



The knowledge accumulation and its relationship to the synthetic thinking among students of science departments in the college of basic education

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Abstract

The current research aims to identify the accumulation of knowledge and its relationship to synthetic thinking among students of science departments in the faculties of basic education. The research sample consisted of (626) male and female students from the science departments (physics branch) in the faculties of Basic Education, University of Sumer, Al-Muthanna University, Babylon University, and Al-Mustansiriya University. A test has been prepared to measure the knowledge accumulation of students and a synthetic thinking scale. The researchers adopted the descriptive research method (associative relationship), which shows the relationship between two variables, knowledge accumulation as an independent variable, and synthetic thinking as a dependent variable. The researchers prepared a test to measure the knowledge accumulation of students, and a measure of synthetic thinking was prepared. After the exploratory application, the validity and stability of the two tools were verified, the difficulty coefficient, the discrimination coefficient, the effectiveness of the wrong alternatives, and the paragraph's correlation with the total score of the scale were calculated. After applying the two tools to the sample, the data was processed using a statistical test equation. The researchers used a t-test for two independent samples. The results showed that there were statistically significant differences in the level of knowledge accumulation according to the variable of the study stage (second - fourth) and gender, and there were no statistically significant differences between the level of synthetic thinking according to the variable of the study stage (second - fourth).

There is a difference between the level of synthetic thinking according to the gender variable and there are statistically significant differences in the relationship between knowledge accumulation and synthetic thinking according to the variable of the study stage (second - fourth) and there are no statistically significant differences in the relationship between knowledge accumulation and synthetic thinking according to the gender variable, and in light of that the researchers recommended By diversifying the learning activities in the curricula for physics that contribute to the development of synthetic thinking, the researchers suggested evaluating the undergraduate curricula in the faculties of basic education in the light of the skills of knowledge accumulation and synthetic thinking.

Keywords: knowledge accumulation, synthetic thinking, students of science departments.

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First: Problem of the Research

The current era is characterized by an increase in knowledge and the speed with dissemination of information as a result of the development of knowledge transfer techniques, which requires attention to various fields of science to improve educational processes, and since teacher

preparation is the duty of basic education faculties, so it should work to teach students how to learn and how they should think in addition to Providing them with knowledge and paying attention to the ways in which they acquire knowledge and ways of thinking that will help them solve the problems they face and develop their thinking skills, especially synthetic



thinking, where synthetic thinking is one of the methods of thinking that depends on three stages (scientific hypothesis, contrast and contradiction, synthesis and creation) as a result of the combination and integration between scientific hypotheses and their application. Through the two researchers' knowledge of many educational research and studies that confirm the lack of interest in all forms of thinking, especially synthetic thinking, and this was confirmed by the study (Al-Tamimi, 2018) and (Ali, 2018), and in light of this, the researchers conducted a survey to determine the research problem by sending a questionnaire to (50) students (College of Basic Education / University of Sumer) and through their answers, the researchers concluded that:

- 1- (66%) of the female student has no knowledge of the knowledge accumulation.
- 2- It was noticed that (30%) of the students have knowledge of synthetic thinking.
- 3- It seems that (77%) of the students do not apply synthetic thinking in their daily lives.

In the foregoing, the research problem can be formulated with the following question: What is the amount of knowledge accumulation among students of science departments in the faculties of basic education, and how is this related to synthetic thinking?

Second: Importance of the Research

The era in which we live is characterized by the rapidity of change, the accumulation of knowledge and the ease of access to information, and in light of the scientific and knowledge progress witnessed by our contemporary world, which prompts nations and peoples to take the initiative to keep pace with the highest energies of knowledge and science, for this reason it is necessary to prepare trainees capable of adapting to scientific changes that will occur in the future,

and these knowledge changes are broader and faster than they can be assimilated and applied in the field of education (Sultani and Muhammad, 2017: 16). Through education, people can receive information that gives them the ability to think of solutions and deal with their daily work, as thinking is currently one of the main aspects of the educational process, among the types of thinking that educators recommend to develop is synthetic thinking, which can be developed by all students regardless of their achievements provided that the conditions are appropriate and students acquire basic knowledge and skills in all areas, and they have different abilities in activities that support higher-order thinking skills. (Al-Kubaisi and Muhammad 2013: 33).

