The Effectiveness of Using Collaborative Integration Strategy for Fragmented Information "Jigsaw IV" Supported by Infographics on Cognitive Achievement of Sports Education Technology Course for Physical Education Faculty's Students

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Research Abstract:

This research aims to identify the effect of using collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics on cognitive achievement of sports education technology course for students of Physical Education Faculty, as the researcher used semi-experimental approach in stage of applying collaborative integration strategy for fragmented information (Jigsaw IV), using pre- and post-measurement of two experimental groups and a control group. Research community included all fourth-year students - Physical Education Teaching Department, including (629) students (377 boys, 252 girls) from Physical Education Faculty - Mansoura University, for the academic year (2022/2023). Research sample amounted to (108) students who were selected intentionally. one of the most important study's results was superiority of the group that used collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics over both the group that used collaborative integration strategy for fragmented information "Jigsaw IV" only and the group that used traditional program. The researcher recommends conducting experimental studies to use collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics for rest of Sports Education Technology course's topics, in addition to the rest of academic courses in physical education faculties.

Keywords:

Collaborative Integration Strategy for fragmented information "Jigsaw IV"- Infographics - Sports Education Technology.

Research Introduction:

The contemporary educational movement called for collaborative learning in the sixties of twentieth century, led by John Dewey and William H. Kilpatrick, who called for classrooms to work as a laboratory for learning in real life, in order to activate student's role in the educational process and put him in a group situation in which he plays the role of teaching and learning at the same time, and they share group work and information in order to achieve common goals such as cognitive achievement and social skills (3: 16).

Despite these beginnings, studies did not focus on collaborative learning applications within classrooms until the beginning of the seventies, and different types of collaborative learning were applied, until the method

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of collaborative integration strategy for fragmented information or cut pictures "Jigsaw" appeared at the hands of E. Aronson. (17) (26)

It was developed by scientists, and development of this strategy continues to this day until the fourth version (Jigsaw IV) appeared. (20), (24)

The idea of collaborative integration strategy for fragmented information "Jigsaw" is based on games of assembling pieces to reach desired shape. In it, the teacher begins with activities to present lecture and divides students into heterogeneous groups consisting of (4-6) students, and assigns a number to each of them within parent group. Each student in the group is assigned to study a specific aspect that is not given to others in the group, then, each number from main groups is called to the Expert group to study the topic in detail and they are given time to cooperate with their colleagues so that they can exchange information about the specific part. Then, they prepare a mini-presentation of that part before returning to the main group, and they take their turn in explaining that part to rest of parent group members, then presenting a plan about the topic in an integrated way, where teacher's role during the strategy is to move between the groups, guide and encourage, provide feedback, and apply a mini-test after each stage. Finally, summarize the topic, clarify unanswered questions, test students individually, give them rewards, and determine a grade for each student and each group.

By reviewing many of previous studies' results related to variables of current research regarding usage of collaborative integration strategy for fragmented information (Jigsaw) in various fields of education: such as achievement in various subjects such as (7), (9), (18), (25), and its applications in sports field such as (15), (11), (13), (21).

The studies were not limited to identifying the impact of collaborative integration strategy for fragmented information (Jigsaw) on previous variables, but rather comparing method's different versions such as (Jigsaw II), (Jigsaw III) and (Jigsaw IV) such as (20), (24).

Infographic technology is a reflection of development in technology field and its educational applications with its designs that work to change the method of reading and presenting complex data and information, and add a new visual form to collect and display information and transfer data in an attractive image to the learner, and help those in charge of educational process in presenting curricula in a new and interesting way (10: 460)

The term infographic consists two parts: (**Information**) which refers to required information, data and various knowledge to be displayed or communicated to the learner, (**Graphic**) which refers to designed shapes, images and drawings that aim to display complex information in a clear and easy-to-read way. (22: 22)

The term infographic refers to the art of converting complex data, information and concepts into images

and drawings that can be understood and absorbed clearly with interest. This method is characterized by presenting complex and difficult information in a smooth, easy and clear way. (10:469)

