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The Effectiveness of an Interactive Video-Based Program in Developing the Skills of Comparing and Ordering Numbers Among Deaf and Hard of Hearing Individuals

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Abstract

The aim of the current research is to enhance the skills of comparing and ordering numbers through the utilization of interactive videos among students with hearing disabilities, including those who are hard of hearing or deaf. Employing a quasi-experimental design, the study adopts a one-group pre-test-post-test design, involving (12) students who received instruction through interactive videos. Initially, pre-test measures were administered, followed by the experimental intervention, and subsequently, post-test evaluations of comparing and ordering number skills were conducted. The study employed specific tools, including a test assessing comparing and ordering numbers skills, as well as an interactive video program. The findings of the study underscore the efficacy of the interactive video-based training program in fostering the development of comparing and ordering number skills among the sampled individuals. Moreover, the research revealed no statistically significant disparities, at a significance level of 0.05, in the post-test scores among students, attributed to variations in the severity of their disabilities. Furthermore, no statistically significant differences were observed, at the same significance level, between the post-test scores and those obtained during the follow-up assessment, indicating the sustained effectiveness of the program over time. In conclusion, the study culminates in a series of recommendations and proposed avenues for further research in this domain.

Keywords: *Comparing And Ordering Numbers Skills, Interactive Video, Hearing Disabilities (Deaf, Hard Of Hearing,).*

INTRODUCTION

The category of the hard of hearing is one of the categories of people with disabilities that require special care and attention, due to their loss of hearing, whether it is complete (deaf) or partial with residual hearing (hard of hearing). They need special preparation for life by acquiring appropriate skills, considering that hearing is one of the most important senses that individuals rely on in their interaction with others. Therefore, hearing disability is considered one of the most challenging sensory disabilities that affect humans, as it leads to the loss of the ability to speak and difficulty in learning various skills. As Al-Zarqat (2003) pointed out, hearing disability, based on its severity, has two types (deaf, hard of hearing). Deaf refers to a person whose hearing disability prevents them from understanding speech through hearing alone, whether with the use of hearing aids or without them. On the other hand, a person who is hard of hearing has residual hearing that enables them to understand speech, whether with the use of hearing aids or without them.

The right of the hard of hearing in education has become recognized in all societies that adopt the principle of equal educational opportunities for all individuals. If the hard of hearing are guided and educated in a scientific and sound manner, they can achieve an educational level that is significantly close to the educational level of the average individual who is intellectually similar to them (Al-Khatib & Al-Haddidi, 1999). Hence, modern trends have emerged calling for the necessity of integrating hard of hearing students into regular classrooms, with additional classrooms for their care at other times. Hard of hearing students do not differ from regular students in physical characteristics in terms of growth rate. However, their academic achievement is low compared to regular students, due to the inadequacy of regular textbooks for hard of hearing students (Al-Khatib, 2002). Since the deaf rely more on their sense of sight in their lives more than on their other senses, due to the broad field of visual perception that makes them rely on visual information in communication and

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learning (Proksch & Bavelier, 2002). Many studies have emphasized the importance of developing visual skills in deaf and hard of hearing students at early stages, as they are the basis for learning sign language, which they rely on for communication and learning (Easterbrooks et al., 2008). One of the best educational methods and tools provided for them is video-based education, as it is a visual means that is characterized by its patience, individualization, and interaction (Al-Saraya, 2001). The current era witnesses great progress in the technological field in the learning process, such as interactive media, which have imposed themselves due to their many advantages and applications in education, helping to provide an interactive environment in which the learner is positive and effective (Al-Baghdadi, 2002).

The use of interactive video is considered one of the methods used to stimulate cognitive growth among students by creating an active learning environment. The current study focuses on developing skills in comparing and arranging numbers among individuals with hearing disabilities, linking this tool to different learning methods and the interests and abilities of students, in sync with their knowledge and previous experiences. They review and practice activities using smart technologies (Giles & Shaw, 2011). Interactive video, as defined by Al- Al-Sayed (2004, p.21), is "a technology that allows interaction between the learner and the presented material, which includes moving images accompanied by sound to make learning more interactive. This technology is a one-way communication method because the learner cannot interact with the teacher. Interactive video technology includes a set of video clips that present educational content, managed in a special way through a desktop computer, laptop, mobile phone, or tablet".

