Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2024-22.1.00238

RESEARCH ARTICLE

Predictive Thinking Skills and their Impact on Physics Achievement among Fourth-Year Female Science Students

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ARTICLE INFO

Received: Apr 24, 2024

Accepted: Jul 5, 2024

Keywords

Thinking
Prediction,
Education
Physics
Fourth year

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ABSTRACT

This research aims to identify the predictive thinking skills of fourth-year female students in physics. A sample of 62 female students was selected and divided into two groups: an experimental group (N=31) and a control group (N=31). The equivalence of the two groups in terms of age was confirmed. An achievement test was then developed, and its items' distinctiveness, difficulty, and effectiveness of incorrect alternatives were verified. The test's reliability was confirmed through split-half (Spearman-Brown) analysis. Tests were conducted to measure the impact of predictive thinking skills on female students' achievement in physics. A t-test was used to verify the differences between the experimental and control groups, and the results indicated that: - Post-tests showed statistically significant differences in the physics achievement test for female students between the experimental and control groups. - The effect size coefficient in the achievement test was found to be 0.81, indicating a substantial effect.

INTRODUCTION

The Research Problem:

The ability to think critically is crucial for understanding the relationships between laws and concepts derived through deduction. It is fundamental for problem-solving and allows students to practice deduction and prediction. This encourages them to clarify available information and deduce new concepts (Abu Zaid, 2010). Predictive thinking, which necessitates an understanding of the sequence of events and their causes, is a key objective of modern education. Thinking is closely linked to study materials, as some of these materials contribute to the development of students' thinking skills. In light of the above, the research problem can be formulated as follows:

What is the relationship between predictive thinking skills and academic achievement among fourth-year female students in physics?

The Importance of Studying:

1. Gaining a deep understanding of predictive thinking skills and their role in the educational process.

2. Emphasizing the role of predictive thinking skills in enhancing academic achievement among female students.

The Previous Studies:

- In a study conducted in 2021 (Algebra, p. 2437), the researchers aimed to investigate the impact of the TASC model on the academic performance of fourth-year students in physics. The study involved 66 individual students and utilized an experimental approach. Achievement tests were administered, and the results indicated that students who were taught using the TASC model performed better than those taught using traditional methods. As a result, the study recommended the implementation of the TASC model in physics education and emphasized the importance of training teachers in its use.
- Study (Jassim, 2022, p. 433): The study aimed to determine the effect of using a predictive model on the academic achievement in physics among fourth-year students. The study was conducted on a sample of 52 individual students using an experimental method. The study utilized achievement tests as study tools and yielded several results, the most important of which was that students who studied using the predictive model outperformed their peers who studied using traditional methods. The study recommended the necessity of using this model in teaching physics.
- Study (Jaafar, 2021, p. 73): The study aimed to identify the challenges in developing predictive thinking among middle school students, based on the perspectives of history teachers in Al-Muthanna. The study involved 308 individual history teachers. It employed a descriptive approach and used a questionnaire as a research tool. The study revealed that the barriers to predictive thinking are moderately related to students, teachers, and the curriculum. The study recommended the adoption of modern teaching methods to stimulate student interest, foster dialogue ,and discussion, and emphasized the importance of integrating predictive thinking into the curriculum for the relevant stage of education.
- Al-Dosari's study (2018, p. 1) aimed to assess the effectiveness of implementing the Woods model in teaching and developing curriculum materials on student achievement and motivation to learn in the College of Education. The study involved 62 individual students from the university and used a quasi-experimental approach with tests as the primary research tool. The results confirmed that using the Woods model improved both achievement and motivation. The study suggested that training educators on using this model in curriculum development is essential.
- In Nasser's study (2019, p. 163), the effectiveness of the PEOE model on students' achievement and problem-solving in fifth-year applied science physics was examined. The research involved 71 students and utilized a quasi-experimental approach. The study demonstrated that teaching using the PEOE model was more effective than traditional methods in improving students' achievement in physics and their ability to solve physics problems. As a result, the study recommended the implementation of the PEOE model in teaching physics and the training of teachers to use this approach.
- A study conducted by Al-Asadi in 2017 aimed to investigate the impact of using thinking skills on the academic achievement of third-year intermediate school female students in a physics course. The study included 61 individual female students and employed an experimental method using tests as research tools. The results indicated statistically significant differences in favor of the experimental group in achievement tests for the physics course. The study concluded that the use of thinking skills in teaching contributed to increased achievement among female students in the experimental group compared to those who were taught using traditional methods. As a recommendation, the study suggested incorporating thinking skills into physics curricula to enhance students' achievement and critical thinking abilities.

