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Learning, Thinking and Behaviour Among Pupils with Learning Disabilities

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Abstract

The educational process is a complex system in which individual subjects such as teachers and pupils interact. However, external elements (e.g. the subject matter or atmosphere in the classroom) also influence them. It is necessary to know how the learning process works and how pupils influence each other's behaviour, how the pupils' behaviour influences learning and how the way of thinking reflects in the behaviour. In addition, we need to take into account various learning and behavioural disorders in the educational process. In pedagogical practice, we consider pupil discipline and learning disorders to be the two most significant problems in education. Research often focuses on only one of these elements. The article focuses on both mentioned aspects of the teaching process. In the first part, we examine why pupils disturb and how the class disturbance is related to the complexity of the topic. Using the test, we find out the pupils' level of knowledge and how they solve the tasks. We observe the success in solving tasks with gradually increasing difficulty based on methods of differentiated teaching. We are interested in the connection between the success in solving tasks and the pupils' disturbance during the lesson. We found out, that most pupils disturb because of the easy subject matter or they disturb spontaneously. The second part of the study focuses on the success of integrated pupils in solving mathematical problems in comparison to the success of pupils without learning disabilities. Our task is to determine whether these two groups are different and whether learning disabilities have a significant impact on pupil success. The success of these two groups has been proven to be statistically not significantly different.

Keywords: intact pupils, integrated pupils, inclusive education, study.

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1. Introduction

Pupils with learning disabilities have difficult access to education for many reasons. We most often encounter dysgraphia, dyslexia, dyscalculia and attention deficit disorder in the teaching process. The influence of individual learning disabilities on information processing is described e.g. in works (Mather, 2003; Moll, et al., 2015; Jimenez-Fernandez, 2016). Since pupils with learning disabilities present only a relatively small number in mainstream schools, a case study method is usually used for the study (e. g. in (Karimi, 2013) the case study focuses on the impact of learning disabilities in mathematics education). According to (Vagge et al., 2015; Zoccolotti, Friedmann, 2010), more boys than girls suffer from dyslexia and approximately the same number of boys and girls suffer from dyscalculia. Dyscalculia often appears together with attention deficit disorder and dyslexia. The work (Butterworth et al., 2011) points to methods that playfully help in the education of pupils with learning disabilities and activate the brain parts that influence the learning disabilities.

The form of inclusive education for pupils with learning disabilities has come to the fore in recent years. Pupils with learning disabilities are integrated into mainstream classes, and their educational process is appropriately adapted. By an estimate, there are less than 10 % of pupils with learning disabilities, and therefore their inclusion in the mainstream class should pull them forward, but it should not restrict their classmates in the educational process. On the contrary, this inclusion should also have a positive effect on the socialization of pupils. Authors in (Ratnaningsih et al., 2019) point out the weaknesses of inclusive education. Inclusive education is largely influenced by the political situation and legislation. Research (Evans, Lunt, 2002) describes this view of inclusive education, pointing out possible further developments in it. Work (Florian, 2019) focuses on the similarities and differences between inclusive education and special schools. Work (Kershner, 1990) points to the interesting fact: learning disabilities do not correlate with IQ and the level of self-evaluation is for pupils with learning disabilities more important than the level of IQ itself.

It is difficult for many pupils to solve mathematical tasks by themselves. Most pupils handle the task successfully on the blackboard, but they fail by solving a similar task unassisted at the desk. This is because the pupil is sometimes directly or indirectly guided to the right step of the solution by solving the task on the blackboard. The direct form can be an indication of the correct step or a direct indication of the step needed to continue solving the task. An indirect form can be the teacher's body language or the reaction of classmates (for example, a raised hand or a question) to a step they don't understand (usually a wrong step).

One of the main reasons for pupils' lack of interest in independent work and task solving is that they have not enough abilities to solve the problem. We can identify several reasons (Šumný, 1974):

- Inadequacy of tasks to the pupil's knowledge,
- Lack of suitable opportunities for independent work,
- Insufficient knowledge of different solving techniques,
- Ambiguity of the solving technique.

