misconceptions.

In the course of the research, we also analyzed the subcategories: all word associations, all misconceptions and all closely unrelated word associations received for each catchword. The results for plants and fungi are presented in **Table 2**. For reasons of article volume, only the most relevant data has been highlighted. There is a significant difference between the two groups of pupils, for example, in the number of all word associations (p = 0.001) and all closely unrelated word associations (p = 0.012) for flowering seed plants. As it can be seen in **Table 2**, students with mild intellectual disabilities produced fewer associations (5.65) but had a higher proportion of closely unrelated associations (0.59). Their unrelated responses included, for example "clean", "it's more expensive", "family", "I like it", "it has a nice color" and so on. In addition, misnaming was also common in this case.

Furthermore, there is also a significant difference between the closely unrelated word associations (p = 0.001) for non-flowering plants as well as the misconceptions (p = 0.012) and closely unrelated responses (p = 0.029) for evergreens. For these three categories, much higher proportions (0.94; 1.26; 1.35) can be seen for pupils with mild intellectual disabilities. We must point out that the "grass" answer was the most common misconception about both non-flowering seeds and evergreens as well. This can be justified by the fact that

Table 3. Proportion of the pupils' answers to the catchwords in the topic of animals

Catchword	Category	Typically developing pupils	Pupils with mild intellectual disabilities	Sig.
Reptiles	Proportion of all misconceptions**	0.070	1.79	0.004
Amphibians	Proportion of all word associations*	5.350	3.53	0.030
	Proportion of all misconceptions*	1.250	2.03	0.048

Note. N = 74; ***<0.001; **0.001-0.01; & *0.01-0.05

Table 4. The proportion of pupils' answers to the catchwords correlated with the use of tools in biology class

Tools		Proportion of all word associations	Proportion of all misconceptions	Proportion of all closely unrelated word associations
Audio	Correlation	-0.161	-0.463**	-0.270
	Sig.	0.321	0.003	0.092
Interactive devices	Correlation	-0.380	-0.373*	-0.218
	Sig.	0.817	0.018	0.177
Map	Correlation	-0.189	-0.363*	-0.052
	Sig.	0.242	0.021	0.752
Video	Correlation	-0.198	-0.432**	-0.307
	Sig.	0.221	0.005	0.054

Note. N = 74; ***<0.001; **0.001-0.01; & *0.01-0.05

pupils do not have sufficient background information about the catchwords or the classification of the plants. However, it can also be explained that they incorrectly associated the answer with the catchwords based on their everyday experience.

Last but not least, a significant difference is also seen for all the answers (p = 0.000) received for fungi. In this case, the typically developing students made more associations (9.15), which may be due to the fact that at the time of the examination the students were repeating the topic of fungi in their biology lessons. This also had an impact on the quality of their associations, as the most frequent answers included "poisonous", "eatable", as well as the parts of the fungus such as "hat" and "stem".

We also analyzed the categories within the topic of animals and the most relevant results are presented in **Table 3**. There is a significant difference between the achievement of the groups of pupils in the proportion of all misconceptions about reptiles (p = 0.004). Associations such as "birds", "stork", "crab", "fish" and even "spider" appeared in the responses of students with mild intellectual disabilities. In the case of typical developing pupils, the associations "amphibians" and "frog" also appeared in connection with the catchword.

Moreover, significant differences are also seen for all the proportion of word associations (p = 0.030) and all the misconceptions (p = 0.048) about amphibians. This was the catchword that received the fewest answers from the pupils. Also, the pupils have been answered with a few misconceptions about the catchword. For example "crocodile", "horse", "turtle", "fish" and also the "platypus". In addition, some students connect egg reproduction with amphibians, however, that is not the case.

Word Association Capacity in the Context of the Use of Tools in Biology Lessons

Misconceptions often cause problems in biology, therefore, in our research we have focused, among other things, on the pupils' relationship with the subject. First of all, in the research we obtained information on the use of tools in biology lessons. Which is important because pupils in special education and pupils in mainstream schools require different methods of learning and, as a result, their teachers may prefer different tools (Juhos & Hegedűs 2023).