- Study (Mohamed, 2019, p. 685): The study aimed to investigate the impact of using the Edelson model on the development of scientific concepts and thinking skills among second secondary school students taking physics. The study was conducted in two secondary schools in Dakahlia, utilizing an experimental method and concept tests, as well as predictive thinking tests as study tools. The results indicated a clear correlation between students' predictive thinking abilities and their understanding of scientific concepts. Furthermore, the study confirmed the significant positive effects of using the Edelson model on the development of scientific concepts and predictive thinking skills in the physics course among the students studied. The study recommended the necessity of providing training courses for teachers on the Edelson model of education.

THEORETICAL FRAME:

The Concept of Predictive Thinking:

The concept of predictive thinking involves linking signs and symbols to generate new ideas that are grounded in reality (Al-Tabbaa, 2017, p. 2). According to Bono, predictive thinking is a crucial aim of modern education. It necessitates an understanding of past events and their causes in order to contemplate future occurrences. There is a common misconception that thinking occurs separately from studying materials. However, some study materials play a key role in developing thinking skills, and this misconception needs to be rectified. Many subjects in school curricula are designed to train students in thinking skills. It's a mistaken belief that only mathematics teaches thinking skills, as these skills can be developed through all subjects where information is structured systematically (Al-Tabbaa, 2017, p. 7).

Prediction is considered a creative skill and a primary learning objective. Science is rooted in comprehending and controlling phenomena, and predicting future events based on them. By employing mental processes and training, individuals can gain new perspectives, understand mysterious phenomena, and solve previously unknown problems. Establishing connections between different types of knowledge leads to the formulation of laws and generalizations that summarize knowledge and represent a mental product. These skills are developed through the learner's ability to process and organize experiences, and through training to develop these mental processes into skills that can be applied to new educational and real-life situations. Individuals possessing these skills are known as skilled thinkers, and these skills assist teachers in posing questions that stimulate students' thinking to identify factors and influences and aid in prediction (Al-Qatami, 2007).

The significance of predictive thinking is evident in the following points (Hammam, 2019, p. 441):

- It prepares students for unexpected future incidents.

- It enhances their sense of responsibility.

- It helps them connect the past and the present.

- It enables them to see the various aspects of the future.

Predictive thinking skills:

These skills were identified based on the stages that students go through during the practice of predictive thinking, as outlined by Ibrahim (2017, p. 40):

- Analysis:

This involves examining various aspects of the problem, asking questions about the collected information, utilizing the natural environment and ideas from others, and using brainstorming to form an initial picture of the future shape of the phenomenon.

- The Induction:

This refers to the learner's ability to ask questions, search for ambiguous or unclear details, conduct investigations and research to solidify thoughts into a mental picture, idea, or drawings, define a goal, and develop a plan to achieve it. Induction includes a series of questions about the task's nature, its goal, the necessary information, and the time required to accomplish it.

- The Assumption:

The learner can create new hypotheses, propose alternatives, and establish new correlations based on existing information.

-**The Proof:**

The process involves creating potential solutions, presenting them as scenarios, and explaining how they could impact accidents.

-The Schedule:

This entails carefully developing the idea and avoiding actions that may increase future risks. Evaluation requires the learner to have a strategy for assessing their progress and guiding their future actions. It also requires awareness and understanding when making judgments about the accuracy of their thinking. The ability to predict helps to leverage strengths and learn from mistakes.

Predictive thinking involves a series of steps, as outlined by Al-Mutairi (2018, p. 60):

1. Survey: Understand the factors that influence the topic or problem being studied.

2. Looking forward: Identify the factors that have been influenced and that will shape and change the future.

3. Planning: Develop a strategic plan to control and lead change, striving to bridge the gap between the current reality and the desired future, and envisioning the preferred future outcome.

-The Implementation:

Apply the planned strategy, while monitoring the results until the desired future outcome is achieved.