We can gradually eliminate these causes, but it is necessary to identify and understand them. We teach and train pupils with several solving methods and support the development of their skills for different methods. A collection of tasks graded by the difficulty can be used for homework. If the pupil gets lost in the solving process, the most common reason is the occurrence of a step that overreaches the pupil's level of knowledge, or that the pupil has missed the logical sequence of solving steps used at some point.

The method of gradual steps can be also helpful. We can increase the complexity of the tasks, while the size of particular steps depends on the pupil's level of knowledge. This method is a part of the Program teaching (Šumný, 1974), which uses the knowledge of behavioural psychology in the teaching process (Semple, 2000). To achieve the goal in the teaching process, we follow the basic principles:

- The principle of small steps
- The principle of active response
- The principle of individual pace
- The principle of evaluation and optimization of the program.

In this work, we compare the success of pupils' solutions of the two groups of the classroom pupils: group of the inclusive educated pupils with learning disabilities (integrated pupils) and a group of the intact pupils without learning disabilities.

2. Background and methods – 1st part

The first part of the study carried out with the pupils of the 9th grade of primary school focuses on classroom management, where we investigate why and how often the pupils disturb. Pupil's lack of concentration, often associated with disturbance during lesson, is the biggest problem in the teaching process.

In the survey form, pupils answered the following questions:

1. How often am I disturbing during the lesson?

I almost don't disturb

I disturb sometimes

I disturb slightly

I disturb often

2. I'm disturbing during the lesson

Because of easy subject matter

Because of difficult subject matter

Without a reason (spontaneously).

We were interested in the connection between the success of solving tasks and whether the pupils in the class disturb (or how often). We conducted several hours of mathematics (using methods of differentiated teaching (O'Brien, Guiney, 2001; Heacox, 2001)) to the repetition of the (physical) units conversion topic (the conversion of units of length, area and volume). We gradually increased the difficulty of the tasks so that the easier tasks were the partial tasks in the more difficult tasks. Pupils solved the more difficult task only after they solved two consecutive easier tasks successfully. After the repetitive lessons, the pupils took a paper- and-pencil test, which included application tasks from physics with gradually increasing difficulty.

3. Results. 1st part

Most pupils (35) said they were disturbing because the topic was easy for them. Least pupils (5) were disturbing because the topic was difficult for them, and 26 pupils said they were disturbing spontaneously.

Figure 1 maps the relationship between the pupils' answers. There are only two subgroups in the group of pupils who interrupt due to the difficult topic: pupils who almost don't disturb and who disturb slightly. So we can conclude, that those pupils who have a problem with attention, disturb quite often during the more difficult task.

