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Students with Special Education Disabilities' Spatial Skills

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Abstract

This study at identifying the development of spatial skills in students with learning difficulties in the Asir region, as well as the relationship between several variables. The researchers also wanted to see if there were any statistical differences in how kids performed the spatial skills exam depending on their grade, kind of learning disorder, and gender. The essential data for this investigation was acquired using the computerized version of Vandenberg's (1975) spatial ability skills test. The study's sample included 320 adolescents with learning difficulties who attended Asir Region Department of Education schools. Based on the findings of this study, there were no significant statistical variations in spatial test skill related to grade. However, the data revealed that the type of learning difficulties and gender had significant effect on how well people performed on the spatial skills test. Throughout the study results, the researcher suggests that learning difficulties be given special attention in to provide trained staff, trainings, and proper diagnostic tools so that students with disabilities can benefit the most and improve their skills.

Keywords : Disabilities in learning, spatial skills, Asir region, Rotational Mental Ability, USA.

1. INTRODUCTION

Spatial abilities are regarded as one of the many cognitive abilities that play a vital role in educational success and profession construction. Spatial ability involves understanding, creating, transforming, manipulating, and recalling visual images and mental models [1]. Several studies have confirmed that spatial ability is strongly related to arithmetic ability. and solving mathematics problems [2]. Previous research has found a link between spatial skills and achievement in science and physics [3]. There is a great importance between spatial abilities and other cognitive abilities such as logical thinking [4]. In addition, the importance of visualizing had long been recognized by psychologists. and how they tried to develop various tools and frames to test individuals [5]. Spatial ability has received much attention from researchers as it forms the major problem for educators and teachers long time ago. This attention is attributed to the effective role of spatial ability in our daily life such as doing sport, using maps, and putting our things in order [6]. Spatial ability is felt strongly in our daily activities as it determines people's achievement and interprets the occurrence of their failures [7].

1.1. Problem Statement

As mentioned earlier, spatial skills have essential role in many areas such as Arts, Engineering, and Mathematics. In order to obtain knowledge or success at the level of major subjects, students with learning difficulties are regarded a heterogeneous class. Some of those students are intelligent and some are more intelligent than others. This implies that disabled students are capable of thinking that can assist them in understanding what their peers are studying, particularly in the instructional techniques utilized in their education [8]. The disability of perceiving spatial relations is one manifestation of the learning difficulties [9, 10]. These difficulties include the disability of recognizing spatial relationships such as: up and down, above and below, near and far, and front and back. These are the most faced challenges for learners with learning difficulties. Those students may have challenges in estimating the distance between numbers, the difficulty of writing in a straight line, and the difficulty of recognizing the sequence of numbers. Most of the previous research has looked on the relation between spatial skill and intelligence. and students' achievement or mathematical abilities among normal students. Based on the researchers' knowledge, there are very few studies conducted to investigate spatial abilities learners with learning difficulties. In addition, very few studies have been carried out to investigate spatial abilities among students with learning disabilities in the Kingdom of Saudi Arabia. Therefore, the purpose of the present study is to analyze the spatial ability between learners with disabilities, as well as their relationship to a set of attributes (i.e., grade, type of learning difficulty, and gender).

The following goals are the focus of this research:

1. The purpose of this research was to find out how spatially intelligent students with learning disabilities in the Asir region are.

2. To analyze the differences between spatial skills of students and some variables (i.e., grade, type of learning difficulty, and gender).

The goal of this research is to find answers to the following:

1. What is the extant of spatial ability of students with learning difficulties in Asir region?

2. Are there statistical significance differences in spatial ability among kids based on their grade, type of learning challenge, or gender?

1.2. Study Significance

The importance of this study comes from the fact that one is just one of those studies in Saudi Arabia that looks at spatial skills in individuals with learning difficulties. Stakeholders will benefit from the findings of this study because they will gain a theoretical understanding of the discrepancies between students' descriptive statistics and spatial skills. The results would also give instructors, students, and curriculum developers with the most effective tool for testing spatial skills in students with learning difficulties. Providing teachers with the effective instrument of measuring spatial ability will help students to exercise their spatial skills and develop them. The size of the study sample has a significant impact on the generalization of findings. The current study is only for students who have learning disabilities. The selected students' ages range from eight to eleven years old, with no further ages being considered. This study's sample is restricted to pupils enrolled in the learning problems rooms of Assir Region's Department of Education-affiliated schools. The data was collected through using Vandenberg's (1975) test for measuring spatial ability, and no other instruments have been used to collect the necessary data.