The learner's role in predictive thinking is crucial. To effectively practice reflective thinking, the learner must possess certain characteristics, as outlined by Al-Ugaili (2020, p. 43):

1. Accept and respect the opinions of others.

2. Not be shy in asking questions about matters that are ambiguous to them.

3. Form good relationships with their colleagues, especially those who suffer from shyness and introversion.

The importance of predictive thinking underscores the crucial role that teachers, especially physics educators, play in developing this skill among students. Their responsibilities include the following (Muhammad, 2018, p. 281):

- Encouraging students to ask questions about the material being studied.

- Instructing students in scientific thinking and problem-solving.

- Assisting students in evaluating their problem-solving skills and scientific activities.

- Using assessments to gauge students' thinking abilities.

- Planning to implement new and innovative teaching methods to engage students and foster their creativity.

In order to achieve the goal of predictive thinking, it is important to examine the past, analyze how problems were previously addressed, and suggest alternative solutions for future problems. In the field of physics, it can be challenging to predict outcomes based on historical information. However, using predictive thinking can inspire students to generate new ideas and develop solutions that were previously unknown. This approach also encourages students to practice planning, forecasting, and expressing their opinions clearly and accurately. Additionally, it motivates students to seek alternative solutions when there is insufficient information to solve a specific problem, thus improving their ability to imagine and evaluate their performance (Al-Hassan, 2019, p. 154).In order to achieve the goal of predictive thinking, it is important to examine the past, analyze how problems were previously addressed, and suggest alternative solutions for future problems. In the field of physics, it can be challenging to predict outcomes based on historical information. However, using predictive thinking can inspire students to generate new ideas and develop solutions that were previously unknown. This approach also encourages students to practice planning, forecasting, and expressing their opinions clearly and accurately. Additionally, it motivates students to seek alternative solutions when there is insufficient information to solve a specific problem, thus improving their ability to imagine and evaluate their performance (Al-Hassan, 2019, p. 154).

The Study Terms:

The Predictive Thinking:

Technically, predictive thinking is the mental process in which the learner uses their experiences and expertise to propose solutions to expected problems. This is based on the premises that lead to an assumed result (Abu Zaid, 2010, p. 5).

Procedurally, it refers to the extent of predictive awareness in the thinking, expertise, and experiments acquired by fourth-year scientific female students.

The Collection:

Technically, collection refers to the amount of educational goals that a student achieves in one academic subject as a result of educational experiences and situations (Al-Asadi, 2017, p. 766).

Procedurally, it refers to the years obtained by female students in the achievement test prepared by the researcher in physics for fourth-year female students. These years are used to judge the information, concepts, facts, and laws of physics that the fourth-year scientific students have absorbed.

The Field framework of the study:

The Research Methodology: The quasi-experimental method was used, where the study sample was divided into two experimental and control groups

The Research questions:

-Are there statistically significant differences between the average scores of female students in the experimental and control groups on the achievement test?

-Does predictive thinking affect female students' achievement in physics in the fourth year?

The Research Objective:

1. Measure the grades of female fourth-year students in physics using an achievement test.
2. Identify the role of predictive thinking skills in improving female students' achievement in physics.
3. Measure the impact of predictive thinking skills on female students' achievement in physics.

The Research Population and Sample:

The study population included fourth-year female students in secondary and middle-day schools affiliated with the Babylon Education Directorate. A sample of 62 female students was selected from this population.

The Search Tool:

A test was created to assess the performance of female students in physics, designed as follows:

• Equality of the two groups in the achievement test:

Statistical parity was assessed for female students in relation to their age in months, as presented in the table below:

Table 1: Grades of female students in the two research groups based on chronological age calculated in months.

Control	Experimental	Ranking	Control	Experimental	Ranking
186	185	16	187	185	1
191	184	17	183	191	2
190	208	18	186	187	3
186	199	19	189	190	4
189	186	20	194	186	5
187	188	21	183	186	6
182	184	22	190	193	7
181	189	23	191	187	8

183	187	24	188	204	9
204	190	25	201	185	10
181	187	26	182	186	11
183	205	27	184	183	12
196	191	28	190	189	13
185	188	29	188	186	14
191	193	30	183	189	15
186	194	31			

The table above displays the scores of the female students in the two research groups to confirm their equality. To do this, we calculated the average scores and standard deviation of the female students in the test and then calculated the value of T, as shown in Table (2). Our conclusion is that the value of T is 1.400, which is smaller than the tabulated value and not significant. Therefore, we can assert that the two research groups are equivalent in terms of chronological age.

