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The Effect of Adaptive Learning Environment in Teaching the Number Concept to Students with Intellectual Disabilities

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Abstract

The objective of the study is to research evidence of the effectiveness of adaptive computer software that enables students with intellectual disabilities to acquire mathematical skills. The hybrid method, in which quantitative and qualitative research patterns are used together, is our research model. For the quantitative pattern of the research, an authentic experimental model including a pre-test and a post-test, was used with the experimental and control group, but for the qualitative pattern, a descriptive model was used with the aim to describe participants' views of the process. The research was conducted on a group of thirty participants – students in the fourth, fifth, sixth, seventh and ninth grades. The materials used in the research had been developed by the researchers. Additionally, overall assessment forms, achievement tests and detailed assessment forms were used in the research. For the analysis of the data, two-way ANOVA for mixed measures and descriptive analysis were used. The analyses indicated that, while there was a significant difference between pre-test and post-test, a significant difference could not be found between the traditional learning environment and adaptive learning environment in terms of effectiveness of the education. Moreover, the participants' views of the application were examined.

Key words: *adaptive learning; intellectual disabilities; number concept; personalized teaching.*

Introduction

Individuals need certain skills and knowledge to be able to live independently in the society. The main aim of teaching-learning activities at school is to prepare

students for social life. Therefore, students are taught functional skills and knowledge so that they can use them in their daily lives and make their lives easier. This is not different for students with intellectual disabilities (Cavkaytar, 2001). Intellectual disability is defined by Schalock et al. (2007, p. 118) in the following manner:

> *"Intellectual disability is characterized by significant limitations both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills".*

Various research studies have been conducted in Turkey regarding people with disabilities but a countrywide extensive research, which was called *The Research on the Problems and Expectations of People with Disabilities*, was carried out in 2010 for the first time by the Turkish Statistical Institute (TSI). According to the research results, there are 280,014 people with disabilities registered in the National Disabled People Database, who live in households within the borders of the Turkish Republic, and who were reported to have 20% disability in their health report. In the study, people with disabilities who live in institutions such as old people's home, senior centers, hostels, prisons, barracks, hospitals, hotels and nursery schools were left out of the scope. *The Research of Problems and Expectations of the People with Disabilities* aimed to determine the problems and expectations in the daily lives of the people with disabilities who were registered in the National Disabled People Database. In Turkey, 29.2% of the people with disabilities who were registered within the National Disabled People Database were intellectually disabled. 61.1% of them were males and 38.9% of them were females (TSI, 2010).

The main aim of the education of the people with intellectual disability is to enable them to achieve independency in society by improving the functional areas of their lives. The main skills required for this aim are basic development skills, basic information about numbers necessary for everyday life and sub-skills such as reading and communication for everyday life (Cavkaytar, 2001).

Recently, with the popularity of technology, computers have been used both as an objective and as a tool for learning and teaching activities. Having been used in everyday life frequently, computers have also been introduced in education after being adapted to school systems. It is known that learning and teaching activities based on tools increase the level of student motivation, reinforce learning, and add variety and diversity to the learning and teaching process (Demirel, Seferoglu, & Yagcı, 2001). The level that educational technologies have reached makes it possible to build systems that have objectives and content that can change depending on the individual. Systems in which content can differ according to each individual and where objectives are determined depending on the users are called adaptive and adaptable systems (Park, 1996).

Adaptive and adaptable systems can differ depending on the users' behaviors. Therefore, adaptation made according to the preferences of the individual at the beginning of the application is an adaptable system but the adaptation in which

the reactions of the individual during the application are processed by a computer is called an adaptive system (Sezer, 2011). An adaptation process can be achieved in two ways: content adaptation and adaptive navigation. In the content adaptation systems, the content can differ depending on the characteristics of the individual. In the adaptive navigation systems, the links related to the content can differ depending on the characteristics of the individual (Brusilovsky, 1998).

Different strategies are used for content adaptation and adaptive navigation. Researchers can use additional explanations, pre-requirement explanations, comparative explanations, different explanation forms and ordering strategies for content adaptation, while for adaptive navigation global guidance, local guidance, global orientation and local orientation strategies can be used. These strategies were summarized by Somyurek (2008):

Content adaptation:

Additional explanations: Additional information can only be given to the student whose readiness level is suitable for that information or to those who want to get additional information.

Pre-requirement explanations: Giving the information that can be a pre-condition for the concept before it is explained.

Comparative explanations: Presenting similarities and differences between the concept that will be introduced and the concepts introduced before.

Different explanation forms: Preparing the same content in different forms and presenting it differently according to the characteristics of the individual.

Ordering: Explanation of the same content in different orders according to the characteristics of the individual.

Navigation adaptation:

Global guidance: helping the student find the shortest route to access the information he/she wants.

Local guidance: Giving the list of links in different orders depending on the individual's characteristics.

Global orientation: This strategy helps the student realize her/his absolute place in the course structure.

Local orientation: This helps the student realize his/her relative place in a local environment.

In the study conducted in 2008, Cakir examined whether personalization of verbal mathematical problems in teaching mathematics has any effect on student achievement. The study established that personalization increased the students' achievement significantly, however, there was no significant difference between the post-test points of generalized application and personalized application. In the study in which the effect of adaptable web environments on student academic achievement and navigation were examined, Somyurek (2008) did not find a

significant difference between the groups with the adaptation and the groups without the adaptation.

In a study (Ozak & Dikmen, 2010) which examined master theses written in Turkey on Functional Academic Skills of Students with Intellectual Disabilities, twenty-nine master theses were examined. Seventeen of the theses were about reading and writing skills while twelve of them were about mathematical skills. Nine out of twelve theses about mathematical skills were master theses and three of them were doctoral theses. The study observed that the computer was used as a tool in reading and writing skills but it was remarkable that in the activities that were carried out for mathematical skills, the computer was not used. This finding indicates that computer use in gaining mathematical skills must be reinforced and there is a need for a study that can be adapted according to the students using a software program.

Hutcherson, Langone, Ayres, and Cless (2004) conducted a study that aimed to teach students with intellectual disabilities item selection in grocery stores with computer assistance. They reported that the time to locate items in grocery stores decreased while the rate of picking the right item increased.

There are very few studies conducted on groups with intellectual disabilities in adaptive computer environments, and individual tutoring is very important for these individuals. Therefore, this study is one of the pioneer studies in the context of applying adaptive environments to these students. By means of adaptive learning systems that enable personalized tutoring, the opportunity of individually personalized tutoring was provided.

The aim of this study is to research the effectiveness of adaptive computer software in enabling students with intellectual disabilities to gain mathematical skills.

In accordance with this general aim, we searched for answers to the following questions:

1. Is there a significant difference between the scores of pre-test and post-test in the experimental group?
2. Is there a significant difference between the scores of the post-test of the experimental group and the control group?
3. What are the positive sides of adaptive learning according to practitioners?
4. What are the practitioners' suggestions about adaptive learning?