In the course of the research, the use of nine tools was examined and correlated with word association achievement. The most relevant results are shown in the **Table 4**.

Table 4 shows the word association achievement of all pupils correlated with the use of tools in biology lessons. The most important results can be seen in the use of the following tools and the proportion of misconceptions. First of all, video is one of the most common tools used in biology lessons, showing a significant negative correlation with misconceptions (r = -0.432**; p = 0.005). The same is also true for audio (r = -0.463**; p = 0.003), for the interactive table (r = -0.373*, p = 0.018) and map (r = -0.363*; p = 0.021). This means that the more these tools are used in biology class, the fewer misconceptions the pupils have.

Table 5. The proportion of the typically developing pupils' answers to the catchwords correlated with the use of tools in biology class

Tools		Proportion of all word associations	Proportion of all closely unrelated word associations	All word associations received for fungi	All word associations received for reptiles
Audio	Correlation	-0.345**	0.010	-0.380**	-0.312**
	Sig.	0.003	0.932	0.001	0.007
Interactive devices	Correlation	0.061	0.252*	-0.085	-0.050
	Sig.	0.605	0.030	0.470	0.673
Model	Correlation	-0.349**	0.029	-0.332**	-0.418***
	Sig.	0.002	0.805	0.004	0.000
Video	Correlation	-0.175	0.258*	-0.179	-0.149
	Sig.	0.136	0.027	0.126	0.205

Note. N = 74; ***<0.001; **0.001-0.01; & *0.01-0.05

Table 6. The proportion of answers of pupils with mild intellectual disabilities to the catchwords correlated with the use of tools in biology class

Tools		Proportion of all closely unrelated word associations	All closely unrelated word associations received for evergreens	All closely unrelated word associations received for fungi	All word associations received for mammals
Interactive devices	Correlation	0.467**	0.358*	0.172	-0.093
	Sig.	0.005	0.038	0.331	0.602
Model	Correlation	-0.124	0.031	-0.364*	-0.424*
	Sig.	0.486	0.862	0.034	0.012
Video	Correlation	0.426*	0.434*	0.365*	0.068
	Sig.	0.012	0.010	0.034	0.700

Note. N = 74; ***<0.001; **0.001-0.01; & *0.01-0.05

It is worth to mention that there is also a significant negative correlation between the video and the misconceptions received for catchword bugs (r = -0.330**; p = 0.037) and reptiles (r = -0.374*; p = 0.018). Moreover, the audio and the misconceptions received for catchword bugs (r = -0.400*; p = 0.011) also shows a significant negative correlation. However, there is a weak relationship between the variables.

We also correlated the proportion of associations and the use of tools separately for the two groups of learners. First, in the **Table 5**, the results obtained among typical developing pupils.

In the case of typical developing pupils, **Table 5** shows that there is a significant negative correlation between the proportion of all word associations and audio tool (r = -0.345**; p = 0.003) and the same can be said about the use of models (r = -0.349**; p = 0.002). In addition, two other categories show similar results for audio and model use. First, there is a significant negative correlation between all word associations received for fungi and audio use (r = -0.380**; p = 0.001), as well as with the use of models (r = -0.332**; p = 0.004). The same applies to all word associations with reptiles, both for audio (r = -0.312**; p = 0.007) and model use (r = -0.418***; p = 0.000). This means that the more audio and models are used, the fewer responses are received for the mentioned categories.

As far as the proportion of closely unrelated word associations is concerned, a significant positive correlation is observed for two tools: the use of interactive devices (r = 0.252*; p = 0.030) and video clips (r = 0.258*; p = 0.027). Although, in this case, the link is weaker, it can be said that the more these two tools are used, the more unrelated associations are made.

