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Introduction of Decimal Fractions to Special Need Children

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Abstract

There is an active collaboration between ELTE Bárczi Gusztáv Practice Elementary School and Methodological Centre for Special Education and ELTE Faculty of Informatics Department of Media & Educational Technology since 2003 to develop ICT tools supporting their pedagogical program and hold experiments to evaluate their effective use.

Children with learning difficulties need much more time and practice to learn new bits of knowledge. We created exercises of common fractions in the Visual Fractions program, developed by the Universite Comenius, Slovakia, for the fifth and sixth grades to help them practise common fractions. After using it for two years in classes, in May 2006 we tested all senior grades (from fifth to eighth), and we repeated it one year later (Réthey-Prikkel, Turcsányi-Szabó, 2007a). Based on that experiment we developed the exercises of decimal fractions to the eighth grades with Fractions program in 2008. This time we did not selected parts to practise, but the whole curriculum was covered. We measured the children's knowledge from the fractions at the beginning and at the end of the learning process. From the answers of the children, we could see that: they decide bigger and smaller relations visually from the pictures, and they have difficulties in identification of the fractions' values, they are more self-confident in counting with the decimal than the common fractions.

From these come a big question that why they get acquainted with the common fractions previously, because they need to use those more often in their life.

Keywords: special needs, fractions, ICT

1. Our collaboration

ELTE Bárczi Gusztáv Practice Elementary School and Methodological Centre for Special Education engages children with learning difficulties, where they can learn

to read and write with dyslexia prevention methods. They also try to assure continuous development of skills and abilities within all classes, for instance mathematic classes. Children can choose different afternoon activities like drama, ICT, journalism, household management, needlework, swimming, table-tennis, singing, playing the piano and the flute.

ELTE Faculty of Informatics Department of Media & Educational Technology provides courses within ELTE teacher training as non-compulsory electives, with relation to developing e-learning materials and running projects in public education, where students develop programs for different curriculum areas, take them out to use in schools and prepare a report about their effects in classes, suggesting some areas of possible improvements for better use.

In ELTE there are a lot of projects on designing tools for children in different ages, from 3 to 18. There are contests and competitions free ideas, ICT tools for teachers, parents and children to play and learn with.

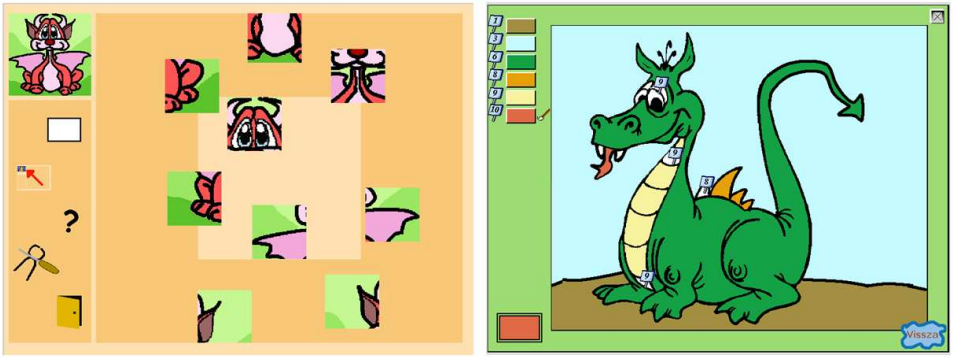


Figure 1: Screen shots of two programs: Puzzle and Colouring

In ELTE teachers training the students learn by evaluating and programming ICT games for learning to concentrate on the most important features that make an ICT based game for a useful learning tool. The main features to focus on for developing more than games (Turcsányi-Szabó, 2006):

- **Motivation**: programs are highly motivating and amusing for children.
- **Focus**: all programs focus on a specific theme handled with flexible perspective.
- **Personalization**: programs can be set for the different needs of children concerning level of difficulty, complexity, visual needs, background knowledge and interest.
- **Learning curve and feedback**: activities can be flexibly set in terms of time frame, repetition, feedback, scaffolding, and applicable rewards in order to support the learning curve.
- **Traceability**: activities of children are recorded and can be traced later by checking the log files and saved screen-shots to evaluate the development of the child and the user interface.

