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The Effects of Computer-Based Video Modelling on Teaching Problem-Solving Skills to Students with Intellectual Disabilities

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Abstract

This study aims to determine the effectiveness of computer-based video modelling in teaching mathematical problem-solving skills that require addition and subtraction operations to students with intellectual disabilities. One of the single subject research designs, i.e. multiple probe design was used in this study with all participants, a girl and five boys with intellectual disabilities between the ages of 11 and 13. At the time of the research, students were attending a Special Education and Rehabilitation Centre in the province Nicosia in North Cyprus. The collected data were analysed, interpreted and presented in graphs. The obtained research results show that computer-based video modelling, i.e. video-based instruction is effective in teaching students with intellectual disabilities mathematical problem-solving skills that require addition and subtraction operations. The students maintained these problem-solving skills after the 10th and 20th day of the intervention and transferred these skills to a different environment (class) and individuals (teachers).

Keywords: *direct instruction; computer-based video modelling; problem solving; intellectual disability*.

Introduction

The right to education applies to everyone, meaning that the education of children with intellectual disabilities is also regulated by educational policy (Silva & Alves, 2019; Ozcan & Merdan, 2020). Agha and Eldaou (2018) focused on the services provided in educational centres for mentally disabled children (grades 1-6) and the manner in which teachers and professional staff supported the additional needs of the subjects. Mathematics is a comprehensive discipline which reflects on every aspect of life (Isik et al., 2008). Although unnoticed in the day-to-day routine, there are many skills necessary for sustaining daily life that require mathematical knowledge, such as knowing the date and time, withdrawing money from the cash machine, adjusting the degree of the oven, dialling a phone number, knowing the prices when purchasing some product, etc. (Yikmis & Cetin, 2010; Ojose, 2011).

Students with intellectual disabilities have difficulties in acquiring and generalizing mathematical knowledge and skills (Yikmis, 2005; Zeenat, 2019). However, they can learn mathematics in alternative ways. Clear, understandable, precise and well-designed instructional strategies and appropriate instructional adjustments help students with special needs in acquiring mathematical skills, understanding concepts and transferring the learned strategies (Saunders et al., 2016; Rexroat-Frazier & Chamberlin, 2019).

Problem solving is seen as an important element of learning mathematics. Students involved in meaningful problem-solving process acquire basic skills and advanced thinking processes necessary for the development of problem-solving strategies. Kasap and Ergenekon (2017) stated that the use of verbal math problems contributes to students solving daily-problems and connecting mathematical concepts to daily life situations, and they touched upon the importance of problems use in learning and teaching mathematics.

The literature review reveals many different methods, techniques and strategies used in teaching problem-solving skills (Devedzic & Devedzic, 2019). *TouchMath* (Mostafa, 2013), *Understand and Solve!* (Karabulut, 2015), schema-based teaching (Rockwell et al., 2011; Kot, 2014) and video models (Yakubova et al., 2015) are among the techniques commonly used in teaching problem solving skills. In recent years, there has been an increase in the amount of research and applications related to the use of video and animations in teaching mathematics to individuals with intellectual disabilities. Studies show that appropriate combinations such as narratives and videos, animation or pictures of related words adjacent to them can enhance students' learning through multimedia materials (Yilmaz & Talas, 2015).

When technology-assisted educational applications were evaluated for their use with intellectually disabled individuals, the findings showed that those students performed more successfully in educational applications using technological tools (Baglama et al., 2018). The studies on using technology in mathematics education show that today's constantly changing and developing technological innovations are

successfully used in the education of children with intellectual disabilities (Burton et al., 2013; Pitchford et al., 2018).

There are studies pointing to effective use of technological tools in teaching students how to solve problems (Inaltekin, 2020; Read, 2020). Moreover, the literature review stresses that using technological tools is rewarding when teaching problem solving to students with intellectual disabilities (Twyman & Tindal, 2006; Adebisi et al., 2015). Therefore, the use of developing technological tools and visual support systems in teaching intellectually disabled children problem solving skills, which are among the important mathematical skills, makes technology use an important part of this research as well.

Dandashly et al. (2019) examined the effects of two blended learning strategies on the academic achievement of pre-service teachers in two academic courses. Given that computer-aided videos and studies on mathematics teaching for children with intellectual disabilities are quite new and limited, further studies in this area are a necessity. From this point of view, the need has emerged to test the effectiveness of computer-aided video modelling in teaching mathematical problem-solving skills to individuals with intellectual disabilities. Moreover, resting upon the studies pointing to the effectiveness of the direct teaching method in teaching mathematics skills to individuals with intellectual disabilities, this study utilises the method of direct teaching. Studies show that the use of modelling with video is more effective than using static graphics, especially in recent years (Fiorella et al., 2019). Besides, the importance of visualization in mathematics teaching and the number of studies indicating the positive role of visualization as an approach to mathematics attitude and success are quite high (Kog & Baser, 2012; Eyyam & Yaratan, 2014; Wright et al., 2020).

This study aims to determine the effectiveness of computer-based video instruction in teaching problem-solving skills to students with intellectual disabilities. The findings of this research may be important for teachers and experts regarding theory and practice. In addition, the implementation of computer-based video instruction prepared in accordance with the learning characteristics of children with intellectual disabilities will contribute to both national and international literature. With its general aim to determine the effectiveness of computer-aided video modelling in teaching mathematical problem-solving skills that require addition and subtraction to students with mild intellectual disabilities, to our knowledge, this research is ground-breaking.

Method

Participants

The research was conducted in a special education and rehabilitation centre where six students who participated in the study were educated. The study was carried out four days a week between the hours of 9 am and 4 pm in an empty classroom. One of the participants was selected for the pilot scheme. Subjects' names were coded. The characteristics of the subjects are given in Table 1.

Table 1.
Demographic characteristics of the participants

	Name of the student	Gender	Age	Number of days he/she attended the institution	Diagnosis	Type of school
1	Ayşe	F	11	2	Mild intellectual disability	Inclusive Education + Special Education and Rehabilitation Centre
2	Ahmet	M	13	5	Mild intellectual disability	Inclusive Education + Special Education and Rehabilitation Centre
3	Hasan	M	12	5	Mild intellectual disability	Inclusive Education + Special Education and Rehabilitation Centre
4	Mert	M	11	2	Mild intellectual disability	Inclusive Education + Special Education and Rehabilitation Centre
5	Kemal	M	13	2	Mild intellectual disability	Inclusive Education + Special Education and Rehabilitation Centre
6	Hüseyin	M	12	3	Mild intellectual disability	Inclusive Education + Special Education and Rehabilitation Centre

The six subjects were an 11-year-old girl and five boys between the ages of 11 and 13. They were all diagnosed with mild intellectual disabilities and attended inclusive and special education and rehabilitation centres. A special education teacher established that the subjects met the prerequisites for the research implementation. They had no additional disabilities or problems.

The aim and the research process was explained in detail to the principal of the centre in an interview. The participation agreement was signed by the students, their families and the teachers. In addition, school administration and the families gave their permission for the students to be recorded on video camera. A pilot study was conducted to ensure the proper implementation of the actual research.

Problem solving requiring addition skills was examined among three participants and problem-solving requiring subtraction skills among other three participants. The prerequisites for participation were determined as:

a) ability to perform simple addition by hand with single-digit numbers;
b) ability to perform simple subtraction operation without decimal distortion;
c) knowledge of the concepts of multiplication and division;
d) following instructions;
e) regular school attendance.

Research model

This study utilised one of the single subject research methods with the aim of determining the effectiveness of computer-based video instruction in teaching mathematical problem-solving skills to students with mild intellectual disability.

Multiple probe design used in this study is based on the same behaviour of three or more subjects in the same environment. It is stated that this model has advantages such as easy implementation, not requiring methodical withdrawal of an effective application and direct monitoring of behavioural changes (Tekin-Iftar, 2012).

Research variables

The dependent variable in this research was the intellectually disabled students' ability of basic addition and subtraction in solving mathematical problems. Direct teaching via computer-based video models served as the independent research variable.

Development of computer-based videos

Twenty separate videos were created as models and guided practices for twenty mathematical problems, ten for teaching addition and ten for teaching subtraction. The videos were developed by a graphic design expert. At the model stage, the researcher explained all the mathematical problems, including all problem solving stages, and presented the model step by step. Simultaneously with the researcher explaining the problem in the video, it appeared in written form on screen. Furthermore, the graphic designer integrated the visuals of objects used in the problem in the video. In the end the researcher carried out the process using the objects, i.e. solved the problem.