As above, we also correlated the data among pupils with mild intellectual disabilities (**Table 6**). The most significant results were for the tools and categories shown in **Table 6**. However, there were a few results that could not be covered in **Table 6** due to volume limitations. In terms of interactive devices, there is a significant positive correlation with two categories: the proportion of all closely unrelated word associations (r = 0.467**; p = 0.005) and all closely unrelated word associations received for evergreens (r = 0.358*; p = 0.038). The same can be seen in these categories for video viewing as a tool because it shows a significant positive correlation with the proportion of all closely unrelated word associations (r = 0.426*; p = 0.012) and the proportion of all closely unrelated associations received for evergreens as well (r = 0.434*; p = 0.010). Furthermore, this is also the case for the proportion of closely unrelated associations with fungi (r = 0.365*; p = 0.034). On this basis, it

Table 7. Proportion of pupils' answers to the stimulus words in the context of the use of tools in biology classes

Category	Typically developing pupils		Pupils with mild intellectual disabilities		Sig.
	High (N = 6)	Low (N = 34)	High (N = 19)	Low (N = 15)	
Proportion of all word associations*	45.83	58.12	36.11	49.53	0.017
Proportion of all misconceptions**	4.67	8.15	11.47	13.53	0.004
Proportion of all closely unrelated word associations**	0.33	0.97	3.32	5.73	0.002

Note. N = 74; ***<0.001; **0.001-0.01; & *0.01-0.05

Table 8. Proportion of pupils' misconceptions about plants and fungi in the context of the use of tools in biology classes

Category	Typically developing pupils		Pupils with mild intellectual disabilities		Sig.
	High	Low	High	Low	
All misconceptions received for flowering seed plants	0.00	0.18	0.05	0.07	0.320
All misconceptions received for non-flowering plants	1.17	1.97	2.89	2.87	0.154
All misconceptions received for evergreens*	1.00	0.59	1.21	1.33	0.012
All misconceptions received for fungi	0.67	0.38	0.58	0.47	0.570

Note. N = 74; ***<0.001; **0.001-0.01; & *0.01-0.05

can be stated that the more interactive devices and videos are used, the more unrelated associations are made among the pupils with mild intellectual disabilities.

As regards model use, significant negative correlations can be seen in two categories: firstly, between the proportion of closely unrelated responses to fungi (r = -0.364*; p = 0.034) and secondly, between the proportion of all word associations to mammals (r = -0.424*; p = 0.012). The more they use the model in biology lessons, the fewer closely unrelated associations they make with the catchword fungi, but their associations with the catchword mammal are also fewer.

There is a strong emphasis on the use of tools because for pupils with mild intellectual disabilities, it is appropriate that their teachers try to use a variety of tools to convey information. For them, the textbook alone is not sufficient for the correct acquisition of knowledge (Hegedűs, 2023b; Juhos & Hegedűs, 2023).

In the questionnaire, we measured the tools used by the students in biology lessons on a scale of one to four, with students responding to a total of nine tools. After that, the pupils were further classified into two groups: pupils those with high and extensive use of tools and those with low and less extensive use of tools. This was compared with the proportion of word associations received for the catchwords (**Table 7**).

The results in **Table 7** show that there was a significant difference in the achievement of the groups of pupils in all three categories. From **Table 7**, it can be seen that within the groups of pupils, those with lower tool use had a higher proportion of all word associations (58.12; 49.53). However, fewer misconceptions (4.67; 11.47) and closely unrelated word associations (0.33; 3.32) were given by students whose biology lessons were marked by higher tool use. It should also be noted that the proportion of these categories was much higher among the pupils with mild intellectual disabilities.

The categories were further examined within the catchwords, and from these we have highlighted the proportion of misconceptions, the results of which are presented in the **Table 8**.