- **Transparent and open**: all programs are developed with the Imagine authoring tool and have similar internal structure that helps further re-developments if needed or media re-configurations by teachers themselves if requested.
- **The curriculum for special needs schools**

2. The curriculum for special needs schools

The Hungarian curriculum for special needs children suggests that children with learning difficulties need two years in order to master the materials defined in first grade, and for the first two grades material three years are suggested, while the schools are free to decide about the terms of progress. Most children in schools for special need lack in different ground skills and abilities. In the mathematical learning and teaching process one of the most important factor is dyscalculia, what can occur within any level of intelligence and is a type of disturbance that is typically noticed in school, but is less researched than dyslexia (Mesterházi, 1996). Children with learning difficulties need much more time and practice to learn new bits of knowledge. They need more experience, representations, experiment, explanation, example to extend their knowledge.

Because of the special needs of the pupils, the school's curriculum is different from that of the usual. Here pupils need much more learning time than most children and they are definitely granted extra time. Teachers in schools pay attention to the development of each pupil, but the local curriculum does not suggest any further requirements.

For the above reasons, we can only calculate with as much as the maximum of expectations, but always have to have in mind, that class (*blue*) are usually far behind the expected curriculum, which can also be the case with normal children (*purple*). Nevertheless, classes often lag behind the suggested timing and would be able to fulfil tasks suggested within 6 years of schooling only within the time frame of 8 years. It cannot be predicted how far children can get in development of their skills, abilities and knowledge.

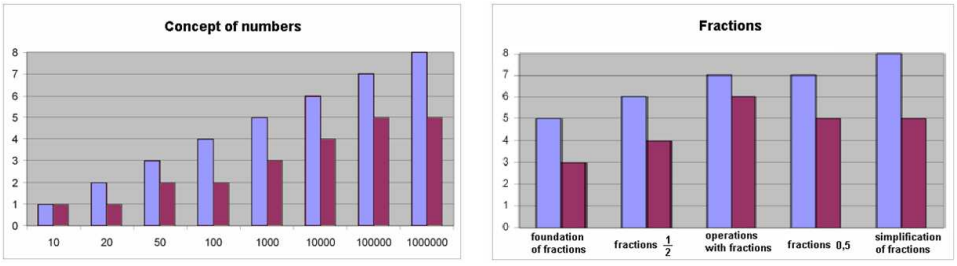


Figure 2: Difference in levels of achievement (in terms of grade) in normal and special schools within different subject areas, based on data available (NAT 2003)

Most children with special educational needs also have dyslexia and/or dyscalculia.

Dyscalculia means the partial lack or error in the counting ability, which is not to be mistaken by acalculia. It can occur within any level of intelligence and is a type of disturbance that is typically noticed in school, but is less researched than dyslexia. Syndromes (Dékány, 2003): perception, recognising numbers, understanding the concept of numbers, leaving out some numbers when calculating, going over 10, understanding and performing functions with fractions, considering signs when subtracting, poor mathematical logic, use of symbols, serialising numbers, grouping, understanding ratios, time, volume, dimension, ... etc.

Due to cultural reasons the society is much more forgiving if a child has problems in maths then if (s)he cannot read properly, or writes with bad spelling.

3. Learning ability tests

It was hard to find a test to measure these children. Standardized tests do not exist in placecountry-regionHungary to measure dyscalculia or dyslexia, and there are also no tests devised to measure progress of special needs children. So, we had to search for alternative measurement systems that might suit these special circumstances.

First we asked in ELTE Bárczi Gusztáv Practice Elementary School and Methodological Centre for Special Education *Judit Dékány* to use her test: in September 2004 and in February 2005. This test is concentrating on the attitudes, skills and abilities of the child (Dékány, 2003):

- Attention
- Graphomotorium
- Visual perception
- Acoustic perception
- Serialisation
- Thinking functions
- Thinking in terms of time
- Speech and language skills
- Addition, subtraction, multiplication and inclusion
- Learning ability
- Motivation

From the 6 children in the experiment 5 were dyscalculic, and one was found to be endangered. After half a year of using the described programs in classes 33 scores within the test have changed, 20 did not and 16 of the changed scores were in the categories that could have been affected by computer programs.