Synthetic thinking helps students to group the elements and parts of the educational situation together to form an integrated unit, and to propose a set of abstract relationships by building appropriate hypotheses based on the analysis of the main factors in the learned material and then modifying these assumptions in the light of new considerations and ideas and building appropriate hypotheses,

We conclude from this that countries and societies that aspire to progress and advancement should take care of their university students by building a strong personality for them that enables them to assume the responsibility of dealing with the latest developments in science and their cognitive, thinking and technology skills. The teacher is the cornerstone of any educational reform or development and is an active element in achieving educational goals. Therefore, it is necessary to retrain the teacher and develop the necessary resources to prepare them scientifically and professionally, which is to bear the burden of raising his generation,



and today the role of the teacher is not limited to the transfer of knowledge only (Abu Jalala, 2007). :258).

From the above, the importance of the research becomes clear in the following:

1- Within the limits of the researchers' knowledge, this research is the first local research dealing with the accumulation of knowledge.

2- Building a test to measure the knowledge accumulation of students in science departments in the faculties of basic education, and to the knowledge of the researchers, it is the first test to measure the knowledge accumulation at the local level.

3- The current research provides a measure of the synthetic thinking of students of science departments in the faculties of basic education, which can benefit researchers in the educational field.

4- The results of this research give insight in favor of those responsible for training students and developing their synthetic thinking to prepare specific programs.

Third: Research objectives

1- What is the level of knowledge accumulation for the second stage among students of science departments in the faculties of basic education?

2- What is the level of knowledge accumulation for the fourth stage among students of science departments in the faculties of basic education?

3- Building a test to detect the accumulation of knowledge among students of science departments in the faculties of basic education according to the variable of the study stage (second - fourth).

4- Detecting the accumulation of knowledge among students of science departments in the faculties of basic education according to the gender variable (males, females).

5- Revealing the synthetic thinking of students of science departments in the faculties of basic education according to the variable of the study stage (second - fourth).

6- Identifying the synthetic thinking of students of science departments in the faculties of basic education according to the gender variable (males, females).

7- Knowing the relationship between knowledge accumulation and synthetic thinking among students of science departments in the faculties of basic education according to the variables of the study stage (second - fourth) and gender (male - female).

Fourth: Research limits

The search is limited to the following limits:

1- The human limit: students of science departments / the second and fourth stages (morning studies) in the faculties of basic education (Babylon, Sumer, Al-Mustansiriya, Al-Muthanna, Maysan, and Wasit).

2- Spatial limit: science departments in the faculties of basic education (Babylon, Sumer, Al-Mustansiriya, Al-Muthanna, Maysan, and Wasit universities).

3- Time limit: the first semester of the academic year (2021/2022 AD).

4- Knowledge limit: courses for the sciences department, the physics branch, in the faculties of basic education.

Fifth: Define terminology

1- Knowledge accumulation:

It was defined (Karabadse N and et.al, 2003) as an integrative cumulative process that is formed and occurs over relatively long periods of time to be ready for implementation and use to address specific problems and conditions (Karabadse et.al, 2003: p4).

Procedural definition: The researchers define it as all the knowledge and experience possessed by the students of the College of Basic



Education as a result of delving into experiences and situations inside and outside the educational institution that help students to make decisions and acquire knowledge to face the problems they may face. It is measured through their responses to the items on the paragraphs of the knowledge accumulation test prepared by the researchers for this purpose.

Synthetic thinking

Defined (Harrison, Bramson and A.F., R.M. 2002) as thinking that is associated with a focus on basic assumptions and abstract ideas, synthetic thinkers tend to focus on integration, while their behavior is often seen as challenging (Harrison, Bramson and A.F., R.M. 2002: p. 57).

Procedural definition: The two researchers define it as a type of thinking that requires students of basic education faculties to collect different ideas and join opposing viewpoints to produce new and innovative ideas that are completely different from what others do. It is measured through their responses to the paragraphs of the Synthetic Thinking Scale, which was prepared by the researchers for this purpose.

Chapter II:

theoretical framework:

First: knowledge accumulation

Knowledge is a set of meanings, perceptions, opinions, beliefs and facts that are formed in a person as a result of his repeated attempts to understand the phenomena and things that surround him.

In this sense, it is not limited to the phenomena of a particular color, but it deals with everything that surrounds the human being and everything that concerns him, and it is a series of integrated and interconnected stages that start with data and information, validation, then thinking, and finally wisdom, which is the individual's ability to absorb and perceive the

facts that surround him, and awareness By acquiring and acquiring knowledge through experimentation or observation and meditation, intuition and continuous exploration to seek and discover the unknown and reveal its secrets and abilities based on it and results (Timo, 2018: p23).