First, the results obtained within the topic of plants and fungi are detailed, where there is a significant difference in the proportion of misconceptions received for the catchword evergreens (p = 0.012). In this catchword, it can be said that among typically developing pupils, those with high levels of tool use produce more misperceptions (1.00). In contrast, among those with mild intellectual disabilities, the proportion of misconceptions is higher for those with low tool use (1.33).

In the case of flowering plants, those students with lower tool use produce more misconceptions in both groups of pupils (0.18; 0.07). Interestingly, the two groups of pupils with mild intellectual disabilities report fewer misconceptions (0.05; 0.07) than typically developing learners, who have lower tool use (0.18).

The proportion of misconceptions received about non-flowering plants is lower among typically developing learners, who have higher tool use (1.17). However, that is not the case among the pupils with

Table 9. Proportion of pupils' misconceptions about animals in the context of the use of tools in biology classes

Category	Typically developing pupils		Pupils with mild intellectual disabilities		Sig.
	High	Low	High	Low	
All misconceptions received for mammals	0.33	0.44	1.11	0.40	0.075
All misconceptions received for reptiles**	0.17	0.79	1.37	2.33	0.004
All misconceptions received for amphibians*	0.67	1.35	1.95	2.13	0.030
All misconceptions received for bugs	0.67	2.44	2.32	3.93	0.228

Note. N = 74; ***<0.001; **0.001-0.01; & *0.01-0.05

mild intellectual disabilities because those have more misconceptions about the catchword, who have higher tool use (2.89). Last but not least, both groups of pupils who have high tool use have more misconceptions about fungi (0.67; 0.58).

In a similar way, we examined the misconceptions about the catchwords within the topic of animals, as shown in **Table 9**. Within the animal topic, two catchwords showed significant differences between the groups of pupils in misconceptions: reptiles (p = 0.004) and amphibians (p = 0.030). In the groups of pupils, those with lower tool use have more misconceptions about reptiles (0.79; 2.33) and the same can be seen with the catchword amphibians (1.35; 2.13).

For the catchword mammals, those typically developing pupils have more misconceptions, who have lower tool use in biology class (0.44). However, the reverse is true for pupils with mild intellectual disabilities (1.11). As for the catchword bugs, the groups of pupils with lower tool use have more misconceptions (2.44; 3.39). Overall, the proportion of misconceptions about the catchword bugs is high among students, which is due to the fact that students learn about insects and bugs in biology lessons but their knowledge remains incomplete or insufficient. However, this can be explained by Malmos and Revákné Markóczi (2015) which found that learners do not always distinguish between insects and bugs.

DISCUSSION

In the present study, we examined the word association capacity in biology of 7th grade students with and without mild intellectual disabilities. The research focused on the pupils' word association achievement and the impact of the use of tools in biology. The results from the two groups of pupils were compared.

First of all, research on the use of word association in typical developing children is common, but there are not as many studies about this kind of research among pupils with mild intellectual disabilities. The results for pupils with mild intellectual disabilities reveal that they produce significantly more misconceptions than typically developing pupils, and they sometimes picked out a word from the catchword (evergreens-green) and took their thoughts in that way. Furthermore, there were also examples of their attention being diverted from the examination and starting to list words that did not seem to fit.

In addition to comparing word association capacities, we highlighted some factors that influence achievement, such as the use of tools in biology lessons. In the case of pupils with mild intellectual disabilities, the tools that their teachers prioritize in their teaching are important (Juhos & Hegedűs, 2023). For them, it is also important to acquire knowledge using more than one method and more than one tool, which their teachers usually try to do as much as they can. It is also worth mentioning the use of ICT tools, as using them in the right way can reduce misconceptions. However, an examination in the context of using ICT tools and the proportion of misconceptions could be revealed in the classroom environment and also could be a part of future research. Teachers need to use these tools correctly, which requires professional knowledge and methodology (Langoi & Deogratias, 2024). In the case of misconceptions, it is important to explore, which can be both through questions and mental mapping as well. Following this, it is important to provide evidence of which ICT tools can be an important part to better address the misconception and to strengthen the correct information.