Table 2: Grades of female students in the two research groups based on chronological age calculated in months.

Significance Level 0.05	**T value**		**Degree of Freedom**	**Variance**	**standard deviation**	**Average**	**number**	**the Group**
	Tabulation	**Calculated**						
Not a sign	**2.000**	**1.400**	**60**	**39.463**	**6.282**	**189.838**	**31**	**Experimental**
				30.063	**5.483**	**187.741**	**31**	**Control**

In the exploratory experiment, the female students' grades in their previous information in the experimental and control groups were also identified, and the following table shows the female students' grades.

Table 3: Female students' scores on previous information for the two research groups

Control	Experimental	Ranking	Control	Experimental	Ranking
11	7	16	14	17	1
7	12	17	5	12	2

7	10	18	12	14	3
13	14	19	8	10	4
10	8	20	6	12	5
16	18	21	13	7	6
15	6	22	5	11	7
10	8	23	16	6	8
14	15	24	9	13	9
6	10	25	9	9	10
8	12	26	11	8	11
15	18	27	11	19	12
14	6	28	10	13	13
10	8	29	12	7	14
11	13	30	10	16	15
11	14	31			

The following table shows the level of differences between the experimental and control groups in the previous information, and after calculating the arithmetic mean and standard deviation of the answers, the T value was calculated and found to be equal to 0.866, which is less than the tabular value (2) and is not significant, and therefore there are no differences in the students' scores in the previous information.

Table 4: Female students' scores on previous information for the two research groups

Significance level 0.05	T value		Degree of Freedom	Variance	standard deviation	Average	the number	The Group
	Tabulation	Calculated						
Not a sign	2.000	0.866	60	14.776	3.844	11.387	31	التجريبية
				9.978	3.158	10.612	31	control

•Previous testing of research groups:

•Previous achievement test for female students in both research groups:

Table 5: Differences in the scores of the previous achievement test for female students in the two research groups

Significance level 0.05	T value		Freedom Degree	Variance	standard deviation	Average	the number	The Group
	Tabulation	Calculated						
Not a sign	2.000	1.269	60	149.646	12.233	74.419	31	Experimental
				220.879	14.862	70.032	31	Control

In Table 5, the results of the test to detect differences in the average scores of the experimental and control groups in the pre-achievement test are presented. The value of t was found to be 1.269, which is not significant. Therefore, there are no differences between the two groups in the achievement test before the experiment.

Exploratory Experience:

An exploratory study was conducted on a sample of 100 female students to examine the characteristics of the study tools. The results were as follows:

- The difficulty and ease factor of the paragraph and the discrimination factor for the academic achievement test items refer to the percentage of female students from the studied population who answered the question incorrectly, compared to the total number of female students in the upper and lower groups. The smaller this coefficient is, the greater the ease coefficient is, meaning their relationship is inverse. The test questions were applied to each of the questions, and it was found that they range between 0.46 and 0.703. All of these coefficients are appropriate in their questions. Additionally, discrimination coefficients were calculated, and it was found that the test items are distinct. The values of the coefficients range between 0.333 and 0.555, which is acceptable and appropriate.

Table 6: Parameters of difficulty and ease of the items, and coefficient of discrimination for the items on the academic achievement test.

Ease	Discrimination	Difficulty	lowest	highest	Ranking
0.518	0.444	0.481	7	19	1
0.351	0.333	0.648	13	22	2
0.370	0.518	0.629	10	24	3
0.5	0.333	0.5	9	18	4
0.407	0.370	0.592	11	21	5
0.444	0.370	0.555	10	20	6

