ASSESMENT OF EYE MOVEMENT TRACKING ON SELECTED EXERCISES

<u>Ágnes Maródi</u>*, Iván Devosa**, Zsuzsa Buzás***, János Steklács****, Damien Sagrillo*****

*PhD student, Institute of Education, University of Szeged, H-6720 Szeged, Dugonics sq. 13., External lecturer, Kecskemét College, Kaszap str. 6-14, H-6000 Kecskemét , agimarodi@gmail.com **Lead researcher, Health Science and Health Promotion Research Group, College of Kecskemét, Kaszap str. 6-14. H-6000 Kecskemét devosa.ivan@tfk.kefo.hu ***Assistant lecturer, College of Kecskemét, Kaszap str. 6-14, H-6000 Kecskemét buzas.zsuzsa@tfk.kefo.hu ****Dean, Institute, College of Kecskemét, Kaszap str. 6-14, H-6000 Kecskemét steklacs.janos@tfk.kefo.hu *****Associate professor, University of Luxembourg, Maison des Sciences Humaines 11, Porte des Sciences L-4366 Esch-sur-Alzette, damien.sagrillo@uni.lu

ABSTRACT

In our studies the eye movements of 10-11-years-old students were analyzed, while they were solving tasks related to the planar orientation in front of the Tobii T120. The students had to follow the instructions on the image according to the text of task guidelines. We found on the basis of various statistical and thermographic studies, that many of the tested students are not fully aware of the basic directions and more of them blended eastern and western directions. The tasks performed with instructions were more accurately solvable for students. Based on the studies exercises should be developed for students that are interesting, understandable and ameliorate the two-dimensional and three-dimensional orientations.

EYE MOVEMENT TRACKING AT SCHOOL

Instrumental monitoring of eye movement has significantly improved over the last decades, naturalized in several areas of international researches, and appears more and more in Hungary too. This technology allows us to get acquainted with the process of evolution of cognitive abilities, the growth of learning abilities common and individual characteristics among elementary school students. Visual information gaining and processing is the key in most subjects – especially in science – so results of eye movement monitoring can influence and make more effective the methodology of various subjects, can provide guidelines for answering the questions of teaching methodology (Steklács, 2014). Furthermore it may help to improve application of course book researches.

The eye movement tracking research enables us to recognize the subjective importance of a particular area - i.e. part of a course book - by the number of fixations (duration of accepting and processing visual input stimuli) belong to it. The length of the fixation belonging to the investigated area shows the complexity of information content of that area. Our sight settles on the most informative places for us, so the time spent on the so-called AOI (Area Of Interest) becomes measurable, how much interest the investigated areas can generate, and the related importance and information value (Hámornik, Józsa, Hlédik and Lógó, 2013). If the monitored area has exact determined goals then this technique is the best way to investigate if the current details (like pictures) attract the desired amount of attention (Maródi, Devosa, Steklács, Fáyné Dombi, Buzas and Vanya, 2015). With this methodology we can demonstrate which area draws significant attention first or that how much and how long do people pay attention to particular areas. We can make some statistical analysis using the gained data which can lead to correlations. These statistics can determine an order among the areas of interest by showing which area was noticed first, second, etc. but also can show how long the subjects viewed them during the research. So the eye movement tracking as visual methodology allows gathering and analysis of data because it monitors the movement of the eye revealing that which parts of the given – course book - page attracts the attention of the students and how much (Duchowski, 2007).

During our previous eye-movement researches we tried to find the answer how the students have a look at pictures belonging to text (Maródi, Devosa, Buzás, Steklács and Sagrillo, 2015; Maródi, Devosa, Steklács and Buzás., 2015; Maródi and Devosa, 2015; Maródi, Steklács and Devosa, 2015) and we came to the conclusion the Hungarian students focus primarily on text and only small percentage of them take a look at the corresponding pictures. The teachers should try harder to draw the students' attention which pictures should be looked at to make learning more effective (Maródi, 2014).

In our eye tracking research the Hungarian students were asked to solve several orientation exercises on computer, which were selected from various Hungarian science course books. We typed the text and enlarged it making it easier to read for the students on the computer, and placed the pictures according to their position in the course books. Numbers were not present in the original exercises, only here for easier understanding. The subject 4th class students had to advance according to the instructions described in the exercises and provide the correct answer. They were asked to think loudly allowing us to be able to keep track of their progress, and we made notes about their solutions. Ten elementary school students participated in our pilot research. It is questionable how exact are the course book's exercises to them, how they feel about the difficulty and complexity, how much time they spend on solving them, can they understand the two dimensional space (Devosa, Maródi and Grósz, 2015). We used Tobii T120 type eye tracker monitor and the data gathering was made by using the Tobii Studio software.