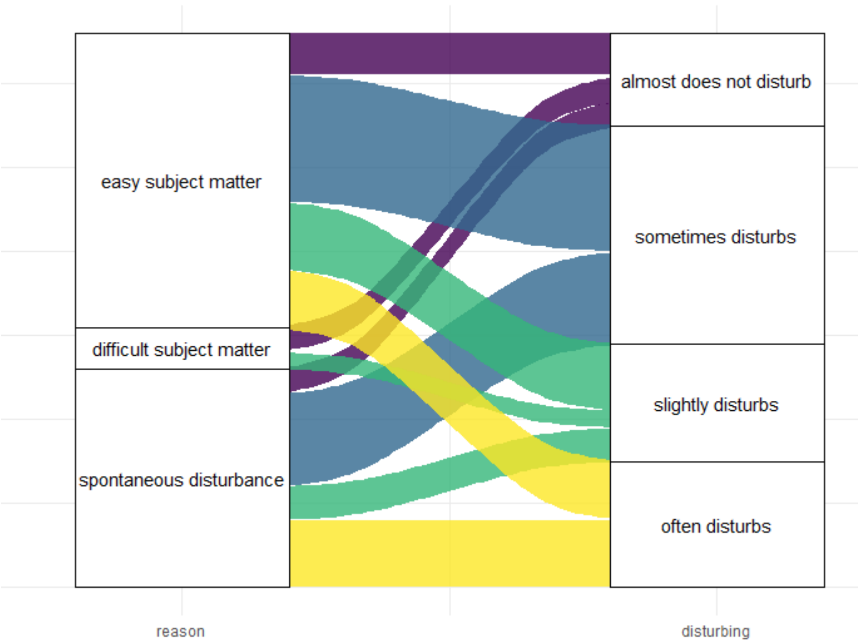

Fig. 1. Alluvial plot for individual categories of answers

Pupils who disturb sometimes, as well as pupils who disturb often, were divided into only two subgroups: pupils disturbing spontaneously or because of the easy subject matter. In this case, we can explain spontaneous disturbance as an occasional need for rest during mental tiredness. If the reason for the disturbance is an easy subject matter, then pupils disturb probably because they don't need to focus well on the problem, which they consider too simple.

Paper-and-pencil test

There were six application tasks from physics with increasing difficulty in the test.

Test tasks:

No. 1. $83hl =$ cm^3

No. 2. $28000a =$ km^2

No. 3. $1800\frac{cm}{min} =$ $\frac{m}{s}$

No. 4. $0{,}01\frac{hl}{s} =$ $\frac{cm^3}{h}$

No. 5. Determine what work a person will do when lifting an object weighing 1200 g to a height of 50 cm, if we know the acceleration due to gravity $10\frac{\mathrm{m}}{\mathrm{s}^2}$.

No. 6. Determine the heat needed to heat the water by 5°C in a pool with dimensions of 4 m, 3 m a 5 m, if the density of water is $1\frac{\mathrm{kg}}{\mathrm{l}}$, the heat capacity of water is $4{,}2\frac{\mathrm{KJ}}{°\mathrm{C}}$.

The first two tasks contained basic conversions of area and volume units. The next two tasks contained the conversions of composite units. The last two were word tasks, in which the pupils needed to convert the units into the basic form and then use the formula. So the solution of the last two tasks required more computational steps. Table 1 gives an overview of the number (and proportion) of pupils according to the individual tasks.

Table 1. Number (proportion) of pupils according to the solutions of individual tasks

	task 1	task 2	task 3	task 4	task 5	task 6
correctly solved	47 (71 %)	47 (71 %)	45 (68 %)	41 (62 %)	46 (70 %)	30 (45 %)
unsolved	19 (29 %)	19 (29 %)	21 (32 %)	25 (38 %)	20 (30 %)	36 (55 %)

Figure 2 shows the distribution of pupils according to the number of correctly solved tasks. More than 24 % of pupils solved four tasks correctly and also all six tasks, 4.5 % of pupils did not solve any task.

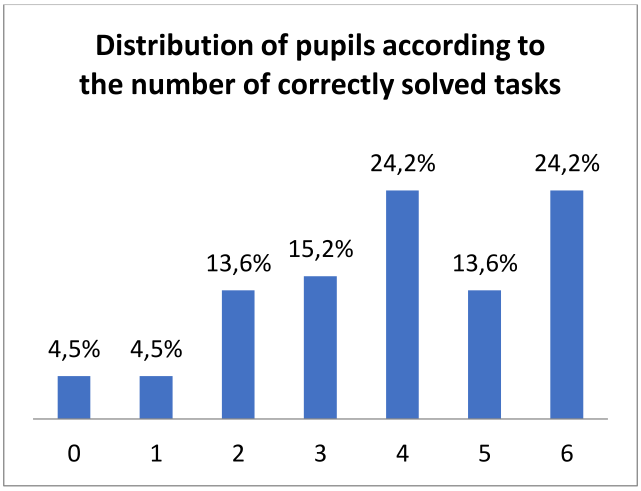

Fig. 2. The distribution of pupils according to the number of correctly solved tasks

The complexity of tasks can be also assessed from the point of view of algorithmic complexity (falls under the level of "fast thinking") and also from the point of view of analytical and logical thinking (thus related to "slow thinking") according to the book of Kahneman (Kahneman, 2011). He adopts terms originally proposed by the psychologists Keith Stanovich and Richard West, and refer to two systems in our mind, System 1 and System 2. „System 1 („thinking fast“) operates automatically and quickly, with little or no effort and no sense of voluntary control. System 2 („thinking slow“) allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice, and concentration.“ (Kahneman, 2011).