Method

Research Model

A hybrid method in which quantitative and qualitative methods were used together was preferred. For the quantitative pattern of the research, an authentic experimental model, which included pre-test, post-test, experimental and control group was used. For the qualitative pattern of the research, a descriptive model was used as it aimed to describe practitioners' views.

Study Group

The study was conducted on a group of thirty participants – students in the fourth, fifth, sixth, seventh and ninth grades who were selected out of 250 students of the Ankara Modern Education Practice Center in the 2012/13 school year. Students with slight and moderate intellectual disability were selected among trainable students, their IQ scores being between 50 and 60.

Of the thirty students selected, eight were girls and twenty-two were boys. A control and experimental group of 15 students was formed through random selection among these students. Three students of the experimental group were girls and twelve of them were boys. In the control group five students were girls and ten of them were boys.

Practitioners' views about the process were obtained with an interview form from three practitioners who conducted the application.

Material

In the study, the software program with adaptive navigation was applied to the control group. The program was developed by researchers using Microsoft Visual Studio 2012 (student license) and Visual Basic Programming Language. In the program, students are able to adapt their navigation by choosing what they want from the options such as cartoons, animals or ball (Figure 1).

Figure 1. Software Interface: Introduction

Students can start their training by choosing the category they prefer. The software contains a system of nine numbers and fifteen stages for each number. Considering the student's first choice, the number concept was attempted to be explained to the students through cartoons, animal pictures or pictures of balls (150*150px).

When the student chooses the correct option, (s)he continues to the next level and if (s)he chooses four options correctly one after the other, (s)he continues with the next number. However, the first three levels for each number are arranged as a trial level and even if the student has made the right choice, scores are not evaluated. As the stages proceed, pictures change to a different color and objects to a different object.

In case of a possible error, an administrator panel was included in the software for administrator's intervention. In the administrator's panel, information about the level at which the student is and how many times (s)he chooses the correct option one after another can be learned (Figure 2).

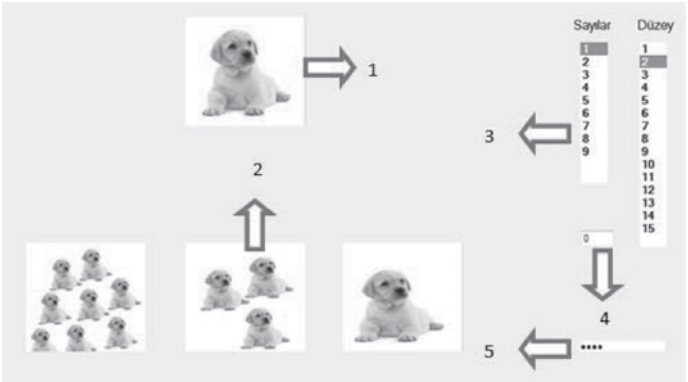

Figure 2. Software Interface: Training Screen

The explanation of the numbers in the figure is given below:

1 This is the reference picture.

2 Option part. The student chooses the picture that has the same object with the same number referring to the reference picture.

3 Administration part, number and stage unit in this part is only visible when the operator /practitioner writes the administrator code in part number five. In case of a possible error, the administrator can achieve number and level management.

4 Successive correct option. This part shows how many correct options students choose successively. When the number reaches four here, it continues with the first level of the next number. This part is also only visible to the administrator.

5 Code part. The operator makes the fourth and fifth units visible by entering the code.

As students progress, the difficulty level of the pictures increases. The screen showing number six and level ten that the student who takes the ball adaptation will see is illustrated in Figure 3. As Figure 3 shows, the student sees different kinds of balls in different colors. Besides, the number of balls used in the options is very close to each other.

Figure 3. Software Interface: Training Screen

When students have completed all the numbers and stages successfully, a new window opens. In this window, the picture of a popular cartoon character is given with the sound effect of applaud in the background. The purpose is to give the student reinforcement. (Figure 4).

Figure 4. Software Interface: Congratulation Screen

Data Collection Instruments

Overall evaluation forms that the class teachers completed at the beginning of the term were examined because their mathematical knowledge had to be at the same level. A pre-test was developed to determine the levels of prior knowledge about the number concept and a post-test was developed to determine the levels of knowledge after the experimental process. The information obtained through the application of these tests was explained in the detailed evaluation form prepared for the number concept.

Overall Evaluation Form

The Overall Evaluation Form is a surface evaluation to prepare a personalized training plan in accordance with the individual's basic needs in coordination with the family about the training module and related attainments/acquisitions chosen for the individual who was determined as someone who needs support education by the Board of the Evaluation of Special Education. While doing overall evaluation, attention must be focused on whether the individual gets the acquisition or knows the acquisition. The level of the acquisition is not significant.

Achievement Tests

A test was prepared by making use of the objects the students come across in their daily lives and visuals that were used in the Turkish National Ministry of Education's Mathematics book to develop pre- and post-achievement tests. Six questions were prepared for each number concept. Two of the prepared questions include indicating the number one in a set of the same objects marked by different numbers (1-9), two of them indicate number one in a set of the same objects in different colors (1-9) and two of them indicate number one in a set of different objects marked by different numbers (1-9).

Detailed Evaluation Forms

The detailed evaluation form is used to determine an individual's level prior to starting the training of selected acquisitions in the personalized education plan at the end of overall evaluation. The selected acquisitions should be divided into smaller sub-scales while the analysis of the subject about the concept or the discipline is being performed.

A prepared detailed evaluation form consists of 31 items. Four of these items include prior knowledge that the students are supposed to have. Three sub-scales were used for each number concept. These indicate the number one item (1-9) among the sets with different objects marked by different numbers and the sets with the same objects in different colors, and numbers and sets with different objects marked by different numbers.

Interview form: The questions of the interview were determined through focus group discussions that were held with the participants as well as literature reviews in the study named "teacher candidates and the opinions of the teachers on personalized teaching" conducted by Cakir in 2013. The views of teachers who participated in the application were taken by asking questions which were prepared as a semi-structured interview.

Process

Preconditions that the participants were supposed to satisfy were determined. The predetermined conditions were: students must not have a physical disability because they have to use computer, rhythmic count out from 1 to 9 and know the concept of sets.

Class teachers' views were taken and overall evaluation forms of the students were examined in order to elect students who met the above mentioned requirements. At the end of this study, it was decided that the sample would consist of thirty students and through random selection, a control and experimental group of fifteen students were formed.

A pre-test was applied to determine prior knowledge of these thirty students about the number concept. Data obtained was recorded in a detailed evaluation form.

The students in the control group were asked to play minefield game for two weeks (two course hours, 40 minutes) in order to acquire the skill of using the mouse.

The application lasted for four weeks (four-course hours).