EXERCISES OF OUR STUDY

For this to be better understandable we translated a few exercises to English (figure 1, figure 2, figure 3).

Laci invited his friend Zoli. As Zoli didn't know where Laci lives, he was given a top view drawing with the following instructions:
Start from the school and head to the following directions (N-North, S-South, E-East, NE-North-East):
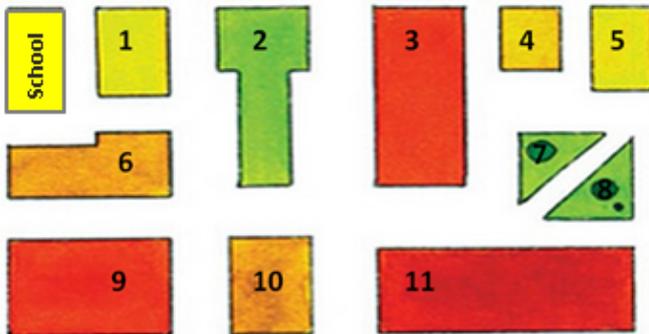E → S → S → NE → N
In which house Laci resides?

Figure 1: Exercise 1

Follow the path of the frog according to the given directions!
To which leaf will the frog arrive in the end? The path of the frog:
E→ S → SW → S → SE →N →NE → SE → S → E → N → NW → N → W → SW →SE
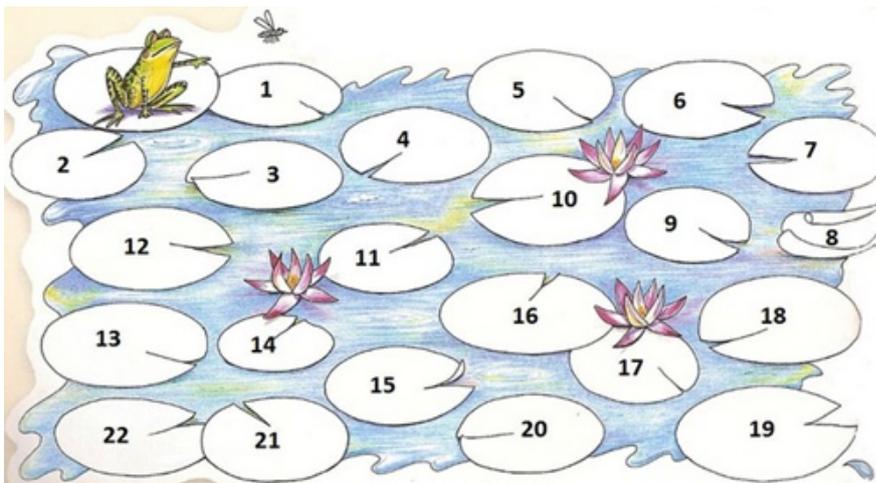
Figure 2: Exercise 2

Follow the given directions. Where will you get to?
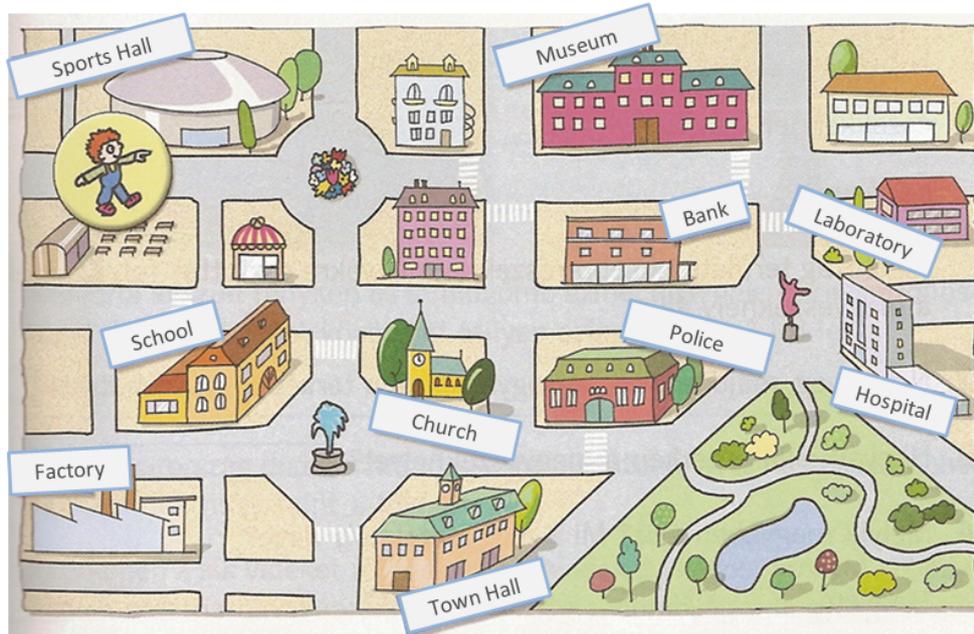
Figure 3: Exercise 3

