Article

The Effect of The Question Grid Strategy on Cognitive Achievement in Mathematics and Lateral Thinking Among Fifth-Grade Science Students

Shaimaa Hussein Mohammed

1. Directorate of Education of Karbala
* Correspondence: Shaimaa.hussein1203a@ihcoedu.uobaghdad.edu.iq

Abstract: The current study aims to identify "the effect of the question grid strategy on achievement and lateral thinking among fifth-grade science students in mathematics." To achieve the research objective, the researcher put forward the following two null hypotheses: 1- At the 0.05 significance level, no statistically significant difference was found between the mean achievement test scores of the experimental group and those of the control group. 2- There are no statistically significant differences, at the 0.05 significance level, between the average scores of the experimental group students and the scores of the control group students on the lateral thinking scale. To achieve the research objective, the researcher adopted the experimental approach, defining the research community as fifth-grade science students in secondary schools affiliated with the Karbala Education Directorate/Center for the academic year (2021-2022). One of the schools was randomly selected to conduct the experiment, using the experimental design with two groups (experimental and control) with a post-test for both academic achievement and lateral thinking. Two groups (A, B) were selected to form the research sample of (59) students, with (29) students in the experimental group, taught according to the "question network" strategy, and (30) students in the control group, taught the subject using the traditional method. The two groups were statistically equivalent in a number of variables, namely: mid-year grades, chronological age calculated in months, parents' academic achievement, and an intelligence test.

Keywords: Question grid strategy, mathematics education, academic achievement, lateral thinking, teaching methods, secondary students, experimental research

1. Introduction

The Research Problem The scientific development, the complexity of life, the expansion of its demands, and the abundance of problems have increased the learner's need to use his skills and abilities [1]. Therefore, educators face the task of qualifying generations to deal properly with technological and scientific developments to confront challenges and difficulties. It is necessary and imperative to focus decisively on modern teaching strategies with the aim of teaching thinking and building a personality capable of identifying problems, which enables the learner to be self-reliant under the supervision of the teacher. This is what modern educational goals emphasized in order to develop the educational process, stimulate student participation, and develop their mental abilities to learn [2], [3]. Therefore, it has become necessary to use modern teaching strategies and methods.

Based on the above, it has become necessary for the mathematics teacher to follow modern teaching methods because his task is no longer limited to lecture and explanation, but rather he is responsible for employing modern teaching strategies to achieve learning goals. The research problem is represented in answering the following question: To what extent does the question network strategy affect the achievement of fifth-grade female students in science and the development of their lateral thinking?

The Importance of research:

Mathematics is a basic curriculum subject that benefits all other sciences. The teacher's use of an appropriate teaching method helps him/her transfer the skills and knowledge contained in the subject and translate them in a way that ensures students interact with the subject and achieve the objectives with ease. Therefore, the research is important in that it presents a new strategy for teaching mathematics, which can be explained through:The "question network" strategy in mathematics is an effective means that enables the learner to understand the scientific material by asking and analyzing the largest possible number of questions, which contributes to linking previous indirect knowledge with acquired direct knowledge, and thus building ideas and knowledge.The importance of mathematics stems from its significant role in daily life and its ability to develop problem-solving skills [4], [5]. The importance of lateral thinking is highlighted in the student, as it has an impact in helping him/her acquire problem-solving skills and interpret them in a correct scientific manner. The importance of the fifth scientific grade in particular and the preparatory stage in general, as it is one of the important stages during which the student faces physical, social and psychological changes.The current research represents an addition to the Iraqi and Arab library.This is the first research, to the researcher's knowledge, in the subject of mathematics.