The success of infographics stems from their ability to communicate a large amount of complex and difficult-to-understand information in a clear, simple and immediate way that is easy to save and retrieve, but the process of producing infographics is not a simple matter as it requires a lot of effort and experience. (19: 161-163)

There are three main types of infographics in terms of form: **Static Infographic**, **Motion Infographic**, and **Interactive Infographic**, each of them has characteristics that distinguish it from other types. A fourth type of infographic can be added, which is **Mixed Infographic**, that combines both animated infographic and regular photography. (5: 2577) (12: 1228) (10: 426)

There are many characteristics of educational infographics, including: organizing information, creativity, attractive design, simplicity in presenting content, adding links between design elements, clarifying cause-and-effect relationships, visual appeal, understanding, memorability, shareability, enrichment capabilities, information encoding, summarizing, and visual contact. (8: 237) (16: 225) (23: 1199)

By reviewing many results of previous studies related to current research variables regarding using infographics in various fields of education, such as achievement in various academic subjects as (5), (14), and its applications in sports field as (1), (2), (4).

Research problem:

Through researcher's work as a faculty staff member at Physical Education Faculty - Mansoura University, he noticed a decrease in learning level in course of sports education technology and associated information and knowledge, for fourth-year students in Physical Education Teaching Department, and this may be due to using verbal explanation method.

Although the importance of collaborative integration strategy for fragmented information "Jigsaw IV" and infographics (within researcher's knowledge), collaborative learning has not been employed in collaborative integration strategy's method for fragmented information "Jigsaw", especially fourth version (Jigsaw IV), supported by infographics in cognitive achievement in sports education technology course; therefore, it was necessary to employ collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics to be a building block in developing education and serving both the teacher and the learner, and sports education technology course.

Research objective:

This research aims to identify the effect of using collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics on cognitive achievement of Sports Education Technology course

for Physical Education Faculty's students, by identifying:

1. The effect of collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics on cognitive achievement in Sports Education Technology course for Physical Education Faculty's students - Mansoura University.
2. The effect of collaborative integration strategy for fragmented information "Jigsaw IV" on cognitive achievement in Sports Education Technology course for Physical Education Faculty's students- Mansoura University.
3. The effect of traditional program on cognitive achievement in Sports Education Technology course for Physical Education Faculty's students - Mansoura University.
4. The difference between collaborative integration strategy effect of fragmented information "Jigsaw IV" supported by infographics and not supported by infographics on cognitive achievement in sports education technology course for Physical Education Faculty's students - Mansoura University.

Research Hypotheses:

1. There are statistically significant differences between pre- and post-measurements of first experimental group (collaborative integration strategy of fragmented information "Jigsaw IV" supported by infographics) in cognitive achievement in sports education technology course.
2. There are statistically significant differences between pre- and post-measurements of second experimental group (collaborative integration strategy of fragmented information "Jigsaw IV") in cognitive achievement in sports education technology course.
3. There are statistically significant differences between pre- and post-measurements of control group (traditional program) in cognitive achievement in sports education technology course.
4. There are statistically significant differences between post-measurements in cognitive achievement in Sports Education Technology course for the three groups in favor of first experimental group (collaborative integration strategy for fragmented information “Jigsaw 4” supported by infographics).

Research terms:

Collaborative integration strategy of fragmented information "Jigsaw IV": (Procedural Definition)

One of collaborative learning strategies, in which students are divided into small groups, and each student is given a specific aspect of the topic that is not given to others, he studies it and becomes an expert in it, then explains this aspect to the rest of his group members, and the teacher's role during the strategy is to guide and apply a mini-test after each stage, then summarize the topic, and determine a score for each student and each group.

Infographic (Procedural Definition)

A visual representation of the content represented in information and skills related to producing digital images

accompanied by pictures, drawings, texts, arrows, animated and interactive shapes, in order to present data or information or complex knowledge clearly and excitingly in a quick and clear way, and has the ability to improve perception by employing graphics in a pictorial way that makes it easy for those who see it to understand it without the need to read a lot of text, and this method is characterized by presenting complex and difficult information in a smooth, easy and clear way.