1. Head to the east until the roundabout!
2. Turn to the south. Walk till the next square!
3. Go to the east till the next intersection!
4. Turn to the north! At the next opportunity head to the east!
5. After reaching the square go to the north till the next intersection!
6. Turn to the east!

RESULT OF THE EYE MOVEMENT TRACKING STUDY

The Tobii Studio software allows you to process huge amount of data i.e. heat map researches, gaze plot analysis, duration of the first fixation, number of fixations, duration of visits, number of visits, etc. These datasets can be examined for each area of interest (i.e. picture, text or part of the text). The heat map is a very efficient was to demonstrate the fixation points of the subjects, which are marked by cool and warm spots. Fixation count and duration also can be calculated using the heat map.
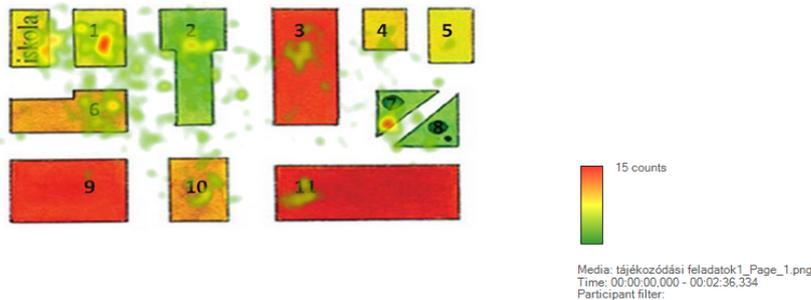
Figure 4: Heat map

The areas on which the subjects spent more time than average were marked by red - the redder the area the more attention were measured on it.
As the students were asked to think loudly, the figure shows they had a look at the number of the building they progressed by (figure 4).

When a picture contains similar colors to the heat map we can use the inverse of the heat map analysis: the gaze opacity analysis (figure 5).
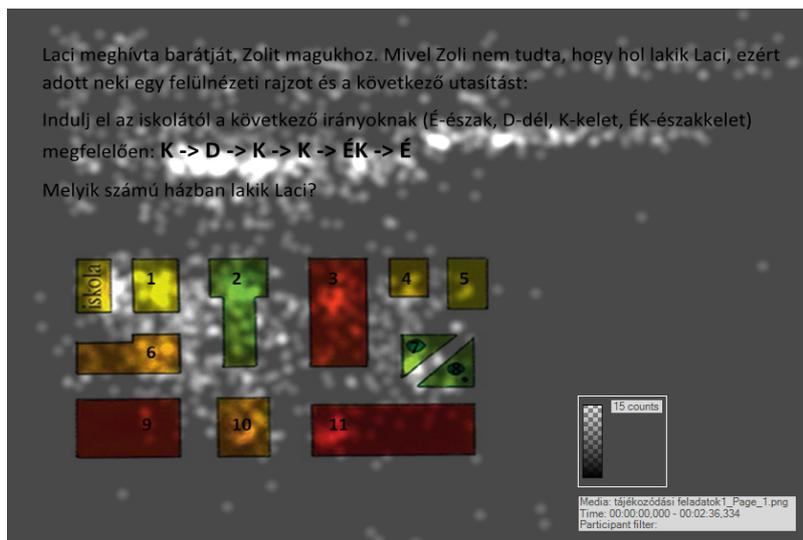

Figure 5: Gaze opacity

In this case the white spots mark the area which drawn attention. The brighter the area the more focus it got from the students.