After the development of the videos, they were evaluated by three experts (two from the field of special education and one from the field of computer education and instructional technologies) regarding the suitability of the subject area and targeted audience, appropriate colour usage, readability, text size, text style and figure-ground harmony. The experts used the *Evaluation Form for Visual Materials with Reflective Characteristics for Educational Purposes* developed by Uzunboylu (2008). This evaluation form includes a 4-point Likert-type scale (3 = excellent, 2 = acceptable, 1 = moderate, 0 = unacceptable).

Data collection tools

In each session, ten mathematics worksheets focusing on addition were used for the students who were taught problem-solving requiring addition skills and ten worksheets with subtraction problems for the students to whom problem-solving with subtraction was taught. The worksheets were written on A4 paper with Times New Romans characters. The camera was used to record all sessions.

Research process

Research stages

The research process entailed the following stages: the initial stage, probe, teaching, monitoring and skills transfer. All stages were conducted in the form of individual instruction in the special education and rehabilitation centre where the subjects were educated. In line with special education teachers' recommendations, social reinforcements were used throughout the entire process, such as *Well done!*, *Excellent!*

and applause. Moreover, the six subjects received a thank you and a present for their participation at the end of the study.

The probe stage entailed collective probe sessions and daily probe sessions. Collective probe sessions entailed four consecutive sessions for each subject. The first collective probe session comprised the initial level data obtained before the start of the teaching sessions; the second collective probe was done after the first subject had finished learning mathematical problem solving that required basic addition or subtraction; the third after teaching the second subject and the fourth after the completion of the third subject's teaching session. This cycle was carried out separately in both three-subject groups.

Probe sessions

The probe sessions of this research were classified into group and daily probe sessions. The subjects were asked to solve ten problems in each probe session. At the end of each session, the subject was verbally reinforced for her/his participation. The researcher did not respond to the right or wrong answer during the probe session and remained neutral.

Collective probe sessions

Four collective probe sessions were held for each subject to determine their initial skills and performances, after the stable data were obtained in accordance with the set criteria. The first collective probe session was conducted to collect the initial data. Collective probe sessions were held in the form of one-to-one instruction and with all the subjects simultaneously.

Three sessions with the first subject were held until stable results were obtained, after which the teaching stage was started with the first subject. When the first subject performed at a level that met the set criteria, the second collective probe was held for all subjects. Three sessions with the second subject continued until the stable data were obtained and, after that, the second subject started the teaching session. When the second subject performed at a level that meets the criteria, the third collective probe session was held for all subjects. In the third subject, three consecutive sessions were continued with the third subject until stable data were obtained, and then the teaching session began for the third subject. When the last subject performed well enough to meet the criterion, the final collective probe session was held for all the subjects.

Daily probe sessions

Daily probe sessions were conducted in a similar manner to collective probe sessions. However, in collective probe sessions data were collected for all the involved subjects, as opposed to daily probe sessions wherein the data on the performance of a single subject, i.e. trainee subject were gathered. Daily probe sessions were held before the training sessions.

Teaching sessions

After obtaining stable data at the initial level, the teaching of the targeted skill was started. Computer-assisted videos presented by the direct teaching method were used in the teaching sessions. They were held once a day over the course of four days with students in both groups simultaneously. Students were asked to solve ten problems requiring basic addition or subtraction skills. In the beginning, a model for each problem was shown in the videos, followed by the guided practice phase with instructions provided for each student. After these two stages, the student was given a paper with the same problem and asked to solve the problem independently. Namely, in the first two stages students were presented with the videos, and in the independent application stage they needed to solve the problems. Thus, all stages of direct instruction were realized.

Monitoring sessions

Follow-up sessions were conducted by the researcher ten and twenty days after the teaching sessions ended to assess the permanence of the acquired skill. These data were also collected via collective probe sessions by the researcher who gave the students a worksheet and said, 'Today, I'll work with you on problem solving. Are you ready? I want you to solve the problems now.' The researcher did not respond to wrong or right answers of the subject and remained neutral. At the end of the follow-up sessions, each subject was verbally reinforced for the participation. The obtained data were noted on worksheets used in the teaching sessions.

Skills transfer sessions

The data on the transference of skills were collected by special education subject teachers. It was investigated whether the subjects could transfer the acquired skills to different people, that is, whether or not they acquired the interpersonal skill. In addition, the data on the skills transfer were collected in different classes, i.e. on whether the subjects could transfer the acquired skills to another environment.

Data collection

Reliability of application

Application reliability regards the implementation of the research as planned. The analysis of the research implementation is used to control this factor (Tekin & Kircaali-İftar, 2001). Application reliability determines the degree to which the research implementation by the practitioner is appropriate. For this purpose, the application reliability form was created entailing the data on the targeted behaviours to be realized during the research implementation stage, and this form was controlled by the observers (Tekin-Iftar & Kırcaali-Iftar, 2004). A special education teacher, from the group that gathered interrater reliability data, collected the data on the reliability of this research, i.e. designed the form to evaluate the computer-based video instruction

with the following data: the name of the observer, research stages and the data on their realisation. The research reliability according to the gathered data was 100% for all subjects in all sessions.

Interrater reliability

Interrater reliability data were also collected within the scope of this research by two graduate students of special education, student teachers at the teaching department for intellectually impaired children who were doing their master's degree in special education at the time. Both observers took mathematics teaching courses during their undergraduate education. Interrater reliability was measured by comparing the records of the practitioner and the observer who conducted the reliability analysis. Interrater reliability coefficient of the study was obtained using the formula "Consensus/ Consensus + Disagreement) x 100" (Tawney & Gast, 1984), and it was found that it was satisfactory for each of the six subjects.

Skills transfer

The data on skills transfer between people and environments were collected via pre-test and post-test. The pre-test was performed immediately after the initial level of the first collective probe session and the final test was conducted right after the last collective probe session.

In transference sessions the researcher put the ten-question math worksheet in front of the student with the following instructions, 'I'm going to study problem solving with you now, ready? Solve the problems in your worksheet.' No reactions were provided for either right or wrong answers. When the subject did not respond, it was recorded as the wrong answer. The subjects were all verbally praised at the end of the process.

Data analysis

The data on the effectiveness, monitoring and skills transfer collected within the scope of this research were graphically analysed and interpreted. A linear graph prepared using Microsoft Excel 2010 program was used for graphical analysis. Data on skills transfer were analysed by comparing pre- and post-test sessions and shown in the column chart.

Research results

Results on the effectiveness of computer-based video modelling in teaching mathematical problem solving with addition

Results show that Ayşe gained the ability to solve mathematical problems after five teaching sessions with computer-aided video instruction provided by a direct teaching method. In addition to these findings, follow-up sessions were held with Ayşe ten and twenty days after the end of the training to assess the permanence of the skill. Ayşe responded correctly to 90% of the problems in the first follow-up session (ten days later) and to 80% in the second follow-up session (twenty days later).