0.444	0.518	0.555	8	22	7
0.351	0.407	0.648	12	23	8
0.481	0.370	0.518	9	19	9
0.425	0.333	0.574	11	20	10
0.314	0.481	0.685	12	25	11
0.444	0.444	0.555	9	21	12
0.537	0.407	0.462	7	18	13
0.407	0.444	0.592	10	22	14
0.425	0.333	0.574	11	20	15
0.388	0.4811	0.611	10	23	16
0.462	0.407	0.537	9	20	17
0.333	0.444	0.666	12	24	18
0.462	0.333	0.537	10	19	19
0.407	0.370	0.592	11	21	20
0.444	0.370	0.555	10	20	21
0.314	0.333	0.685	14	23	22
0.296	0.444	0.703	13	25	23
0.425	0.407	0.574	10	21	24
0.462	0.407	0.537	9	20	25
0.333	0.518	0.666	11	25	26
0.351	0.407	0.648	12	23	27
0.481	0.370	0.518	9	19	28
0.314	0.481	0.685	12	25	29
0.370	0.444	0.629	11	23	30
0.518	0.444	0.481	7	19	31
0.425	0.481	0.574	9	22	32
0.518	0.370	0.481	8	18	33
0.370	0.370	0.629	12	22	34
0.370	0.444	0.629	11	23	35

0.425	0.333	0.574	11	20	36
0.333	0.518	0.666	11	25	37
0.351	0.555	0.648	10	25	38
0.444	0.444	0.555	9	21	39
0.314	0.481	0.685	12	25	40

Effectiveness of Wrong Alternatives:

When designing multiple-choice questions, it's important to consider the effectiveness of the answer choices. The goal is to create alternatives that will appeal to a large number of female students in the low-achieving group while minimizing their appeal to high-achieving students. Additionally, any alternatives that attract more female students from the high-achieving group than the low-achieving group should be modified. A test was conducted to assess the effectiveness of the alternatives for achievement test items in the low-achieving group, and the results are as follows:

Table 7: The Effectiveness of Incorrect Alternatives for Achievement Test Items

Effectiveness of placebos				The Alternatives				The Correct Alternative	Group		R
D	**C**	**B**	**A**	**D**	**C**	**B**	A				
-0.22	☑	-0.18	-0.37	0	26	0	1	C	27	The highest	1
				6	5	5	11		27	The lowest	
-0.07	-0.19	-0.22	☑	0	4	1	25	A	27	The highest	2
				2	9	7	9		27	The lowest	
-0.18	-0.25	☑	-0.14	1	0	21	5	B	27	The highest	3
				6	7	5	9		27	The lowest	
☑	-0.11	-0.18	-0.22	19	5	2	1	D	27	The highest	4
				5	8	7	7		27	The lowest	
-0.41	☑	-0.26	-0.11	0	23	2	0	C	27	The highest	5

				11	6	9	3		27	The lowest	
-0.19	-0.07	-0.33	☑	1 6	1 3	0 9	26 4	A	27 27	The highest The lowest	6
-0.11	-0.14	-0.03	☑	0 3	6 10	0 1	21 13	A	27 27	The highest The lowest	7
-0.22	-0.26	☑	-0.30	1 7	1 8	25 4	0 8	B	27 27	The highest The lowest	8
-0.22	-0.03	☑	-0.11	3 9	6 7	16 6	2 5	B	27 27	The highest The lowest	9
-0.11	-0.15	☑	-0.11	1 4	3 8	22 11	0 4	B	27 27	The highest The lowest	10
-0.07	☑	-0.07	-0.11	0 2	23 7	2 13	2 5	C	27 27	The highest The lowest	11
-0.18	-0.07	-0.22	☑	0 5	4 6	3 9	20 7	A	27 27	The highest The lowest	12
☑	-0.14	-0.22	-0.37	21 10	2 6	3 9	1 2	D	27 27	The highest The lowest	13
-0.18	-0.07	-0.11	☑	0	3	5	19	A	27	The highest	14

				5	5	8	9		27	The lowest	
☑	-0.19	-0.19	-0.19	27 6	0 5	1 6	0 5	D	27 27	The highest The lowest	15
-0.11	-0.19	-0.15	☑	1 4	2 7	2 6	22 9	A	27 27	The highest The lowest	16
-0.07	☑	-0.33	-0.14	0 2	25 10	1 10	1 5	C	27 27	The highest The lowest	17
☑	-0.14	-0.25	-0.18	22 6	2 6	1 8	2 7	D	27 27	The highest The lowest	18
-0.22	-0.19	☑	-0.22	0 6	0 5	25 6	1 7	B	27 27	The highest The lowest	19
-0.22	-0.04	-0.33	☑	0 6	1 2	2 11	25 4	A	27 27	The highest The lowest	20
☑	0,074 -	-0.18	-0.29	25 10	0 2	0 5	2 10	D	27 27	The highest The lowest	21
-0.25	-0.07	-0.25	☑	3 10	7 5	3 10	14 2	A	27 27	The highest The lowest	22
-0.07	-0.33	☑	-0.07	2	4	18	3	B	27	The highest	23