Based on Cochran's Q-test, we state that the difficulty of individual problems didn't equal ($Q(5) = 18.6$, p-value = 0.002). Task 6, which was correctly solved by the least pupils (45 %), differed significantly from all other tasks in its difficulty. Task 5 was mastered at a similar level as tasks 1, 2 and 3. This is due to the fact that it was focused on the conversion of units of length and weight, which were then subsequently used to calculate the positional energy by the known formula. Tasks from 1 to 5 had a straightforward solution and their complexity depended only on the used mathematical techniques and the number of steps. Tasks 3 and 4 included (in addition to the conversion of physical units) also the computing with fractions, which yielded their higher computational complexity. Task 6 was the most difficult due to the insertion of a weight calculation, for which the volume had to be determined first. Therefore it seemed like two different tasks combined into one.

Figure 3 maps the flows between the solutions of the tasks 1 to 6, representing the individual pupils. The columns visually represent the proportion of pupils who solved or didn't solve the task. We can see that approximately half of the pupils who solved task 5, failed to solve task 6. That agrees with the result of Cochran's Q-test, that task 6 was unlike the all others. On the contrary, only small proportion of pupils who solved a more complex task 6 were unable to solve task 5. That is what we expected: if they could solve a more complex task 6, they were more likely to cope with an easier task 5.