Research Procedures:

Research Methodology:

The researcher used semi-experimental approach in applying collaborative integration strategy for fragmented information (Jigsaw 4), using pre- and post-measurement for two experimental groups and a control group.

Research Community:

The research community included all fourth-year students at Physical Education Teaching Department, including (629) students, (377 boys, 252 girls) from Physical Education Faculty - Mansoura University, for the academic year (2022/2023).

Research Sample:

The researcher selected research sample intentionally from fourth year male students, Physical Education Teaching Department, including (108) students, who were randomly distributed into two experimental groups and a control group, in addition to (30) students for exploratory study to experimentally control of research tools, within the community and outside the basic sample, and Table (1) shows a description of research community and sample.

Table (1)
Description of research community and sample

	Sample type	Groups	Number	Percentage	Program
1	Basic study sample	First experimental group	36	9.55	"Jigsaw4" supported by infographic
2	(108)	Second experimental group	36	9.55	"Jigsaw4"
3		Control group	36	9.55	Traditional program
4	study sample	Survey	30	7.96	Verification of validity and reliability coefficients
5	Rest of community	(excluded)	239	63.40	—
	Total	(overall)	377	100	—

Verification of distribution normality of research total sample:

Table (2)
Skewness coefficients for variables under research. (N=138)

Variables		Measurement nit	Mean	Median	Deviation	Skewness
Basic	Chronological Age	Year	22.09	22.25	0.49	-0.98
	Intelligence	Score	97.25	97.00	1.85	0.41
Cognitive	First Dimension: Introduction to Sports Education Technology	Score	3.41	4.00	1.15	-1.54
	Second Dimension: Selected Topics in Sports Education Technology	Score	10.20	10.00	1.48	0.41
	Third Dimension: Innovations in Sports Education Technology	Score	6.30	6.00	1.61	0.56
	Cognitive Test (Total Score)	Score	19.91	20.00	2.45	-0.11

It is clear from Table (2) that skewness coefficients' values ranged between (±3), which indicates distribution moderation of values under the normal curve in all selected variables under research.

Equivalence between research groups:

The researcher conducted equivalence between experimental groups and control group in cognitive test's results, which may affect the research. Table (3) shows equivalence between groups in cognitive test's results under research.

Table (3)
variance analysis between (pre-) measurements in cognitive test's results for the three research groups (N1=N2=N3 =36)

Dimensions	Source of variance	Sum of Squares	df	Mean Square	F
First Dimension: Introduction to Sports Education Technology	Between Groups	1.91	2	0.95	0.74
	Within Groups	135.53	105	1.29	
	Total	137.44	107		
Second Dimension: Selected Topics in Sports Education Technology	Between Groups	3.13	2	1.56	0.70
	Within Groups	236.08	105	2.25	
	Total	239.21	107		
Third Dimension: Innovations in Sports Education Technology	Between Groups	3.19	2	1.59	0.56
	Within Groups	296.03	105	2.82	
	Total	299.21	107		
Cognitive Test (Total Score)	Between Groups	10.50	2	5.25	0.87
	Within Groups	635.75	105	6.05	
	Total	646.25	107		

Tabular F at degree of freedom (2 and 105) and significance level (0.05) = 3.07

It is clear from Table (3) that there are no statistically significant differences at level (0.05) as calculated (F) value was less than tabular (F) value; which indicates that there are no statistically significant differences between measurements, which indicates groups' equivalence in cognitive test's results under research.

Data collection tools:

1. Cognitive achievement test in Sports Education Technology course: (Attachment 2)

After the researcher reviewed models of cognitive achievement tests in Sports Education Technology course and how to prepare them, the researcher followed successive scientific steps to build and prepare cognitive achievement test in terms of determining: test objective, axes, setting test instructions, and presenting them to (9) experts (Attachment 1), then verifying psychometric properties and relative importance of test axes (specification table) and analyzing test items, determining time required to answer it, and setting correction key.

The test's scientific coefficients were verified (validity - reliability - coefficients of ease and difficulty - determining the time).