As mathematics is considered the common factor of human culture, being the foundation of many sciences, it is necessary for mathematics to be directed towards the development of life skills so that its study has meaning and function for its learners (Powell et al., 2009). Several educators specialized in mathematics education have called for a shift from traditional mathematics teaching goals that focus on mathematical knowledge to goals that emphasize developing thinking skills and preparing for life (Fayez, 2003). The mathematics curriculum prescribed for regular students is the same curriculum taught to hard of hearing students. Although its content is closely related to professional, life, and social fields, the teaching methods used are still traditional and limited to using sign language and lip reading. Therefore, many hard of hearing students struggle to understand and accept these methods, and most teachers face difficulties in improving students' achievement in this subject (Ibrahim, 2019).

Interactive video is considered one of the effective and suitable tools in assisting hard of hearing individuals in learning, due to the visual and animated images it provides accompanied by audio. Since videos often attract the attention and focus of students and stimulate them to learn, researchers believe that an interactive video-based training program can be used to develop comparison and arrangement skills in numbers at the elementary education stage. This is especially relevant as this group often faces issues related to academic achievement and academic skills. By providing engaging stimuli in the form of interactive videos, it becomes easier for them to comprehend through visual perception, leading to a sense of success and self-confidence.

Due to the importance of teaching mathematics to students with hearing disabilities (deaf, hard of hearing) using technology, many studies have focused on this. One such study is by Dahdah (2004), which aimed to uncover the effectiveness of teaching a proposed mathematics program using technology to develop word problem-solving skills in elementary students with hearing disabilities. The study showed that technology plays a significant role in improving the academic levels of students with hearing disabilities in mathematics. Similarly, the results of the study by Al-Harbi (2005) confirmed the effectiveness of using computers in imparting mathematical concepts and stimulating motivation among hard of hearing students. The study also indicated that there were no statistically significant differences attributed to the severity of the disability (low vision, deaf).

Studies have emphasized the importance of using modern technology widely in teaching most academic subjects, such as mathematics and language, to students with sensory disabilities, especially at the elementary level. This is because the elementary stage plays a significant role in shaping the students' personalities in general and those with hearing disabilities in particular, as well as in the effectiveness of teaching using technology. Smith et al. (2006) highlighted the role of video in increasing classroom interaction. Their study aimed to

investigate the impact of using video technology on increasing interaction between teachers and students in math classes. The study found that interactive video led to changes in student-teacher interaction and the development of math skills. Additionally, Lin (2010) aimed to determine the effectiveness of using video and students' attitudes towards it. The study sample consisted of 20 students from the third grade in Kaohsiung County schools in China. The results showed a positive impact of using interactive video on students' achievement in English language. Moreover, Mansour (2014) conducted a study titled "The Effectiveness of an Interactive Educational Program in Developing Some Thinking Skills in Mathematics for Preparatory Stage Students." The study confirmed the effectiveness of the program in developing algebra and arithmetic skills among the experimental group. Furthermore, Turel and Johnson (2012) aimed to uncover the impact of using interactive media on the academic achievement of third and fifth-grade students in South Carolina. The results showed that using interactive media improved students' performance in language and mathematics skills. Additionally, Mohammadian et al. (2018) aimed to determine the impact of using video technology on improving reading comprehension for language learners. The study results indicated that video materials significantly enhanced reading comprehension. Finally, Hassan (2021) confirmed the effectiveness of a training program based on interactive video in developing academic skills among students with difficulties.

The study's problem can be summarized in the following questions:

1- What is the effectiveness of a program based on interactive video in developing comparison and ordering skills among students with hearing disabilities?

2- Are there statistically significant differences at the significance level of (0.05) between the mean ranks of students' scores for the comparison and ordering test in the dimensional measurement attributed to the difference in the severity of hearing disability (deaf, hard of hearing)?

3- Are there statistically significant differences at the significance level of (0.05) between the mean ranks of students' scores for the comparison and ordering test among the sample individuals in the dimensional and follow-up test?

METHODS

Based on the nature of the research, its objectives, questions, and the desired information, a quasi-experimental method was used, specifically the one-group pre-test-post-test design, along with a variety of statistical methods using the SPSS software.

Population and Sample of The Study

The sample for the study consisted of (12) students with hearing disabilities (deaf, hard of hearing) in the fourth grade, integrated into public schools in the Najran region, for the academic year 2023. Table 1 shows the distribution of study participants according to the severity of their hearing disability.

Table 1. Distribution of the study sample according to disability

	Category	No.
Disability	Hard of hearing	8
	Deaf	4
Total		12

Tools of the Study

Based on their review of the theoretical framework and previous studies, the researchers found that the most suitable tool for achieving the study's objectives and answering its questions was the questionnaire. The final questionnaire consisted of (10) statements, each rated on a five-point Likert scale.