The gaze plot (also known as scanpath) analysis allows us to get acquainted with the path of sight movement and the method of searching. The sight tracking technique reveals where the subjects look for the information they need by instinct. All subjects were denoted by different colors in the analysis and all of their fixations denoted by a dot, where the length of the radius reflects the duration of the fixation. The largest circles denote approximately half-a-second fixations. According to this it's easy to decide whether the subject looked at a certain area. The following gaze plot analysis summarizes the eye movement of all students (figure 6).
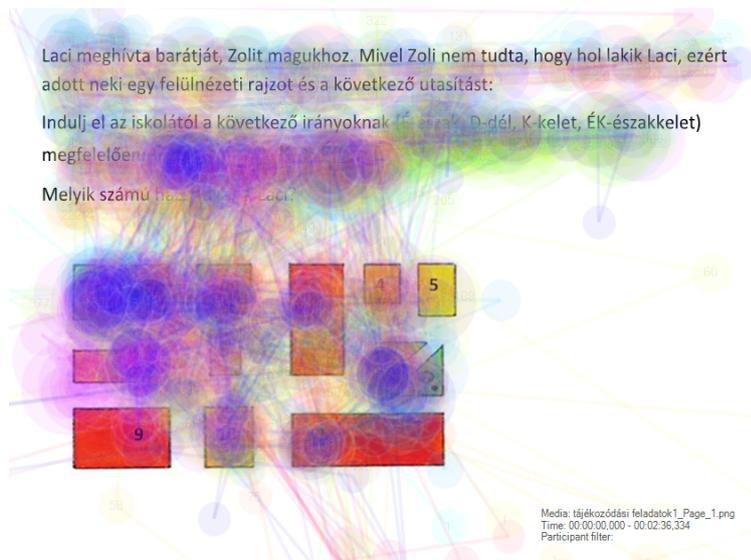

Figure 6: Gaze plot analysis

The gaze plot analysis shows to what the students paid attention at the first, or the first few seconds, where did their sight jump to among the parts of the course book and in what order.
The students could hardly follow the long instructions, more of them have been stalled even at the beginning of the task, as seen on the image (in the first and third red areas of the leaf on figure 7).
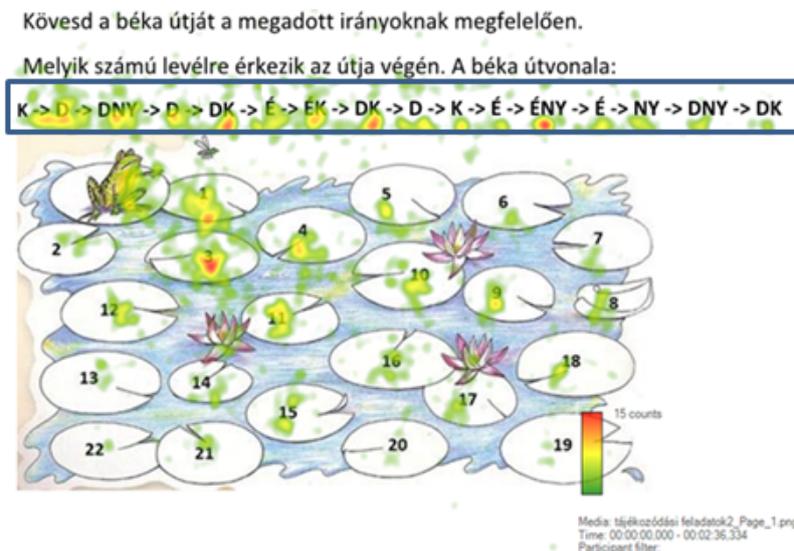

Figure 7: Heat map

The realistic examples – in which the students receive guidelines to the task – the students could perform much better (figure 8). Although these helping guidelines (i.e. roundabouts) meant difficulties to whom can't read perfectly yet.