From the pupils' point of view, it is of particular importance to identify misconceptions as well as prior knowledge (Kádár & Farsang, 2019), as previous research has shown that education and teachers are not aware of or do not sufficiently address pupils' prior knowledge (Juhász & Márkus, 1999 cited in Malmos, 2014;

Ledbetter, 1993, cited in Korom, 1997). On the other hand, the use of the tools must be accompanied by the right explanations, as the correct integration and interdependence of knowledge achieved can only be successful in this way.

The study has broadened the scope of comparability between the two groups of pupils, providing new results on pupils' abilities, revealing new misconceptions, and allowing us to highlight areas of concern. Furthermore, we also draw attention to the importance of pupils' prior knowledge and interpretation, which can be achieved by using the word association method.

In summary, we have gained a clearer picture of not only the word association achievement but also of the factors influencing it, which may provide a basis for extending and further developing the current study and opening up the possibility of new researchers on the topic.

CONCLUSION AND IMPLICATIONS

In this research, we examined the word association capacity in biology of students with and without mild intellectual disabilities. Our research questions, based on the literature, focused on pupils' word association achievements as well as the question of the impact of the use of tools on their achievement and misconceptions.

This research provided us with the opportunity to explore the two groups of pupils' knowledge of biology and also the areas of concern. The word association method provided an opportunity to quickly map pupils' knowledge of biology. Pupils with mild intellectual disabilities tend to give examples and features, while typically developing pupils tend to give more curriculum-focused answers. At the same time, the first question of the research was confirmed, because pupils with learning disabilities did indeed produce more misconceptions in the same amount of time. There was a significant difference in the achievement between the two pupil groups in the proportion of all misconceptions, but also in the catchword's evergreens and reptiles.

Our second question, based on the literature, is partially confirmed. The correlated data from the tools and the word association test produced variable results: for both groups of learners, the use of certain tools resulted in fewer responses and more closely unrelated word associations. Although in terms of the extent of tool use, pupils with mild intellectual disabilities were more likely to have more misconceptions with higher tool use than the groups of typically developing students. The concept of tool use does not explicitly address the differences in frequency, duration or pedagogical quality, which limits the interpretability of the results. In the classroom environment, much more attention should be paid to uncovering misconceptions using different methods. During correction, much more concrete reinforcement is needed, which can be a picture, video or model. When teaching abstract concepts, one should also try to present the concept and processes. Another option is to carry out modeling and experimentation in such a way that children are also active participants.

The research highlights the importance of mapping prior knowledge and the applicability of the word association method to this issue. As we cannot draw firm conclusions about the number of participants, we aim to extend the research. The main aim is to carry out this research in several regions, even at national level. Furthermore, in the present study, pupils with mild intellectual disabilities who are in special education were included, but pupils with mild intellectual disabilities integrated into mainstream classes could also be involved. This would allow us to highlight both the successes and possible weaknesses of the integration of pupils with mild intellectual disabilities, and it would also give a complex picture of their achievement. In addition, the word association test can be followed by an interview, where students can explain why they gave the answers for a given catchword, helping to examine the misconceptions more comprehensively.

In summary, the present study allowed a comparison between typically developing pupils and pupils with mild intellectual disabilities and expanded the applications of the word association method. We had the privilege to map the pupils' knowledge and to investigate the impact of the tools on the pupils' word associations and knowledge acquisition.

Limitations

The limitation of the research is that the number of items is low, but we still found significant results. In special education institutions, class sizes are very low (5-6 people), so our sample can be considered large and focuses on several institutions. The questionnaire could have had more questions, but it was important that even a child with mild intellectual disabilities could complete it and that it was not burdensome for them. We did not examine the implementation of the biology lessons only with the help of questionnaires, so we have no information about the specific implementation of the lessons. Furthermore, classroom observations or interviews were not possible, which may limit the interpretation of the data

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