Based on the above, (MARIA, 2018) sees that knowledge is what an individual acquires from experience and skills, and it can be defined mainly as the fruit of experience and learning represented by theoretical and practical understanding of any idea or subject. It should be noted that knowledge can be built through thought (MARIA, 2018: p9).

It may be useful to conclude that knowledge is a mixture of experiences, values and prior knowledge that provides a general framework for evaluating and integrating new experiences and information over time and questioning and criticizing existing knowledge in order to build knowledge broader than its predecessors (Al-Ali et al., 2009: 25).

Types of knowledge:

Knowledge is divided into five main sections as follows:

- 1- Personal knowledge: It is knowledge about a person's personal experience, facts, and information about the person's life.
- 2- Synthetic knowledge: organizing terms and concepts that have deep meanings in the mind, such as thinking about arithmetic, thinking about what happens in the world, causes and effects, ...etc (Gregg, 2013: p12).

Knowledge Characteristics:

(Kluge & other, 2001) identified a set of characteristics for knowledge, including the following:

- 1- Subjectivity: Knowledge of information is the product of the process of interaction between a person and information, which enables a



person to be affected by his past and different backgrounds.

2- Meridianism: The value and importance of knowledge is not a fixed issue, as it is subject to change and loss under the influence of various influences after development.

3- Instant: Information can be produced suddenly as a result of the processes of analysis, synthesis, and understanding (Kluge & other, 2001: p2).

Ways to get knowledge:-

(2013, Gregg) chose different methods of obtaining knowledge, including the following:

1- The empirical method: From the point of view of empirical philosophers, knowledge is derived from empirical observation through the human senses.

2- The Rational Method: Rationalist philosophers argue that logic is used to draw conclusions about different statements and tends to formulate hypotheses, extract different facts from arguments and disagreements, and construct logical systems consistent with nature (Gregg, 2013: p13).

In light of these data, the researchers concluded that the accumulation of knowledge is a cumulative process, which is a mixture of experiences and knowledge created by individuals through different experiences and situations or through observation, thinking, and acquiring methods. Knowledge varies in different stages of human development.

Second: Composite Thinking

Synthetic thinking is a mental process that the student develops through the processes of mental interaction acquired by the individual in order to develop structures of knowledge and reach new assumptions and expectations and connect opposite viewpoints. These students are open and look for contradictions or

disagreements in their ideas, changes and innovations (Ali, 2018: 400).

On the other hand, (Golian.L.M., 1999) sees that synthetic thinking is a mental process that the learner develops through the processes of mental interaction with the experiences he has acquired in order to develop knowledge structures and reach new assumptions and expectations (Golian.L.M., 1999: p23).

People with synthetic thinking depend on the dialectical strategy, and his contribution to knowledge is based on three stages: the scientific hypothesis, the contradiction, and the synthesis as a result of the combination of scientific hypotheses and their opposite (Al-Khalili, 2005: 218).

(Harrison, A. & Bramson, R. 1982) indicated that the synthetic method is one of the least common methods among people, and that the synthetic and idealistic thinking methods have a strong orientation towards values and self-reflection (Harrison, A. & Bramson, R. 1982: p 112).

The researchers adopted Harrison & Bramson's theory when constructing the synthetic thinking scale in the current research, due to its distinction in explaining the variable, stages and characteristics of synthetic thinking.

Features of Synthetic Thinking:

1- It moves easily and comfortably from one opposite to another in all axes, which gives greater meaning to ideas and concepts through associative and consensual relationships between them and the previous knowledge structures.

2- It attempts to group parts of the educational material together into a completely new form or content (Bernardo, 2002: p 136).

The importance of synthetic thinking



(Jones, M.S. & Galbraith, M.W. 2006) illustrate the importance of compositional thinking as follows:

1- Synthetic thinking bears the brunt of mental imagery activities and mental processes in the right hemisphere and helps students respond better to visual and motor instructions rather than verbal instructions

2- Synthetic thinking attempts to change, direct, and control the way an individual uses his intelligence and knowledge abilities that affect his academic life (Jones, M.S. & Galbraith, M.W. 2006: p34).

Synthetic thinking skills

1- Assembly skills: The skill of assembly is defined as creating a new structure by combining items and things that were not there before in a new style.

2- Analysis skill: it is the study of every opinion or statement made by students that describes the differences between things (to distinguish between types of problems) (Katet, 2008: 40-41).

characteristics of synthetic thinking

1- Synthetic thinking can be developed for all students regardless of their achievements, provided it is appropriate to the students' circumstances.

