The Effectiveness Of Synectics Strategy In Achievement And Statistical Thinking

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ABSTRACT: The aim of the research is to identify the effectiveness of Synectics strategy in the academic achevment sof the students of Mathematics department of Al-Mustansiria university, college of basic education and their statistical thinking . To achieve the aim of the research, the researchers use the experimental method, and designed two tests: one for achievement, and the other is for statistical thinking, each test consists of 20 MCQ items. After applying the two tests on the research sample which consisting of (82) students, distributed to two groups, experimental consisting of (42), and a control group consisting of (40) students, and statistical data processing, the results showed: the experimental group students generally outperformed, and female students over the control group students. In both tests, the differences between the average scores of male students were not statistically significant.

Keywords: Synectics strategy, achievement, statistics, statistical thinking

INTRODUCTION

Mathematics is "one of human brain critical and creative activities" (Ahmed, 2017, p.358). it is not a mere academic content. "It is a mindset" (Ahmed, 2014, p.261), and it has special characteristics that promote thinking. Statistics is an important area of mathematics, which includes a set of educational experiences that focus on dealing with individuals with different types of data. It is not limited to the traditional view associated with a collection of data, description and analysis of data, and associated statistical processes, but it serves as a pattern of thinking. Therefore, statistical thinking is a goal in teaching statistics and is related to measurement, modeling, sampling, representation, probability and other processes

As a result of scientific and technical development in the present era, statistical research, practice and education have entered a new era focusing on the development and use of statistical thinking (Snee, 1999, P255). Rhagen and Singer (Kugle, rHagen and Singer, 2003) demonstrated that students should engage in activities that stimulate statistical thinking such as: using samples to make inferences about communities and drawing real conclusions, the central tendency measures, and comparing and differentiating to use some of them to suit the nature of the data, and to distinguish between the independent and dependent variables.

Statistical thinking is defined as "mental processes and skills undertaken by an individual to develop ideas related to statistical attitudes and experiences, the ability to present and describe data using statistical metrics, and to draw conclusions through certain verbal or quantitative data." It includes four aspects: data description, data organization and summarization, graphically represent and display data, and analyze and interpret data (Jardat, 2013).

We have observed through the work of teaching the material of the course of educational statistics for several years in the Department of Mathematics, College of Basic Education, University of Mustansiriya that there is a decrease in the level of student achievement, and their success rates in this course. Therefore, this decline leads to a decrease in their level of statistical thinking. A number of studies showed a correlation between achievement and thinking, such as the study (Ahmed, 2017, p. 356), which showed that "those who possess patterns of thinking in mathematics are able to think and link mathematical knowledge to reality, and possess higher thinking skills which makes them able to understand mathematical topics and be excellent in mathematics" as the results of a number of studies pointed to the low levels of statistical thinking among students, including the study (Ahmed, 2000), and (Jardat, 2013). The researchers believe that there are a number of reasons that lead to the low level of achievement of students in the subject of educational statistics, including: Using the traditional teaching methods represented by lecturers, which may not suit their needs, tendencies, and abilities, and do not raise their motivation and desire to learn and acquire concepts and application in their lives which affects negatively on their achievements and their statistical thinking. The nature and content of the course requires students to deal with and apply information individually to be able to understand statistical concepts and laws. This is not available in the classroom with a huge number of students. The use of assessment methods based on laws and related applications without linking them to

real life situations illustrate the importance of statistical methods in describing attitudes, problems and phenomena is another reason for the low level of student achievement in the course of educational statistics.

Jalbani has shown that (Jalbani, 2014. P2) "there is a great need for new teaching methods to meet global challenges." The problem in all processes of learning and knowledge acquisition is to try to integrate new information into the learner's cognitive structure (Friedrich & Mandl 2006, p2) without seeking to arrange this information. The use of educational strategies and the selection of a proper methods of teaching increases the understanding and organization of information in the learner's cognitive structure. Therefore, the process of recalling becomes faster because "it links between new information and the prior knowledge of the learner" (Wegner & Minnaert & Swehlke, 2013, P39). The effectiveness of a proper teaching method is highlighted when we find that students "create similes and things that reminds them about the facts that must be learned to relate new ideas to their previous knowledge or to express new information in their own words" (Schräder - Naef 2006, p 44).