The *Hiskey-Nebraska Test of Learning Aptitude* (H-NLAT: Hiskey, 1966) is an individually administered, nonverbal test of learning ability suitable for children between ages 3 and 17 and is activity oriented. Most children with special needs have big differences between their real age and their mental age. In the H-NLAT there are seven exercises to solve:

- Recollection of colours

- Recognition of pictures
- Association of pictures
- Paper folding
- Extent of visual attention
- Building out of cubes
- Completion of drawing

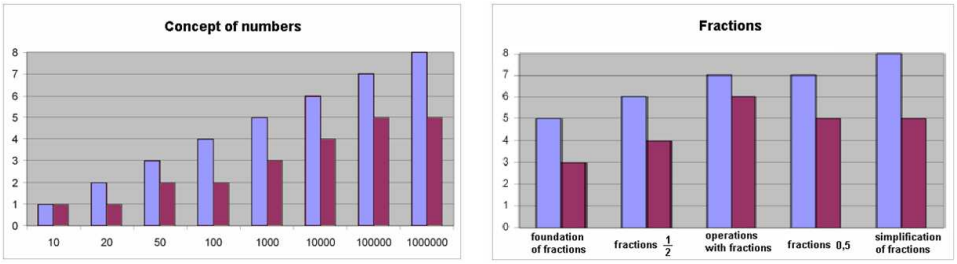
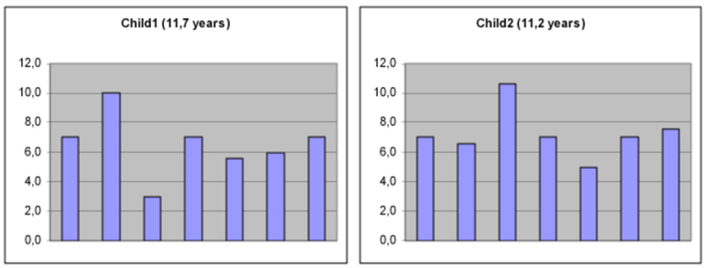


Figure 3: H-NLAT test results of administered group of children

At first we administered the H-NLAT test in 2004 September for the fifth grade (9 children) and later the same children in May 2007. Comparing the two results shows that in the 2,7 years of time an average changing of 0,6 in median mental age and average changing of 1,1 year in sub-test age could be detected. We found a big difference between each individual child, as well as their mental age in different attitudes, skills and abilities, differential teaching is needed (Réthey-Prikkel, Turcsányi-Szabó, 2007b).

This result shows, that the curriculum is not suitable neither for the pupils real age nor their mental age, it is somewhere between the two, and the teacher also needs to take into account the skills and abilities of each individual child to be able to find suitable methods for personalised development of the learning process. They need much more experience, representations, experiment, explanation, example to extend their knowledge. placeOpportunity to develop they individually require, developing new mental models and the ability to be able to extend their own knowledge.



Titles of skills tested are (from left to right): recollection of colours, recognition of pictures, association of pictures, paper folding, extent of visual attention, building out of cubes, completion of drawing.

Figure 4: Individual differences in attitudes

4. Visual fractions program

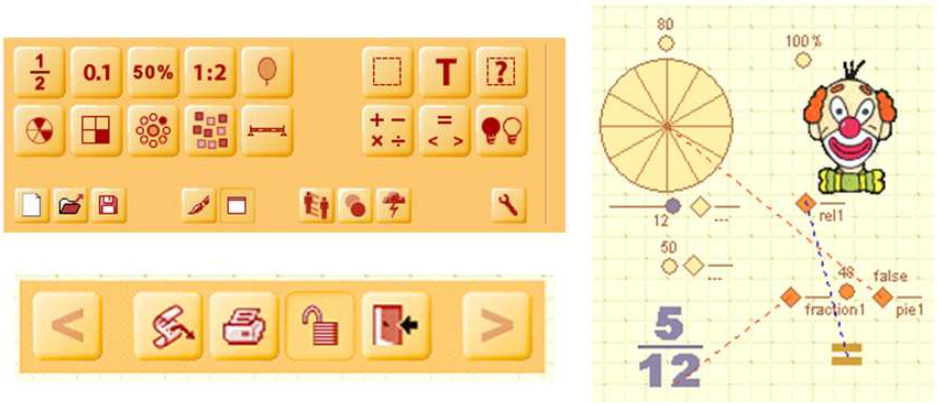


Figure 5: Left: editor of the Visual Fractions. Right: microworld under editing.