Research objectives: The current research aims to identify:

(The effect of the question grid strategy on the achievement of the mathematics lesson and the development of lateral thinking among fifth-grade science students) Research hypotheses: - The research has two hypotheses to achieve its objective:At the 0.05 significance level, there are no statistically significant differences between the mean achievement test scores of the experimental group students who employed the question grid strategy and those of the control group students who followed the traditional method.At the 0.05 significance level, there are no statistically significant differences between the mean scores of the experimental group students who used the question grid strategy and the mean scores of the control group students who used the traditional method on the dimensional lateral thinking scale [6], [7]. Research Limits: The current research is defined as follows: Human Limits: It includes a sample of fifth-grade science students.Temporal Limits: The experiment will be implemented in the second semester of the academic year. Objective Limits: Chapters (sixth, seventh, eighth) of the mathematics subject, edition, Ministry of Education Spatial Limits: Preparatory schools affiliated with the Karbala Education Directorate. Sixth: Defining Terms: The effect was defined by as: The procedures carried out by the teacher in order to make the learning process easier, faster, more enjoyable and more self-directed, as well as the possibility of transferring it to a new situation [8].

The strategy was defined by as: "The teacher's movements within the classroom must be sequential and regular, and have sufficient flexibility to take into account the nature and needs of the students, and reflect the actual reality of the classroom environment in terms of exploiting the available capabilities; with the aim of achieving the pre-planned educational objectives.

The question grid strategy was defined by as: "The strategy that helps build knowledge by presenting thought-provoking questions. It relies on questions as a basis for correcting basic concepts and alternative perceptions in training students to pose questions among themselves in which they search for answers." Operational definition: The amount of change caused by the question grid strategy in the average mathematics scores of fifth-grade science students in the experimental group compared to the control group [9], [10].

Achievement: defined it as: "The set of skills and knowledge acquired by the student and developed during the academic period, as indicated by test scores or grades prepared by teachers, or both."

Lateral Thinking: defined it as: A mental process that includes defining the problem and gathering the largest possible amount of information to choose the correct alternative in any scientific, educational, or life situation.

2. Materials and Methods

The researcher adopted the experimental design.

Research Community: One of the important basics of the experiment is determining the research community. When determining the school that the researcher visited according to the mission letter issued by the Education Directorate in Karbala Governorate, the school was randomly selected to conduct the experiment. It includes six sections for the fifth grade due to its proximity to residential areas and includes many sections. The two sections (A, B) were chosen to represent the research sample, which consisted of (59) students, with (29) students for the experimental group in which the question network strategy was applied, while the number of the control group was (30) in which the traditional method was applied.

Table 1. What is meant by the research sample is a part of the research community

Variable	Group	Mean	SD	t-value (calculated)	t-value (tabulated)	Sig. Level	Result
Chronological age	Experimental	14.0106	0.522	1.011	2.02	0.05	Not significant
	Control	14.0145	0.521				
Previous Achievement	Experimental	14.044	0.221	1.055	2.02	0.05	Not significant
	Control	14.024	0.210				
Intelligence Test	Experimental	14.014	0.442	1.055	2.02	0.05	Not significant
	Control	14.020	0.421				

The table 1 presents the results of statistical analyses comparing two groups (Experimental and Control) across three variables: Chronological Age, Previous Achievement, and Intelligence Test. For each variable, the table includes the mean, standard deviation (SD), calculated t-value, tabulated t-value, significance level (Sig.), and the overall result for the hypothesis test.(Research sample 3) The data analysis shows that there are no significant differences between the experimental and control groups across any of the three variables tested (Chronological Age, Previous Achievement, and Intelligence Test). All the calculated t-values were lower than the tabulated t-value, leading to the conclusion that the groups are statistically similar in these respects at the 0.05 significance level.

3. Results and Discussion

Equivalence of the two research groups: Before starting the experiment, the researcher worked on establishing statistical equivalence between the two research groups in a number of variables that affect the research results (the students' chronological age, intelligence test, previous achievement scores in mathematics) [11], [12]. Data on these variables was obtained and the arithmetic mean, standard deviation, and variance were extracted, see Table 2.

Table 2. Mean, Variance, Standard Deviation, Tabulated and Calculated T-Value for Chronological Age, Prior Achievement in Mathematics, and IQ Test

Variable	Group	N	Mean	Standard Deviation	Variance	Calculated T-Value	Tabulated T-Value	Degrees of Freedom	Significance Level
Chronological Age	Experimental	29	170.136	12.922	165.178	1.110	1.99	80	Not statistically significant
	Control	30	168.039	12.381	152.179				
Prior Achievement	Experimental	29	67.234	10.881	118.379	-1.544	1.99	80	Not statistically significant
	Control	30	68.039	12.381	158.324				
IQ Test	Experimental	29	26.478	9.362	85.612	-1.314	1.99	80	Not statistically significant
	Control	30	28.684	5.388	29.023				

Research tools: The two tools are an achievement test and a lateral thinking scale, which can be explained.