The number concept was given to students in the control group with the materials existing in the classroom environment.

The program which was prepared in the computer environment was introduced to students in the experimental group. The program explained that whenever they give a correct answer, they continue to the next question and when they give a correct answer one after the other four times after the first three questions, they continue to the next number concept.

At the end of the application, a post-test was applied to measure students' achievement and the data obtained was recorded in the detailed evaluation form.

During this period, three volunteer teachers wanted to participate in the application. Brief information about the training was given to these teachers and the aim of this study was explained. When the program that would be used in the application was completed, some information about the application was given to the teachers. These teachers actively participated in every stage of the application and they were asked to give answers to the questions which were carried out as a semi-structured interview at the end of the application.

Data Analysis

Pre- and post-test scores for each student were obtained by calculating the total points in the evaluation form. Since there are 31 items in the evaluation form and scoring was dichotomous (0 or 1), the minimum score from the evaluation form is 0 and the maximum score is 31.

After examining the pre-test and post-test scores, the pre-test Skewness and Kurtosis values were -.117 and -.555; post-test's Skewness and Kurtosis values were -.680 and -1.008, respectively. So, the distribution of the data is not significantly different from a normal distribution. The analysis also established a Box's M=8.437; $p>.05$ and Levene Statistics=8.477, $p<.05$ for pre-test; and Levene Statistics=.340; $p>.05$ for post-test. Based on the scores, Skewness and Kurtosis values, Box's M statistics and post-test's Levene statistics, a two-way ANOVA for Mixed Measures was selected for data analysis because a control and experimental group and pre- and post- tests were used.

Results

Students' scores in the control and experimental group before and after the application and their standard deviation values are given in Table 1.

Table 1

Pre- and post-test values for control and experimental groups

Group	Pre-test			Post-test		
	N	$\bar{X}$	S	N	$\bar{X}$	**S**
Control	15	10.80	5.00	15	24.20	6.60
Experimental	15	12.73	2.49	15	26.73	5.66

When Table 1 was examined, it was observed that the mean of pre-test scores for control group increased from 10.80 to 24.20. The mean of pre-test scores for the experimental group was 12.73 and the mean of post-test scores was 26.73.

Whether or not there was a significant difference between the scores obtained for the control and experimental groups before and after the training was tested with a two-way ANOVA for Mixed Measures and the results are given in Table 2 below.

Table 2

Pre- and post-test ANOVA results for control and experimental groups

The Source of Variance	Sum of Squares	df	Mean Square	F	p
Between Test Subjects					
Group (Experimental / Control)	74.817	1	74.817	1.607	.215
Within Test Subjects					
Measurement (Pre-test – post-test)	2815.350	1	2815.350	408.868	.000
Group-measurement	1.350	1	1.350	.196	.661

When the results in Table 2 are examined, it can be seen that there is a significant difference between the pre- and post-test scores of the participants both for control and experimental groups ($F_{1,28}$=408.868, p<.01). Besides, the variance between pre- and post-test scores did not show a significant difference for control and experimental groups ($F_{1,28}$=.196; p>.05).

When the views of the practitioners about the process were examined; having more fun in the lessons, reaching the target, easier classroom management, instant feedback, better student recognition, observation of student improvement, recognition of different characteristics of the students, longer student motivation, more time allocation for students, increased student motivation were reported as the positive sides of adaptive education.

Practitioner 1 mentioned an increase in student motivation: "As far as I observed in the application, teaching with different materials and applying them through games increased students' motivation". Practitioner 3 stated his/her views in the following statement: "I think they seem to be more motivated for the lesson because on the days of the lessons, the students ask questions such as "when will we have the lesson?" or "Are there any lessons today?".

Practitioner 2 stated that this application helped them recognize students better and she said: "This helped us learn about their different characteristics as well as learning the things they like or they do not like". Furthermore, practitioner 2 also stated that they could observe students' improvement: "You can see student improvement day by day". He/she made a statement about student concentration by saying "They can concentrate longer because they can study with their favorite objects."

Practitioner 3 gave his/her opinion about time allocation for each student saying, "There are academic differences among students so we have to work with students one- to- one and we cannot allocate equal time for each student". This practitioner thought that this program increased the time for each student. Practitioner 1 expressed the same attitude saying: "more time allocation for each student".

There are some negative sides of adaptive teaching: for example, classroom management is difficult, the other screens distract the attention, students compete with each other, interests change very fast, problems of self-expression arise, lower stages cannot be reached, discrimination, lacking interests because of different objects and an inefficient evaluation are the dominating negative sides of this program.

Practitioner 2 mentioned problems with classroom management: "I think classroom management is more difficult because this is the first application for the students". Practitioner 1 pointed out that some problems could appear for the students with physical disability. Practitioner 2 stated that competition between the students could have a negative effect on their education. Practitioner 3 drew attention to students who can fall behind: "I think it can create a loss of motivation in those who fall behind".

Practitioner 1 explained that working with more than one computer in the same environment affects learning in a negative way, "Although students chose the objects to work with themselves, when they saw something different on their friends' screen, they wanted to change their own screens and this affected learning in a negative way". Similarly, Practitioner 3 stated that the students' wondering what was on their friends' screens affected learning in a negative way.

Practitioner 2, in particular, stated that in some cases, students can continue with the next stage without seeing all the sub-stages , "Students have to be correct four times in a row but we do not know at what stage they do it correctly. Therefore, I do not think that the evaluation is exact and precise."

Practitioners' views about adaptive teaching application were collected under the headings such as *the size of the visuals, reinforce frequency, sound alarms, visual design and the order of array.*

Statements such as "*the pictures in the material must be larger and visible* (practitioner 1), *larger and clearer pictures can make the program more efficient* (practitioner 2), *I think pictures must be larger and more understandable* (practitioner 3)" have common perceptions about bigger-sized pictures.

The statement of practitioner 1 "*I think the program can be more effective if reinforcement is given when the time comes for the student to continue to the next stage*" shows that reinforcements must be given more often in the program.

Practitioner 2 proposed the enrichment of the program with visuals: "It can be more fun if the program is enriched with more visuals like picking apples from the tree or the rabbits eating the carrots".

Practitioner 3 suggested more detailed sub-stages: "I think the evaluation is insufficient so more visuals must be added for each sub-goal and the students should not continue to the next stage without finishing the visuals, which would help us make a more precise evaluation".

Discussion and Conclusion

The findings of the study that aimed to research the effectiveness of adaptive software program to enable students with intellectual disabilities to acquire mathematical skills showed that traditional education and education with adaptive materials on the computer are both effective teaching methods at similar levels. In other words, a software program is as effective as a traditional method in teaching the number concept.

If we considered that the teacher cannot deal with each student equally at the same time in a traditional classroom, it is clear that this result can be promising.