Figure 8: Heat map

The second analysis may demonstrate more that the part of the students got lost at the beginning so they didn't even reach the roundabout (figure 9).
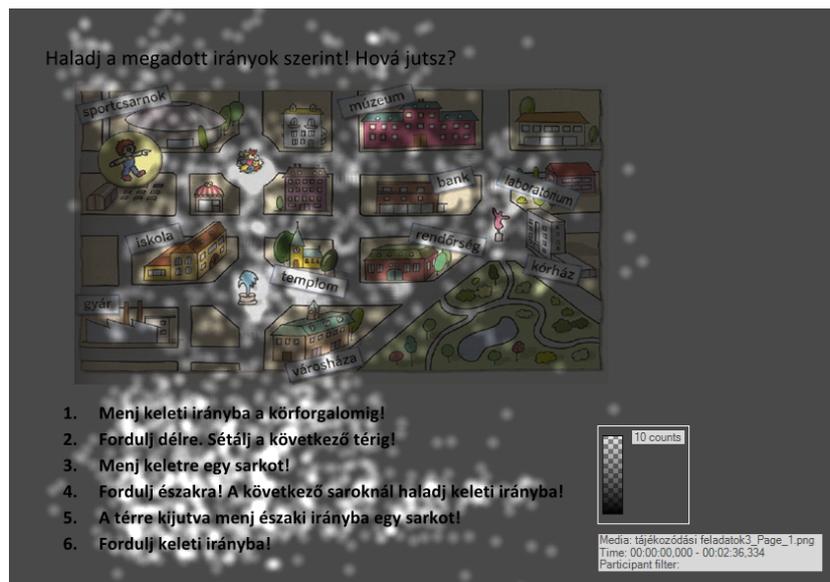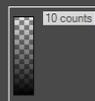
Figure 9: Gaze opacity

Exercise 3 proved the easiest among the students this was solved correctly by 50% of them (figure 10).
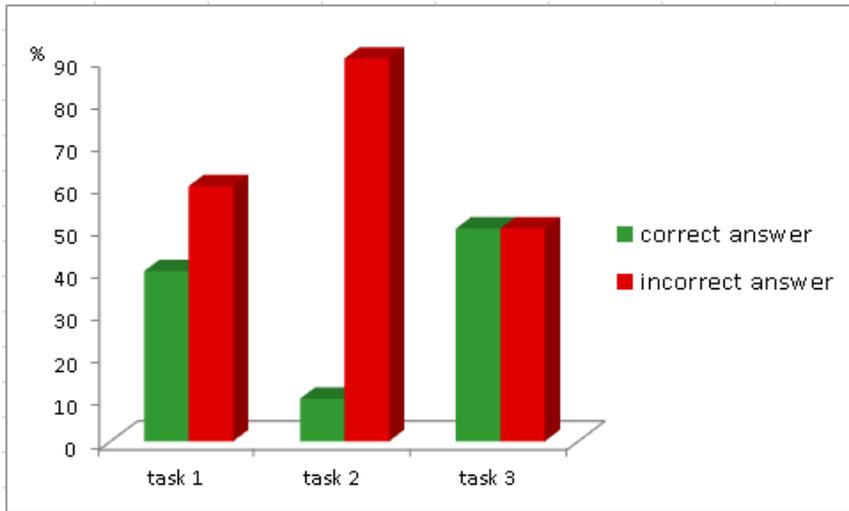
Figure 10: The rate of solving tasks

This was followed by Exercise 1 for which 40 percent of them provided correct answer. Exercise 2 turned out to be the most difficult as only 10 percent of them could solve it. The students can follow detailed instructions more easily than they can when they need to follow directions one after another. I wonder how they would perform with a compass.
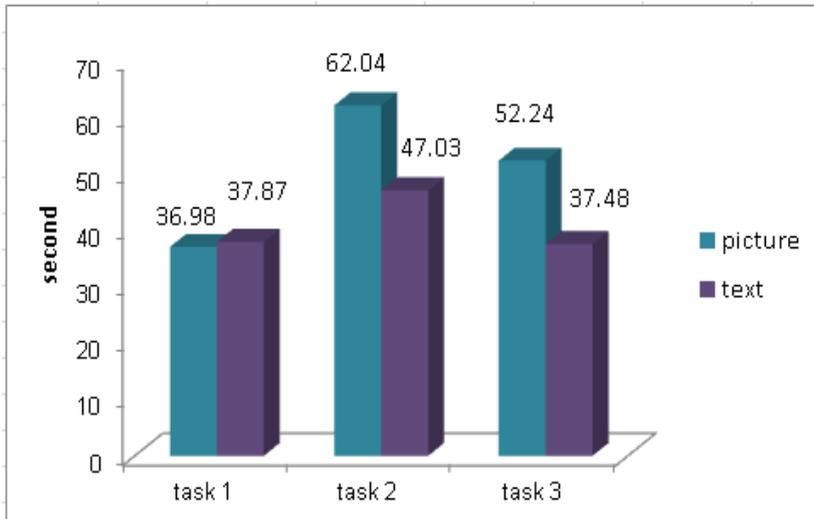