Psychometric properties for testing skills in comparison and ordering were assessed. The test for comparison and ordering skills comprised (10) questions. Each correct answer scored (1), while each incorrect answer scored (0), resulting in a total score range of (0-10).

Analysis of the test questions related to comparison and ordering skills was conducted. To analyze the test items, a sample of (10) students was selected for statistical analysis of the test items, focusing on difficulty and

discrimination, and to extract reliability and validity indicators. The students were divided into two groups based on their total test scores: an upper group and a lower group, each comprising (50%) of the sample, with (4) students in each group.

A. Difficulty and discrimination indices for the test: A. Difficulty indices: The difficulty index for objective questions, where the answer is either true or false, is calculated according to the following equation: Difficulty Index = (Total score of students in the upper and lower groups on the question) / (2) (number of students in one of the groups) (Awadah, 2005).

Table 1 shows the difficulty indices for the test questions related to comparison and ordering skills based on the survey sample results.

Table 2. Difficulty indices for the test

Question	Difficulty index
Comparison of numbers	0.40
Ordering numbers in ascending and descending order	0.40
Greater than, less than, and equal to	0.50
Place values of numbers	0.70
Reading numbers in letter position	0.50
Converting numbers from word form to numerical form	0.60
Writing numbers in expanded form	0.40
Writing numbers in standard form	0.50
Rounding numbers	0.50
Comparing fractions	0.60

Table 2 shows that the difficulty coefficients for the questions in the comparison and arrangement of numbers skills test range between 0.40 and 0.70. According to Awadah (2005, p. 257), any item with a difficulty coefficient between 0.20 and 0.80 is considered acceptable, and it is recommended to include it in the test. The average difficulty of the test was 0.51.

B. Discrimination Coefficients: Discrimination coefficients were calculated for the test questions, which consist of objective questions with true or false answers. The students were divided into two groups: the upper group, consisting of 50% of the students who scored the highest grades in the test, and the lower group, consisting of 50% of the students who scored the lowest grades in the test, with 4 students in each upper and lower group. Awadah (2005) indicates that measurement specialists have established benchmark values for judging the items of the test, as follows:

Items with negative discrimination coefficients are deleted.

Items with discrimination coefficients less than 0.20 are recommended for deletion.

Items with discrimination coefficients of 0.20 or higher are accepted. The discrimination coefficient is calculated using the following equation: Discrimination Coefficient = (Tu - TI) / (N) Where: Tu = Sum of scores of individuals in the upper group on the question. TI = Sum of scores of individuals in the lower group on the question. N = Number of individuals in either the upper or lower group. Table 3 shows the discrimination coefficients for each question of the comparison and arrangement of numbers skills test.

Table 3. Discrimination coefficients for the test

Question	Discrimination coefficient
Comparison of numbers	0.60
Ordering numbers in ascending and descending order	0.40
Greater than, less than, and equal to	0.60
Place values of numbers	0.60
Reading numbers in letter position	0.60
Converting numbers from word form to numerical form	0.80
Writing numbers in expanded form	0.60
Writing numbers in standard form	0.80
Rounding numbers	0.80
Comparing fractions	0.40

From Table 3, it is evident that the discrimination coefficients for the test questions range between 0.40 and 0.80. According to Awadah (2005, p. 257), any question with a discrimination coefficient of 0.20 or higher is considered acceptable, and it is recommended to retain such questions in the test.

Calculation of the reliability and validity coefficients for the test of comparing and ordering numbers skills:

Reliability:

Internal Consistency Reliability: The researchers used the Pearson correlation coefficient to measure the relationship between each question's score and the total score of the test of comparing and ordering numbers skills. This was done by administering the test to a sample of (10) students, as shown in Table 4.

Table 4. Pearson correlation coefficients for the relationship between the questions in the test of comparing and ordering numbers skills and the total score of the test

Question	correlation coefficient	Sig.
Comparison of numbers	.856**	.002
Ordering numbers in ascending and descending order	.711*	.022
Greater than, less than, and equal to	.864**	.001
Place values of numbers	.780**	.008
Reading numbers in letter position	.781**	.008
Converting numbers from word form to numerical form	.636*	.035
Writing numbers in expanded form	.780**	.008
Writing numbers in standard form	.655*	.040
Rounding numbers	.816**	.004
Comparing fractions	.781**	.008

*sig. at the 0.01 level, ** sig. at the 0.05 level

It appears from Table 4 that the Pearson correlation coefficients for measuring the relationship between the scores of the comparison and ordering of numbers test questions and the total test score are statistically significant at the 0.01 or 0.05 significance level. The correlation coefficients ranged from 0.636* to 0.864**, indicating that the test demonstrates validity, confirming the tool's effectiveness in measuring what it was designed for.