When the views of practitioners about the process were examined, they indicated that adaptive teaching practices have positive sides such as fun learning, more time allocated for each individual, students have longer concentration, more motivated students, immediate feedback and better student recognition.

On the other hand, the program has some negative sides such as distraction of the students by looking at other students' screens, difficulty in classroom management, not being able to reach lower stages and students' competing against each other.

The practitioners' suggestions generally refer to the following: make larger pictures, give reinforcement more often, give audio warnings and make the software more suitable for students from the visual aspect,…etc.

As a conclusion, it is possible to say that teaching with computer software programs is as effective as traditional education. Students participate in learning activities having more fun, there is an increase in student concentration and they are more interested in the subjects. However, it is concluded that web-based learning systems need to be improved in some areas and some indicative results were obtained for future practices.

At the end of this study, the following suggestions were developed for future studies:

1. A similar study should be conducted after increasing the frequency of feedback.
2. Similar studies should be performed using software programs developed for different subject areas.
3. The study should be repeated using a software program that collects more information from the students during the practice.
4. Larger visuals should be selected for future studies.
5. Students' views should be examined about adaptive software programs.

References

Brusilovsky, P. (1998). Methods and Techniques of Adaptive Hypermedia. In P. Brusilovsky, A. Kobsaand J., & Vassileva (Eds.), *Adaptive Hypertext and Hypermedia* (pp. 1-44). Boston: Klower Academic Publishers. http://dx.doi.org/10.1007/978-94-017-0617-9

Cavkaytar, A. (2001). Aim of Mentally Retards' Education. *Anadolu University Journal of Education Faculty*, *10*(1), 115-121.

Cakir Balta, Ö. (2008). *The Effect of Personalized Mathematical Word Problems Usage on Students' Achievement in Computer and Classroom Based Environments. (Doctoral Dissertation).* Ankara: Ankara University Institute of Educational Sciences.

Cakir, Ö. (2013). Teacher Candidates and Teachers' Opinions on Personalized Teaching. *Global Journal of Human Social Science Linguistics* & *Education, 13*(6), 15-19 /*online*/. ISSN: 2249-460x.

Demirel, O., Seferoglu, S.,S., & Yagci, E. (2001*). Instructional Technologies and Development of Materials.* Ankara: Pegem Publishing.

Hutcherson, K., Langone, J., Ayres, K., & Clees, T. (2004). Computer Assisted Instruction to Teach Item Selection in Grocery Stores: An Assessment of Acquisition and Generalization. *Journal of Special Education Technology.* 19(4), 33-42.

Ozak, H., & Dikmen I. H. (2010). Reviewing Master Thesis and Doctoral Dissertations on Functional Academic Skills of Students with Intellectual Disabilities in Turkey. *Ankara University Faculty of Educational Sciences Journal of Special Education, 11*(1), 43-58.

Park, O. (1996). *Adaptive Instructional Systems.* In D. H. Jonassen (Ed.), *Handbook of Research on Educational Communications and Technology* (pp. 634–664). New York: Macmillan.

Sezer, İ. (2011). *Comparison of Adaptable and Adaptive Methods in Hypermedia Systems and Developing a Sample Tool in Foreign Language Learning. (Master Thesis)*. Ankara: Gazi University, Informatics Institute.

Schalock, R. L., Luckasson, R. A., Shogren, K. A., Borthwick-Duffy, W. S., Bradley, V., Buntinx, W. H. E., & Yeager, M. H. (2007). The Renaming of Mental Retardation: Understanding the Change to the Term Intellectual Disability. *Intellectual and Developmental Disabilities*, *45*(2), 116–124. http://dx.doi.org/10.1352/1934-9556(2007)45[116:TROMRU]2.0.CO;2

Somyürek, S. (2008). *The Effects of Adaptive Educational Web Environments to Learners Academic Achievement and Navigation. (Doctoral Dissertation)*. Ankara: Gazi University, Institute of Educational Science.

Turkish Statistical Institute (TSI). (2010). *Problems and Prospects of Research on Disability.* /online/. Retrieved on 21st January 2013 from www.tuik.gov.tr/IcerikGetir.do?istab_id=244.

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Učinak prilagodljive okoline za učenje kod poučavanja pojma broja učenika s intelektualnim poteškoćama

Sažetak

Cilj je ovoga istraživanja proučiti dokaze o učinkovitosti prilagođenog računalnog softvera koji omogućuje učenicima s intelektualnim poteškoćama da usvoje matematičke vještine. Hibridna metoda, u kojoj se zajedno koriste kvantitativni i kvalitativni istraživački uzorci, naš je model istraživanja. Za kvantitativni uzorak istraživanja koristio se autentični eksperimentalni model koji podrazumijeva predtest i konačni test s eksperimentalnom i kontrolnom skupinom. Za kvalitativni uzorak koristili smo se deskriptivnim model putem kojega smo mogli opisati mišljenja ispitanika vezana uz sam proces. Istraživanje je provedeno na uzorku od trideset ispitanika – učenika iz četvrtoga, petoga, šestoga, sedmoga i devetoga razreda. Materijale koji su korišteni u istraživanju razvili su sami istraživači. Nadalje, u ovome su se istraživanju koristili cjelokupni obrasci za ocjenjivanje, testovi postignuća i detaljni evaluacijski obrasci. Za analizu podataka koristila se dvosmjerna ANOVA za mješovita mjerenja i deskriptivna analiza. Na kraju analize, iako je uočena značajna razlika između predtesta i završnoga testa, značajna razlika nije utvrđena između tradicionalne okoline za učenje i prilagođene okoline za učenje s obzirom na učinkovitost obrazovanja. Štoviše, također su bila ispitana mišljenja sudionika u istraživanju o samoj primjeni.

Ključne riječi: *prilagođeno učenje; individualno poučavanje; intelektualne poteškoće; pojam broja*

Uvod

Pojedincima su potrebna određena znanja i vještine kako bi samostalno živjeli u društvu. Glavni cilj aktivnosti za učenje u školama jest pripremiti učenike za društveni život. Prema tome, učenici uče funkcionalne vještine i znanja kako bi se njima mogli koristili u svakodnevnom životu i kako bi njihovi životi bili lakši. To se ne razlikuje ni kod učenika s intelektualnim poteškoćama (Cavkaytar, 2001). Intelektualnu poteškoću Schalock i sur. (2007, str. 118) definiraju kao:

"poteškoću (koju) karakteriziraju značajna ograničenja u intelektualnom djelovanju kao i u prilagođenom ponašanju koje se očituje u konceptualnim, društvenim i praktičnim vještinama prilagodbe".