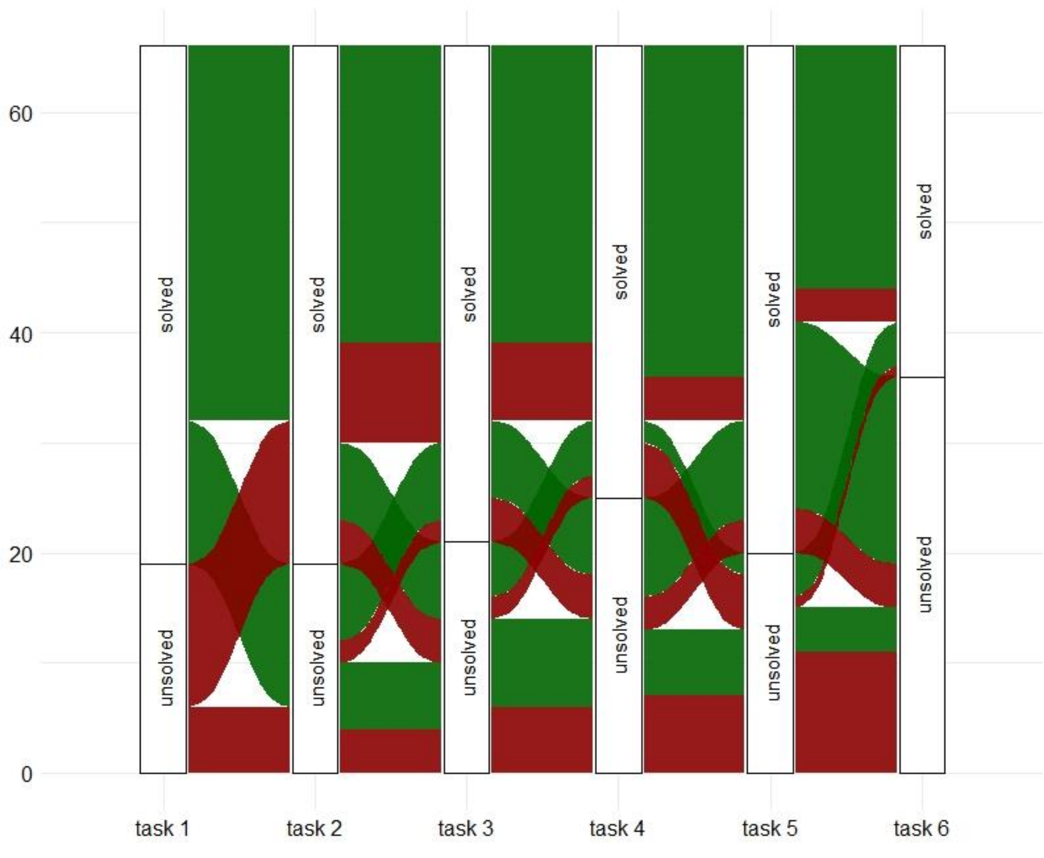

Fig. 3. Alluvila plot of the success of solving individual tasks

Analysis of the pupils' mistakes

We further analyzed the types of mistakes. In tasks 1 to 4, there were mistakes resulting only from the calculations by the conversion of units. Tasks 5 and 6 were more complex and the conversion of physical units was only a partial but essential step for the successful solution of the task. We have identified computational mistakes, mistakes resulting from the use of an incorrect unit conversion relationship, and mistakes caused by a misunderstanding of a physical problem.

We have marked the types of mistakes as follows:

Mistake A – wrong conversion of units (the pupil did not know multiples (kilo-, milli-, micro- and their arrangement),

Mistake B – calculation error by modifying a formula as an equation,

Mistake C – incorrect analysis of a physical problem (the pupil was not able to make a record of the word problem and could not proceed).

Table 2 summarizes the error rates of the two most challenging test tasks and Figure 4 shows the visualisation of the pupils' solutions of these two tasks.

Table 2. Frequencies of mistakes in pupils' solutions of tasks 5 and 6 (source: own calculation)

	correct solution	mistake A	mistake B	mistake C	not solved
task 5	46	3	5	2	10
task 6	30	11	17	8	0

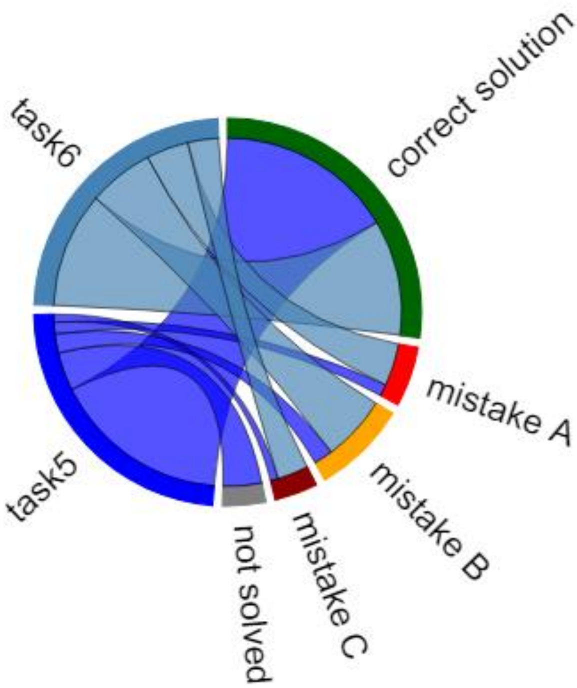

Fig. 4. Circleplot of the pupils' solutions of the task 5 and 6

From the survey form, we found that up to 53 % of pupils consider the subject matter simple, but only 24 % of pupils were able to solve all tasks unassisted. We know from experience that pupils disturb most often in the exposure phase. During the subject explanation they think that they understand the subject. Therefore, it is appropriate to insert knowledge verification methods into the exposure phase in order to immediately reveal ambiguities in the understanding and application of the teaching subject.