The Visual Fractions microworld is a program developed in the Colabs 101301-CP-1-2002-1-HU-MINERVA-M project by the Universite Comenius, Slovakia with our help. In this program exercises (activities) can be designed and integrated as interactive workbooks (scripts). Visual Fractions is ideal for use by the teacher or pupil on a classroom whiteboard, comes with a rich palette of visual maths objects that can be dynamically connected together and their properties varied with just a point and a click. Using a selection of simple tools, mathematical objects can be connected to show a wide variety of dynamic teaching points that just aren't possible in any other way. Visual Fractions comes with a large number of pre-prepared activities that can enhance and extend teaching of fractions. Connecting objects and creating visual relationships on the screen gives a new opportunity for teachers and pupils to understand those hard-to-grasp fraction concepts. Children will quickly see the behaviour of fractions, decimal fractions, percentages, ratio, picture fractions, group fractions and more, where they may have struggled to understand with traditional methods.

ELTE Bárczi Gusztáv Practice Elementary School and Methodological Centre the fifth grade children are getting acquainted with fractions. For the fifth and sixth grades 22 scripts have been created in our experiment. In the Semester 2004-2005 the fifth grade started to learn fractions Visual Fractions program once a week for more practicing and experimenting. After using the Fractions program for two years in classes, in May 2006 we tested all senior grades, 48 children with a written test for understanding and using fractions and we repeated it one year later in May 2007 with 43 children (Réthey-Prikkel, Turcsányi-Szabó, 2007a). The children had to solve 15 exercises on fractions. There were exercises like reading values, inserting relational symbols, counting with fractions, finding the biggest value.

In 2006 at the time of the testing, fifth and sixth graders learned fractions

with the Fractions program, while seventh and eighth graders without it. There were three exercises where the classes, who used Visual Fractions, had a better result than the other classes (Table 1). These were questions concentrating on understanding the values of fractions. Fractions program was helping children to develop better models of fraction values for themselves.

	used Visual Fractions	NOT used Visual Fractions
Giving values	96 %	95 %
Reading values from pictures	77 %	73 %
Reading missing values	50 %	45 %

Table 1: Solving rates on some critical exercises in Fraction test (2006)

We used the same test one year later, in 2007, when few classes have started to use Visual Fractions program, some stopped using it. All classes that used Fractions had a better result in fractions test than expected from the mathematical test at the end of the school year.

The test attracted our attention on common types of errors on which the teachers did not pay attention before. The most important is the ordering problem: reversing the ordering (biggest and the smallest number) and mixing nominator and denominator (instead of 2/3 reading out 3/2). In 2007 from the 501 given answers 214 was false, and from this 66 were of this type.

5. Decimal fractions with Visual Fractions

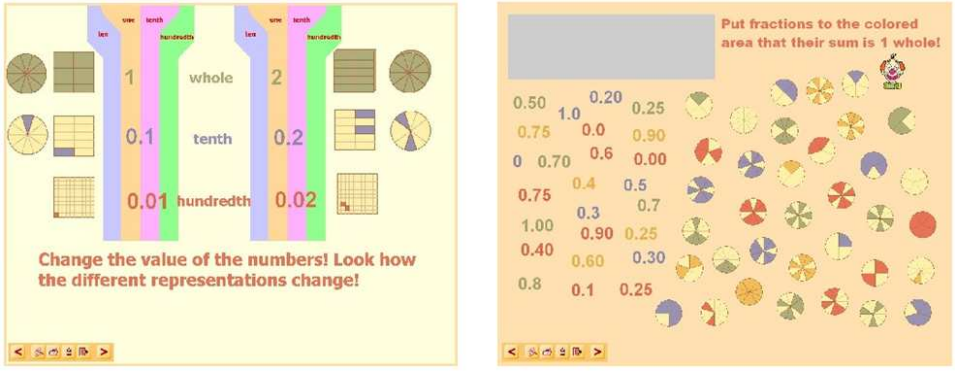


Figure 6: Screen shots of two microworlds from Visual Fractions. Left: experimenting on decimal fraction values Right: quiz exercise on adding to one whole.