2- The development of synthetic thinking requires the use of multiple strategies, methods and techniques to awaken the energies of students (Bernardo, 2002: p149).

Characteristics of a learner with a synthetic thinking

(Agwa, A. H., 1998:380)) defines the characteristics of the learner with synthetic thinking as follows:

1- It processes information simultaneously and in parallel and tends to be more typical and ambiguous in matters of a visual and spatial nature.

2- The student of compositional thinking has the ability to add parts or details to show something in its integrated form (Agwa, A. H., 1998: p380).

Previous studies:

1- Study of (Al-Sa'adi, 2021): The study aimed to know the cultural accumulation of the students of Imam Al-Kadhim(peace be upon him) College and its relationship to the challenges they face in light of the repercussions of extremism.In order to verify the objective of the study, the researcher used the descriptive approach.

The sample of the study consisted of (96) male and female students at Imam Al-Kadhim (peace be upon him)College. For the purpose of achieving the goal of the study, the researcher built the cultural accumulation test in its final form, which consisted of (30) items. The researcher also prepared a scale to measure the challenges facing college students consisting of (15) items. The results showed the weak level of cultural accumulation among the students of Imam Al-Kadhim (peace be upon him) College and the challenges they face in light of the repercussions of extremism, as well as the existence of a correlation between the level of cultural accumulation among students And the challenges they face in light of the repercussions of extremism for all research samples.

2- Study of (Ali, 2018): The study aimed to find out the effectiveness of employing contract-based teaching strategy in teaching physics in developing synthetic thinking and science operations skills for fifth-grade biology female students. For the purpose of verifying the purpose of the study, the researcher used the experimental method, and the number of the research sample was (76) female students. In order to achieve the objectives of the study, the researcher prepared a test to measure synthetic



thinking consisting of (57) items, as well as constructing an objective test of the type of multiple choice to measure the extent to which fifth-grade biological female students possess science processes consisting of (46) items distributed over (12) science operations After collecting the results and analyzing them statistically using the appropriate statistical methods, the two groups were equivalent in all the variables.

Chapter III:

Research community: The term community refers to the large group that the researcher wants to circulate the results of his samples, that is, the total group that we are interested in knowing more about (Johnson & Christensen, 2015: p254).The research community included students from science departments (Physics Department) in six faculties of basic education in the universities of (Babylon, Muthanna, Wasit, Maysan, Sumer, and Al-Mustansiriya), as the number of students in science departments (physics branch) reached (1142) male and female students.

Research sample: The research sample refers to a sub-group of the research community chosen by the researcher in an appropriate way to achieve the purposes of the research when it is difficult to conduct the study on the whole community (Edmonds & Kennedy, 2016: p 19). The research sample was (626) male and female students.

Research Methodology: The researchers adopted the descriptive correlative approach to achieve the objectives of the research.

search tools:

Knowledge accumulation test for the second stage:

1- Determining the objective of the test: The test aims to measure the amount of knowledge accumulation among students of science

departments (Physics Branch) second stage in the faculties of basic education.

2- Building the test items: The two researchers formulated a set of scientific questions of gradual difficulty, where the number of test items reached (40) items.

3- Formulating test instructions: Special instructions have been formulated on how to answer the test in order to avoid mistakes that may affect the students' score.

4- Correction of test answers: The researchers prepared a key for the typical answers, as they set one point for each paragraph (one score for each correct answer, and zero for the wrong answer).

5- The first exploratory application: The knowledge accumulation test for the second stage was applied exploratory on (30) male and female students from the science departments (physics branch) for the second stage of the faculties of basic education at (University of Maysan and Wasit University).The researchers noted that the time for students to answer the test is (40) minutes.

6- The apparent validity of the test: The apparent validity was reached by presenting the test in its initial form to a group of experts and specialists in teaching methods.

7- The second exploratory application: the researchers applied the test for the second time on a sample of (100) male and female students from the science departments (physics branch) in the faculties of basic education (University of Maysan and Wasit University) for the second stage, the purpose of which is to analyze the test items statistically.

8- The construct validity: The indicator that shows construct validity is the relationship between the paragraph degree and the total degree in the feature scale (1976: 164, Anastasi)



Using Pearson's coefficients, the correlation coefficients were calculated by applying the test to the exploratory application sample of (100) male and female students. All items were statistically significant, as the correlation coefficient values ranged between (327-653).

