Effect of Visuospatial Ability on E-learning for Pupils of Physics Option in Scientific Common Trunk

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***Abstract*—This study aims to reveal the existence of a relationship between the visuospatial capacity of pupils with a specialization in physics, with high educational performance, and the capacity for E-learning. To achieve the study, we used the Wechsler intelligence test of cognitive ability. Our sample is composed of 204 adolescents, whose average age is 15 years, 12 months, and 11 days, with a standard deviation of 00 years, 1 month and 19 days. The selection criterion was based on the general results and specifically the physics science mark. The results of the study showed the existence of a significant relationship between visuospatial ability and scientific thinking, and statistically significant homogeneity attributed to specialization in visuospatial ability and creative thinking.**

***Keywords*—Visuospatial; e-learning; physics; intelligence**

I. Introduction

For more than two thousand years, psychological studies have been interested in mental abilities and have occupied a prominent place among cognitive psychologists because of the importance of this topic in the professional, academic and social life of an individual. Mental abilities are of great importance in guiding the individual to studies appropriate to his abilities and preparing him to integrate into it, something that will allow him to know his faculties. The holder of high mechanical ability is qualified to study mechanical engineering with distinction, the holder of high linguistic ability is qualified to study linguistics with distinction, and the holder of distinguished ability to understand mathematical problems is qualified to study successfully engineering and mathematics [1]. Indeed, spatial visual ability has a significant impact on pupils, as it develops their mental abilities, and helps them to understand study material and solve problems they face from different method, so as to raise their level of success [2]. This visuo-spatial ability is defined as the ability to represent and transform non-linguistic symbolic information [3]. Spatial visual ability requires the ability to mentally rotate models, as well as short-term visual memory, in addition to a series of sequential operations [4].

A lot of studies indicate the relationship between visuospatial ability, performance, and academic achievement, and have shown the superior performance of high-performing pupils in measures of visuospatial ability. Various studies have also shown that academic performance and success in many subjects is associated with high visuospatial ability. Studies indicate that the visuospatial ability of pupils when solving mathematical problems is related to their abilities for academic achievement, [5].

Some experimental research shows the importance of the role of visuospatial experience in the development of mental abilities, and the importance of visuospatial experience in explaining the differences between individuals in abilities [6]. A study indicates that movement and displacement in the environment is one of the most important sources of learning visuospatial skills [7], which reinforces the role of the environment in abilities development.

Visuospatial experience can be acquired through academic specialization, and this is confirmed by a study that found that pupils with math and engineering backgrounds go on to study science and engineering in college and succeed in advantages than others. They did a long way in shortening many visuospatial concepts and thinking about their performance, compared to others that still need exposure to experiences to improve that performance [8]. This confirms that differences in pupils' visuospatial abilities date to their earliest school and extracurricular experiences [9]. The study specify that shape visualization abilities increase whenever pupils are exposed to appropriate experiences, in which the teacher plays a major role [10].

Intelligence tests are the best tests for measuring visuospatial ability, however it is rare in our environment that this skill is studied, or indeed measured, before pupils choose the best academic orientation. As a result, many pupils who fail visuospatial skills may complete their studies in fields that require such skills, such as science and technology, or vice versa, where pupils who have visuospatial skills complete their studies in fields such as than languages. It doesn't depend on the high school, but also on the university course.

Intelligence is one of the important factors that help the pupil achieve success. The most intelligent pupils are more capable than others of learning and acquiring the experiences provided by the environment [11] [12] [13] [14].

Pupils with learning difficulties are considered a heterogeneous group, whether in terms of intelligence or achievement in academic subjects. In terms of intelligence for Moroccan pupils, some pupils' intelligence is average, and others' intelligence is above average; This means that they possess mental abilities that help them to learn what their ordinary peers are learning while making some necessary

adaptations, especially in the teaching methods used in their education, which is reflected in their development in university research [15] [16] [17]. Thus, the use of techniques and electronic media in learning requires skills and tasks on the part of the learner such as the quality of knowledge of E-learning, where visuospatial intelligence exceeds the capabilities required for successful learning. E-Learning in period of COVID, is among the causes of this study, since learning was online where many new educational technologies were applied, which makes E-Learning possible, such as visual digital media that makes teaching effective. The visuospatial interaction of the learner with electronic media is the first to control performance and academic success.