Validity:

To calculate the test reliability coefficients on the total test score, the test was administered to the survey sample, and the reliability coefficients were calculated using Cronbach's alpha and the split-half reliability coefficient (Spearman-Brown). Table 5 illustrates the results.

Table 5. Test reliability coefficients using Cronbach's alpha and the split-half reliability coefficient

Total	No. of questions	Cronbach's alpha	Spearman-Brown
	10	0.91	0.88

Table 5 shows that the Cronbach's alpha coefficient for the total test reliability was 0.91, and the split-half reliability coefficient was 0.88. These are high and suitable reliability coefficients for the study, indicating the test's reliability.

Interactive Video-Based Training Program

The interactive video-based training program aims to develop the skills of comparing and ordering numbers among students with hearing disabilities (deaf and hard of hearing) in the fourth grade of basic education. It is a systematic and planned process designed to enhance these skills, containing 10 sub-skills. The program is intended to improve the academic achievement of students with hearing disabilities in mathematics at the basic education stage. It includes a series of interactive video activities aimed at developing these skills, with teaching continuing for a month and a half, comprising 12 instructional sessions, each lasting 40 minutes. The researchers evaluated the training program to assess its effectiveness by comparing the results of the pre-application assessment with those of the post-application assessment after implementing the program on the study sample. They also calculated the effect size.

Data Analysis

The study employed two statistical tests to evaluate the effectiveness of a video-based program in enhancing the skills of comparing and ordering numbers among students with hearing disabilities. The Wilcoxon test is utilized to determine the program's effectiveness, comparing pre-test and post-test scores. Additionally, the Mann-Whitney test is employed to investigate whether there are significant differences in the students' average scores based on the severity of their hearing disability (deaf, hard of hearing). Finally, another Wilcoxon test is conducted to assess any significant differences in the average scores between the post-test and follow-up assessments, providing a comprehensive evaluation of the program's impact on the students' skills development.

RESULTS

Results of the 1st research question: What is the effectiveness of a program based on interactive video in developing comparison and ordering skills among students with hearing disabilities?

The Wilcoxon test was used to determine the significance of differences in the mean ranks of students with hearing disabilities on the test of comparing and ordering numbers in the pre-test and post-test, and Table 6 shows this:

Table 6. Wilcoxon test to show the significance of differences between the mean ranks of children on the test of comparing and ordering numbers in the pre-test and post-test

	Rank means -	Rank means +	Sum of ranks -	Sum of ranks +	Z	Sig.	Effect size	Level
Total score	.00	7.50	.00	105.0	-3.373	.001	1.07	High

The results presented in Table 6 reveal the following:

1- There is a statistically significant difference at the 0.05 level between the mean scores of students on the test of comparing and ordering numbers in the pre-test and post-test, in favor of the post-test. The value of (z) was (3.373) with a significance level of (0.001), which is less than (0.05), indicating the effectiveness of a video-based program in developing the skills of comparing and ordering numbers among deaf students.

2- The effect size was (1.07), indicating a very high effect size, which suggests that the video-based program is effective in developing the skills of comparing and ordering numbers among students with hearing disabilities.

The study results demonstrate the superiority of education using interactive videos over traditional methods. The results also show a clear improvement in the academic achievement of the study sample after being taught using videos. The researchers attribute this improvement to the fact that using interactive videos allows the hard of hearing student an opportunity for direct self-learning. This method has a clear impact on increasing students' attention in the experimental group, motivating them to learn, and better understanding the subject matter, giving students' motivation to learn, which may not be available in the traditional method in the regular classroom. Using video technology helps make the scientific material closer to the minds of hard of hearing students, helps them acquire knowledge and skills, and obtain information clearly, enjoyable, and attractive. Additionally, the ability to repeat the video clips several times and confirm the important ideas helps students to achieve the desired educational objectives. The researchers believe that the use of videos is one of the most beneficial educational methods in enriching educational situations and enriching them with multiple stimuli that lead to the formation of diverse experiences for learners. The presentation of educational videos was an effective method in education to address the senses of deaf students, especially the sense of sight, helping them to understand and perceive facts, presenting content in an attractive and enjoyable way, and providing students with real experiences.