- Paragraph difficulties coefficient: The purpose of calculating it is to choose the paragraphs of appropriate difficulty and delete the very easy and very difficult ones. After calculating the difficulty coefficient for each of the test items, the researchers found that the difficulty coefficient ranged between (0.33-0.67).

Clause discriminatory strength: It is defined as the difference between the percentage of students who answered the higher category item correctly and the percentage of students who answered the lower category item incorrectly (Al-Manzil, 2009: 14), and after calculating the discriminatory power of the test items, the researchers found that The discriminatory power of the test items ranges between (0.41 - 0.78), and this means that the test items have good discriminatory power.

- The effectiveness of the wrong alternatives: It means the ability of the wrong alternative to attract the attention of the learners with the lowest level to choose it as an alternative that represents the correct answer (Al-Nuaimi, 2014: 242), and after calculating the effectiveness of the wrong alternatives to test the accumulation of knowledge, the researcher found that its value ranges between (-0.04/ -0.37) The researcher found that the alternatives attracted the students of the lower group more than the students of the upper group, so the researchers kept the alternatives unchanged.

1- The stability of the test: The stability of the test was calculated using the (Kewer Richardson - 20) equation, and the researchers found when calculating the reliability coefficient that it is

equal to (0.93) and this means that the reliability coefficient is good. The stability of the test was calculated to find the stability of the knowledge accumulation test for the second stage using the half-segmentation to calculate the stability, and it was found that the stability coefficient before correction is equal to (0.89), and the stability coefficient after correction is equal to (0.94) and thus all the test items were kept in its final form Thus, it is ready for application.

Fourth stage knowledge accumulation test:

1- Determining the objective of the test: The test aims to measure the amount of knowledge accumulation among students of science departments (Physics Branch) fourth stage in the faculties of basic education.

2- Building the test items: The two researchers formulated a set of scientific questions of gradual difficulty, where the number of test items reached (51) items.

3- Formulation of test instructions: Special instructions have been formulated on how to answer the test and some directions that must be taken into account when answering the test.

4- Correction of test answers: The researchers prepared a key for the typical answers, where (one point for each correct answer, and zero for the wrong answer) were given.

5- The first exploratory application: The research tool (the knowledge accumulation test for the fourth stage) was applied exploratory on the first random sample (not the research sample) on (30) male and female students from the science departments (physics branch) for the fourth stage on (21/12/2021).) (from the University of Maysan and the University of Wasit) was chosen randomly by the faculties of basic education.

6- The apparent validity of the test: The apparent validity was reached by presenting the



test in its initial form to a group of experts and specialists in teaching methods.

7- The second exploratory application: the researchers applied the test for the second time to a sample of (100) male and female students from the science departments (physics branch) in the faculties of basic education (University of Maysan and Wasit University) for the fourth stage (without the research sample) on (29/12/2021) to statistically analyze the test items.

8- Structure validity: It refers to the degree to which the measuring instrument accurately measures the theoretical structure or feature that is designed to be measured (Jackson, 2015: p70). The correlation coefficients were calculated by applying the test to the second exploratory application sample of (100) male and female students, and then comparing the calculated value with the critical tabular value of the correlation at the level of significance (0.05) and all items were statistically significant as the correlation coefficient values ranged between (0.229 - 0.693).

- Paragraph difficulties coefficient: The difficulty coefficient was calculated by applying the difficulty coefficient, and it was determined that the paragraphs' difficulty coefficient ranged between (0.28-0.54), and then the test item was good.

- The discriminatory power of the paragraph: that is, the ability of the paragraph to distinguish between individual differences between students who knows the answer to the test items and who does not have the correct answer (Al-Yaqoubi 2013: 111), and after calculating the discriminatory power for all test items, it was found that it was between (0.30-0.74)).

- The effectiveness of wrong alternatives: After applying the alternatives effectiveness

equation, it appeared that the alternatives had attracted a greater number of students of the two lower groups compared to the students of the higher group, and thus the wrong alternatives were left unchanged.

9- The stability of the test: The stability of the achievement test was calculated using the equation (Kewder Richardson -20) and it is equal to (0.93).

Synthetic Thinking Scale:

1- Determining the objective of the scale: The current research aims to identify the accumulation of knowledge and its relationship to the synthetic thinking of students of science departments (physics branch) in the faculties of basic education for the second and fourth stages.

2- Drafting the scale items: The synthetic thinking scale prepared by the researchers consists of (40) items with three alternatives (always apply to me, sometimes apply to me, do not apply to me).