This study is the first in Morocco, this research work aims to research the types of abilities via a cognitive and E-learning test with pupils with a scientific orientation, physics option, who excel in performance and academic success. The results of this study will provide on the one hand to researchers and specialists a theoretical basis on the role of visuospatial intelligence in the success of E-learning, on the other hand to evaluate educational programs which aim the development of abilities and the skills of his pupils.

II. Method

A. Participants

Our sample is composed of many adolescents' pupils from the Physics Option in the scientific common trunk in the city of Safi in Morocco. The number of pupils who participated in our survey was 204 pupils with a mean age is 15 years 12 months 11 days with a standard deviation of 00 years 1 month 19 days which corresponds to a very important period in a person's life, when the child undergoes a range of changes, such as physical, emotional, social, cognitive, perceptual, and other developments. The study included the same number of participants of both sexes.

B. Material

In order to calculate Visuospatial ability, two subtests of a cognitive test were choice from the Wechsler Intelligence Scale for Children and Adolescents. The Visuospatial intelligence scale is calculated by both the Cubes and Visual Puzzles subtests. The Visuospatial Intelligence Scale subtests were administered individually during vacant hours. The administration of the scale was carried out by the use of the cubes and the images in the booklet of stimuli which calculates the Visuospatial intelligence. The attribution and rating were carried out according to the procedure of the administration and rating manual [18] [19]. The questionnaire given to pupils includes questions on the social and cultural environment of the family as well as the visual and auditory problems which the pupils could suffer.

C. Data Collection and Analysis

The overall raw scores obtained after running each subtest were transmitted for unlimited correction online to Q-global instead of manual conversion, which requires more time and may lead to miscalculations. The final results were obtained in the form of Standard Scores and Composite Scores. In order to analyse the study data, the program Statistical Package for Social Sciences (SPSS version 25) was used for research of reliability, statistical descriptive and t-test results.

D. Socio-Economic Status and Level of Education

The cultural characteristics of the social environment of the participants include the level of education of the child and his parents which reflect on the social level of the families of the participants. The study conducted represents the Moroccan public school which suffers from the absence of children from the high earning class and the absence of children from an integrated family educational environment, in terms of the presence of a high level of education. The level of parental education is very low, and all participants haven't a telephone or a computer, at least one member of their family have a telephone that can be connected to the internet.

III. Results

Pupils participating in this study get an average Composite Score equal to the theoretical average in visuospatial intelligence of 100.43, with a standard deviation half of the theoretical average of 8.98. Thus, girls' pupils and boys' pupils get equal marks.

Concerning the ranking of the results studies, we note that important number of the participating pupils amounted to 65.70% on average, 19.60% of the participating pupils on average strong, and 14.70% of the participating pupils on average weak. The reliability measured by Cronbach's alpha in this test was 0.860.

The average and the standard deviations of the standard marks of the two subtests Cubes and Visual Puzzles which builds the visuospatial intelligence are successively with the theoretical average. The Cubes subtest average is 10.01 with a standard deviation of 1.86, also the Visual Puzzles subtest average is 10.22 with a standard deviation of 2.33.

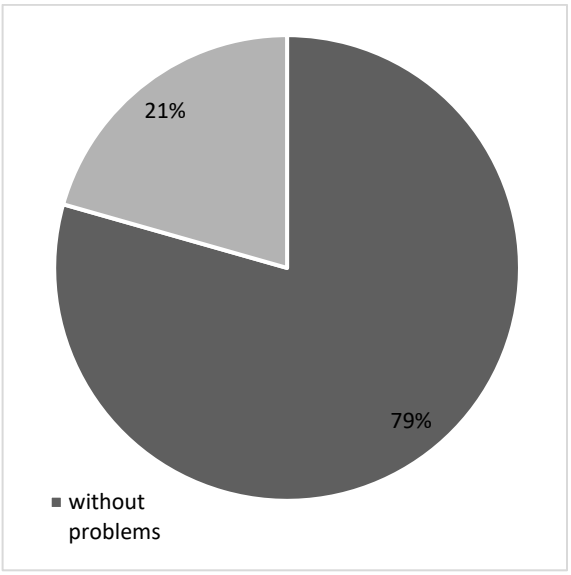

Fig. 1. Percentage of Pupils with Problems among All Participants.