1.3. Operational Term Definition

Many concepts were used in this study that can be described as follows:

Spatial Skills: The capacity to comprehend objects' spatial and spatial relationships. The spatial skills were analyzed by the degree to which the student was able to respond to Vandenberg's (1975) computerized version of spatial ability, which has a total score of 43 points.

Rotational mental ability: a part of spatial Skills that need a mental rotation of the three-dimensional stimuli. The student is required to rotate the objects in order to match them with the original form.

Students with disabilities: those who have problems with one or more of the fundamental psychologies, such as understanding and using written or spoken language.

Literature review

This part comprises some literature on the subject of the current investigation. The literature contains concepts of spatial skills, spatial orientation, and. spatial visualization

The prior studies on spatial ability revealed no rigorous definition of the concept. Thus, many researchers have defined spatial ability in different ways. Spatial ability is creating mental image of objects and manipulate them. This ability is considered as spatial visualization [11]. Other definition stated that spatial skills are defined as a set of mental abilities that entail visually comprehending, manipulating, and interpreting relationships [12, 13] Moreover, the ability to build imagination and modify those images in the memory was also termed as spatial ability [14]. Some scholars defined it as the cognitive abilities that allow people to deal with spatial relationships [15]; Others define it as the mind manipulation of two- and three-dimensional objects [16]. The definition of spatial skills also involves the definition of its ability sub-skills. Researchers have divided the spatial abilities into different sub-skills, such as, spatial thinking, which includes the creation of mental images and the manipulation of those images. A mental image can be considered of a mathematical principle or attribute that contains information and is based on diagrammatic or graphics components [17-19]. Other scholars divided spatial ability into two visual abilities: visual processing of the information that entails the manipulation of visual imagery and the transition of one mental picture into another. The second ability involves the information interpretation of spatial vocabulary used in graphs, diagrams, and charts, which would be useful in getting information necessary to solve a problem [20, 21]. Another classification provided a more detailed classification of spatial ability. This classification included four imagery and mental image processes: 1. forming a cognitive map based on the data collected 2. Observing the position of a mental image or the existence of pieces or components, 3. Rotating, translating, scaling, or dissecting a mental image, and finally, 4. Answering questions with a mental picture. The present study used a specific classification [22-24], this had to do with two major characteristics of spatial skills: spatial orientation and visualization. The capacity to envision how certain items seem from a specific viewpoint other than the one in which they are shown is referred to as spatial orientation. Alternatively, spatial visualization implies mental rotation of the visualized objects such as rearrangement of object pieces from a whole object.

1.4. The Importance of Spatial Skills in Education

As mentioned earlier, spatial skills are extremely important in teaching and learning, and it is also important for life in a three-dimensional world. Spatial ability is really important. and skills in detecting objects; manipulate quantities, and understanding charts, drawings, and graphics [25]. Spatial ability includes a wide range of thinking processes such as motor, visual, behavioral, and analytical skills. It is also divided into three groups: spatial orientation, spatial visualization, and mental rotation [26, 27]. The educational research concerning spatial ability started in the 1940s. These research works have emphasized the importance of spatial ability and spatial reasoning skills in improving the students' comprehension of Mathematics; and it also leads to improving the curriculum and pedagogy of Mathematics, and determines the students' achievement in Mathematics and other relevant fields [28]. The prior studies conducted on spatial ability have revealed that spatial skills are influenced by certain factors. This study aims at identifying the role of those factors in spatial skills, and how these factors affect people's ability. Much of research attempted to investigate the possible gender gap exists in spatial ability. Some of these researches indicate no gender difference in spatial ability [28, 29]. However, majority of the research revealed male advantage in mental rotation test scores [30-32]. In addition, research indicates that spatial skills are not only influenced by gender, but also by age, which may contribute to the gender difference for some age groups.