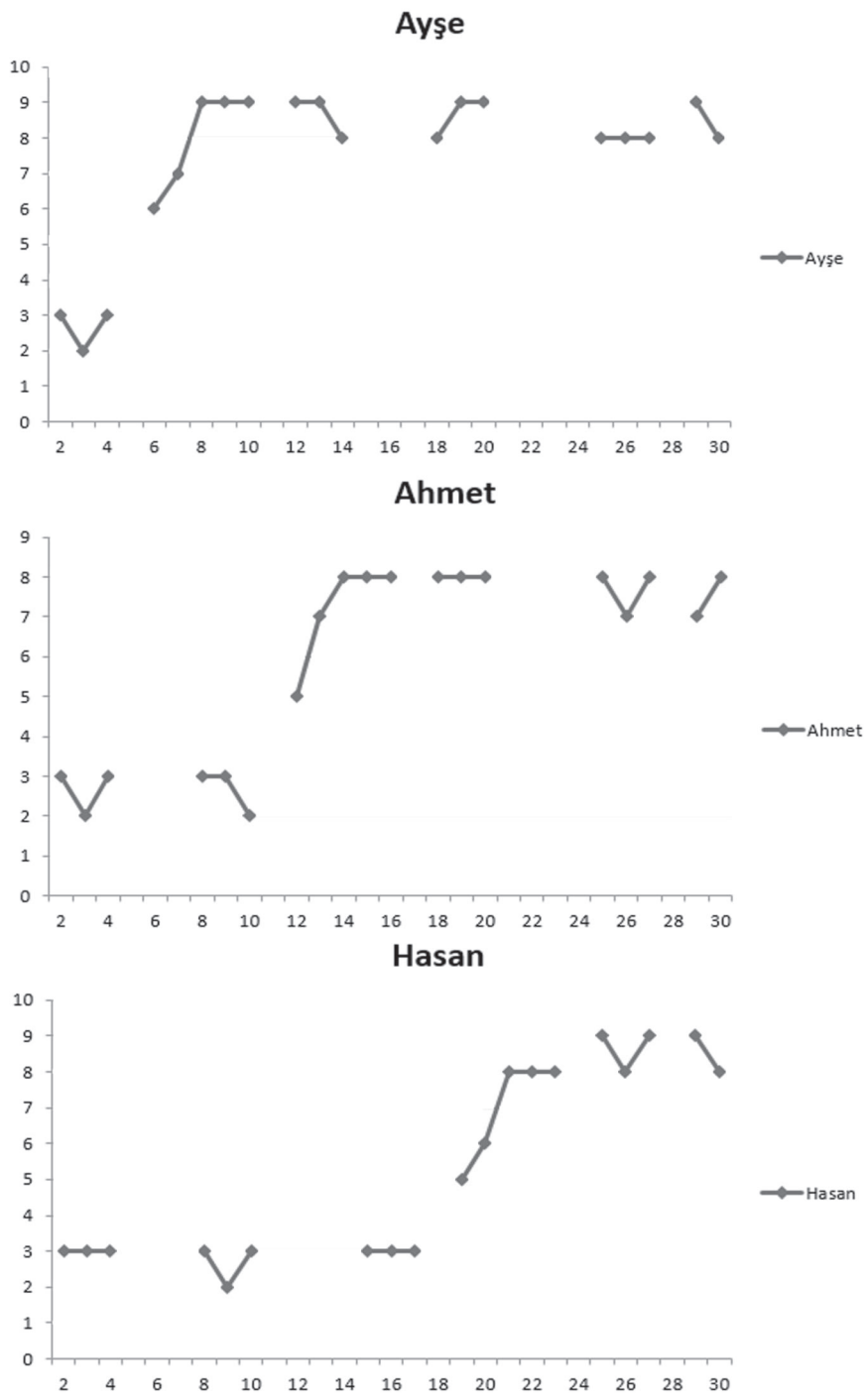

Figure 1. Probe, application and monitoring data on the direct teaching of mathematical problems that require addition via computer-based video

Ahmet gained the ability to solve mathematical problems at the end of five teaching sessions offered by computer-aided video modelling with a direct teaching method. Follow-up sessions were held ten and twenty days after the end of teaching. He responded correctly to 70% of the questions in the first monitoring session and to 80% of the questions in the second monitoring session.

The results show that Hasan gained the ability to solve mathematical problems at the end of five teaching sessions offered by computer-assisted video instruction provided by a direct teaching method. Ten and twenty days after the end of training with Ahmet, follow-up sessions were held and he responded correctly to 70% of the problems in the first monitoring session and to 80% in the second monitoring session.

Based on the findings obtained in the follow-up, i.e. monitoring sessions, it can be concluded that the targeted mathematical problem solving skills gained through modelling with computer-based videos presented with the direct teaching method were maintained by the subjects ten and twenty days after instruction. In line with this finding, it can be concluded that computer-based video instruction is effective in teaching mathematical problem-solving skills that require addition to students with mild intellectual disabilities.

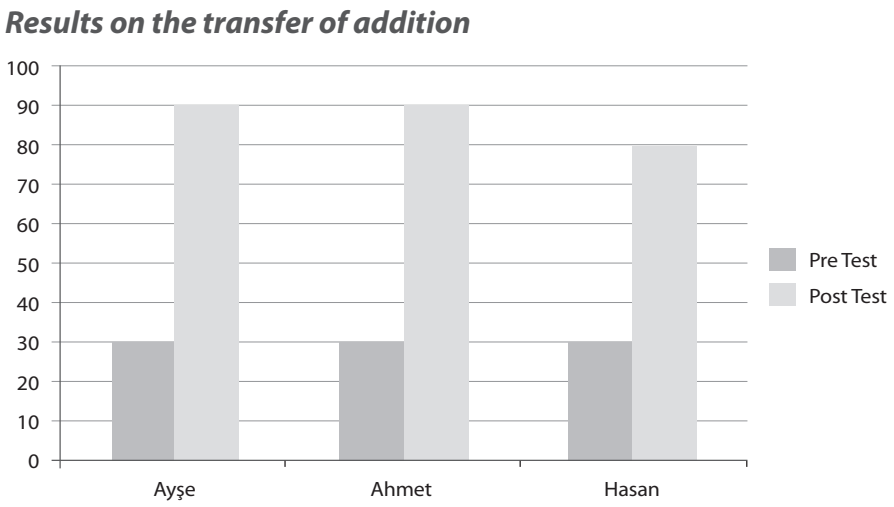

Figure 2. Data on skills transfer for the group in which problem-solving that required addition was taught

Skills transfer sessions were conducted in this study in a different classroom than the classroom where the teaching sessions were held, and six interpersonal skills transfer sessions were conducted with other teachers. The results are given in Figure 2.

In the pre-test session, Ayse and Ahmet scored 30% and 90% in the post-test, while Hasan scored 30% on the pre-test and 80% on the post-test. In light of these findings, it can be concluded that the subjects were able to transfer the acquired skills to different environments and different people as a result of instruction based on computer-aided video.

Results on the effectiveness of computer-based video modelling in teaching mathematical problem solving with subtraction

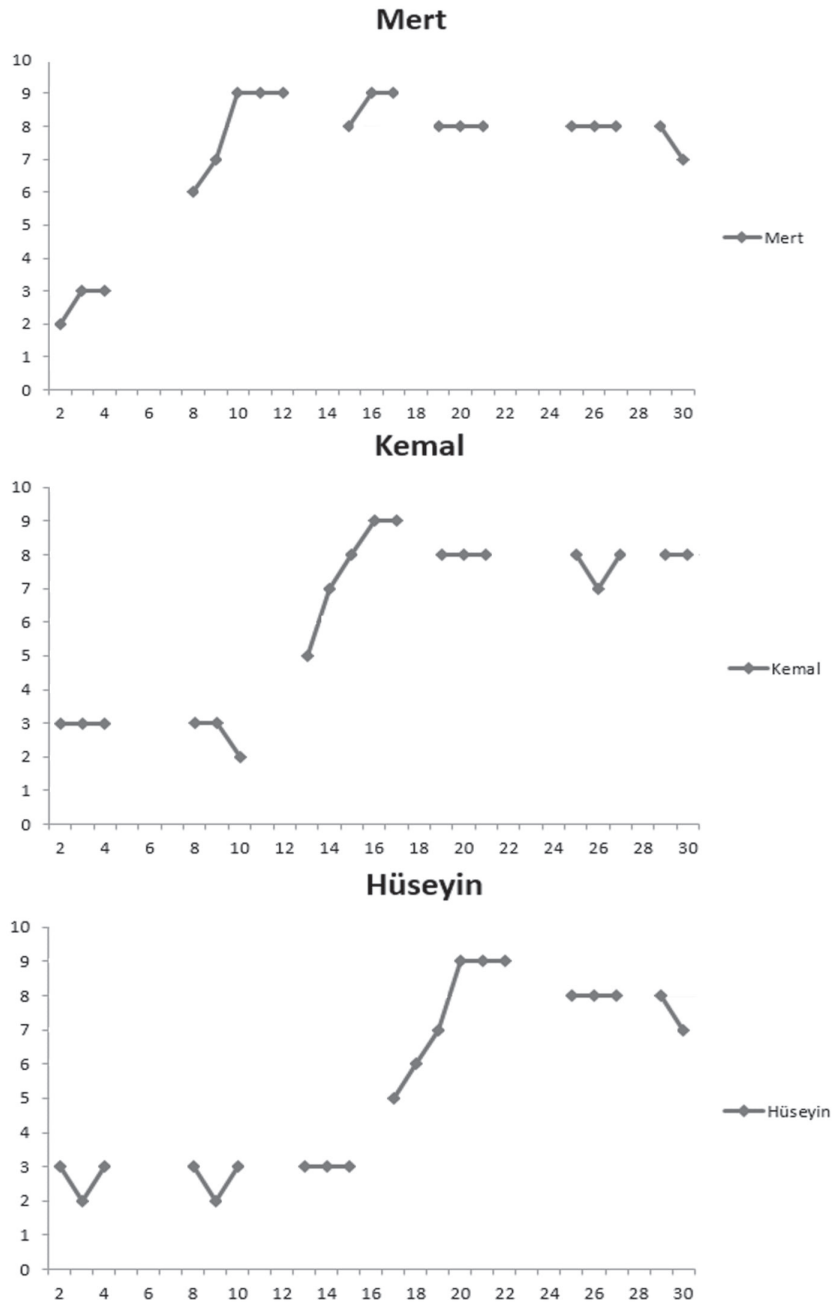

Figure 3. Probe, application and monitoring data on the direct teaching of mathematical problems that require subtraction via computer-based video