Achievement test: The researcher prepared an achievement test, which is a structured procedure to determine the student's learning in a specific topic. It consists of 30 objective questions based on behavioral objectives and their levels, including the first five levels of Bloom's taxonomy of the cognitive domain (knowledge, understanding, application, analysis, synthesis).

Test validity: One of the most important characteristics and qualities that the researcher is keen to ensure in the test before applying it [13].

Apparent validity: Validity refers to the quality of the test by presenting the achievement test items in their initial form to a group of 20 specialists and arbitrators specializing in teaching methods in mathematics to obtain their opinions on the validity of the items. In light of their recommendations and comments, some items were modified and others were retained as they achieved an agreement rate of more than 80%. The test remained in its final form, consisting of 30 items. Content validity: This type of validity is assessed when the test items represent the intended behavior to be measured, and the behavioral objectives [14]. A test map has been created. Achievement tests are acceptable if they indicate the content of the subject matter or the extent to which each item relates to the content of the objective it measures, or if they have content validity.

Exploratory Application of the Achievement Test:

To ensure the clarity of the achievement test items, the test was administered to a pilot sample similar to the study group, consisting of female students from *Bilad Al-Nahrain Secondary School* under the supervision of the Karbala Education Directorate. It was verified that the pilot group had completed the study of the topics designated for the experiment. In coordination with the school administration and the subject teacher, the test date was scheduled for Sunday, November 25, 2021 [15]. All students were notified of the date one week in advance. The results indicated that all test items were clear and comprehensible, and the average time required to complete the test was approximately 40 minutes.

Correction of the Achievement Test:

The test was scored by assigning one point for each correct answer and zero points for each incorrect answer, to ensure measurement accuracy and precisely determine the level of achievement.

Analysis of the statistical and psychometric properties of the achievement test: Item difficulty coefficient: The goal was to identify items with appropriate difficulty, as its values ranged between (0.27–0.62), which is within the acceptable limits. Studies indicate that test items are considered good if their difficulty coefficient ranges between (0.20–0.80), which applies to the items in this test. Item discriminating power coefficient: The degree to which test items can distinguish between students with different levels of the trait assessed by the test. It was found that discriminating power values ranged between (0.36–0.62). Measurement and evaluation specialists agree that items with a discriminating power of (0.20) or more are considered acceptable. Therefore, the items in this test are acceptable in terms of their ability to distinguish between high- and low-performing sample members. Effectiveness of false alternatives: A false option is effective when it attracts a greater number of students from the lower group compared to students who choose this option in the upper group. Therefore, the more negative the value of the false alternative, the stronger and more preferable it is. Reliability of the achievement test: The reliability coefficient of the achievement test was calculated using two methods: the split-half method after applying it to a pilot sample of (112) students. After selecting (27%) of the highest-performing students as the upper group and (27%) of the lowest-performing students as the lower group, the Pearson correlation coefficient was calculated between the two halves of the test, reaching (0.854). Since this coefficient represents only half of the test and does not measure overall homogeneity, it was corrected using the Spearman-Brown equation, where the reliability coefficient reached (0.922), which is a high reliability coefficient and indicates good internal consistency. The researcher also used Cronbach's alpha equation to calculate reliability on the same survey sample, and the reliability coefficient reached (0.92), which confirms that the test has a high degree of reliability and stability and is ready for final application.

Lateral Thinking Scale:

First: Defining the Scale's Objective: The current scale aims to measure female students' lateral thinking skills, through items designed to directly measure these skills.

Second: Test Validity: Apparent Validity:

The scale's items were presented to a group of experts and specialists in the educational and psychological fields, most of whom expressed their approval of the validity of the items, while suggesting some minor amendments. Since the agreement rate between the arbitrators reached (80%) or more, (30) items were retained after modification, thus achieving the apparent validity of the scale.