Figure 11: Total Fixation Duration (mean)

The duration of fixation was similar for picture and text at Exercise 1 whilst in case of the rest the fixation's duration was longer on the picture (figure 11).
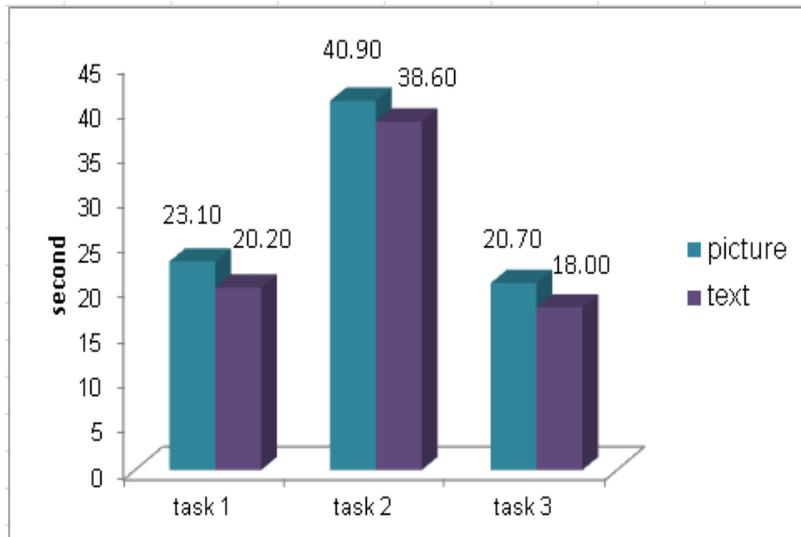
Figure 12: Visit Count (mean)

The number of jumps between the text and the picture was the highest at Exercise 3 because they were able to follow instructions from text from and they could memorize where they're at (figure 12).
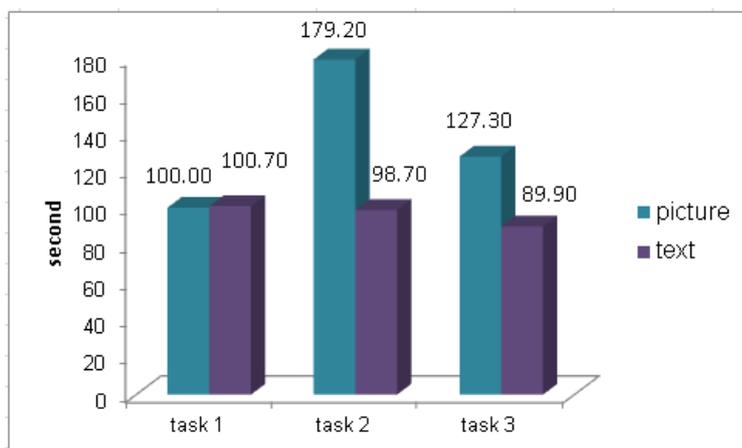

Figure 13: Fixation Count (mean*)*

According to number of fixations the students focused on the picture of Exercise 2 the most often because it was hard to follow that long sequence of instructions (figure 13).

CONCLUSION

Students participated in our research had difficulties to solve these simple exercises even if they are already 4th grade students. It can be stated following instructions took much time. They often missed east and west directions while they are familiar with south and north. One reason can be that children are often lack confidence in setting left and right side. The students enjoyed the monitoring of their eye movement and according to them they found the exercises mediocre difficult. We continuously encouraged them while they solved the tests and gave full marks for performing well.

The students use several brain functions during reading and writing, such as orientation in plain and in space. These abilities are very important in gaining new knowledge. Lack of space orientation can often cause difficulties in reading. Developing plain orientation is important because it helps the student not to miss the direction and positions of letters (i.e. p-d-b). If a child cannot orient well in plain and space can have difficulties in Mathematics too. As long a student has problems with any of these part-abilities their reading, writing, calculation can't evolve. Spotting these problems is very important as soon as possible because the student has difficulties in orienting in space. Games connecting to directions can prove powerful tool for improvement in form of exercise, board game or even online games too.

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