These findings suggest that Mert gained the ability to solve mathematical problems at the end of five direct teaching sessions in the form of computer-based video modelling. The follow-up sessions were held ten and twenty days after the end of instruction, as with the subjects in the first group. Mert responded to 80% of the problems correctly in the first follow-up session (ten days later) and to 70% in the second follow-up session (twenty days later). Kemal gained the ability to solve mathematical problems at the end of five teaching sessions. In the monitoring sessions Kemal had 80% correct responses in the first monitoring session and 80% in the second monitoring session.

Hüseyin gained the ability to solve mathematical problems after five completed teaching sessions. In the follow-up sessions Hüseyin had 80% correct responses ten days later and 70% in the second monitoring session held twenty days later.

Based on the findings obtained in the follow-up sessions, it can be concluded that the targeted mathematical problem-solving skills gained through modelling with computer-based videos, presented by the direct teaching method, were maintained by the subjects ten and twenty days after instruction. Thus, it can be concluded that computer-based video instruction is effective in teaching students with mild intellectual disabilities mathematical problem-solving skills that require subtraction.

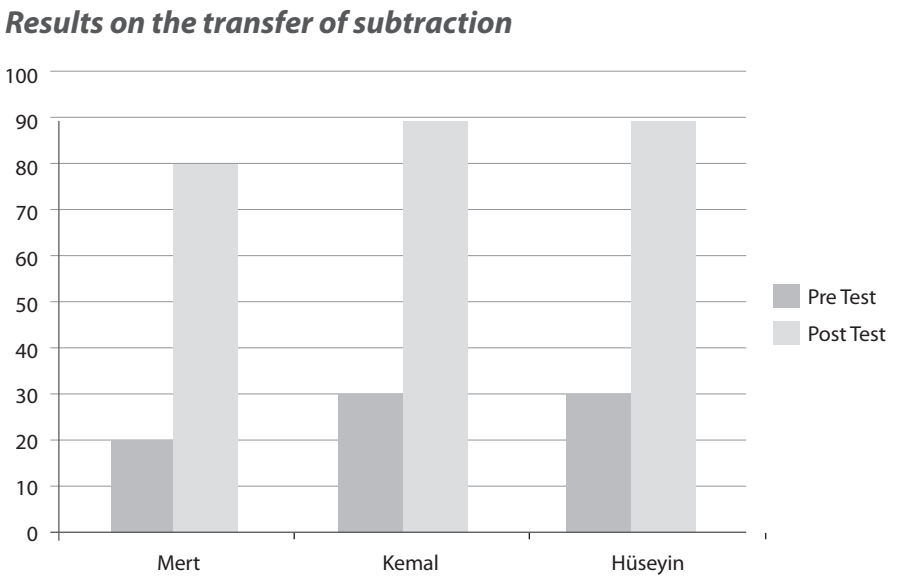

Figure 4. Data on skills transfer for the group in which problem-solving that required subtraction was taught

As presented in Figure 4, Mert performed 20% in the pre-test and 80% in the post-test session, Kemal scored 30% in the pre-test and 90% in the post-test while Hüseyin's performance in the pre-test session was 30% and 90% in the post-test. In light of these findings, it can be concluded that the subjects could transfer the acquired skills to different environments and people as a result of direct instruction via computer-based videos.

Discussion and conclusion

The findings of this study suggest that computer-based video instruction is effective in teaching mathematical problem-solving skills requiring addition and subtraction to students with mild intellectual disabilities. In addition, the monitoring data showed that the participants were able to transfer the acquired mathematical problem-solving skills after teaching and maintain it. Furthermore, the findings of this research are consistent with the results of previous studies examining the effectiveness of video use in teaching mathematics skills to individuals with intellectual disabilities in the literature (Burton et al., 2013; Saunders et al., 2017).

According to the results of this study, the subjects showed considerable interest in computers and video screenings from the beginning of the teaching sessions in which computer-based video instruction was used. Therefore, it is considered that since the students have high interest and motivation for technologies such as computer and video, they gain the targeted skills more easily. This reinforces the assumption that video-based instruction increases student interest and motivation, similar to the findings in related literature (Kebritchi et al., 2010).

In the current study, the direct teaching method was used for teaching mathematical problem-solving skills that require addition and subtraction, which makes it a pioneer in this field in terms of investigating the use of videos via direct teaching of mathematics skills. The findings of this study are consistent with the findings of other studies in the literature showing that the direct teaching method is effective in teaching students with intellectual disabilities mathematical problem-solving skills (Jitendra & Xin, 1997; Montague, 2008; Elicin et al., 2013; Takahashi et al., 2016).

Another result obtained in this study showed that the effects of teaching with computer-based video presented by the direct teaching method continued on the 10^{th} and 20^{th} day after the acquisition of problem-solving skills that required addition and subtraction. Along these lines, Yakubova et al. (2015) aimed to determine the effectiveness of a video-based application in teaching fractional problems to students with autism spectrum disorder. The findings showed that the number of correct answers of all students in solving fractional problems increased considerably and the results of a one-week follow-up evaluation session showed they retained the acquired skill.

The findings show that computer-based video instruction, implemented via the direct teaching method, enabled students to transfer the gained problem-solving skills to a working situation with different teachers and in other environments. The students were able to solve the problems in a way that met the criteria in skills transfer sessions after the end of the teaching sessions with the researcher. Along these lines, Burton et al. (2013) examined the effectiveness of the use of video-based applications in teaching functional mathematics skills to students with autism spectrum disorder and intellectual disability and found that students were able to maintain these skills and transfer them into different environments in later teaching sessions.

This research has some limitations. One of these was a difficult access to computers at certain times and in some conditions, and limited financial resources of institutions and families. Furthermore, since using computers may create addictive behaviour among students, this can also be seen as a drawback. It may be challenging for teachers or families who continue this education at home, because students may want to turn on computers or use computers in different activities or courses.

The evaluation of students' problem-solving skills acquisition according to their results rather than the process itself could be seen as another limitation of the study.

Today, technology-assisted teaching practices in the field of special education have become increasingly common and important (Sabayleh & Alramamneh, 2020; Elicin, 2016; Ismaili & Ouazzani-Ibrahimi, 2017). In addition, as mentioned before, studies are showing the positive contribution of direct teaching and video-based model applications to mathematics learning for students with intellectual disabilities. This study, where students with intellectual disabilities were provided with direct teaching consisting of technology-supported applications, especially model and guided applications, will shed light on the related literature and mathematics teaching applications in special education. In addition, this research provides a very important finding since a complex skill such as problem solving, which is challenging for individuals with intellectual disabilities to gain cognitively, can be gained through computer-based video teaching applications. At this point, instead of using traditional teaching methods or other teaching methods alone, the integration of videos into teaching will make positive contributions to the teaching practice and student learning.

This study is crucial as, to our knowledge, it is one of the first studies conducted in North Cyprus on computer-assisted video instruction in the field of teaching mathematical problem-solving skills to students with intellectual disabilities, and it will contribute to the literature and special education applications in North Cyprus.

In conclusion, the findings have revealed the effectiveness of computer-assisted video instruction in teaching mathematical problem-solving skills that require basic addition and subtraction operations to students with mild intellectual disabilities.