3- Answer instructions: The scale instructions are a guide that guides the respondent during his answer to the paragraphs, and it has been taken into account that the paragraphs are clear.

4- Scale correction instructions: The researchers set the answer key for all paragraphs of the synthetic thinking scale, as the degrees of their correction were ascending (3, 2, 1) respectively, and at a rate of (3) degrees for the alternative that (always applies to me) and (2) degrees for the alternative that (sometimes applies to me) and (1)) degree for the alternative (does not apply to me).

5- The first exploratory application: The synthetic thinking scale for the two stages (second - fourth) was applied exploratory to (30) male and female students from the science departments (Physics Branch) for the two



stages (second - fourth), the purpose of which is to know the extent of understanding and clarity of the paragraphs of the scale for students and calculating the time period Necessary for the scale, and the researchers reached an average response time for the scale items (43) minutes.

6- The apparent validity of the scale: The apparent validity of the test means the judgment of specialists on the degree of test measurement of the measured characteristic, by presenting the test items to a group of specialists.

7- The second exploratory application: the researchers applied the synthetic thinking scale for the second time to a sample of (100) male and female students from the science departments (Physics Branch) in the faculties of basic education (University of Maysan and Wasit University) for the two stages (second - fourth),to analyze the items of the scale statistically.

8- The validity of the construction: The researchers verified the validity of the construction of the synthetic thinking scale by using the degrees of the statistical analysis of the scale to find the following:

- The relationship of the item's correlation with the total score of the scale: The discriminatory strength of the scale items was calculated and the correlation coefficient of each item's score with the

the fourth chapter:

Presentation and interpretation of results:

- To verify the first objective, the researchers used the t-test for one sample to compare the arithmetic mean of the sample (27.20) with the hypothetical arithmetic mean of (20).It is clear that there is a difference between the two averages, as the calculated T-value was (17.44), which is greater than the tabular value of (1.65) at the significance level (0.05) and the degree of freedom (626).

This indicates that there is an accumulation of knowledge among students of the second stage, science departments/physics branch in the faculties of basic education. Table (1) shows the results of the T-test for one sample to indicate the accumulation of students in the second stage of science departments (physics branch) in the faculties of basic education.

total score of the scale was calculated using the Pearson correlation coefficient. The correlation coefficients ranged between (0.521-0.759).

- Discriminatory power: After applying the discrimination coefficient equation, all values ranged from (6.23-13.04), and according to the criterion adopted by the researchers, which indicates that the paragraph is well discriminated if its discriminatory strength is (1.98) or more, so it was kept on all paragraphs as it is characterized by the ability to distinguish between paragraphs.
- 9- Scale stability: The reliability of the test refers to the consistency with which the same ranking is obtained when it is applied several times to the same test subjects (Kubiszyn & Borich, 2013: 338).
- The Cronbach's alpha coefficient was calculated to calculate the internal consistency of the synthetic thinking scale from the degree of the exploratory sample, which amounted to (0.97), which is a good statistical indicator.
- The stability of the synthetic thinking scale was calculated using the half-segmentation to calculate the stability. It was found that the stability coefficient before correction is equal to (0.97), and the stability coefficient after correction is equal to (0.98).



Table (1)Arithmetic mean, standard deviation, hypothetical mean, two T-values (calculated and tabular), degree of freedom, and statistical significance of the scores of second stage students in the knowledge accumulation scale

Variable	sample	Arithmetic mean	standard deviation	hypothetical mean	T-value		Indication level 0.05
					calculated	tabular	
The knowledge accumulation for the second stage	626	27.20	7.37	20	17.44	1.65	Statistically significant

This result indicates that there are statistically significant differences between the level of cumulation of the second stage students.

- To verify the second objective, the researchers used the t-test for one sample to compare the arithmetic mean of the sample, which amounted to (33.09) with the hypothetical arithmetic mean of (47.5). It is clear that there is a difference between the two averages, as the calculated T-value reached (25.32), which is greater than the tabular value of (1.65), at the level of significance (0.05) and the degree of freedom (626), this indicates that there is an accumulation of knowledge among students of the fourth stage, science departments/physics branch in the faculties of basic education, table (2) shows the results of the T-test for one sample to indicate the accumulation of students of the fourth stage science departments (physics branch) in the faculties of basic education.