U Turskoj su provedena različita istraživanja vezana uz osobe s poteškoćama, a nacionalno istraživanje pod nazivom *Istraživanje problema i očekivanja od osoba s poteškoćama*, proveo je 2010. prvi put turski institut za statistiku (TSI). Prema rezultatima istraživanja postoje 280 014 osoba s poteškoćama koje su registrirane u nacionalnoj bazi osoba s poteškoćama koje žive u kućanstvima unutar Republike Turske i koje imaju 20 % invalidnosti prema svojim zdravstvenim kartonima. U istraživanju su izostavljene osobe s poteškoćama koje žive u domovima za stare i nemoćne, centrima za starije, hostelima, zatvorima, barakama, bolničkim hotelima i vrtićima. Istraživanje problema i očekivanja od osoba s poteškoćama za cilj je imalo odrediti probleme i očekivanja u svakodnevnom životu od osoba s poteškoćama koje su bile registrirane u nacionalnoj bazi osoba s poteškoćama. U Turskoj je 29,2 % osoba s poteškoćama koje su registrirane u nacionalnoj bazi kao osobe s intelektualnim poteškoćama. Njih 61,1% su muškarci, a 38,9% žene (TSI, 2010).

Cilj obrazovanja osoba s intelektualnim poteškoćama je omogućiti im postizanje neovisnosti u društvu, poboljšavajući funkcionalna područja njihova života. Glavne vještine potrebne za ostvarenje toga cilja jesu osnovne razvojne vještine, osnovne informacije o brojevima potrebnima za svakodnevni život, zatim podvještine poput čitanja i komunikacije za svakodnevni život (Cavkaytar, 2001).

U posljednje vrijeme, kako raste popularnost tehnologije, računala se koriste kao svrha i kao alat za aktivnosti učenja i poučavanja. Računala koja su postala uobičajen alat u svakodnevnom životu počela su se koristiti i u obrazovanju tako da su prilagođena primjeni u obrazovnim sustavima. Poznato je da aktivnosti učenja i poučavanja koje su utemeljene na alatima dižu raznu motivacije studenata, doprinose boljem učenju, unose raznolikosti u procese učenja i poučavanja (Demirel, Seferoglu, i Yagcı, 2001). Razina koju su dostigle obrazovne tehnologije omogućuje im razvoj sustava koji imaju ciljeve i sadržaje koji se mogu mijenjati u ovisnosti o pojedincu. Sustavi u kojima se sadržaj može razlikovati s obzirom na pojedinca i sustavi kod kojih su ciljevi određeni prema samim pojedincima zovu se prilagođeni i prilagodljivi sustavi (Park, 1996).

Prilagođeni sustavi i prilagodljivi sustavi razlikuju se s obzirom na osobu koja čini prilagodbu. Prema tome, prilagodba prema sklonostima pojedinca na početku primjene je prilagođeni sustav, ali prilagodba u kojoj se reakcije pojedinca za vrijeme primjene obrađuju računalno jest ono što zovemo prilagodljivi sustav (Sezer, 2011). Proces prilagodbe može se postići na dva načina: prilagodba sadržaja i prilagodba navigacije. U sustavima prilagodbe sadržaja sadržaj se može razlikovati prema karakteristikama pojedinca. U sustavima prilagodbe navigacije poveznice o sadržaju mogu se razlikovati prema karakteristikama pojedinca (Brusilovsky, 1998).

Za prilagodbu sadržaja i navigacije možemo se koristiti različitim strategijama. Dodatna objašnjenja, preduvjetna objašnjenja, usporedna objašnjenja, različiti oblici objašnjenja i strategije poretka mogu se koristiti za prilagodbu sadržaja, a za prilagodbu navigacije koriste se strategije globalnih ili lokalnih vođenja, kao i potpore lokalnih i globalnih orijentacija. Te strategije sažeo je Somyurek (2008).

Prilagodba sadržaja:

Dodatna objašnjenja: Dodatne informacije mogu se dati samo onim učenicima čija razina spremnosti odgovara toj informaciji ili onima koji žele dobiti dodatne informacije.

Preduvjetna objašnjenja: Davanje informacija koje mogu biti preduvjet za pojmove i prije nego što je pojam objašnjen.

Usporedna objašnjenja: Prikazivanje sličnosti i različitosti među pojmovima koji će biti uvedeni i među već uvedenim pojmovima.

Različiti oblici objašnjavanja: Priprema istoga sadržaja u različitim oblicima i različita prezentacija sadržaja prema karakteristikama pojedinca.

Poredak: Objašnjenje istoga sadržaja različitim poretkom prema karakteristikama pojedinca.

Prilagodljiva navigacija:

Globalno vođenje: pomaže učeniku u nalaženju najkraćeg puta kod pronalaženja tražene informacije.

Lokalno vođenje: Davanje popisa poveznica različitim poretkom ovisno o karakteristikama pojedinca.

Globalna orijentacija: Pomaže učeniku da osvijesti stvarno mjesto u strukturi predmeta

Lokalna orijentacija: Pomaže učeniku da osvijesti svoje relativno mjesto u lokalnom okruženju.

U istraživanju provedenome 2008. Cakir je proučavao učinkovitost individualizacije verbalizacijom matematičkih problema kod poučavanja matematike na postignuće učenika. Istraživanje je potvrdilo da individualizacija značajno povećava postignuće učenika, međutim, nije uočena značajna razlika između rezultata posttestova kod općenite primjene i kod individualizirane primjene. U istraživanju u kojemu se proučava učinak prilagodljivih mrežnih okruženja i navigacije na postignuće učenika (Somyurek, 2008) nije uočena značajna razlika među skupinama s prilagodbom i skupinama bez prilagodbe.

U istraživanju (Ozak i Dikmen, 2010) koje je proučavalo teme magistarskih radova u Turskoj vezane uz funkcionalne akademske vještine učenika s intelektualnim poteškoćama izdvojeno je dvadeset i devet magistarskih radova. Među tim radovima sedamnaest ih je obrađivalo vještine čitanja i pisanja, a dvanaest ih proučavalo matematičke vještine. Devet od ukupno dvanaest radnji vezanih uz matematičke vještine bile su magistarske radnje, a tri su bile doktorske radnje. Istraživanje je

pokazalo da se računalo koristilo kao alat za vještine čitanja i pisanja, ali iznenađuje da matematičke aktivnosti nisu bile vezane uz računalo. To otkriće upućuje na to da se korištenje računala za razvoj matematičkih vještina mora pojačati, kao i da postoji potreba za daljnjim proučavanjem prilagodbe za učenike koji se koriste računalnim programom.

Hutcherson, Langone, Ayres i Cless (2004) proveli su istraživanje koje je za cilj imalo poučavati učenike s intelektualnim poteškoćama u izboru proizvoda u trgovinama uz pomoć računala. Oni su utvrdili da je vrijeme potrebno za lociranje proizvoda u trgovinama umanjeno, a da je povećana brzina biranja potrebnog proizvoda.