4. Background and methods. 2nd part

The second part of the study focused on the success of integrated pupils in solving mathematical problems in comparison to the success of pupils without learning disabilities. We analyzed paper-and-pencil tests from the physics of 9th grade elementary school pupils. The tasks examined the electrical resistance of the conductor, and their solution required to know the methods of solving linear equations. The necessary mathematical methods were taught in mathematics lessons, so it was not necessary to teach new methods in physics lessons, but only to practice and apply knowledge from mathematics. Since there were 53 intact and only 8 integrated pupils in the study sample, we used a nonparametric Wilcoxon 2-sample test for statistical evaluation (samples don't meet the normality condition for the parametric test).

5. Results. 2nd part

Intact pupils achieved an average test score of 16.3 (median 17.5) integrated pupils achieved an average test score of 14.4 (median 16.5). Resulting from the nonparametric Wilcoxon 2-sample test (p-value = 0.29), we don't reject the hypothesis that the mean score does not differ significantly between intact and integrated pupils.

Figure 5 graphically shows the distribution of pupils according to the success rate for both groups of integrated and intact pupils. This representation also supports our hypothesis that groups of pupils don't differ significantly in the achieved test results – pupils were relatively evenly divided into all groups according to the success rate.

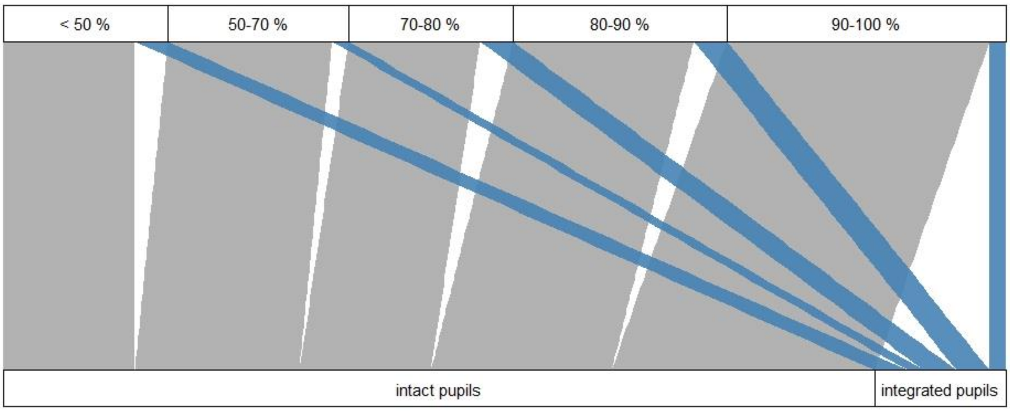

Fig. 5. Distribution of pupils according to the success rate in the paper-and-pencil test

6. Conclusion and further research

The article focused on two educational problems. The first was classroom management, where we analyzed the reasons why and how often pupils disturb by the lessons. We applied differentiated teaching (O'Brien, Guiney, 2001;Heacox, 2001) and then we examined the level of knowledge by the paper-and-pencil test with gradually increasing difficulty tasks. We found out, that most pupils disturb because of the easy subject matter or they disturb spontaneously. The paper-and-pencil test results showed, that pupils mastered easier tasks well, but many of them couldn't solve the most complex last task.

The second problem was the integration of the pupils with learning disabilities into the mainstream classes. We focused on comparing the success of pupils with learning disabilities and pupils without learning disabilities in the same class. The success of these two groups has been proven to be statistically not significantly different.

As an explanation, we can find the interpretation of mathematical models of learning in articles (Dedera et al., 2011) and (Dudáková et al., 2016). In the work (Dedera et al., 2011) the coefficients of learning and forgetting appear. It is these coefficients that, in the extreme case, manifest themselves as learning and attention disorders. The second learning model (Dudáková et al., 2016) is focused on the gradual creation of connections in a neural network. Creating a fixed connection means storing and processing information. These are the parameters associated with the creation and cancellation of connections, that can be related to the parameters mentioned in

(Dedera et al., 2011) and thus, in the extreme case, they manifest themselves as a learning disorder. In addition, the work (Kershner, 1990) pointed out the influence of self-concept in the case of integrated pupils, and this phenomenon can also influence the attitude of ordinary pupils to their mindset toward teaching.