2. Building proposed educational program with collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics:

After reviewing models of programs that addressed the effectiveness of using collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics, especially in physical

education field, such as (15), (11), (13), (21), with regard to using infographics and their applications in sports field, such as (1), (2), (4)

The researcher built a program with collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics in Sports Education Technology course, and took scientific foundations for planning educational programs into consideration, through reviewing scientific references and studies related to research variables, then determining program goal and basic variables, and presented them to the experts (Attachment 1) with program basic aspects to express their opinions on them, and the appropriate learning method, as well as time period set for program implementation, and number and time of educational units. The researcher prepared: The student guide as Attachment (5), The educational infographic design as Attachment (6).

Research implementation procedures:

In second semester of academic year (2022/2023), as follows:

1- Exploratory study:

The researcher conducted it on 19/2/2023 to verify validity and reliability of cognitive test under research, and to ensure validity of used devices, and progress of the educational unit.

2- Pre-measurement:

The researcher conducted pre-measurement on 26/2/2023, to test cognitive achievement.

3- Research application:

The basic experiment was applied for (8) educational units, on Sunday of each week in period from (5/3/2023) to (30/4/2023), and the researcher took into consideration all weather conditions and holidays.

Table (4)

Educational units' goal of collaborative integration strategy program for fragmented information "Jigsaw IV" supported by infographics

Date	Educational units' goal
5/3/2023	Introduction to sports education technology
12/3/2023	Selected topics in sports education technology
19/3/2023	
26/3/2023	
2/4/2023	
9/4/2023	Innovations in sports education technology
16/4/2023	
30/4/2023	

1- Post-measurement:

The researcher conducted post-measurement on (7/5/2023) to test cognitive achievement, under same conditions used in pre-measurement.

Statistical treatments:

The researcher used (SPSS) version (27) in data statistical

treatments, using following coefficients:

1. Mean , Median, Standard Deviation, Skewness
2. Difficulty and Ease coefficients (DR), and discrimination coefficient (ID).
3. Pearson Correlation Coefficient
4. Spearman-Brown split-half, and Getman equation.
5. Kuder-Richardson 20 (KR20) method.
6. Paired Sample t-Test.
7. One-Way ANOVA.
8. Least significant difference (LSD).
9. Effect Size using:

a. Eta square (η2) in case of (t) test and in case of (f) test.

b. (Cohen's d) and interpreted according to Cohen's criteria

10. Change Ratio
11. McGuigan's Gain Ratio.
12. Black's Modified Gain Ratio

Presenting research results:

Presenting first hypothesis results:

To verify validity of first, second and third hypotheses, the researcher used a (t) test for two related data samples. The effect size was also calculated using Eta square (η2) in case of (t) test, and using (Cohen's d) and interpreted according to Cohen's criteria. To verify program effectiveness, the researcher used gain ratio for "McGogian" and it is acceptable if the value of this ratio is not less than (0.6) in addition to modified gain ratio for "Black" and cut-off point for this ratio is (1.2), in addition to improvement rate, as follows:

Table (5)

Differences' significance between pre-measurement and post-measurement in cognitive test results for the first experimental group (n=36)

Dimensions	Measurement Unit	Pre-measurement		Post-measurement		(t) Value	Effect size	
		Deviation	Mean	Deviation	Mean		(η^2)	Cohen's *d*
First Dimension: Introduction to Sports Education Technology	Score	3.50	1.13	8.22	1.10	17.55	0.972	7.7
Second Dimension: Selected Topics in Sports Education Technology	Score	10.39	1.55	23.08	1.30	37.34	0.994	16.6
Third Dimension: Innovations in Sports Education Technology	Score	6.36	1.81	18.42	1.98	27.07	0.988	12.1
Cognitive Test (Total Score)	Score	20.25	2.59	49.72	2.54	48.83	0.996	21.8

Tabular t at degree of freedom (35) and significance level (0.05) = 2.03

It is clear from table (5) that calculated (t) values ranged between (17.55) and (48.83). To determine applied significance of independent variable on dependent variable, the effect size was calculated using Eta square (η2), which expresses effect size of independent variable on dependent variable. The values of (η2) ranged between (0.972) and (0.996), which indicates a (huge) effect size. The values of (Cohen's d) ranged between (7.7) and (21.8), which indicates a (huge) effect size.