These results are consistent with the findings and trends of the study by Hassan (2022), Ibrahim (2019), Turel (2012), and Mohammadian et al. (2018), which all showed the superiority of teaching using videos over

traditional methods. The studies recommended the necessity of employing technology to teach hard of hearing students, as it has an effective impact on increasing their academic achievement in various subjects.

Results of the 2nd research question: Are there statistically significant differences at the significance level of (0.05) between the mean ranks of students' scores for the comparison and ordering test in the dimensional measurement attributed to the difference in the severity of hearing disability (deaf, hard of hearing)?

The Mann-Whitney test was used to assess the significance of differences between the mean scores of children on the Spatial Concepts Test in the post-measurement according to the disability variable, and Table 7 illustrates the results.

Table 7. Mann-Whitney test for the significance of differences between the mean ranks of students' scores on the test of comparing and ordering numbers attributed to the difference in the disability.

Disability	No.	Rank means	Sum of ranks	U	Sig.
Hard of hearing	7	7.93	55.50	21.500	.674
Deaf	7	7.07	49.50		

Through the results presented in Table 7, the following is evident:

- There is no statistically significant difference at the 0.05 level between the mean scores of students on the test of comparing and ordering numbers attributed to the difference in the severity of the disability in the post-measurement according to the disability severity variable. This indicates that the program's effectiveness is the same for both deaf and hard of hearing students.

This result means that the severity of hearing disability (deaf, hard of hearing) does not play a significant role in determining the increase in acquiring the skills of comparing and ordering numbers for the sample individuals. This is confirmed by Al-Harbi's (2005) study. The reason for this is that integrating students with hearing disabilities (deaf, hard of hearing) and providing them with educational services equally, as well as working to provide modern devices, has influenced the lack of differences among individuals with hearing disabilities (deaf, hard of hearing). The use of technology for students with hearing disabilities is the appropriate method for teaching these students mathematics. This is confirmed by the studies of Dahdah (2004) and Issa (2007). Thus, this method achieves one of the goals of special education, which is individualized education for students with special needs, including hard of hearing students (Sissalem, 2018).

Results of the 3rd research question: Are there statistically significant differences at the significance level of (0.05) between the mean ranks of students' scores for the comparison and ordering test among the sample individuals in the dimensional and follow-up test?

Table 8. Results of the Wilcoxon test and the value (Z) and its significance for the differences between the means of the rankings of students' scores in the post-test and the follow-up.

	No.	Rank means -	Rank means +	Sum of ranks -	Sum of ranks +	Z	Value	Sig.
Test	14	3.00	1.50	3.00	3.00	.00	1.00	Insig.

Based on the results shown in Table 8, the following can be concluded: There is no statistically significant difference at the significance level of (0.05) between the means of students' scores in the post-test and the follow-up test for the comparison and ordering of numbers. This indicates that a program based on videos is effective in developing comparison and ordering skills among deaf students. The researchers justify this result by stating that repeated presentation of information to students helped solidify mathematical concepts and information. The computer and its features played a significant role in stimulating motivation for learning mathematics among all participants in the experimental group. This highlights the importance of its use. The researchers also note that the availability of diversity, excitement, and visual appeal in processing scientific content through video explanations, animations, and various visual examples increased the learning rate of deaf students. It allowed them to connect theoretical aspects with practical aspects by watching videos and engaging

in educational activities. This result contributed to retaining scientific material, a finding supported by the studies of Hassan (2022) and Ibrahim (2019).

CONCLUSION

In conclusion, the study aimed to investigate the effectiveness of a video-based program in developing the skills of comparing and ordering numbers among students with hearing disabilities. The program was found to be highly effective, as evidenced by the statistically significant difference between the mean scores of students on the pre-test and post-test, with a significant effect size indicating substantial improvement in skills. In addition, there was no significant difference in the program's effectiveness based on the severity of the disability, suggesting that it is equally beneficial for both deaf and hard of hearing students. These results highlight the superiority of education using interactive videos over traditional methods, leading to clear improvements in academic achievement. The implications of this study suggest that incorporating video-based programs into education for students with hearing disabilities can be highly beneficial in developing their mathematical skills. For future studies, it would be valuable to explore the long-term effects of such programs and their impact on other areas of learning. Additionally, investigating the optimal ways to integrate technology into education for students with disabilities could further enhance their learning outcomes.

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