2. Previous Studies on Spatial Ability

A variety of studies were conducted to investigate pupils' spatial abilities, with varying findings. In Turkey, a study investigated the spatial ability among middle school students in Istanbul. The study's sample included 704 middle school students in grades 6, 7, and 8 who attended various schools in Istanbul. To assess the study's data, the researchers employed empirical investigation and validity analysis. Three factors emerged from the findings of the study: spatial imaging, mental rotation, and spatial relations. The results have also revealed that these factors constitute an appropriate model of measuring spatial ability. The 23 items emerged from the scale show credibility and validity to measure spatial ability among those students [33]. Another study in Spain looked into the usage of instructional robots to help 12-year-old kids improve their spatial ability. It also aimed at preparing motivational and practical sessions to increase student participation in the actual learning process. Hence; a curriculum was developed to introduce sixth grade students to robots. The teacher taught the students to deal with the problems and work in groups of 3 members. Students were split into two groups: an experimental group that received robot sessions at random, and a control group that did not. A pre-test was used to assess the control and experimental groups' spatial abilities. That post-test findings revealed that the individuals' spatial abilities had improved after the tutorial sessions in robots than the students who did not participate in the sessions, and the improvement was statistically significant [34]. In the US, one study designed questionnaires, spatial tasks, and rotation capabilities and gave them to a group of adults of 41 males aged 57-90, as well as other tests on rotation capabilities (mental rotation test, embedded image test) and Tests of visual-spatial working memory. When comparing to the latter, the results demonstrated that the new spatial exercises were true and interrelated with active memory and spatial capacity tests, they showed a stronger correlation with self-assessment questionnaires with respect to rotation capabilities. The model was also tested so that it was assumed that new missions were related to spatial capabilities to predict rotation capabilities [35]. Another study was carried out to determine gender variations in conducting spatial capacity tests, as well as their connections to experience and achievement attitudes. The sample of the study encompassed 183 students who enrolled to Arts, Humanities, Mathematics, and Computer Science disciplines. The research instrument used was the Vandenberg’s (1975) test of mental rotation. The results revealed that academic specialization and gender had an impact on mental rotation test performance. Gender, on the other hand, has a different impact. Males in the social sciences and humanities were more affected. For females exclusively, the data revealed a statistically significant link among proficiency on the mental rotation task and computer knowledge [36].

Finally, one study in Hong Kong looked at gender variations in gifted Chinese kids' spatial abilities. The study included 337 gifted students from Hong Kong's primary and secondary schools, ranging in age from 7 to 17. Males outperformed females in the spatial skills test, according to the findings. The findings also showed that high school students outscored primary school kids, indicating that spatial aptitude increases as pupils go through school and age.

2.1. Methodology of the study

This section discusses the study's methodology, including the sample size, the instrument, and the instrument's reliability and validity.

2.1.1. Population and Sample

The study's population included (750) participant with difficulties in learning from the region of Asir. A total of 320 students, aged 8 to 11, were included in the study. and their percentage was (42.6%) from the overall study population. These students have been randomly chosen from four grades: the third, the fourth, the fifth, and the sixth grades. The data for the study sample is shown in Table 1:

Table 1. *The Study Sample's Demographic Distribution*

Type of Difficulty	No.	Gender	No.	Grade	No.
Dictation	90	Males	160	Third	130
Written Expression	90			Fourth	80
Reading	65	Females	160	Fifth	60
Spelling	55			Sixth	50
Arithmetic	20				
Total	32 0	Total	320	Total	320

As illustrated in the table, the sample's distribution based on the difficulty type was as follows: 90 students with dictation difficulty, 90 students with writing expression difficulty, 65 students with reading difficulty, 50 students with spelling difficulty, and 20 students with arithmetic difficulty. The gender of the sample was equal (160 male students, and 160 female students. Regarding the students’ grade, the distribution was as follows: 130 students in the third grade, 80 students in the fourth grade, 60 students in the fifth grade, and 50 students in the sixth grade.

2.1.2. Instrument of the Study

The researcher used in this study the computerized version of Vandenberg’s (1975) test of mental rotation as an instrument. This test measures the spatial ability of people, and it contains 43 geometric shapes. This instrument is non-verbal test and it does not need to be adapted to the Saudi environment. Each item of the instrument contains two contiguous shapes, and students will be asked to determine whether they are similar or different, after they mentally rotate the right shape. The following figure is one example of the instrument's items:

Same Different

(The correct answer is "same", meaning that the two shapes are the same)

Figure 1. *Example of Vandenberg's test of mental rotation (Source: Vandenberg's test of mental rotation)*

2.1.3. Data Collection

The researchers have made the necessary email correspondence in order to get the computerized version of Vandenberg's (1975) mental rotation test. The content of the test has been thoroughly revised to ensure its accuracy. The test has been uploaded to computers of learning disabilities rooms. The researchers provided the necessary instruction to the participant's tp clarify things for students. In addition, the students have been informed that their identities will remain anonymous, and the results obtained from this study will be used for research purpose only. Then, the students were required to respond to the test items and they were informed that the duration to complete the test is one hour. After finishing the test, the students' responses have been marked by giving 1 mark for correct answer and 0 for wrong answer.