Table (6)

Improvement ratio and program effectiveness ratio for "McGogian" and adjusted gain ratio for "Black" in cognitive test results for First Experimental Group

Dimensions	Maximum score	Average Pre-measurement	Average Post-measurement	Difference between the two measurements	*Change Ratio*	*Gain Ratio* (Mg)	*Gain Ratio* (Mg_{blak})
First Dimension: Introduction to Sports Education Technology	10	3.50	8.22	4.72	134.92	0.7	1.2
Second Dimension: Selected Topics in Sports Education Technology	27	10.39	23.08	12.69	122.19	0.8	1.2
Third Dimension: Innovations in Sports Education Technology	23	6.36	18.42	12.06	189.52	0.7	1.2
Cognitive Test (Total Score)	60	20.25	49.72	29.47	145.54	0.7	1.2

It is clear from Table (6) that improvement ratio for first experimental group ranged between (122.19) and (189.52), and that all axes of cognitive test achieved appropriate effectiveness.

Discussion of first hypothesis results:

It is clear from Table (5) that there are differences between pre-measurement and the post-measurement in favor of post-measurement in cognitive test results, for first experimental group.

It is clear from Table (6) that there are appropriate improvement and effectiveness ratio of collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics on cognitive achievement.

This result is consistent with studies' results that dealt with

collaborative integration strategy for fragmented information "Jigsaw IV" in its various versions in cognitive achievement for various different academic subjects such as (7), (9), (18), (25), and its applications in sports field such as (15), (11), (13), (21)

This result is consistent with studies' results that dealt with infographics on cognitive achievement for various academic subjects such as (5), (14), and its applications in sport field such as (1), (2), (4)

The researcher attributes the improvement that occurred in the group to collaborative integration of fragmented information "Jigsaw IV", in which it benefits learners with good use. This may be due to teacher's knowledge of how to apply collaborative learning and distribute roles to learners and trust between teacher and learners and raise cooperation spirit between learners with each other, as the teacher gives appropriate evaluation at the same time or another time when the learner inquiries from the teacher, so the response to educational interaction between teacher and learners is quick and correct without information overlapping with each other, and then teacher's evaluation helps learners to improve their learning methods and academic achievement in a correct way.

Also, collaborative integration strategy of fragmented information "Jigsaw IV" supported by infographics works to learn the material in depth better than if he tried to learn it completely by himself depending on his effort, and since each student has a special part that he is responsible for presenting to his colleagues in the group, it encourages ensuring the extent to which all students understand subject with all its details and overcoming the problem of not understanding a part during its presentation. (16:18)

Infographics improve communication between students by capturing complex ideas, behaviors, or knowledge and presenting them in a visual form that students can comprehend. They can also convey the greatest possible amount of information in the minimum amount of time and space that information occupies. They combine images and words to increase understanding and retention of that information. (6:99)

Thus, the validity of first hypothesis is achieved, which states: "There are statistically significant differences between pre- and post-measurements of first experimental group (the collaborative integration strategy for fragmented information "Jigsaw 4" supported by infographics) in cognitive achievement in sport education technology course."

Presenting second hypothesis results:

Table (7)
Significance of differences between pre-measurement and post-measurement in cognitive test results for second experimental group (n=36)

Dimensions	Measurement Unit	Pre-measurement		Post-measurement		(t) Value	Effect size	
		Deviation	Mean	Deviation	Mean		(η^2)	Cohen's *d*
First Dimension: Introduction to Sports Education Technology	Score	3.19	1.14	7.28	1.06	16.33	0.967	7.0
Second Dimension: Selected Topics in Sports Education Technology	Score	10.39	1.52	21.06	2.19	25.88	0.987	10.7
Third Dimension: Innovations in Sports Education Technology	Score	6.42	1.71	16.19	1.69	24.65	0.985	10.9
Cognitive Test (Total Score)	Score	20.00	2.62	44.53	3.24	40.91	0.995	15.7

Tabular t-test at degree of freedom (35) and significance level (0.05) = 2.03

It is clear from Table (7) that calculated (t) values ranged between (16.33) and (40.91). To determine applied significance of independent variable on dependent variable, the effect size was calculated using Eta square (η2), which expresses effect size of independent variable on dependent variable. The values of (η2) ranged between (0.967) and (0.995), which indicates a (huge) effect size, and values of (Cohen's d) ranged between (7.0) and (15.7), which indicates a (huge) effect size.