Recommendations

Some recommendations for further research and practices are provided based on the results: teachers working with students with intellectual disabilities should use computer-aided video modelling to teach mathematical problem-solving skills; videos developed and used within the scope of this research can be distributed to schools as a package program; an elective university course can be organised at special education departments under the suggested name *Using Video-Supported Model Applications in Special Education*; the effectiveness of direct teaching with computer-aided video modelling can be studied with different practitioners (e.g., peers and class teachers) and in different settings (general education classes); the effectiveness of computer-based video modelling as a direct teaching method in teaching mathematical problem-solving

skills to individuals with different types and degrees of disability can be investigated in the future; computer-based video modelling can also be carried out based on different teaching methods such as methods of errorless teaching for different types of problems, such as multiplication and division; in teaching mathematics problem-solving skills, it is possible to compare the efficiency of computer-assisted video modelling to the effects of traditional (paper-pencil) teaching methods in future research.

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Učinci računalnih videomodela u poučavanju učenika s intelektualnim teškoćama vještinama rješavanja matematičkih problema

Sažetak

Cilj je ovoga istraživanja utvrditi učinkovitost računalnih videomodela u poučavanju učenika s intelektualnim teškoćama vještinama rješavanja matematičkih problema zbrajanjem i oduzimanjem. U istraživanju je korištena tehnika višestrukoga ispitivanja sa svim sudionicima, jednom djevojčicom i petoricom dječaka s intelektualnim teškoćama u dobi od 11 do 13 godina. Za vrijeme provođenja istraživanja učenici su pohađali Centar za obrazovanje i rehabilitaciju djece s posebnim potrebama u Nikoziji u Sjevernom Cipru. Prikupljeni su podatci analizirani, objašnjeni i prikazani u grafovima. Dobiveni rezultati pokazuju učinkovitost računalne videopoduke učenika s intelektualnim teškoćama vještinama rješavanja matematičkih problema zbrajanjem i oduzimanjem. Učenici su zadržali naučenu vještinu i bili je sposobni prenijeti na različito okruženje (razred) i osobe (učitelje).

Ključne riječi: *intelektualne teškoće; izravno poučavanje; računalni videomodeli; rješavanje problema.*

Uvod

Pravo na obrazovanje odnosi se na sve. Obrazovna politika podrazumijeva i odredbe kojima se regulira obrazovanje u centrima za djecu s posebnim potrebama (Silva i Alves, 2019; Ozcan i Merdan, 2020). Agha i ELDaou (2018) istraživali su usluge koje ti centri pružaju učenicima od prvoga do šestoga razreda i način na koji učitelji i stručni suradnici zadovoljavaju posebne potrebe sudionika. Matematika je sveobuhvatna disciplina koja se odražava u svakom aspektu života (Isik i sur., 2008). Iako neprimijećene u svakodnevnoj rutini, mnoge su vještine nužne za njezino održavanje koje zahtijevaju matematičko znanje, poput prepoznavanja datuma i točnoga vremena, podizanja novca s bankomata, namještanja stupnjeva na pećnici, biranja broja na telefonu, prepoznavanja cijena prilikom kupovine itd. (Yikmis i Cetin, 2010; Ojose, 2011).

Učenici s intelektualnim teškoćama imaju problema u stjecanju i prenošenju matematičkoga znanja i vještina (Yikmis, 2005; Zeenat, 2019). Ipak, oni mogu naučiti matematiku na druge načine. Jasne, razumljive, precizne i dobro osmišljene obrazovne strategije i primjerene prilagodbe pomažu učenicima s posebnim potrebama u stjecanju matematičkih vještina, razumijevanju koncepata i prenošenju naučenih strategija (Saunders i sur., 2016; Rexroat-Frazier i Chamberlin, 2019).

Rješavanje problema promatra se kao važan element učenja matematike. Učenici uključeni u smislen proces rješavanja problema stječu osnovne vještine i napredne procese razmišljanja važne za razvoj strategija rješavanja problema. Kasap i Ergenekon (2017) navode kako upotreba verbalnih matematičkih problema doprinosi uspješnom rješavanju svakodnevnih problema učenika i povezuje matematičke koncepte sa svakodnevnim životnim situacijama te također spominju i važnost upotrebe problema u učenju i poučavanju matematike.

Pregled literature otkriva mnoge različite metode, tehnike i strategije koje se koriste u poučavanju vještina rješavanja problema (Devedzic i Devedzic, 2019). *TouchMath* aplikacija (Mostafa, 2013), *Razumij i riješi!* (Karabulut, 2015), poučavanje zasnovano na shemama (Rockwell i sur., 2011; Kot, 2014) i videomodeli (Yakubova i sur., 2015) neke su od često korištenih tehnika u poučavanju vještina rješavanja problema. U novije vrijeme zabilježen je porast broja istraživanja i aplikacija povezanih uz upotrebu videa i animacija u poučavanju matematike djece s intelektualnim teškoćama. Istraživanja pokazuju da primjerene kombinacije poput naracije i videa te animacija ili slika prikazanih uz riječi na koje se odnose mogu povećati uspjeh učenja putem multimedijskih materijala (Yilmaz i Talas, 2015).

Rezultati evaluacije upotrebe tehnoloških obrazovnih aplikacija u radu s pojedincima s intelektualnim teškoćama pokazuju da ti učenici postižu bolji uspjeh kada koriste obrazovne aplikacije na tehnološkim uređajima (Baglama i sur., 2018). Istraživanja upotrebe tehnologije u matematičkom obrazovanju pokazuju da se današnje kontinuirano promjenjive i napredne tehnološke inovacije uspješno koriste u obrazovanju djece s intelektualnim teškoćama (Burton i sur., 2013; Pitchford i sur., 2018).

Postoje istraživanja koja ukazuju na učinkovitu upotrebu tehnoloških uređaja u poučavanju učenika rješavanju problema (Inaltekin, 2020; Read, 2020). Štoviše, pregled literature naglašava da upotreba tehnoloških alata ima prednosti prilikom poučavanja djece s intelektualnim teškoćama rješavanju problema (Twyman i Tindal, 2006; Adebisi i sur., 2015). Stoga upotreba razvijenih tehnoloških alata i sustava vizualne podrške u poučavanju intelektualno zakinute djece vještinama rješavanja problema, kao važnim matematičkim vještinama, čini upotrebu tehnologije važnim dijelom i ovoga istraživanja.

Dandashly i suradnici (2019) istraživali su učinke dviju mješovitih strategija učenja na akademsko postignuće budućih učitelja u dva sveučilišna kolegija. S obzirom da su računalno potpomognuti videozapisi i istraživanje poučavanja djece s intelektualnim

teškoćama matematici novi i ograničenoga opsega, potrebna su daljnja istraživanja u ovome području. S obzirom na to, pojavila se potreba za testiranjem učinkovitosti računalno potpomognute videonastave u području poučavanja vještina rješavanja matematičkih problema učenika s intelektualnim teškoćama. Štoviše, oslanjajući se na načela istraživanja koja pokazuju učinkovitost metode neposrednoga poučavanja matematičkih vještina učenicima s intelektualnim teškoćama, ovo istraživanje također koristi, tj. utemeljeno je na metodi izravnoga poučavanja. Istraživanja pokazuju da su videomodeli učinkovitiji od statičkih grafičkih prikaza, posebno u posljednjim godinama (Fiorella i sur., 2019). Osim toga, važnost vizualizacije u nastavi Matematike i broj istraživanja koja pokazuju pozitivnu ulogu vizualizacije kao pristupa matematičkom stavu i uspjehu prilično je visok (Kog i Baser, 2012; Eyyam i Yaratan, 2014; Wright i sur., 2020).

Ovim se istraživanjem nastoji utvrditi učinkovitost računalne videopouke u području stjecanja vještina rješavanja problema učenika s intelektualnim teškoćama. Rezultati ovoga istraživanja mogu biti važni za učitelje i stručnjake u teoriji i praksi. Osim toga, primjena računalnoga videopoučavanja pripremljenoga u skladu s karakteristikama učenja djece s intelektualnim teškoćama doprinijet će oboje nacionalnoj i međunarodnoj literaturi. Sa svojim općim ciljem utvrđivanja učinkovitosti računalnoga videomodeliranja u poučavanju vještina rješavanja matematičkih problema učenika s blagim intelektualnim teškoćama, prema našim saznanjima, ovo je istraživanje revolucionarno.