Table (2): Arithmetic mean, standard deviation, hypothetical mean, two T-values (calculated and tabular), degree of freedom, and statistical significance of fourth-stage students' scores in the knowledge accumulation scale

variable	sample	Arithmetic mean	standard deviation	hypothetical mean	T-value		Indication level 0.05
					calculated	tabular	
Fourth stage knowledge accumulation	262	33.09	10.05	47.5	25.32	1.65	Statistically significant

This result indicates that there are statistically significant differences between the level of accumulation among students of the fourth stage.

-To verify the third objective, the researchers used a two-sample t-test to compare the arithmetic mean of males of (27.19) with a standard deviation of (7.32) with the arithmetic mean of females of (33.08) and with a standard deviation of (10.06). It was found that the calculated t-value (8.378) is greater than The tabular t-value at the level of significance (0.05) and the degree of freedom (624) amounting to (1.65), which indicates that there are statistically significant differences between the second and fourth stages in favor of the fourth stage, and Table (3) shows the results of the t-test for two independent samples to indicate the accumulation of knowledge according to the variable of the study stage. (second - fourth) among students of science departments (physics branch) in the faculties of basic education.



Table (3): The results of the T-test for two independent samples to measure the accumulation of knowledge according to the variable of the study stage and its statistical significance

Group	Sample's number	Arithmetic mean	Standard deviation	Degree of freedom	level of significance	The calculated t-value	the calculated t-value	Statistical significance
Second	214	27.19	7.32	624	0.000	8.378	1.65	Statistically significant
Fourth	312	33.08	10.06					

The researchers attribute this result to the fact that the students of the fourth stage were exposed to educational situations and studied more scientific subjects than the students of the second stage, which made them have scientific experiences and a good knowledge store.

- To verify the fourth objective, the researchers used a two-sample t-test to compare the arithmetic mean for males of (32.81) with a standard deviation of (9.19) with the arithmetic mean for females of (28.37) and with a standard deviation of (28.37). It was found that the calculated t-value (6.011) is greater than the tabular t-value at the significance level (0.05) and the degree of freedom (624), which is (1.65), which indicates that there are statistically significant differences between (males - females) in favor of males, and table (4) shows the results of the T-test for two independent samples to measure the accumulation of knowledge according to the gender variable among students of science departments (physics branch) in the faculties of basic education.

Table (4 :)The results of the t-test for two independent samples to measure the accumulation of knowledge according to a variable Gender and its statistical significance

Group	Sample's number	Arithmetic mean	Standard deviation	Degree of freedom	level of significance	The calculated t-value	the calculated t-value	Statistical significance
Second	248	32.81	9.19	624	0.000	6.011	1.65	Statistically significant
Fourth	378	28.37	9.02					

The researchers attribute this result to the fact that students may have more experiences than female students, as they are more able to deal with others, communicate with them, interact with the environment around them and try new things, and this is what made them outperform their peers.

To verify the fifth objective, the researchers used a two-sample t-test to compare the arithmetic mean of the second stage of (86.32) with a standard deviation of (21.30) with the arithmetic mean of the



fourth stage of (85.73) and with a standard deviation of (19.07). It was found that the calculated T value (0.365) is less From the tabular t-value at the level of significance (0.05) and the degree of freedom (624), which is (1.65), which indicates that there are no statistically significant differences between the two stages (second - fourth), Table (5) shows the results of the two-sample t-test for the significance of the synthetic thinking scale according to The variable of the study stage (second - fourth) among students of science departments (physics branch) in the faculties of basic education.

Table (5) The results of the t-test for one sample to measure synthetic thinking according to the variable of the school stage and its statistical significance

Group	Sample's number	Arithmetic mean	Standard deviation	Degree of freedom	level of significance	The calculated t-value	the calculated t-value	Statistical significance
Second	314	86.32	21.30	624	0.715	0.365	1.65	Not statistically significant
Fourth	312	85.73	19.07					

The researchers attribute this result to the fact that synthetic thinking is developed through training programs, and that students during their learning stages were not exposed to those training programs, and this did not make significant differences between them in synthetic thinking.

- To verify the sixth objective, the researchers used a two-sample t-test to compare the arithmetic mean of males of (89.67) with a standard deviation of (19.36) with the arithmetic mean of females of (83.63) and with a standard deviation of (20.42). It was found that the calculated t-value (3.693) is greater than The tabular t-value at the level of significance (0.05) and the degree of freedom (624), which is (1.65), this result indicates that there are statistically significant differences between the level of synthetic thinking among students of science departments for the current research sample according to the gender variable (males - females) and in favor of males. Table (6) shows the results of the T-test for two independent samples to measure synthetic thinking according to the gender variable among students of science departments (physics branch) in the faculties of basic education.