2.1.4. Data Analysis

To find the correlated linkages of variables involving spatial abilities among students with learning difficulties, the returned test was recorded and tabulated with the help of Statistical Package for Social Sciences (SPSS) for Windows 17.0. To meet the investigation's major goals, a variety of statistical methodologies were applied. Descriptive statistics, independent sample T-Tests, and (ANOVA). To summarize the students' responses to spatial abilities, descriptive statistics such as means, standard deviation, and frequencies were computed; descriptive statistics and frequencies were used to generate the demographic data of the students in terms of gender, type of difficulty, and grade. An unrelated sample the T-test is a statistical method for demonstrating differences between the means of two main groups of a variable. This statistics method was utilized in the current study to uncover significant differences in students' spatial skills based on their gender. (ANOVA) is a statistical approach for determining differences between the means of multiple groups of a variable. This statistics method was utilized to determine the association between students' spatial competence, grade, and level of difficulty in the current study.

3. The Instrument's Validity and Reliability

The coefficient of correlation was obtained to establish the instrument's validity. The correlation has been achieved as the test was not verbal test but 3D geometric shapes. The coefficient of correlation as illustrate in table (2):

Table 2. *Test Items of the coefficient of correlation*

No.	coefficient of correlation	I No.	coefficient of correlation
1	0.638**	23	0.662**
2	0.737**	24	0.634**
3	0.726**	25	0.731**
4	0.649**	26	0.791**
5	0.833**	27	0.826**
6	0.695**	28	0.764**
7	0.817**	29	0.778**
8	0.837**	30	0.853**
9	0.821**	31	0.899**
10	0.747**	32	0.865**
11	0.887**	33	0.798**
12	0.754**	34	0.919**
13	0.814**	35	0.749**
14	0.811**	36	0.573**
15	0.542**	37	0.763**
16	0.887**	38	0.710**
17	0.908**	39	0.795**
18	0.824**	40	0.725**
19	0.899**	4	0.702**
20	0.876**	42	0.875**
21	0.617**	43	0.733**
22	0.705**	**Ove rall**	**0.822

Table (2) shows that all questionnaire items had a coefficient of correlation greater than 0.40, with a total correlation value of 0.822, indicating that the assessment was acceptable to conduct in Saudi Arabia. To ensure the test's dependability, the internal reliability was determined using the

(Cronbach Alpha) analytical approach to measure the reliability of the participants' answers. Internal consistency results revealed that the answers' Cronbach Alpha was (0.96.8), which is acceptable for accepting the test's stability.

4. Results and Discussion

The results of the current investigation are presented in this section. These results are given in light of the research topics that guided the current study.

4.1. The Level of Students' Spatial Ability

This section provides answers to the first research question: What is the extant of spatial ability of students with learning difficulties in Asir region? Descriptive statistical analysis, such as standard deviation (Sd, were used to determine the extent of spatial skills of learners with disabilities in order to address this issue. The findings have been classified and tabulated according to the variables of the present study. Table (3) shows the level of spatial ability of students according to their grade.

Table 3. *Descriptive Statistics of Students' Spatial Levels of Ability Based on Grade*

Grade	No. of Students	Mean	Std. Deviation
Third	130	23.68	4.245
Fourth	80	24.10	3.896
Fifth	60	25.17	3.542
Sixth	50	26.40	5.845
Total	320	24.80	4.349

As shown in Table (3), the overall mean of spatial ability reported by students was (M= 24.80). The sixth-grade students came in the first rank regarding spatial ability (M= 26.40), followed by fifth graders (M= 25.17), fourth graders (M= 24.10), and third graders (M= 23.68). The following table shows the descriptive statistics depending on the type of learning difficulty, of the amount of spatial skills

Table 4. *Descriptive Statistics of Students' Spatial Ability Levels Based on Type of Learning Disability*

Type of Difficulty	No. of Students	Mean	Std. Deviation
Written Expression	90	24.32	4.250
`Reading	65	23.99	4.833
Dictation	90	23.78	3.832
Spelling	55	24.00	5.138
Arithmetic	20	24.78	2.920
Total	320	24.80	4.349

As illustrated in Table (4), students with arithmetic difficulty reported the highest level of spatial ability (M= 24.78), followed by written expression difficulty (M= 24.32), spelling difficulty (M= 24.00), reading difficulty (M= 23.99), and dictation difficulty (M= 23.78). The next table illustrates the descriptive statistics of the level of spatial skills based on gender.