Metoda

Sudionici

Ovo istraživanje provedeno je u Centru za obrazovanje i rehabilitaciju djece s posebnim potrebama koji je pohađalo šest učenika (ispitanika u istraživanju). Istraživanje je provedeno tijekom četiri dana u tjednu u vremenu između devet sati ujutro i četiri sata popodne, u praznoj učionici. Jedan od ispitanika odabran je za pokusno istraživanje. Imena su ispitanika kodirana, a njihovi su demografski podatci predstavljeni u Tablici 1.

Tablica 1.

Šestero ispitanika bili su jedanaestogodišnja djevojčica i petorica dječaka u dobi od jedanaest do trinaest godina. Svi su imali dijagnozu blage intelektualne invalidnosti i pohađali su centre inkluzivnoga obrazovanja i centar za posebno obrazovanje i rehabilitaciju. Učitelj djece s posebnim potrebama ustanovio je da svi ispitanici zadovoljavaju preduvjete za sudjelovanje u istraživanju. Ispitanici nisu imali dodatnih problema, ni onih s pohađanjem nastave.

Cilj istraživačkoga procesa detaljno je objašnjen ravnatelju centra u intervjuu. Ugovor o sudjelovanju potpisali su učenici, njihove obitelji i učitelji. Osim toga, dobivena je dozvola školske administracije i obitelji da se učenici snimaju videokamerom. Pokusna studija provedena je kako bi se osigurala valjana provedba istraživanja.

Vještine rješavanja problema zbrajanjem ispitivane su s tri ispitanika, a vještine rješavanja problema oduzimanjem s druga tri ispitanika. Preduvjeti za sudjelovanje u istraživanju bili su sljedeći:

a) sposobnost zbrajanja jednoznamenkastih brojeva (uz upotrebu prstiju)
b) sposobnost oduzimanja jednoznamenkastih brojeva bez decimala
c) poznavanje koncepata množenja i dijeljenja
d) slijeđenje uputa
e) redovito pohađanje škole.

Model istraživanja

U ovome istraživanju korištena je jedna od metoda istraživanja s jednim ispitanikom s ciljem utvrđivanja učinkovitosti računalne videopouke vještina rješavanja matematičkih problema učenika s blagim intelektualnim teškoćama.

Model višestrukoga ispitivanja korišten u ovome istraživanju zasnovan je na ponavljanju istoga ponašanja tri ili više ispitanika u istom okruženju. Navode se prednosti ovoga modela poput lake primjene, izostanka potrebe metodičkoga opoziva učinkovite primjene i direktno nadgledanje promjena ponašanja (Tekin-Iftar, 2012).

Varijable

Zavisna varijabla u ovome istraživanju bila je osnovna sposobnost zbrajanja i oduzimanja učenika s intelektualnim teškoćama. Neposredno poučavanje putem računalnih videomodela bila je nezavisna istraživačka varijabla.

Razvoj računalnih videozapisa

Stvoreno je dvadeset odvojenih videa koji su služili kao modeli i vođene vježbe za dvadeset matematičkih problema, deset za poučavanje zbrajanja i deset za poučavanje množenja. Videa je kreirao grafički dizajner. U stadiju modela istraživač je objasnio matematički problem, uključujući sve faze rješavanja problema i predstavio model korak po korak. Istovremeno dok je istraživač objašnjavao problem na videu, na ekranu se pojavljivao i pisani tekst. Osim toga, grafički je dizajner u video uključio slike predmeta koji su se pojavljivali u problemu. Nakon objašnjenja istraživač je riješio problem koristeći predmete.

Troje stručnjaka evaluiralo je videa (dva iz područja obrazovanja djece s posebnim potrebama i jedan iz polja računalnoga obrazovanja i obrazovnih tehnologija) prema primjerenosti predmetnoga područja i ciljanoga uzorka, primjerenosti upotrebe boja, čitljivosti, veličini teksta, stilu teksta i usklađenosti figura i pozadine. Stručnjaci su koristili obrazac za evaluaciju koji je osmislio Uzunboylu (2009), tj. *Evaluacijski obrazac za vizualne materijale s refleksivnim karakteristikama za obrazovane svrhe.* Ovaj obrazac sadrži četverostupanjsku skalu Likertova tipa (3 = odlično, 2 = prihvatljivo, 1 = umjereno, 0 = neprihvatljivo). Neke snimke zaslona iz videa prikazane su u Tablici 2.

Instrumenti za prikupljanje podataka

U svakome mjerenju upotrijebljeno je deset matematičkih radnih listića sa zbrajanjem za učenika koje se poučavalo vještinama rješavanja problema zbrajanjem i deset radnih listova s problemima oduzimanja za učenika koje se poučavalo vještinama rješavanja problema oduzimanjem. Radni listići napisani su na listu formata A4 Times New Roman fontom. Sva mjerenja, tj. dijelovi poučavanja, snimljeni su kamerom.

Proces istraživanja

Stadiji istraživanja

Istraživanje se odvijalo kroz sljedeće stadije: inicijalni stadij, pohađanje, poučavanje, praćenje i prijenos vještina. Svi su stadiji provedeni u obliku individualne pouke u Centru za obrazovanje i rehabilitaciju učenika s posebnim potrebama u kojemu su ispitanici obrazovani. U skladu s preporukama učitelja djece s posebnim potrebama, korišteni su izrazi poput *Bravo!, Odlično!* i aplauza u svrhu osnaživanja djece, tj. pohvale. Osim toga, šest ispitanika primilo je usmenu zahvalu i poklon za sudjelovanje u istraživanju.

Stadij pohađanja uključivao je grupno ispitivanje i dnevno ispitivanje, tj. mjerenje. Grupno mjerenje uključivalo je četiri uzastopne sesije ispitanika. Prvi grupni intervju proveden je kako bi se sakupili početni podatci i proveden je prije početka poučavanja; drugo grupno ispitivanje provedeno je nakon što je prvi ispitanik završio učenje matematičkih problema sa zbrajanjem ili oduzimanjem; treće mjerenje nakon što je drugi ispitanik završio s nastavom i četvrto nakon završetka poučavanja trećega ispitanika. Ovaj ciklus odvijao se odvojeno u obje skupine od tri ispitanika. Dnevno mjerenje održavalo se izvan nastave, prije ostalih ispitivanja.

Stadij mjerenja

Stadij ispitivanja, tj. mjerenja ovoga istraživanja, podijeljen je u skupno i dnevno ispitivanje. Od ispitanika se tražilo da riješe deset problema u svakom mjerenju. Na kraju svakog ispitivanja, ispitanici su primili usmenu zahvalu za sudjelovanje. Istraživač nije reagirao na točne niti netočne odgovore i ostao je neutralan.

Grupno mjerenje

Četiri grupna ispitivanja, tj. mjerenja provedena su sa svakim ispitanikom kako bi se utvrdile njihove inicijalne vještine i izvedba nakon što su dobiveni stabilni podatci u skladu s postavljenim kriterijima. Prvo grupno ispitivanje provedeno je kako bi se sakupili početni podatci. Grupna mjerenja održana su u obliku poduke jedan-na-jedan i sa svim ispitanicima istovremeno.

Tri su mjerenja provedena s prvim ispitanikom, do postizanja stabilnih rezultata, nakon čega je započet stadij poučavanja prvoga ispitanika. Nakon što je prvi ispitanik postigao razinu koja zadovoljava kriterije, provedeno je drugo grupno ispitivanje za sve ispitanike. S drugim ispitanikom također su održana tri mjerenja do postizanja

stabilnih podataka, nakon čega je za njega otpočeo stadij poučavanja. Nakon što je drugi ispitanik rješavao probleme na razini koja zadovoljava kriterije, održano je treće grupno mjerenje sa svim ispitanicima. Za trećega ispitanika također su održana tri ispitivanja dok nisu dobiveni stabilni podatci i tada je za istoga počela nastava, tj. faza poučavanja. Kada je i posljednji ispitanik u grupi stekao ciljanu vještinu, tj. rješavao probleme na razini zadovoljenja postavljenih kriterija, održano je završno grupno ispitivanje za sve ispitanike.

Dnevno mjerenje

Dnevna ispitivanja provedena su na sličan način kao grupna. Ipak, u grupnim mjerenjima podatci su sakupljeni za sve uključene ispitanike, za razliku od dnevnih mjerenja u kojima su prikupljani podatci o jednom ispitaniku, tj. učeniku. Dnevna mjerenja odvijala su se drugim danima prije faze poučavanja, osim prvoga dana.