Scale Correction: When scoring the scale of the second variable, a score of (2) was given for each correct answer and a score of (1) for each incorrect answer. Accordingly, the maximum possible score on the scale is (60) and the minimum is (30), with a hypothetical mean of (42), representing the cutoff point between individuals with high lateral thinking skills and those below the required level.

Constructive validity (verification of the general structure of the scale):

The construct validity of the scale was verified by calculating the discriminatory power of each item, based on the ability of the items to differentiate between the responses of the upper group and those of the lower group for each item on the scale, after administering it to a pilot sample of (60) female students. The results revealed that all items were statistically significant, as the calculated *t*-value exceeded the tabulated value (2.00) at the 0.05 significance level and a degree of freedom of (58). This indicates that the items effectively distinguish between female students with high and low levels of lateral thinking, as presented in Table 3.

Table 3. Discriminatory Power of the T-Test Results for the Significance of the Difference Between the Mean Scores of the Upper and Lower Groups on the Lateral Thinking Scale

Item No.	Lower Group Mean	Variance	Upper Group Mean	Variance	Calculated T-Value	Statistical Significance
1	1.801	0.165	1.401	0.258	3.406	Significant
2	1.633	0.240	1.367	0.240	2.107	Significant
3	1.767	0.217	1.300	0.217	3.324	Significant
4	1.700	0.185	1.200	0.166	5.242	Significant
5	1.833	0.144	1.567	0.254	2.316	Significant
6	1.733	0.202	1.400	0.248	2.720	Significant
7	1.833	0.144	1.567	0.254	2.316	Significant
8	1.800	0.166	1.500	0.259	2.523	Significant
9	1.767	0.185	1.367	0.240	3.360	Significant
10	1.832	0.143	1.440	0.253	3.473	Significant
11	1.801	0.165	1.234	0.184	5.243	Significant
12	1.801	0.165	1.334	0.240	4.165	Significant
13	1.834	0.142	1.300	0.227	4.861	Significant
14	1.833	0.144	1.301	0.216	4.862	Significant
15	1.732	0.212	1.323	0.231	3.334	Significant
16	1.801	0.165	1.332	0.231	4.062	Significant
17	1.866	0.121	1.101	0.092	9.105	Significant
18	1.768	0.186	1.376	0.241	3.350	Significant
19	1.765	0.186	1.332	0.231	3.567	Significant
20	1.857	0.121	1.211	0.156	6.829	Significant
21	1.901	0.091	1.156	0.143	8.256	Significant
22	1.868	0.123	1.457	0.258	3.567	Significant
23	1.765	0.167	1.323	0.231	3.675	Significant
24	1.732	0.212	1.331	0.261	3.657	Significant
25	1.801	0.165	1.432	0.247	3.416	Significant
26	1.932	0.063	1.200	0.165	8.377	Significant
27	1.865	0.130	1.433	0.256	3.773	Significant
28	1.768	0.186	1.167	0.143	5.731	Significant
29	1.782	0.121	1.267	0.132	5.832	Significant
30	1.564	0.185	1.156	0.134	6.543	Significant

Internal consistency validity: This type of validity was verified by extracting the discriminating power of the items using the two extreme groups method, the item's relationship to the domain of the scale, its relationship to the domain to which it belongs, and the relationship of the domain to the total score of the scale. This was verified by comparing the calculated value with the tabular value of (0.245) at a significance level of (0.05) and a degree of freedom of (58), as shown in Table 4. These results indicate that the scale has a good degree of internal consistency validity.

Table 4. Correlation Coefficients Between Each Item and Its Domain, and Between Each Item and the Total Score of the Lateral Thinking Scale

Domain	Item No.	Item–Domain Correlation	Item–Total Correlation	Domain–Total Score Correlation
Generating New Perceptions	1	0.687	0.413	0.681
	2	0.639	0.302	
	3	0.614	0.628	
	4	0.737	0.480	
	5	0.742	0.578	
	6	0.620	0.442	