Table 5. *Descriptive Statistics of Spatial Ability Level of Students According to their Gender*

Gender	No. of Students	Mean	Std. Deviation
Males	160	24.53	3.98
Females	160	23.83	4.67
Total	320	24.80	4.32

As shown in Table (5), male students showed higher spatial ability (M= 24.53) compared to their female students' counterparts (M= 23.83).

4.2. Variation in Students' Level of Spatial Ability

This section tends to explore the variations in the students' overall spatial ability according to three variables: grade, type of learning difficulty, and gender. This will be done to response to the second research question: Are there statistical significance differences in spatial ability among kids based on their grade, type of learning challenge, or gender? The researchers used several statistical methods to present the results of data analysis. The statistical methods include: T-test which has been used in order for the researchers to find out what the significant differences are among the overall level of students of spatial ability and their gender. The significance of the overall pupils' degree of spatial ability, as well as their grade and kind of learning difficulties, was determined using (ANOVA).

Variation in Students' Overall Spatial Ability According to Grade

Table (6) shows the differences in the students' overall spatial ability according to their grade

Table 6. *ANOVA Test of Students' Overall Spatial Ability According to their Grade*

Grade	No. of Students	Mean	Std. Deviation	F -Value	Significance Level
Third	130	23.68	4.245	1.680	.171
Fourth	80	24.10	3.896		
Fifth	60	25.17	3.542		
Sixth	50	26.40	5.845		
Total	320	24.80	4.349		

As revealed in Table (6), the students showed moderate level of spatial ability across all grades. the findings of the ANOVA test shows that here are no significantly different between students' general spatial aptitude and their grade ($F= 1.680$, $p > .005$). These findings are in accord with other studies [33] and [37], which found that spatial ability evolves as school years progress. In this study, fifth grade students showed higher level of spatial ability than sixth grade students. The possible explanation for this finding is that the education system in the learning difficulties rooms in the Asir region provides suitable programs for people with learning disabilities. Table (7) illustrates the differences in the students' overall spatial ability according to the type of learning difficulty.

Table 7. *ANOVA Test of Students' Overall Spatial Ability According to their type of learning difficulty*

Type of Difficulty	No. of Students	Mean	Std. Deviation	F -Value	Significance Level
Written Expression	90	24.32	4.250	.471	.757
Reading	65	23.99	4.833		
Dictation	90	23.78	3.832		
Spelling	55	24.00	5.138		
Arithmetic	20	24.78	2.920		
Total	320	24.80	4.349		

The above table showed There were no significant variations in total spatial skills and the type of learning difficulties across students ($F= .471$, $p > .005$). These findings are consistent with other studies [36] and [30], which found that spatial ability does not differ because of the learning difficulty type. This outcome might be attributed to the consistent academic level of students as they are all participants with learning difficulties. The following table shows the differences in the students' overall spatial ability according to their gender.

Table 8. *T-Test Results of Students' Overall Spatial Ability According to their Gender*

Gender	No. of Students	Mean	Std. Deviation	T-Value	F-Value	Significance Level
Males	160	24.53	3.98	1.429	.318	.154
Females	160	23.83	4.67			
Total	320	24.80	4.32			

According to Table (8) there was no significant difference between students' total spatial skills and their gender. This result contradicts with the findings of other studies [29] and [37], According to the study, males performed better on spatial capacity tests than females. This finding explains why the curricula make no distinction between genders when it comes to preparedness. It also indicates that teachers handle all students equally, irrespective of gender, and that this behavior is shown in their exam and general test results.

5. Conclusion and Recommendations

This research looked into the spatial abilities of disabled students in the Asir region of Saudi Arabia. The researchers also wanted to see if there were any significant differences between students' spatial abilities and three variables (i.e., students' grade, type of learning difficulty, and the students; gender. The students indicated a modest level of spatial competence, according to the findings, and this is considered normal as they are students with learning disabilities. In addition, there were no statistically significant differences between the students' spatial ability and the variables of this study (i.e., students' grade, type of learning difficulty, and the students' gender. The researcher proposes that, in light of the study's findings, special attention be paid to the areas of learning challenges in terms of providing skilled professionals and training programs in order to obtain the greatest advantage and develop the abilities of persons with learning impairments. There is also a need to reviewing the study plans offered in line with technological and scientific development. Future research is highly recommended to further studying spatial ability dealing with other variables, and the psychometric characteristics of the spatial intelligence scale.

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