Poučavanja

Nakon dobivanja stabilnih podataka na početnoj razini, započelo je poučavanje ciljane vještine. Računalno utemeljena videa predstavljena metodom neposrednoga poučavanja upotrijebljena su u fazi nastave. Ona je trajala jedan sat tijekom četiri dana. Nastava se održavala jednom dnevno s učenicima u obje grupe istovremeno. Od učenika se tražilo da riješe deset problema s osnovnim operacijama zbrajanja ili oduzimanja. U početnoj fazi prikazan je model na videu za svaki problem, nakon čega je uslijedila faza vođene vježbe s uputama za svakoga učenika. Nakon ove dvije faze učenici su dobili papir s istim problemom koji su trebali riješiti samostalno. Naime, u prve dvije faze učenicima su prezentirana videa, a u fazi neovisne primjere trebali su riješiti probleme. Na taj su način ostvarene sve faze neposredne pouke.

Kontrolni stadij

Kontrolnu fazu proveo je istraživač deset i dvadeset dana nakon završetka nastave kako bi se procijenila trajnost stečene vještine. Te podatke sakupljao je istraživač tako što je ispitanicima podijelio radne listove i rekao: „Danas ćete rješavati probleme, jeste li spremni? Možete započeti s rješavanjem." Istraživač nije reagirao na točna ni netočna rješenja ispitanika. Na kraju kontrolne faze svaki je učenik usmeno pohvaljen za sudjelovanje. Dobiveni podatci zabilježeni su na radne listove koji su korišteni u fazi poučavanja.

Ispitivanje prijenosa vještina

Podatci o prijenosu vještina sakupljali su predmetni učitelji učenika s posebnim potrebama. Cilj je bio ispitati mogu li ispitanici prenijeti stečene vještine na druge ljude, tj. jesu li stekli interpersonalnu vještinu. Osim toga sakupljeni su podatci o prijenosu vještine na različite razrede, tj. nastojalo se utvrditi mogu li ispitanici prenijeti stečenu vještinu na druge okoline.

Prikupljanje podataka

Pouzdanost provedbe istraživanja

Pouzdanost primjene odnosi se na provedbu istraživanja prema planu. Analiza pouzdanosti provedbe koristi se radi kontrole ovoga čimbenika (Tekin i Kircaali-İftar, 2001). Pouzdanost provedbe određuje stupanj primjerenosti izvedbe istraživanja koje je proveo praktičar. Za tu svrhu osmišljen je obrazac pouzdanosti provedbe koji sadrži podatke o ponašanjima koja se nastoji ostvariti tijekom stadija provedbe istraživanja, a koje kontroliraju promatrači (Tekin-Iftar i Kırcaali-Iftar, 2004). Učitelj posebnoga obrazovanja, iz skupine koja je prikupljala podatke o pouzdanosti među ocjenjivačima, prikupio je podatke o pouzdanosti provedbe istraživanja, tj. osmislio obrazac kako bi evaluirao računalnu videopouku prema sljedećim kriterijima: ime promatrača, stadiji istraživanja i podatci o njihovoj realizaciji. Pouzdanost provedbe istraživanja prema prikupljenim podatcima bila je stopostotna za sve ispitanike i sve dijelove istraživanja.

Pouzdanost među ocjenjivačima

Podatke o pouzdanosti među ocjenjivačima u ovome istraživanju sakupljala su dva studenta poslijediplomskoga studija na odsjeku za obrazovanje budućih učitelja djece s intelektualnim teškoćama koji su u vrijeme istraživanja radili na magisteriju u području posebnoga obrazovanja. Oba promatrača pohađala su kolegije iz matematike tijekom dodiplomskoga studija. Pouzdanost među ocjenjivačima izmjerena je uspoređivanjem zapisa praktičara/istraživača i promatrača koji su proveli analizu pouzdanosti. Koeficijent pouzdanosti među ocjenjivačima dobiven je upotrebom formule (Slaganje/slaganje + neslaganje) x 100 (Tawney i Gast, 1984) i bio je zadovoljavajući za svakog od šest ispitanika.

Prijenos vještina

Podatci o prijenosu vještina na druge ljude i okoline sakupljeni su predtstom i posttestom. Predtest je primijenjen odmah nakon inicijalne razine prvoga grupnog mjerenja, a završni (posttest) odmah nakon posljednjega grupnog mjerenja.

U dijelu istraživanja koji je za cilj imao utvrditi sposobnost prijenosa vještina ispitanika istraživač je učenicima dao deset radnih listića uz sljedeću uputu: „Sada ću s vama proučiti rješavanje problema, jeste li spremni? Riješite probleme na svom radnom listiću." Istraživač ni na koji način nije reagirao na točne ili netočne odgovore. Izostanak odgovora ispitanika bilježio se kao netočan odgovor. Ispitanike se usmeno pohvalilo nakon završetka procesa.

Analiza podataka

U ovome istraživanju sakupljeni su podatci o učinkovitosti, zadržavanju i prijenosu stečenih vještina. Podatci su zatim analizirani, grafički prikazani i objašnjeni. Za grafičku analizu korišten je program Microsoft Excel 2010. Podatci o prijenosu vještina analizirani su usporedbom rezultata predtesta i posttesta u stupčastom dijagramu.

Rezultati istraživanja

Rezultati o učinkovitosti računalnoga videomodeliranja u poučavanju vještine rješavanja matematičkih problema zbrajanjem

Graf 1.

Rezultati su pokazali da je Ayşe stekla sposobnost rješavanja matematičkih problema nakon pet sati nastave putem neposredne metode poučavanja upotrebom računalnih videa. Osim toga, Ayşe je sudjelovala u kontrolnom mjerenju deset i dvadeset dana nakon poučavanja. Cilj toga mjerenja bio je utvditi trajnost stečene vještine, a Ayşe je točno odgovorila na 90 % pitanja u prvom mjerenju (deset dana nakon pouke) i na 80 % u drugom mjerenju (dvadeset dana nakon pouke).

Ahmet je stekao vještinu rješavanja problema nakon pet sati neposredne pouke uz upotrebu računalnih videa. Kontrolna mjerenja provedena su kao i s ostalim ispitanicima, deset i dvadeset dana nakon pouke. Ahmet je točno odgovorio na 70 % pitanja u prvom, a na 80 % u drugom dijelu kontrolnoga mjerenja.

Rezultati pokazuju da je Hasan usvojio sposobnost rješavanja matematičkih problema zbrajanjem nakon pet sati pouke putem računalnih videa. Deset i dvadeset dana nakon pouke, Ahmet je točno riješio 70 % problema u prvom kontrolnom mjerenju i 80 % problema u drugom.

Na osnovi rezultata dobivenih u kontrolnom mjerenju može se zaključiti da su ciljane vještine rješavanja matematičkih problema stečene putem neposredne pouke uz upotrebu videomodela ispitanici zadržali deset i dvadeset dana nakon pouke. U skladu s tim rezultatom može se zaključiti da je neposredna videopouka učenika s blagim intelektualnim teškoćama u rješavanju matematičkih problema zbrajanjem i oduzimanjem učinkovita.

Rezultati o prijenosu vještine zbrajanja

Slika 2.

Mjerenja prijenosa vještina u ovome istraživanju provedena su u različitoj učionici od one u kojoj se odvijala nastava. Održano je šest mjerenja prijenosa vještina na druge učitelje, tj. interpersonalnoga prijenosa. Rezultati su predstavljeni na Slici 2.

Ayse i Ahmet su imali su 30 % riješenosti u predtestu, a u posttestu 90 %, dok je Hasan imao 30 % točnosti na predtestu i 80 % na posttestu. U svjetlu ovih rezultata može se zaključiti da su ispitanici sposobni prenijeti stečene vještine na različite okoline i ljude kao rezultat pouke računalnim videima.

Rezultati o učinkovitosti računalnoga videomodeliranja u poučavanju rješavanja matematičkih problema oduzimanjem

Slika 3.

Ovi rezultati pokazuju da je Mert usvojio sposobnost rješavanja matematičkih problema na kraju pet neposrednih pouka putem računalnih videomodela. Kontrolna

mjerenja provedena su deset i dvadeset dana nakon pouke, kao i s ispitanicima iz prve skupine. Mert je točno odgovorio na 80 % problema u prvom kontrolnom mjerenju (deset dana nakon pouke) i na 70 % u drugom (dvadeset dana kasnije).