A fifth of the participants indicated in the questionnaire that they suffer from hearing or visual disorders or both Fig. 1. The percentage of girl's pupils and boys' pupils participating in this

study is equal, but the percentage of girls who report suffering from a hearing or visual disorders or both is 22%, and 78% do not suffer from any disorders.

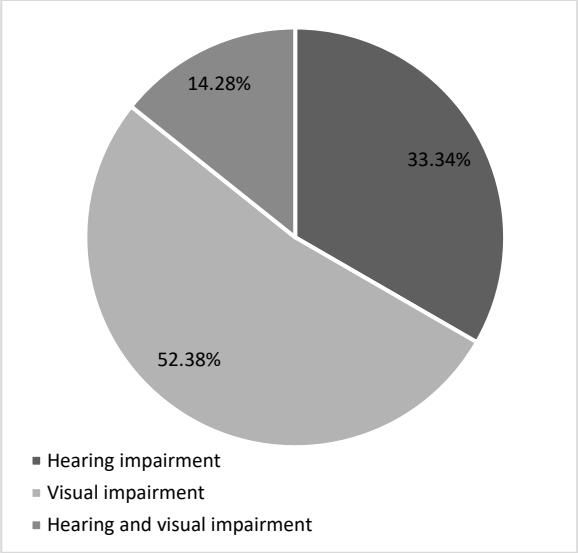

Fig. 2. Percentage of Pupils with Hearing or Visual Disorders or Both.

Fig. 2 shows the percentage of pupils with hearing or visual disorders or both. A half of pupils who have disorders confirmed having visual disorders. While a third of pupil's report having a hearing disorder. The lowest percentage are pupils who have hearing and visual disorders.

According to gender, the large percentage of female who suffer from problems 45.45%, and this percentage concerns female who have visual problems, followed by a percentage of 36.36% of female who report that they have visual problems, hearing problems; the low percentage of 18.18% is among female reported that they have hearing and visual problems. A large percentage of male who have problems is 60%, is linked to male who have vision problems, with a percentage of 30% of male who suffer from hearing problems, the 10% of male reported that they have hearing and visual problems.

TABLE I. CORRELATIONS BETWEEN VISUOSPATIAL INTELLIGENCE SCORES AND DEVELOPMENTAL AND COGNITIVE IMPAIRMENT FACTORS

Factor	r	p
The quality of family earnings	-0,240	0,015
The quality of the family's level of education	0,244	0,013
Submission to the preschool period	0,167	0,093
Got at least one phone in the family	0,326	0,001
Got at least one computer in the family	0,474	0,000
Participate in e-learning (the Covid-19 pandemic)	0,540	0,000
Desire for E-learning	0,339	0,000

The correlation between visuospatial intelligence scores and participation in e-learning (Covid-19) is the highest according to the Table I which presents the correlation between visuospatial intelligence scores and the seven factors. The high correlation is followed by the correlation between the availability of electronic communication tools such as computer and telephone and visuospatial intelligence. The desire for e-learning is also great. Social and educational factors are also important.

IV. DISCUSSION

Hybrid learning remains a promising technological approach that reduced the existing difference in a disrupted world, the covid 19 pandemic brought different constraints and changed the voices maintained for normal life. However, the success of the E-Learning process depends on a set of skills and cognitive abilities of the learners. Visuospatial intelligence is no longer considered one of the components of the intelligence quotient of each individual but also an essential component to complete one's learning. The study indicates that the results are equal between the female and male gender, this result explains that the programs don't distinguish between two genders in terms of preparation, and that the teachers treat their pupils equally regardless of their gender, and this treatment is reflected in their performance in examinations and general tests [20][21].