The studies indicated the need to use modern teaching strategies because they are "necessary for students" (Wegner & Minnaert & Swehlke, 2013: p37). They increase their understanding of concepts in general, and statistical concepts in particular (Jardat, 2013) and (Al-Qahtani, 2017). Therefore, the researchers sought to search for methods and strategies that work to raise the level of achievement in the course of educational statistics, and thus raise the level of statistical thinking.

After reviewing studies related to teaching strategies and their importance in the development of statistical thinking and achievement, the researchers chose the Synectics strategy, a strategy for developing students' creativity, which was developed by William Gordon and his colleagues in 1961. Gordon used the term (Synectics) to describe the synthesising process. The word is originally Greek which describes the integration of dissimilar elements (Roshka, 1989, p. 1989). There are also different names for this teaching method including: (Gordon strategy, Strategy Synectic, the connected or similar).

The use of Synectics strategy contributes to the development of ideas and the formation of new relationships from information stored in the student's mind. It is "an effective tool in facilitating students' knowledge-building process. It is consistent with the student growth because of its close association with the real world of students" (Prince, 1971). It also "engages members in the production of new ideas, and it creates a free environment in which criticism and evaluation are neglected. They also have different connotations: they use metaphors and systematic visual representations to solve different types of problems." (Abu Jadu and Nofal, 2007, p. 198).

A researcher pointed out (Abdul Amir, 2016, p. 348) that the strategy of Synectics received a great acceptance by teachers and students during the application of the study and believes that this is due to its advantages and its active role in the development of innovative thinking of the students. Therefore, she called for employing and focusing on it during the teaching process to allow students to detonate their potential abilities.

The results of the study (Tajari & Tajari, 2014, P451) showed that teaching in Synectics method not only increased creativity, but also helped to raise the achievement level of students. The study (Khan & Mahmood, 2017, P253) indicated that students were able to redefine and remember the concept in a new way using their own words, connect the knowledge learned in their daily lives, and apply the gained knowledge in everyday life. A study (Djudin, 2017, P 65) also showed that learning using a synectic strategy makes learning meaningful and promote new thinking.

Therefore, the researchers suggest to apply Synectic strategy and to focus on it during the teaching process

RESEARCH PROBLEM

The problem of the research is determined by answering the following questions:

1- What is the effectiveness of the strategy of Synectics in the achievment of students of Mathematics department in the college of Basic Education, University of Mustansiriya in educational statistics subject ?

2- What is the effectiveness of the strategy of Synectics in the statistical thinking of students of the Department of Mathematics in the college of Basic Education, University of Mustansiriya ?

RESEARCH IMPORTANCE

Important points in the research are:

1 - to identify the effectiveness of Synectics strategy in the achievement and statistical thinking of the students of Mathematics department of Al-Mustansiria university, college of basic education

2 - to draw the attention of those concerned with the teaching of statistics, and the importance of statistical thinking and its active role in increasing the ability of students to collect data, summarize, analyze and interpret, and select appropriate statistical measures.

3 - Increasing the ability of students to use statistical analyzes and benefit from them in the practical life.

4 - the resposibility of the university, which is to prepare competent teachers who are able to practice the profession of educating in a way that enables them to teach students and stimulate thinking for them.

5 - scarcity of research and studies that deal with the effectiveness of the strategy of Synectics in the development of achievement and statistical thinking in Iraq (to the knowledge of the researchers).

RESEARCH OBJECTIVES

The research aims to identify

1 - The effectiveness of the strategy of Synectics in the acquisition of statistics for students of the Mathematics department, college of basic education, Al-Musansiriah

2 - The effectiveness of the strategy of Synectics in statistical thinking among students of the Mathematics department, college of basic education, Al-Musansiriah

RESEARCH HYPOTHESES

1 - There is no statistically significant difference between the average scores of the experimental group students who will be taught according to the strategy of Synectics and the control group which will be taught according to the usual method in the achievement test.