Kemal je stekao sposobnost rješavanja matematičkih problema oduzimanjem nakon pet nastavnih sesija. U oba kontrolna mjerenja imao je 80 % točnih odgovora (deset i dvadeset dana nakon poduke).

Hüseyin je stekao sposobnost rješavanja matematičkih problema nakon pet sati nastave. U kontrolnim mjerenjima imao je 80 % točno riješenih problema nakon deset i 70 % nakon dvadeset dana.

Na osnovi rezultata dobivenih u kontrolnim mjerenjima može se zaključiti da su ciljane matematičke vještine razvijene kroz neposrednu računalnu videopouku održane deset i dvadeset dana kasnije. Stoga se može zaključiti da je računalna videopouka učinkovita u stjecanju vještina rješavanja matematičkih problema oduzimanjem učenika s blagim intelektualnim teškoćama.

Rezultati o prijenosu vještine oduzimanja

Slika 4.

Kako je prikazano na Slici 4, Mert je točno riješio 20 % problema u predtestu i 80 % u posttestu, Kemal 30 % u predtestu i 90 % u posttestu a Hüseyin 30 % u predtestu i 90 % u posttestu. Ovi rezultati navode na zaključak da su ispitanici prenijeli stečene vještine na različite okoline i ljude kao rezultat neposredne pouke uz upotrebu računalnih videa.

Rasprava i zaključak

Rezultati ovoga istraživanja pokazuju da je računalno zasnovana pouka učinkovita u polju matematičkoga rješavanja problema zbrajanjem i oduzimanjem za učenike s blagim intelektualnim teškoćama. Osim toga, praćenje podataka pokazalo je da su sudionici zadržali stečene vještine rješavanja matematičkih problema nakon poučavanja te ih prenijeli na druge okoline i osobe. Nadalje, rezultati ovoga istraživanja sukladni su s rezultatima prijašnjih istraživanja koja su ispitivala učinkovitost upotrebe videa u poučavanju matematičkih vještina učenika s intelektualnim teškoćama u literaturi (Burton i sur., 2013; Saunders i sur., 2017).

Prema rezultatima ovoga istraživanja sudionici su pokazali znatan interes za računala i videoprojekcije od početka nastave u kojoj je korišteno računalno videopoučavanje. Stoga, smatra se da će zbog visokoga interesa i motivacije za tehnologije poput računala i videa učenici lakše će steći ciljane vještine. Navedena činjenica podupire pretpostavku da videopouka povećava učeničko zanimanje i motivaciju, slično rezultatima u srodnoj literaturi (Kebritchi i sur., 2010).

U ovoj studiji upotrijebljena je metoda direktnoga poučavanje vještina rješavanja matematičkih problema zbrajanjem i oduzimanjem uz upotrebu videomodela, što ga

čini pionirskim u ovom području. Rezultati istraživanja u skladu su s nalazima drugih studija u literaturi koji pokazuju učinkovitost metode direktnoga poučavanja učenika s intelektualnim teškoćama vještinama rješavanja matematičkih problema (Jitendra i Xin, 1997; Montague, 2008; Elicin i sur., 2013; Takahashi i sur., 2016).

Još jedan rezultat ove studije pokazuje da se učinci neposrednoga poučavanja s upotrebom računalnih videa zadržavaju nakon desetoga i dvadesetoga dana nakon stjecanja vještina rješavanja problema zbrajanjem i oduzimanjem. U skladu s navedenim, Yakubova i suradnici (2015) nastojali su odrediti učinkovitost videoaplikacije u poučavanju problema s razlomcima za učenike s poremećajem iz spektra autizma. Rezultati su pokazali da se broj točnih odgovora svih učenika u rješavanju problema s razlomcima značajno povećao, a rezultati evaluacije tjedan dana nakon primjene pokazali su da su ispitanici zadržali stečeno znanje.

Rezultati ovoga istraživanja pokazuju da računalna videopouka neposrednom metodom omogućuje učenicima prijenos stečenih vještina rješavanja problema na radne situacije s drugim učiteljima i okolinama. Učenici su bili sposobni riješiti probleme na način koji zadovoljava kriterije u fazi istraživanja koja je ispitivala prijenos vještina nakon završetka poduke s istraživačem. Sukladno ovom rezultatu, Burton i suradnici (2013) ispitivali su učinkovitost upotrebe videoaplikacija u poučavanju funkcionalnih matematičkih vještina učenika s poremećajem iz spektra autizma i drugim intelektualnim teškoćama te otkrili da su bili sposobni zadržati te vještine i prenijeti ih na različite okoline u kasnijim nastavnim sesijama.

Ovo istraživanje ima neke nedostatke. Jedan od njih je težak pristup računalima u određeno vrijeme i u nekim uvjetima te ograničena financijska sredstva institucija i obitelji. Nadalje, budući da upotreba računala ponekad izaziva ovisničko ponašanje učenika, također se može smatrati manjkom ovoga istraživanja. Za učitelje ili obitelji koje nastavljaju s ovom vrstom obrazovanja ono može biti problematično jer će učenici možda htjeti upotrebljavati računala za različite aktivnosti ili na satima na kojima to nije potrebno.

Evaluacija stjecanja vještina rješavanja problema učenika prema rezultatima, a ne prema samom procesu također se može promatrati kao ograničenje ovoga istraživanja.

Danas su prakse poučavanja zasnovane na tehnologiji u polju obrazovanja učenika s posebnim potrebama postale sve uobičajenije i važnije (Sabayleh i Alramamneh, 2020; Elicin, 2016; Ismaili i Ouazzani-Ibrahimi, 2017). Osim toga, kao što je prije spomenuto, istraživanja pokazuju pozitivan doprinos direktnoga poučavanja i primjene videomodela u učenju matematike učenika s intelektualnim poteškoćama. Ovo istraživanje, u kojemu se učenike s intelektualnim poteškoćama neposredno poučavalo pomoću tehnoloških aplikacija, posebno pomoću aplikacija modela i vođene vježbe, osvijetlit će srodnu literaturu i aplikacije za poučavanje matematike u specijalnom obrazovanju. Osim toga, ovo istraživanje daje vrlo važne rezultate jer se složena vještina poput rješavanja problema, čije je kognitivno stjecanje izazov za pojedince s intelektualnim teškoćama, može usvojiti metodom neposrednoga poučavanja upotrebom računalnih

videoaplikacija. U ovome trenutku, umjesto korištenja isključivo tradicionalnih metoda poučavanja, integracija videa u poučavanju uvelike će doprinijeti nastavnoj praksi i učenju učenika.

Ovo istraživanje vrlo je važno zbog toga što je, prema našim saznanjima, među prvima provedenim u Sjevernom Cipru o računalnoj videonastavi metodom neposrednoga poučavanja vještina rješavanja matematičkih problema i kao takvo će doprinijeti literaturi i aplikacijama u polju obrazovanja učenika s posebnim potrebama u Sjevernom Cipru.

Zaključno, rezultati ovoga istraživanja pokazali su učinkovitost računalne videopouke u polju poučavanja vještina rješavanja matematičkih problema zbrajanjem i oduzimanje učenika s blagim intelektualnim teškoćama.

Preporuke

Ovdje dajemo neke preporuke za dalja istraživanja i prakse zasnovane na rezultatima: učitelji koji rade s učenicima s posebnim potrebama trebali bi koristiti računalno videomodeliranje u poučavanju rješavanja matematičkih problema; osmišljena i korištena videa u sklopu ovoga istraživanja mogu se raspodijeliti školama u obliku paket programa; može se pokrenuti sveučilišni izborni kolegij na odsjecima za obrazovanje učenika s posebnim potrebama pod naslovom *Korištenje aplikacija s videomodelima u posebnom obrazovanju*; učinkovitost neposrednoga poučavanja putem računalnih videomodela može se proučavati s raznolikim praktičarima (npr. vršnjacima i razrednim učiteljima) u različitim okruženjima (razredi općega obrazovanja); ubuduće može se istražiti učinkovitost računalnoga videomodeliranja u direktnom poučavanju učenika s različitim tipovima i stupnjevima teškoća; računalno videomodeliranje također se može izvoditi na osnovi različitih metoda poučavanja, poput poučavanja bez greške i za različite vrste problema, poput množenja i dijeljenja; također, u budućim istraživanjima direktno poučavanje upotrebom računalnih videomodela može se usporediti prema učinkovitosti s tradicionalnim (papir-olovka) metodama.