Based on the above results and theoretical knowledge, we incline to the opinion arising from the work (Kershner, 1990) that self-perception has a greater effect on the success of pupils in solving tasks, than their learning disabilities. Therefore, in order to compensate for learning disabilities, it is appropriate that pupils with learning disabilities get sufficient enough time to solve tasks. But it is necessary to examine this phenomenon from different perspectives to create a suitable teaching plan for pupils with learning disabilities.

The problem of the study is that the reasons and frequency of interruptions is the subjective attitude of the pupils. It would be much more effective to pair the questionnaires with a video recording of the lesson, where the behavior of the individual could be observed and compared with the answer in the questionnaire. As a continuation of our study, it would be appropriate to compare the questionnaire answers with success in the test. A very interesting approach is also to describe the behaviour of pupils in the classroom from the perspective of Game Theory using the "Hawk-dove" model (Ďuriš, Šumný, 2018), which allows us to analyze conflicting situations and to find the best strategy to maximize the satisfaction of the personal needs of pupils and teachers.

The further research will focus on critical thinking and its formation, which is one of the most cognitively demanding activities and confirms the consequences of differentiated teaching. Solving tasks requires more cognitive activities such as searching for information, transforming the task into a standard task and finally algorithmic solution of the standard task. Critical thinking is based on obtaining and filtering information, subsequent processing and evaluation of the obtained information. A set of these activities forms the basis for critical thinking. While critical thinking itself in its individual phases uses the principles of other types of thinking such as abstract thinking, which sets a filter for essential and true information when filtering information, algorithmic thinking, which is mainly involved in information processing, and logical thinking in the evaluation phase. Critical thinking is necessary for various fields of study, e.g. for physics, as we can see in the publication (Velmovská et al., 2019) where the authors focus on primary and secondary school pupils. Similarly, the article (Velmovská, 2015) focuses on critical thinking in physics teaching, which deals with a specific strategy for the development of critical thinking and applies it to physical tasks. For mathematics, we find the article (Tomková, 2017), in which the author points out the knowledge and skills acquired when solving mathematical problems and their influence on critical thinking.

References

Butterworth et al., 2011 – *Butterworth, B., Varma, S., Laurillard, D.* (2011). Dyscalculia: from brain to education. *Science*. 332(6033): 1049-1053. DOI: 10.1126/science.1201536

Dedera et al., 2011 – *Dedera, P., Tomčíková, I., Miklecová, T.* (2011). Mathematical modelling of study. *Advances in Electrical and Electronic Engineering*. 9-13.

Dudáková et al., 2016 – *Dudáková, S. et al.* (2016). Microscopic Model of Knowledge Increase and Its Verification. *CBU International Conference Proceedings*. Central Bohemia University. 4: 888-895. DOI: 10.12955/cbup.v4.872

Ďuriš, Šumný, 2018 – *Ďuriš, V., Šumný, T.* (2018). Modelling Behaviour on a Game Theory Principle. *TEM Journal*. 7(4): 758-761. DOI: 10.18421/TEM74-09.

Evans, Lunt, 2002 – *Evans, J., Lunt, I.* (2002). Inclusive education: are there limits?. *European Journal of Special Needs Education*. *17*: 1-14, DOI: 10.1080/08856250110098980.

Florian, 2019 – *Florian, L.* (2019). On the necessary co-existence of special and inclusive education. *International Journal of Inclusive Education*. 23: 691-704. DOI: 10.1080/13603116.2019.1622801

Heacox, 2001 – *Heacox, D.* (2001). Differentiating Instruction in the Regular Classroom: How to Reach and Teach All Learners, Grades 3-12, Minneapolis: Free Spirit Publishing Inc. 192.