Generating New Concepts	7	0.464	0.306	0.743
	8	0.494	0.402	
	9	0.681	0.453	
	10	0.561	0.502	
	11	0.658	0.581	
	12	0.692	0.548	
Generating New Ideas	13	0.675	0.581	0.846
	14	0.702	0.643	
	15	0.608	0.452	
	16	0.725	0.531	
	17	0.507	0.475	
	18	0.373	0.443	
Generating New Alternatives	19	0.267	0.476	0.855
	20	0.461	0.726	
	21	0.652	0.735	
	22	0.321	0.576	
	23	0.332	0.521	
	24	0.343	0.501	
Generating New Creations	25	0.471	0.517	0.845
	26	0.602	0.573	
	27	0.336	0.573	
	28	0.358	0.562	
	29	0.432	0.587	
	30	0.452	0.560	

Reliability of the Lateral Thinking Scale: The reliability of the Lateral Thinking Scale was verified using two methods: - Test-Retest: A repeated application of the scale was conducted, and the reliability coefficient was calculated using Pearson's correlation coefficient between the results of the first and second applications. The coefficient value reached (0.985), indicating that the scale possesses a high degree of reliability, which is considered an acceptable coefficient in educational and psychological studies. - "Cronbach's Alpha Method": To extract reliability using this method, the equation mentioned above was applied, and the reliability coefficient reached (0.907), which is a strong indicator of the scale's internal consistency, reflecting the quality and homogeneity of the items. - The scale in its final form: After verifying the validity and reliability of the scale, its final form was approved, consisting of (30) items equally distributed across (5) main skills representing the dimensions of lateral thinking. The items were formulated to align with the research objectives and the level of the target sample. Presentation and Interpretation of Results: First: Interpretation of the Results of the First Hypothesis Related to Achievement: The results showed that the experimental group that used the Question Grid strategy outperformed the control group that used the traditional method. This can be explained through the following:

1. The Question Grid strategy is based on applied teaching methods, carried out in a specific sequence of steps, which facilitates the process of interaction and content comprehension.
2. The Question Grid strategy contributes to enhancing comprehension in studies, boosting students' confidence, and focusing on what qualifies them to improve academic performance.

3. Applying the Question Grid strategy facilitates students' freedom to express their ideas, enhances their engagement with both the teacher and the subject, and results in deeper learning among students.
4. It is an interactive and creative teaching method that motivates students to exert greater mental effort.
5. It contributes to teaching mathematics in particular, as it is one of the modern teaching methods that works to activate the student's role in the classroom. Second: Interpreting the results of the second hypothesis related to lateral thinking: The research results indicated a significant superiority of the experimental group that used the question grid strategy over the control group that used the traditional teaching method, for the following reasons:

   a. Directed thinking is a type of modern learning style characterized by reversing the educational process and providing many opportunities and diverse forms for students to freely express their opinions and ideas.

   b. Lateral thinking is one of the educational styles that helps students generate ideas through the use of specific tools that contribute to stimulating their creative thinking.

   c. The question grid strategy trains students in thinking skills through directed questions and practical examples, stimulating students to think scientifically and creatively simultaneously.

   d. It enhances students' ability to generate new ideas by developing higher-order thinking skills, such as analysis, interpretation, evaluation, and synthesis. This increases their ability to solve various problems, expands their mental awareness, enables them to perceive similarities and differences in various life situations, and enhances their creative thinking.

4. Conclusion

The research results proved that the experimental group that used the question grid strategy outperformed the control group in the academic achievement of students in the experimental group compared to the students in the control group. The research results proved that the experimental group students outperformed the control group students in the lateral thinking test.

The question grid strategy contributes to raising the level of achievement among female students.

The question grid strategy in teaching mathematics contributes to enhancing creativity and practical thinking among students, achieving understanding, developing concentration, reducing anxiety, and promoting the generation of more modern and creative ideas. Fourth: Recommendations Based on the research results, a number of recommendations are proposed, including: The need to train mathematics teachers on how to teach students due to its impact on academic performance and its ability to enhance creative thinking. Using the strategy within educational programs to develop curricula, as well as preparing textbooks, and teaching students thinking tools. Focus on developing students' lateral thinking by developing scientific thinking skills and providing diverse methods that motivate students to think. Encourage teachers to stimulate thinking and develop students' creative thinking by employing diverse teaching strategies in classrooms. Encourage students to participate independently and express their views in the classroom to enhance their creative thinking abilities.

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