Table (6) results of the t-test for two independent samples to measure synthetic thinking according to the gender variable (male - female) and its statistical significance

Gender	Sample's number	Arithmetic mean	Standard deviation	Degree of freedom	level of significance	The calculated t-value	the calculated t-value	Statistical significance
Males	248	89.67	19.36	624	0.000	3.693	1.65	statistically significant
Females	378	83.63	20.42					



The researchers attribute this result, perhaps, to the fact that the male students have a large amount of accumulated experiences that they have been exposed to through their interaction with the surrounding environment and their contribution to solving problems, which helped them to increase their ability to think synthetically compared to female students who may not have been exposed to this amount of experiences.

- In order to detect the differences in the correlation between knowledge accumulation and synthetic thinking according to the stage variable (second - fourth), the researchers used the Z value to identify the differences between Pearson's correlation coefficients in two societies using two independent samples to detect the differences in the relationship between knowledge accumulation and synthetic thinking according to Stage and gender variable, as follows:

1- According to the variable of the study stage (second - fourth):

The correlation coefficient for the second stage was (0.473), and by converting it to the corresponding standard value called (Fisher), which amounted to (0.661), the correlation coefficient for the fourth stage was (0.528) and the corresponding standard value (Fisher) was (0.854), and therefore the Z value was (2.402). And it is greater than the tabular Z-value at the level of significance (1.9), which means that the differences in the relationship of knowledge accumulation and synthetic thinking among students of science departments in the faculties of basic education according to the variable of the study stage are statistically significant and in favor of the fourth stage, as shown in Table (5).

2- By gender variable (male - female):

The male correlation coefficient amounted to (0.214), and by converting it to the corresponding standard value called (Fischer), which amounted to (0.165), the female correlation coefficient was (0.174) and the corresponding standard value (Fisher) was (0.123), and therefore the Z value was (0.511), which is less than the tabular Z-value at the level of significance (1.9), which means that the differences in the relationship of knowledge accumulation and synthetic thinking among students of science departments in the faculties of basic education according to the gender variable are not statistically significant, as shown in Table (7).

Table (7): The differences in the correlation between knowledge accumulation and synthetic thinking according to the study stage variable (second - fourth)



	Variables	num ber	Correlation coefficient between knowledge accumulation and synthetic thinking	Standard tabular value (Fisher) for correlation coefficient	calculate d Z-value	tabular Z- value	الدلالة الاحصائية (0.05) عند
Study stage	second	314	0.473	0.661	2.402	1.9	statistically significant
	fourth	312	0.528	0.854			
Gender	males	248	0.214	0.165	0.511		Not statistically significant
	females	378	0.174	0.123			

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Through table (7), we notice that the (computed positive value) of the academic stage variable at the level of significance (0.05) and the degree of freedom (624), amounting to (2.402) is greater than the table value of (1.9), and this means that there are statistically significant differences between students in Correlationrelationship according to the stage variable.

Through table (5), we note that the (computed positive value) of the gender variable at the level of significance (0.05) and the degree of freedom (624) of (0.511) is smaller than the table value of (1.9), and this means that there are no statistically significant differences between students in Correlation relationship according to the gender variable.

Second: the conclusions

Based on the research results, the following conclusions were reached:

- 1- There are statistically significant differences in the level of knowledge accumulation between the second and fourth stage and in favor of the fourth stage.
- 2- There are statistically significant differences in the level of knowledge accumulation according to the gender variable (males - females) and in favor of males.
- 3- There are no statistically significant differences between the level of synthetic

thinking according to the variable of the study stage (second - fourth).

4- There is a difference between the level of synthetic thinking according to the gender variable (male-female) and in favor of males.

5- There are statistically significant differences in the relationship between knowledge accumulation and synthetic thinking according to the academic stage variable.

6- There are no statistically significant differences in the relationship between knowledge accumulation and synthetic thinking according to the gender variable.

Third: Recommendations

Based on the findings of the researcher, the following recommendations were made:

- 1- Attention to the development of knowledge accumulation and synthetic thinking among students at all stages of their learning, through the physics curriculum.
- 2- Training undergraduate teachers on modern teaching strategies that develop the synthetic thinking of their students.

Fourth: Suggestions

- 1- Evaluating the undergraduate curricula in the faculties of basic education in light of the skills of knowledge accumulation and synthetic thinking.



2- Building an educational program based on activities in developing the synthetic thinking of students in the faculties of basic education.

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