Jimenez-Fernandez, 2016 – *Jimenez-Fernandez, G.* (2016). How can I help my students with learning disabilities in Mathematics? *Journal of Research in Mathematics Education*. 5(1): 56-73. DOI: 10.17583/redimat.2016.1469

Kahneman, 2011 – *Kahneman, D.* (2011). Thinking, fast and slow. New York: Farrar, Strauss and Giroux. 499.

Karimi, 2013 – *Karimi, S.* (2013). Is the regender difference between learning disabled students' performances in mathematical activities?(Case study). *Mathematics Education Trends and Research*. 1-7. DOI: 10.5899/2013/metr-00030

Kershner, 1990 – *Kershner, J.R.* (1990). Self-concept and IQ as predictors of remedial success in children with learning disabilities. *Journal of Learning Disabilities*. 23(6): 368-374. DOI: 10.1177/002221949002300608

Mather, 2003 – *Mather, D.S.* (2003). Dyslexia and dysgraphia: More than written language difficulties in common. *Journal of Learning Disabilities*. 36(4): 307-317. DOI: 10.1177/002221940 30360040301

Moll, et al., 2015 – *Moll, K., Göbel, S. M., Snowling, M. J.* (2015). Basic number processing in children with specific learning disorders: Comorbidity of reading and mathematics disorders. *Child Neuropsychology*. 21(3): 399-417. DOI: 10.1080/09297049.2014.899570

O'Brien, Guiney, 2001 – *O'Brien, T., Guiney, D.* (2001). Differentiation in Teaching and Learning: principles and practice. New York: Bloomsbury Academic. 224.

Ratnaningsih et al., 2019 – *Ratnaningsih, N., Arhasy, E. A. R., Hidayat, E.* (2019). The Analysis of Dyscalculia Students Learning Difficulty in Inclusive Education of Primary School Level in Tasikmalaya. *JETL (Journal Of Education, Teaching and Learning)*. 4(1): 238-243.

Semple, 2000 – *Semple, A.* (2000). Learning the Neories and their influence on the development and use of educational technologies. *Australian Science Teachers Journal*. 46: 21-28.

Šumný, 1974 – *Šumný, J.* (1974). Differentiation in written work set in mathematics. Jednotná Škola.

Šumný, 1974 – *Šumný, J.* (1974). Training pupil to systematic and independent work in mathematics. Jednotná Škola.

Tomková, 2017 – *Tomková, V.* (2017). Význam kritického myslenia pre matematiku a technické vzdelávanie [Importance of Critical Thinking in Mathematics and Technical Education]. *Acta Mathematica Nitriensia*. 3: 8-14. [in Slovak]

Vagge et al., 2015 – *Vagge, A., Cavanna, M., Traverso C. E., Iester, M.* (2015). Evaluation of ocular movements in patients with dyslexia. *Annals of Dyslexia*. 65(1): 24-32. DOI: 10.1007/s11881-015-0098-7

Velmovská et al., 2019 – *Velmovská, K., Kiss, T., Trúsiková, A.* (2019). Critical thinking and physics education. *AIP Conference Proceedings*. 2152.

Velmovská, 2015 – *Velmovská, K.* (2015). Rozvíjanie kritického myslenia žiakov pomocou stratégie EUR a jej aplikácia na vyučovanie fyziky [Developing pupils' critical thinking using the EUR strategy and its application to teaching physics]. *Tvorivý učiteľ fyziky VII*. Pp. 253-262. [in Slovak]

Zoccolotti, Friedmann, 2010 – *Zoccolotti, P., Friedmann, N.* (2010). From dyslexia to dyslexias, from dysgraphia to dysgraphias, from a cause to causes: at look at the current research on developmental dyslexia and dysgraphia. *Cortex*. 46(10): 1211-1215. DOI: 10.1016/j.cortex. 2010.09.003