Based on that experiment we developed the exercises of decimal fractions to the eighth grades with Visual Fractions program in 2008. This time we did not selected parts to practise, but the whole curriculum was covered. We prepared 23 scripts,

in them 125 activities with explanations, experiments, test exercises, competitions and games. The children worked on them for six weeks, once a week they always got acquainted with new materials, and also once they had time to practice. We asked the teacher to let us teach the decimal fractions with the program, and not only as a helping tool but for the whole learning process.

At the beginning of the learning process and at the end, we tested the children's knowledge on fractions. In the first test we used common fractions, and in the second one we used both common and decimal. The children had to solve 14 exercises on fractions:

1. Inserting relational symbols
2. Reading values
3. Giving values
4. Inserting relational symbols and Giving values
5. Reading the smallest value
6. Reading the biggest value
7. Sorting the values to growing order
8. Text assignment on pairing
9. Reading missing values
10. Addition of 2 values
11. Subtraction of 2 values
12. Operations (addition, subtraction)
13. Operations (multiplication, division)
14. Counting circumference and area

We compared the answers of the children, at the beginning and at the end of the learning process. In the pre-test there were exercises on common fractions, and in the final test there were exercises on common and decimal fractions as well. There were exercises in which they had to choose which representation they use. Table 2 shows the solving rates of the children in different types of exercises with different fraction representations.

The results shows, what the previous measurements confirm (Réthey-Prikkel, Turcsányi-Szabó, 2007a), that their numeral-concepts are injured and they decide bigger and smaller relations visually from the pictures if they can. In ordering values it was easier for them to work with decimals than common fractions: as a typical example $3<4$ and $0{,}3<0{,}4$ but $1/3>1/4$. In the final test we found that they had better average and smaller variance in the operating with decimal fractions than operating with common fractions, because of the analogy of the whole numbers.

In case of choosing representation they choose: common fractions in 78,57% and decimal fractions in 26,19%. It is understandable because they learned the common fractions much longer, but it also shows that this causes a worse result in solving exercises. In the exercise counting circumference and area in the pre-test it had common fraction values, but in the final test it had decimal fraction values. They were more self-confident with the decimal (63,57%) than the common (7,14%) fractions (Table 3).

	Pre-test	**Final test**		
		all	**common**	**decimal**
Relations (with visual help)	85,71 %	67,86 %	-	-
Ordering Fractions (1/2, 1/5, 1/6, 1/10)	85,71 %	14,29 %	14,29 %	-
Ordering Fractions (1/2, 1/5, 1/10)	85,71 %	57,14 %	57,14 %	-
Colouring Fraction values (easy)*	100,00%	85,71%	85,71%	71,43 %
Colouring Fraction values (hard)*	7,14%	64,29%	57,14%	71,43 %
Operating with fractions(in complex exercise)	14,29 %	71,43 %	-	71,43 %

*In the easy exercises the area was divided into the same pieces as the denominator, in the hard ones not

Table 2: Solving rates on different exercises

	circumference	**area**	**circumference**	**area**
	Pre-test / common		Final test / decimal	
Good	14.29%	0.00%	42.86%	28.57%
Finished	42.86%	0.00%	85.71%	85.71%

Table 3: Solving rates on counting circumference and area with different fraction representations

6. Conclusion and future work

Children with learning difficulties need much more time and practice to learn new bits of knowledge. Learning complex things like fractions is hard for them, and analogies help them to solve exercises, where the numerical concept is injured. Decimal fractions are much closer to the whole numbers than common fractions. Deciding relations and operating is easier to these children with decimal fractions than the common ones. From these come a big question that why they get acquainted with the common fractions previously, because they need to use those more often in their life. The teachers in Bárczi School listened to our ideas and they are now teaching decimals in the fifth and sixth classes.

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