Vrlo je malo istraživanja provedeno na skupinama s intelektualnim poteškoćama u prilagođenim računalnim okruženjima, a individualno poučavanje vrlo je važno za takve osobe. Ovo je istraživanje jedno od prvih istraživanja u kontekstu primjene prilagođenih okruženja nad učenicima s intelektualnim poteškoćama. Koristeći se prilagođenim sustavima učenja koji omogućuju individualizirano poučavanje, omogućuje se pojedinačno individualizirano poučavanje.

Cilj ovoga istraživanja bio je proučiti učinkovitost prilagođenog računalnog softvera u dostizanju matematičkih vještina učenika s intelektualnim poteškoćama.

U skladu s općim ciljem pokušali smo pronaći odgovore na sljedeća pitanja:

1. Postoji li značajna razlika među rezultatima predtesta i posttesta u eksperimentalnoj skupini?
2. Postoji li značajna razlika među razlikama u posttestu kod eksperimentalne i kontrolne skupine?
3. Koje su pozitivne strane prilagođenog učenja prema mišljenju praktičara?
4. Koje prijedloge daju praktičari u vezi s prilagođenim učenjem?

Metode

Model istraživanja

Preferirana je metoda hibrida u kojoj se zajedno koriste kvantitativne i kvalitativne metode. Za kvantitativni uzorak u istraživanju koristio se autentični eksperimentalni model koji uključuje predtest i posttest, eksperimentalnu i kontrolnu skupinu. Za kvalitativno istraživanje koristio se deskriptivni model kako bi se opisala mišljenja praktičara.

Uzorak

Istraživanje je provedeno na skupini od trideset sudionika – učenika četvrtih, petih, šestih, sedmih i devetih razreda koji su izabrani od ukupno 250 učenika koji se obrazuju u Centru za modernu obrazovnu praksu, u 2012./13. školskoj godini. Učenici s neznatnim i umjerenim intelektualnim poteškoćama izabrani su kao ispitanici podobni za istraživanje, a njihovi rezultati u testovima inteligencije bili su između 50 i 60.

Od trideset izabranih učenika osam je bilo djevojčica, a dvadeset i dva su bili dječaci. Kontrolna i eksperimentalna skupina nastale su nasumično biranjem 15 učenika za svaku skupinu. Tri učenika u eksperimentalnoj skupini bile su djevojčice, a dvanaest su bili dječaci. Pet učenika u kontrolnoj skupini bile su djevojčice a deset su bili dječaci.

Mišljenja praktičara o procesu dobivena su od tri praktičara koji su provodili primjenu koristeći se tehnikom intervjua.

Materijal

U samom istraživanju softver u kojemu je prilagođena navigacija primijenjen je na kontrolnu skupinu. Program su razvili istraživači koristeći se programom Microsoft Visual Studio 2012 (dopuštenje za učenike) i Visual Basic Programming Language. U tom su programu učenici mogli prilagoditi svoju navigaciju odabirući ono što žele iz ponude, poput likova iz crtića, životinja, lopte (slika 1).

Slika 1.

Učenici započinju s učenjem u trenutku kada odaberu kategoriju koju preferiraju. Softver sadrži sustav od devet brojeva i petnaest razina za svaki broj. S obzirom na prvi izbor učenika pojam broja pokušava se prenijeti učenicima putem likova iz crtića, slika životinja ili lopti (150*150px).

Kada učenik odabere točan odgovor, prelazi na sljedeću razinu, a ako odabere četiri točna odgovora uzastopno, prelazi na sljedeći broj. Međutim, prve tri razine za svaki broj zamišljene su kao probne razine pa se čak i ako učenik odabere točan rezultat, bodovi ne zbrajaju. U nastavku slike mijenjaju boju, a predmeti se pretvaraju u neke druge predmete.

U slučaju moguće pogreške, upravljački okvir uključen je u softver za intervenciju administratora. U upravljačkom okviru nalaze se podaci o razini na kojoj se učenik nalazi i koliko je puta odabrao točan odgovor uzastopno (slika 2).

Slika 2.

Objašnjenje brojeva u slici:

1 Ovo je referentna slika.

2 Izborni dio. Učenik odabire sliku koja ima isti predmet i isti broj koji označava referentnu sliku.

3 Administrativni dio, broj i razina vidljiva je samo kada praktičar (administrator) upiše lozinku u petom dijelu. U slučaju moguće pogreške, administrator može uskladiti broj i razinu.

4 Izbor uzastopnog točnog odgovora. Taj dio pokazuje koliko je točnih odabira učenik imao uzastopno. Kada dosegne broj četiri, nastavlja na prvu razinu sljedećeg broja. Taj je dio vidljiv samo administratoru.

5 Kodirani dio. Administrator omogućuje vidljivost četvrtog i petog dijela samo ako upiše lozinku.

Kako učenik napreduje, tako se povećava i razina težine slika. Ekran koji učenik vidi kod broja šest i razine deset prikazan je u Slici 3. Kao što slika 3 prikazuje, učenik vidi različite vrste lopti različitih boja. Osim toga, broj lopti koje se koriste vrlo je blizu jedan drugome.

Slika 3.

Kada učenici uspješno dovrše sve brojeve i razine, otvara se novi prozor. Taj prozor, sa slikom popularnog lika iz crtanih filmova daje zvuk pljeska u pozadini. Svrha je učenika ohrabriti za daljnji rad (slika 4).

Slika 4.

Instrumenti za prikupljanje podataka

Obrasci za ukupnu evaluaciju koje su popunjavali nastavnici na početku polugodišta proučavani su zbog matematičkog znanja koje je trebalo biti na istoj razini. Predtest je razvijen kako bi se odredile razine prijašnjeg znanja o pojmu broja, a posttest je razvijen kako bi se odredile razine znanja nakon eksperimenta. Dobivene informacije iz primjene tih testova detaljno su objašnjene u obrascu procjene znanja o pojmu broja.

Obrazac opće procjene

Obrazac opće procjene je površinska procjena koja je priprema za individualizirani plan učenja u skladu s potrebama pojedinca i u suradnji s obitelji o modelu treniranja i povezanim postignućima odabranim za pojedinca, a kojega je odredio Odbor za evaluaciju posebnog obrazovanja kao pojedinca kojemu je potrebna pomoć. Kod opće procjene važno je imati na umu da li pojedinac usvaja ili poznaje usvajanje. Razina usvajanja nije toliko značajna.

Testovi postignuća

Test je pripremljen koristeći se predmetima na koje su učenici naišli u svakodnevnom životu i slikama kojima se koristi Tursko nacionalno ministarstvo obrazovanja u udžbenicima iz matematike kako bi se razvili predtestovi i testovi postignuća. Šest pitanja pripremljeno je za svaki brojevni pojam. Dva pitanja uključivala su pokazivanje broja jedan u skupini istih predmeta, ali različitih brojeva (1 – 9), dva pitanja uključivala su pokazivanje broja jedan u skupini istih predmeta, ali različitih boja (1 – 9), a dva su uključivala pokazivanje broja jedan u skupini različitih predmeta i različitih brojeva (1 – 9).