2 - There is no statistically significant difference between the average scores of students of the experimental group, which will be taught according to the strategy of Synectics in the achievement test according to the sex variable.

3 - There is no statistically significant difference between the average scores of students of the experimental group, which will be taught according to the strategy of Synectics and the control group, which will be taught according to the usual method in the statistical thinking test.

4 - There is no statistically significant difference between the average scores of students of the experimental group, which will be taught according to the strategy of Synectics in the test of statistical thinking according to the sex variable.

RESEARCH LIMTS

The research was limited to:

1- A sample of students of the second stage morning study in the Department of Mathematics, College of Basic Education, University of Mustansiriya.

2- Second semester of the academic year 2017-2018.

3 - subjects (measures of central tendency, measures of dispersion, measures of correlation) from the syllabus of the course of educational statistics.

RESEARCH METHODOLOGY

The researchers used experimental research methodology, partially controlled design and post-test of two equal groups (experimental and control) to meet the research objectives, Figure (1):

Figure 1 : Experimental design

Groups	Equivalence	Independent Variable	Dependent variable
Experimental	prior-kowledge	Synectics strategy	Acquisition
Control	Age Intelligence	Usual method	Statistical thinking

a) RESEARCH COMMUNTTY AND SAMPLE

The research community consisted of students of the Department of Mathematics / Morning Study at the College of Basic Education, University of Mustansiriya, for the academic year 2017 – 2018.

The researchers selected two classrooms from the second stage students in the Department of Mathematics to represent the basic research sample, which number (82) students, Table (1):

Table 1 : Distribution of the research sample to two groups (experimental and control)

Group	Section	Gender	NO. of students	Eliminated students	NO. of students after elimination
Experimental	B	Male	29	6	23
		Female	23	6	17
Control	D	Male	27	4	23
		Female	25	6	19
Total			104	22	82

The sample of verifying the clarity of the instructions and items of the tests included students from A and C of the second stage in the Department of Mathematics, and the number was (86) students.

b) Equivalence of the research groups and control of non-experimental outer variables

The two groups were equal in age, knowledge of statistics, and intelligence.

Despite the equivalence procedures between the two research groups that may affect dependent variables. However, there are factors or variables other than the independent factor, which in one way or another affect the accuracy of the experiment, which should be determined and controlled in order to limit their influence on the dependent variables. These factors include: (Experiment conditions, waste, measuring instruments, differences between the members of the sample, the impact of experimental conditions which are: confidentiality of the experiment, the subject, teacher, distribution of classes, place of experiment, duration of the experiment).

c) The experiment

The application of the research experiment took 6 weeks, during which the experimental group was taught according to the Synectics strategy, while the control group was taught according to the traditional method.

d) Research Tools

The research Objective is To identify the effectiveness of the strategy of the Synectics strategy in achevment and statistical thinking of students of the Mathematics department of the college of Basic Education, University of Mustansiriya. To achieve the objectives of the research, and test the hypotheses, the researchers prepared the following

e)1) Statistical Thinking Test

After reviewing studies that deal with the subject of statistical thinking, the researchers prepared a test in statistical thinking consisting of (20) items of multiple choice type, and verified its validity after being presented to a number of specialists in statistics and teaching methods, and applied to a sample to check the clarity of the instructions and the test items.

Table 2 : Distribute the paragraphs of statistical thinking test to his four skills

Subjects	Statistical thinking skills				Total
Measures of central tendency	Data collecting	Data organization and description	Data analyzing	Data Interpretation	
Measures of dispersion	2	2	2	2	8
Measures of dispersion	2	2	2	1	7
Correlation metrics	2	1	1	1	5
Total	6	5	5	4	20

e)2) Achievement Test in Educational Statistics

The two researchers have prepared an educational test in the subject of educational statistics consisting of (20) items of multiple-choice type. The validity of test was verified after being presented to a number of specialists in statistics and teaching methods and applied to a sample to check the clarity of the instructions and the test items.

f) Statistical means

Equation of the difficulty and discrimination coefficient, the effectiveness of the special alternatives, the Pearson correlation coefficient, the equation (KR-20) and the T test of two independent samples.