Table (8)
Improvement ratio and program effectiveness ratio for "McGogian" and adjusted gain ratio for "Black" in cognitive test results for Second Experimental Group

Dimensions	Maximum score	Average Pre-measurement	Average Post-measurement	Difference between the two measurements	*Change Ratio*	*Gain Ratio* (Mg)	*Gain Ratio* (Mg_{blak})
First Dimension: Introduction to Sports Education Technology	10	3.19	7.28	4.08	127.83	0.6	1.0

Follow Table (8)

Improvement ratio and program effectiveness ratio for "McGogian" and adjusted gain ratio for "Black" in cognitive test results for Second Experimental Group

Dimensions	Maximum score	Average Pre-measurement	Average Post-measurement	Difference between the two measurements	*Change Ratio*	*Gain Ratio* (Mg)	*Gain Ratio* (Mg_{blak})
Second Dimension: Selected Topics in Sports Education Technology	27	10.39	21.06	10.67	102.67	0.6	1.0
Third Dimension: Innovations in Sports Education Technology	23	6.42	16.19	9.78	152.38	0.6	1.0
Cognitive Test (Total Score)	60	20.00	44.53	24.53	122.64	0.6	1.0

It is clear from Table (8) that improvement ratio for second experimental group ranged between (102.67) and (152.38), and that all cognitive test axes achieved appropriate effectiveness according to "McGogian" and medium effectiveness according to modified gain ratio of "Black" (MGBlak) Gain Ratio.

Discussion of second **hypothesis results:**

It is clear from Table (7) that there are differences between pre- and post-measurements in favor of post-measurement in cognitive test results for second experimental group.

Table (8) shows improvement ratio and an average effectiveness ratio for collaborative integration strategy for fragmented information "Jigsaw IV" on cognitive achievement.

This result is consistent with studies' results that dealt with collaborative integration strategy for fragmented information "Jigsaw IV" in its various versions in cognitive achievement for various different subjects such as (7), (9), (18), (25), and its applications in sport field such as (15), (11), (13), (21).

The researcher attributes the improvement in the group to activities carried out by the teacher to present the lesson, such as brainstorming, problem solving, and working to attract students' attention before starting the lesson, in addition to applying partial tests to verify whether students studying in expert groups have learned information, and finally the teacher summarizes and reviews unfamiliar parts, and this step is considered very important, especially for students with a low level of achievement before moving on to next chapter.

Thus, validity of second hypothesis is achieved, which states: “There are statistically significant

differences between pre- and post-measurements of second experimental group (collaborative integration strategy for fragmented information "Jigsaw 4") in cognitive achievement in sport education technology course" .

Presenting third hypothesis results:

Table (9)

Significance of differences between pre-measurement and post-measurement in cognitive test results for control group (n=36)

Dimensions	Measurement Unit	Pre-measurement		Post-measurement		(t) Value	Effect size	
		Deviation	Mean	Deviation	Mean		(η^2)	Cohen's *d*
First Dimension: Introduction to Sports Education Technology	Score	3.44	1.13	6.81	1.58	10.00	0.917	4.3
Second Dimension: Selected Topics in Sports Education Technology	Score	10.03	1.42	17.14	1.38	19.98	0.978	8.2
Third Dimension: Innovations in Sports Education Technology	Score	6.03	1.50	14.97	3.28	14.46	0.959	6.2
Cognitive Test (Total Score)	Score	19.50	2.14	38.92	4.51	21.22	0.980	8.1

Tabular t-test at degree of freedom (35) and significance level (0.05) = 2.03

It is clear from Table (9) that calculated (t) values ranged between (10.00) and (21.22). To determine applied significance of independent variable on dependent variable, the effect size was calculated using Eta square (η2), which expresses effect size of independent variable on dependent variable. The values of (η2) ranged between (0.917) and (0.980), which indicates a (huge) effect size, and values of (Cohen's d) ranged between (4.3) and (8.2), which indicates a (huge) effect size.