Obrazac detaljne procjene

Obrazac detaljne procjene koristio se kako bi se odredila razina pojedinca prije samog poučavanja odabranih predmeta usvajanja u personaliziranom planu učenja na kraju opće evaluacije. Odabrani bi predmeti trebali biti podijeljeni u manje podskale dok se provodi analiza predmeta o konceptu ili disciplini.

Osmišljeni obrazac detaljne procjene sadrži 31 stavku. Četiri stavke vezane su uz prethodno znanje učenika. Tri podskale koristile su se za svaki brojevni pojam. To su skupine s različitim predmetima različitih brojeva, skupine s istim predmetima različitih boja i brojevi koji upućuju na broj jedan u skupinama s različitim predmetima različitih brojeva (1 – 9).

Intervju: Pitanja u intervjuu odabrana su za vrijeme rasprave u fokus grupama koje su održane sa sudionicima u istraživanju i preuzete iz pregleda literature pod nazivom „nastavnici ispitanici i mišljenja nastavnika o personaliziranom poučavanju" što je proveo Cakir 2013. Mišljenja nastavnika koji su sudjelovali u primjeni dobivena su posredstvom pitanja koja su pripremljena u obliku polustrukturiranoga intervjua.

Proces

Određeni su preduvjeti koje su ispitanici morali zadovoljiti. Preduvjeti su bili: učenici ne smiju imati fizičke poteškoće jer se moraju koristiti računalom, moraju znati brojati od 1 do 9 te moraju poznavati koncept skupine.

Zabilježena su mišljenja nastavnika kao i ukupna evaluacija učenika kako bi se izdvojili učenici koji su udovoljili zadanim kriterijima. Analizom tih podataka odlučeno je da će uzorak biti sastavljen od trideset učenika nasumičnim izborom, a kontrolnu i eksperimentalnu skupinu činit će po petnaest učenika.

Primijenjen je predtest kako bi se ustanovilo prethodno znanje ispitanika vezano uz pojam broja. Podaci su zabilježeni u detaljnom obrascu evaluacije znanja.

Učenici u kontrolnoj skupini igrali su igru minolovca dva tjedna (dva školska sata tjedno po 40 minuta) kako bi usvojili vještinu upotrebe miša.

Primjena je trajala četiri tjedna (četiri školska sata).

Pojam broja dan je učenicima u kontrolnoj skupini uz pomoć materijala iz razrednog okruženja.

Program koji je pripremljen u računalnom okruženju predstavljen je učenicima u eksperimentalnoj skupini. Program im je objasnio da kada god daju točan odgovor, nastavljaju sa sljedećim pitanjem, a kada četiri puta uzastopno daju točan odgovor za prva tri pitanja, nastavljaju sa sljedećim brojevnim pojmom.

Na kraju eksperimenta, učenici su dobili posttest kako bi se ustanovilo njihovo postignuće, a dobiveni su podaci uneseni u detaljan obrazac evaluacije.

U isto vrijeme tri nastavnika dobrovoljca htjela su sudjelovati u eksperimentu. Njima su dane sažete upute i priprema za sudjelovanje u eksperimentu. Objašnjen im je cilj istraživanja. Kada je program koji bi bio korišten u eksperimentu završio, nastavnicima su dane dodatne informacije o programu. Ti su nastavnici aktivno sudjelovali u svakoj fazi eksperimenta te su dali odgovore na pitanja koja su postavljena putem polustrukturiranog intervjua na kraju eksperimenta.

Analiza podataka

Rezultati predtestova i posttestova za svakog su učenika dobiveni zbrajanjem ukupnih bodova u evaluacijskom obrascu. S obzirom na to da evaluacijski obrazac

sadrži 31 stavku, a bodovanje je dihotomno (0 ili 1), najmanji mogući broj bodova u evaluaciji bio je 0, a najveći mogući rezultat bio je 31.

Nakon proučavanja rezultata predtestova i posttestova, vrijednosti asimetrije i zaobljenosti predtesta bile su -,117 i -,555; vrijednosti asimetrije i zaobljenosti posttesta bile su -,680 i -1,008.

Distribucija podataka nije značajno drukčija od normalne distribucije. Analizom smo također ustanovili Boxovu M=8,437; p>,05 i Levenovu statistiku =8,477, p<,05 za predtest; i Levenovu statistiku =,340; p>,05 za posttest. S obzirom na vrijednosti asimetrije i zaobljenosti, Boxovu M statistiku i posttest Levenovu statistiku podaci su analizirani dvosmjernim ANOVA testom za miješani model mjerenja s obzirom na to da su korištene kontrolna i eksperimentalna skupina, kao i predtest i posttest.

Rezultati

Rezultati učenika u kontrolnoj i eksperimentalnoj skupini prije i nakon implementacije i vrijednosti standardne devijacije prikazani su u Tablici 1.

Tablica 1.

Nakon proučavanja podataka iz Tablice 1, srednja vrijednost za rezultate predtesta za kontrolnu skupinu porasla je od 10,80 do 24,20. Srednja vrijednost rezultata predtesta za eksperimentalnu skupinu bila je 12,73, a srednja vrijednost za posttest bila je 26,73.

Postojanje značajne razlike među rezultatima dobivenim od kontrolne i eksperimentalne skupine prije i nakon implementacije mjereno je dvosmjernim ANOVA testom za miješana mjerenja, a rezultati su prikazani u Tablici 2.

Tablica 2.

Nakon proučavanja rezultata iz Tablice 2, može se učiti značajna razlika među rezultatima predtesta i posttesta za sudionike i u kontrolnoj i u eksperimentalnoj skupini ($F_{1,28}$=408,868, p<,01). Međutim, razlika među rezultatima predtesta i posttesta nije ukazala na značajnu razliku za kontrolnu i eksperimentalnu skupinu ($F_{1,28}$=,196; p>,05).

Analizom mišljenja praktičara o procesu, ustanovili smo da su sljedeće stavke pozitivne strane prilagođenog obrazovanja: učenici se više zabavljaju za vrijeme sati, dostizanje cilja, lakše upravljanje razredom, neposredna povratna informacija, bolje prepoznavanje učenika, promatranje napretka učenika, dulja motivacija kod učenika, dobivanje dodatnog vremena za učenike i povećana motivacija.

Nastavnik 1 spomenuo je porast motivacije učenika: „Koliko sam primijetio u implementaciji, uvidio sam da poučavanje s različitim materijalima i njihova primjena kroz igre povećava motivaciju učenika". Nastavnik 3 iznio je sljedeće mišljenje: „Mislim da učenici postaju više motivirani za nastavu jer u dane kada su imali tu nastavu, postavljali bi pitanja poput: „Kada će biti taj sat?" ili „Imamo li danas taj sat?"