RESULTS

1) The results of the first hypothesis: There is no statistically significant difference between the average scores of students of the experimental group, which will be taught according to the strategy of Synectics and the control group, which will be taught according to the usual method in achievement test.

To test the hypothesis, the average and variance of the scores of the students of the research sample (All, male, female) were calculated in the achievement test. To find out the significance of the differences between the averages, the Z-test was used for two independent samples.Table (3):

Table 3 : The significance of differences between the mean scores of the experimental and control groups of students on the achievement test

Group	Gender	Number	Mean	Variance	Degree of freedom	Value of Z		Significance level
						Calculated	Tabular	
Experimental	Male	23	10.652	16.874	44	1.488	2.021	Not significant
Control	Male	23	8.956	14.680				
Experimental	Female	19	13.684	19.895	34	2.501	2.042	Significant
Control	Female	17	10.647	13.993				

Experiment al	Total	42	12.024	20.121	80	2.349	2	Significant
Control	Total	40	9.678	14.738				

It is clear from the results of Table (3) that the value of z calculated from the scores (students as a whole, and female students) is greater than the tabular value, and this indicates the existence of a difference for the benefit of the experimental group, but for male students the difference is not statistically significant.

2) The results of the second hypothesis: There is no statistically significant difference between the average scores of students of the experimental group, which will be taught according to the strategy of Synectics in the achievement test according to sex variable.

To test the hypothesis, the mean and variance of the scores of the students of the experimental group (males and females) in the achievement test were calculated. To find out the significance of the differences between the averages, a Z-test for two independent samples was used., table (4)

Table 4 : Significance of differences between the mean scores of students of the experimental research sample (males and females) on the achievement test according to sex variable

Group	Gender	Number	Average	Variance	Degree of Freedom	Value of Z		The level of significance
						calculated	Tabular	
Experimental	Male	23	10.652	16.874	40	2.290	2.021	Significant
Control	Female	19	13.684	19.895				

It is clear from the results of Table (4) that the value of z calculated from the scores of the experimental group (males and females) according to the sex variable is greater than the tabular one, and this indicates the existence of a difference for the benefit of female students, and therefore rejects the second hypothesis.

3) Results of the third hypothesis: There is no statistically significant difference between the average scores of students of the experimental group, which will be taught according to the strategy of Synectics and the control group, which will be taught according to the usual method in statistical thinking test.

To test the hypothesis, the mean and variance of the scores of the students of the research sample (total, male, female) on the statistical thinking test were calculated. To find out the significance of the differences between the averages, a Z-test for two independent samples was used. Table (5):

Table 5 : The significance of the differences between the mean scores of students of the experimental and control groups on the statistical thinking test

Group	Gender	Number	Average	variance	Degree of Freedom	Value of z		The level of significance
						Calculated	Tabular	
Experimental	Male	23	12.391	7.976	44	1.325	2.021	Not Significant
Control	Male	23	11.304	7.503				
Experimental	Female	19	3.789	5.731	34	4.649	2.042	Significant
Control	Female	17	10.059	9.434				
Experimental	Mix	42	13.024	7.292	80	3.634	2	Significant
Control	Mix	40	10.775	8.435				

It is clear from the results of Table (5) that the value of z calculated from the scores (for students as a whole, and for female students) is greater than the tabular one, and this indicates the existence of a difference for the benefit of the experimental group, but for male students the difference is not statistically significant.

4) The results of the fourth hypothesis: There is no statistically significant difference at the level of significance (0.05) between the average scores of students of the experimental group, which will be taught according to the strategy of Synectics in the test of statistical thinking according to sex variable.