Table (10)
Improvement ratio and program effectiveness ratio for "McGogian" and adjusted gain ratio for "Black" in cognitive test results for control group

Dimensions	Maximum score	Average Pre-measurement	Average Post-measurement	Difference between the two measurements	Change Ratio	Gain Ratio (Mg)	Gain Ratio (Mg_{blak})
First Dimension: Introduction to Sports Education Technology	10	3.44	6.81	3.36	97.58	0.5	0.8
Second Dimension: Selected Topics in Sports Education Technology	27	10.03	17.14	7.11	70.91	0.4	0.7
Third Dimension: Innovations in Sports Education Technology	23	6.03	14.97	8.94	148.39	0.5	0.9
Cognitive Test (Total Score)	60	19.50	38.92	19.42	99.57	0.5	0.8

It is clear from Table (10) that improvement ratio for control group ranged between (70.91) and (148.39), and that all cognitive test axes did not achieve effectiveness

Discussion of third hypothesis results:

It is clear from Table (9) that there are differences between pre- and post-measurements in favor of post-measurement in cognitive test results for control group.

It is clear from Table (10) that there are improvement ratio and a weak effectiveness ratio for traditional program on cognitive achievement.

This result is consistent with studies' results that dealt with traditional program on cognitive achievement for various academic subjects (41), (44), (45), (49).

The researcher attributes group's improvement to the fact that traditional program, which is followed in teaching the course in lecture method may lead to an increase in individual's level as a result of direct retrieval of information during learning process.

Thus, validity of third hypothesis is achieved, which states: "There are statistically significant differences between pre- and post-measurements of control group (traditional program) in cognitive achievement in sports education technology course".

Presentation of fourth hypothesis results:

To verify validity of fourth hypothesis, the researcher used one-way analysis of variance (One-Way ANOVA) and the least significant difference (LSD) test; for differences' significance between average scores in post-measurement of the three research groups, the effect size was calculated using Eta square (η2) in case of (F) test, and using (Cohen's d) and interpreted according to Cohen's criteria, as follows:

Table (11)

Analysis of variance between post-measurements in cognitive test results for the three research groups (N1=N2=N3=36)

Dimensions	Variance Source	Sum of Squares	df	Mean Square	F	Effect size	
						(η^2)	Cohen's *d*
First Dimension: Introduction to Sports Education Technology	Between Groups	37.46	2	18.73	11.63	0.181	0.5
	Within Groups	169.08	105	1.61			
	Total	206.55	107				
econd Dimension: Selected Topics in Sports Education Technology	Between Groups	657.46	2	328.73	117.83	0.692	1.5
	Within Groups	292.94	105	2.79			
	Total	950.41	107				
Third Dimension: Innovations in Sports Education Technology	Between Groups	219.56	2	109.78	18.79	0.264	0.6
	Within Groups	613.36	105	5.84			
	Total	832.92	107				
Cognitive Test (Total Score)	Between Groups	2102.72	2	1051.36	84.73	0.617	1.3
	Within Groups	1302.94	105	12.41			
	Total	3405.67	107				

Tabular F- at degrees of freedom (2 and 105) and significance level (0.05) = 3.07

It is clear from Table (11) that calculated (F) values ranged between (13.53) and (22.08) and to determine applied significance of independent variable on dependent variable, the effect size was calculated using Eta square (η2) which expresses effect size of independent variable on dependent variable, and values of (η2) ranged between (0.843) and (0.935) and this

indicates a (huge) effect size, and values of (Cohen's d) ranged between (3.3) and (5.29) and this indicates a (huge) effect size.