Nastavnik 2 rekao je da je ta implementacija pomogla u prepoznavanju učenika preko tvrdnje: „Ovo nam je pomoglo u razumijevanju različitih karakteristika učenika kao i prepoznavanje onoga što oni vole, a što ne vole." Nadalje, nastavnik 2 također je rekao da je implementacija omogućila praćenje učenikova napretka: „Možete vidjeti svakodnevni napredak učenika." Također se osvrnuo na koncentraciju učenika: „Mogu se dulje usredotočiti jer uče sa svojim najdražim predmetima."

Nastavnik 3 dao je svoje mišljenje o danom vremenu za svakoga učenika: „Postoje akademske razlike među učenicima pa moramo pojedinačno raditi s učenicima, što znači da ne možemo svakom učeniku posvetiti jednako vrijeme." Taj nastavnik – ispitanik smatra da program povećava vrijeme koje posvećujemo svakom učeniku. Nastavnik 1 rekao je da prilagođeni program povećava vrijeme koje možemo dati svakom pojedinom učeniku – „više vremena za svakog učenika".

Postoje i negativne strane prilagođenog učenja. Primjerice, upravljanje razredom postaje teže, drugi ekrani odvraćaju pažnju, učenici se natječu jedni s drugima, njihovi interesi brzo se mijenjaju, nastaju problemi vlastitoga izražavanja, ne mogu se dostići niže razine, diskriminacija, smanjeni interes zbog različitih predmeta i nedovoljna evaluacija dominiraju kao negativne strane programa.

Nastavnik 2 rekao je: "Mislim da upravljanje razredom postaje teže jer je ovo prva takva primjena s učenicima." Nastavnik 1 htio je ukazati na to da problemi mogu nastati zbog učenika s tjelesnim poteškoćama. Nastavnik 2 izjavio je da nadmetanje među učenicima može imati negativan učinak na njihovo obrazovanje. Nastavnik 3 ukazao je na učenike koji mogu nazadovati: „Mislim da to može stvoriti i gubitak motivacije kod onih koji ne dostignu očekivanu razinu."

Nastavnik 1 objasnio je da rad na više računala u istome okruženju utječe na učenje i to na negativan način: „ Iako učenici sami biraju predmete s kojima će raditi, kada bi uočili nešto drugo na ekranu svoga prijatelja, htjeli su promijeniti vlastite odabire, a to je imalo negativan utjecaj na učenje." Slično, Nastavnik 3 izjavio je da znatiželja učenika o onome što se nalazi na ekranima drugih ima negativan učinak na učenje.

Nastavnik 2 izjavio je da u nekim slučajevima učenici mogu nastaviti na sljedeću razinu i prije nego što su vidjeli sve potkategorije: "Učenici moraju odgovoriti točno četiri puta uzastopno, međutim, mi ne znamo na kojoj se razini to dogodi. Prema tome, mislim da evaluacija nije ispravna i precizna."

Mišljenja nastavnika – ispitanika o prilagođenom učenju prikupljena su pod nazivima kao što su, *veličina slika, učestalost podrške, audio upozorenja, vizualni pregled* i *redoslijed prikaza*.

Tvrdnje kao što su „*slike u materijalima morale bi biti veće i vidljivije* (nastavnik 1), *veće i jasnije slike mogu program učiniti učinkovitijim* (nastavnik 2), *mislim da bi slike trebale biti veće i jasnije* (nastavnik 3)" ukazuju na zajedničku percepciju praktičara o veličini slika.

Tvrdnja Nastavnika 1: „Mislim da bi program mogao biti učinkovitiji ako se učeniku daje podrška kada dođe vrijeme za prijelaz na sljedeću razinu" ukazuje na to da podrška u programu mora biti učestalija.

Nastavnik 2 rekao je da bi program mogao biti dodatno obogaćen slikama: „Program bi mogao biti zanimljiviji dodavanjem slika poput branja jabuka s drveća ili gledanje zečeva kako jedu mrkve".

Nastavnik 3 rekao je da program mora sadržavati detaljnije potkategorije: „Mislim da nema dovoljnu evaluaciju pa bi trebalo dodati više slika za svaki podcilj, a učenici ne bi trebali prijeći na sljedeću razinu bez prethodnog dovršavanja slika, što bi nam omogućilo i točniju evaluaciju".

Rasprava i zaključak

Rezultati istraživanja čiji je cilj bio testirati učinkovitost prilagođenog softverskog programa kako bi učenici s intelektualnim poteškoćama usvojili matematičke vještine ukazali su na to da su tradicionalni oblici obrazovanja i prilagodljivi materijali na računalu učinkovite metode poučavanja na sličnim razinama. Drugim riječima, softverski program učinkovit je jednako kao i tradicionalna metoda poučavanja pojma broja.

Uzmemo li u obzir da nastavnici u tradicionalnom razredu ne mogu posvetiti svim učenicima jednako vrijeme, jasno je da rezultat ne može biti obećavajući.

Nakon proučavanja mišljenja praktičara o procesu, utvrđeno je da oni smatraju kako prilagođene nastavne metode imaju pozitivne strane kao što su zabavno učenje, više vremena koje se može posvetiti svakom učeniku, učenici imaju dulju koncentraciju, učenici su motiviraniji, izravna povratna informacija i bolje upoznavanje učenika.

S druge strane, program ima i neke negativne strane poput ekrana drugih učenika koji ih često ometaju jer gledaju u njih, poteškoće u upravljanju razredom, nemogućnost prjelaza nižih razina, međusobna natjecanja učenika.

Nastavnici – ispitanici dali su sljedeće prijedloge: ponuditi veće slike, učestalije davanje podrške, davanje audio upozorenja, učiniti softver prikladnijim za učenike iz vizualnog aspekta itd.

Kao zaključak može se reći da je poučavanje putem računalnih programa jednako učinkovito kao i tradicionalno poučavanje. Učenici sudjeluju u aktivnostima učenja na zabavniji način, povećava se koncentracija učenika te postaju više zainteresirani za predmet. Međutim, zaključuje se da je računalne sustave za učenje potrebno usavršiti u nekim područjima, a dobiveni su i određeni indikativni rezultati koje treba uzeti u obzir u budućem radu.

Rezultati ovoga istraživanja omogućili su i razvoj smjernica za buduća istraživanja:

1. Treba provesti slično istraživanje uz učestalije davanje povratne informacije;
2. Treba provesti slična istraživanja uz softverske programe razvijene za druge predmete;
3. Istraživanje je potrebno ponoviti sa softverskim programom koji prikuplja informacije od učenika za vrijeme rada;
4. Za buduća istraživanja trebaju se koristiti veće slike;
5. Trebaju se proučavati mišljenja učenika vezana uz prilagodljive softverske programe.