In general, the average theoretical visuospatial intelligence is one hundred. The results of this study indicate that the participants received a composite average score equal to the theoretical average of 100.43, it's superior to all intelligence studies in Morocco [22]. This result is between M=99.1 and M=105.6 in the study which conducted in America twice over a same sample belonging to the same age group as the study sample [23]. The average result derived from the theoretical standard and the results of various studies conducted in the United States is concord with the results obtained. The situation of 1,607 Caucasian child with 830 girls and 777 boys aged 6 to 16, with a Visuospatial of 103.49 and a standard deviation of 14.46 (girls with M=102.97 and SD= 13.85; boys with M=104.05 and SD=15.12). Two other studies reveal average inferior. The first concerns 409 African - American child: 221 girls and 188 boys, aged 6 to 16, with a Visuospatial of 90.69 and a standard deviation of 13.71 (girls with M=90.95 and SD=13.67; boys with M= 90.39 SD = 13.76). The second study concerns 621 Hispanic child: 313 girls and 308 boys, from 6 to 16 years old, with a Visuospatial of 97.17 and a standard deviation of 13.41 (girls with M = 95.83 SD = 12.75; boys with M = 98.54 and SD = 14.09) [24]. The difference in study results can be explained by the nature of the development of minds and the use of imagination while they ponder, analyse and reflect on school subjects, in addition to the nature of schools and cultural level and social of parents.

Despite cultural differences and demographic characteristics, the results obtained in our study show similarities with most studies. It's important to emphasize that the samples of American studies serving as a point of comparison with our study, differ from the samples of our study from the point of view of the educational composition of the parents (holders of a bachelor's degree or more), which very logically leads, a set of social and economic privileges for their children [25].

The Moroccan pupils are science pupils, which suggests why they excelled in the test which is due to family orientation and continuous educational development since childhood, unlike pupils who tend to acquire languages, who perform less well on tests.

Suggestion of interventions in the curriculum is necessary to become more adapt to pupil, through the development of

curricula that contain activities that develop visuospatial ability with the diversification of teaching strategies to include both visuospatial methods, and not limited to traditional methods of presenting subject. Using visuospatial skills help pupils find multiple solutions to the same problem during their studies which leads to an improvement in their level of creative thinking and achievement.

The results of the present study indicate that there is a correlation between the development of visuospatial intelligence of participants, and the rate of their participation in E-learning. Also, the acquired spatial visual skills reflected in academic achievement and contribute to the acquisition of learning skills at an early age, have relatively eliminated the comparison between the social and economic privileges of the Moroccan and American learner.

V. Conclusion

Based on the results of the research, where spatial ability isn't affected by gender, it can be concluded that public school pupils who excel in the physics course have a high level of spatial ability and that they have a higher level in demonstrating their spatial capability. This is due to the development of their abilities due to the early experiences they are exposed to inside and outside of school, which affects academic achievement. It also shows the strength of the correlation between E-learning and spatial ability, which is reflected in the quality of nature of instructional orientation for this sample, as well as fat status in performance and academic achievement based on e-learning.

VI. Recommendation

The pupils participating in this study have very good academic performance. Didactic aids to increase and develop the visuospatial skills of all pupils may include providing activities to support visuospatial strengths, activities that build creative structures, provide many educational digital games, and support visuospatial strengths, provide visuospatial activities; encourage the child to engage in visual-spatial tasks, such as putting together puzzles; creating maps; drawing or playing with construction toys. Provide visual learning opportunities to help understand and remember new ideas. When new information is presented in the classroom, visual aids should be presented to supplement the content presented orally. This means decreasing or increasing the number of visual displays with manipulatives, drawings, diagrams, and charts may overwhelm the pupil. It is necessary to explain in words, all new skills and concepts, graphics and visual tasks.

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