To test the hypothesis, the mean and variance of the scores of the students of the experimental research sample (male and female) on the statistical thinking test were calculated. To find out the significance of the differences between the averages, a Z-test was used for two independent samples, Table (6):

Table 6 : Significance of differences between the mean scores of students of the experimental research sample (males and females) on the statistical thinking test according to sex variable

Group	Gender	Number	means	Variance	Degree of freedom	Value of Z		The level of significance
						Calculated	Tabular	
Experimental	Male	23	12.391	7.976	40	1.709	2.021	Not significant
Control	Female	19	13.789	5.731				

It is clear from the results of Table (6) that the value of z calculated from the scores of the experimental group (males and females) according to the sex variable is smaller than the tabular one, and this indicates that there is no difference between male and female students, and therefore accept the fourth hypothesis.

DISCUSION AND CONCLUSION
a) Discussion of the results:
1) Regarding the Effectiveness of the Synectics Strategy in the achievement:
The results of Table (3) showed that there is a difference between the average scores of students of the experimental and control groups (students as a whole and female students) and for the benefit of the experimental group. This result was consistent with the results of the study (Al-Shorafat, 2007) and (Al-Tamimi, 1026), whose results showed the effectiveness of the strategy of Synectics, and the study (Al-Sudani, 2004), the results of which showed a positive impact of the use of computer in raising the level of achievement in the course of Educational statistics among students of the college of Basic Education.
2) "The Effectiveness of the Strategy of Synectics in Statistical Thinking":
Table (5) showed that there is a difference between the mean scores of the students of the experimental and control groups (students as a whole and female students) and for the benefit of the experimental group. This may be due to the fact that teaching the course of educational statistics using the strategy of Synectic, helps to improve the level of statistical thinking. The steps of strategy: (addressing the problem, analysis of the problem, individual proposals, the problem as understood, drifting from the problem, real conformity, Scientific conformity, a new perspective or problem) (Abu Jadu and Nofal, 2007, 269) were consistent with statistical thinking skills, which allowed them to apply some tools and collect data in the field, and to apply what they learned from statistical treatments in practice, which was not available to students who taught the same subjects with the usual method (theoretical lectures). The Synectics Strategy provides an opportunity to work individually in research, knowledge and dealing with situations and problems, providing greater opportunities for discussions among students to support the building of their statistical thinking levels.
The results were similar to the results of a number of studies, including the study (Abdul Hamid, 2006), which stressed the importance of using learning and teaching strategies based on student participation in applied and practical learning tasks that help them developing their statistical thinking skills. The study (Al-Qahtani, 2017), whose results showed the effectiveness of the strategy of learning contracts in the development of statistical thinking among graduate students at College of Education University of Tabuk.

b) Conclusions
1) The strategy of Synectics raises the level of achievement of students of mathematics department of the College of Basic Education, University of Mustansiriya (experimental group) compared to the students who were taught according to the usual method.
2) The impact of the strategy of Synectics on the female students was higher than the one on the male students (research sample) in raising the level of achievement.
3) The strategy of Synectics raises the level of statistical thinking for students of mathematics department of the college of Basic Education, University of Mustansiriya (experimental group) compared to the students who were taught according to the usual method.
4) There is a difference between the average scores of students of the research sample (male and female) in statistical thinking, but it is not statistically significant.

c) Recommendations
Considering the findings of the current research, the researchers recommend the following:
1) raising the level of achievement in educational statistics using appropriate teaching strategies, including the strategy of Synectics.
2) employing the strategy of Synectics in teaching the course of educational statistics due to its importance and importance in developing statistical thinking skills.
3) Include statistical thinking skills as one of the main objectives in the course of educational statistics and work to develop them using appropriate strategies and develop appropriate tools to measure them.
4) The two researchers propose the following studies: Developing the statistical thinking skills of students / teachers in the Department of Mathematics, and training mathematics teachers on the use of the Synectics strategy in the teaching of mathematics in various educational stages.

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