Table (12)
Significance of differences between pairs of post-measurements averages and test of least significant difference (L.S.D) in cognitive test results for the three research groups

Dimensions	Groups	Average Measurements	Significance of differences between measurements		
			First Experimental	Second Experimental	Control
First Dimension: Introduction to Sports Education Technology	First Experimental	8.22		0.94*	1.42*
	Second Experimental	7.28			0.47
	Control	6.81			
second Dimension: Selected Topics in Sports Education Technology	First Experimental	23.08		2.03*	5.94*
	Second Experimental	21.06			3.92*
	Control	17.14			
Third Dimension: Innovations in Sports Education Technology	First Experimental	18.42		2.22*	3.44*
	Second Experimental	16.19			1.22*
	Control	14.97			
Cognitive Test (Total Score)	First Experimental	49.72		5.19*	10.81*
	Second Experimental	44.53			5.61*
	Control	38.92			

* Differences are significant at the (0.05) level

Table (13)
Improvement ratio in cognitive test results for the three research groups

Dimensions	Change Ratio		
	First Experimental	Second Experimental	Control
First Dimension: Introduction to Sports Education Technology	134.92	127.83	97.58
second Dimension: Selected Topics in Sports Education Technology	122.19	102.67	70.91
Third Dimension: Innovations in Sports Education Technology	189.52	152.38	148.39
Cognitive Test (Total Score)	145.54	122.64	99.57

It is clear from Table (13) that improvement ratio for first experimental group ranged between (122.19) and (189.52), and that improvement ratio second experimental group ranged between (102.67) and (152.38), and improvement ratio for control group ranged between (70.91) and (148.39).

Discussion of fourth hypothesis results:

It is clear from Table (11) that there are differences between post-measurements in cognitive test results for the three research groups, and it is clear from Table (18) and that there are differences between pairs of post-measurements in cognitive test results for the three research groups in favor of post- measurement for first experimental group.

It is clear from Table (13) that improvement ratio in cognitive test results for the three research groups in favor of first experimental group.

This result is consistent with studies' results that dealt with collaborative integration strategy for fragmented information "Jigsaw IV" in its various versions in cognitive achievement for various different subjects such as (7), (9), (18), (25), and its applications in sports field such as (15), (11), (13), (21), and this result is consistent with studies' results that dealt with infographics on cognitive achievement for various subjects such as (5), (14), and its applications in the sports field such as: (1), (2), (4).

The researcher attributes group's superiority that used collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics over the rest of the groups to the fact that collaborative learning helped the student to identify objectives of each task assigned to him and then distribute roles and start solving activities, and as a result of students' cooperation of one group, their academic achievement and tasks presented to them increases, and the competition between groups and each other makes the students present their best, in addition to positive effect of educational infographics in its ability to attract students' attention to information and details that should be focused on when viewing infographics.

Thus, fourth hypothesis validity is achieved, which states: "There are statistically significant differences between post- measurements in cognitive achievement in Sports Education Technology course for the three groups in favor of first experimental group (collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics)."

Conclusions:

In light of results reached by current research, the following conclusions can be presented:

- Collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics has a positive effect on cognitive achievement in Sports Education Technology course.
- Collaborative integration strategy for fragmented information "Jigsaw IV" has an acceptable effect on cognitive achievement in Sports Education Technology course.
- The traditional program has a weak effect on cognitive achievement in Sports Education Technology course.
- The group that used collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics outperformed both the group that used collaborative integration strategy for fragmented information "Jigsaw IV" only and the group that used the traditional program.

Recommendations:

In light of results of the current research, the following recommendations can be presented:

- Benefiting from collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics in solving problems of teaching sport education technology course in educational institutions.
- Train and qualify faculty staff members at universities on how to use and prepare collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics in achieving targeted learning outcomes and contributing to developing educational process and improving its outputs.

Recommendations for future research:

- Conducting experimental studies to use collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics for the rest of the topics of Sports Education Technology course, in addition to the rest of the courses in physical education faculties.
- Comparing collaborative integration strategy for fragmented information "Jigsaw IV" supported by infographics with other educational means.

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