				4	13	5	5		27	The lowest	
-0.11	-0.11	☑	-0.07	0	0	25	2	B	27	The highest	24
				3	3	17	4		27	The lowest	
-0.18	-0.07	-0.18	☑	2	3	2	20	**A**	27	The highest	25
				7	5	7	8		27	The lowest	
-0.11	-0.11	☑	-0.48	0	0	23	2	**B**	27	The highest	26
				3	3	8	15		27	The lowest	
-0.33	-0.33	☑	-0.11	0	0	25	2	**B**	27	The highest	27
				9	9	6	5		27	The lowest	
☑	-0.22	-0.33	-0.26	24	1	0	0	**D**	27	The highest	28
				7	7	9	7		27	The lowest	
-0.07	-0.26	-0.30	☑	1	3	0	24	**A**	27	The highest	29
				3	10	8	8		27	The lowest	
-0.25	-0.22	☑	-0.14	2	2	22	1	**B**	27	The highest	30
				9	8	5	5		27	The lowest	
-0.19	-0.19	-0.37	☑	0	0	1	20	**A**	27	The highest	31
				5	5	11	6		27	The lowest	
-0.37	☑	-0.14	-0.11	1	10	15	1	**C**	27	The highest	32

				2	2	19	4		27	The lowest	
-0.37	-0.18	☑	-0.11	2	0	25	0	**B**	27	The highest	33
				3	5	16	3		27	The lowest	
-0.03	-0.07	-0.18	☑	4	3	5	15	**A**	27	The highest	34
				5	5	10	7		27	The lowest	
-0.15	-0.15	-0.26	☑	2	2	0	26	**A**	27	The highest	35
				6	6	7	6		27	The lowest	
-0.14	-0.03	☑	-0.07	4	11	11	1	**B**	27	The highest	36
				8	12	4	3		27	The lowest	
☑	-0.11	-0.22	-0.22	20	2	2	2	**D**	27	The highest	37
				9	5	8	8		27	The lowest	
-0.26	-0.15	-0.30	☑	1	1	0	25	**A**	27	The highest	38
				8	5	8	4		27	The lowest	
-0.37	-0.11	☑	-0.37	0	2	25	0	**B**	27	The highest	39
				10	5	11	1		27	The lowest	
-0.14	-0.03	☑	-0.14	2	6	13	6	**B**	27	The highest	40
				6	7	4	10		27	The lowest	

Reliability: is an important factor to consider when determining the validity of a test. It involves re-administering the test to the same group or to a different group on another day to measure consistency. To ensure the stability of the test, reliability coefficients were calculated using the split-half method, specifically the Sipperman-Brown and Pearson correlations. The results of the analysis showed that the overall reliability coefficient using Pearson is 0.931, and using Sipperman-Brown is 0.964. These high coefficients indicate strong overall reliability of the test.

The Results:

• Are there statistically significant differences between the experimental and control groups on the achievement test?

The table below shows the scores of female students in the achievement test.

Table 8: Final achievement test scores for female students in the two research groups

Control group	Experimental group	Ranking
33	22	1
17	24	2
18	30	3
28	29	4
31	25	5
7	32	6
19	33	7
27	32	8
19	24	9
9	27	10
27	29	11
14	26	12
26	19	13
23	37	14
26	35	15
17	19	16
19	24	17
23	28	18
26	24	19
22	30	20
17	34	21

32	27	22
16	19	23
23	35	24
17	30	25
31	30	26
35	27	27
29	21	28
22	34	29
10	22	30
19	33	31

To verify the differences in the scores of female students between the two groups on the achievement test, the t-value was calculated, where the arithmetic mean for the experimental group was 27.774 and for the control group 22.00. The t-value was equal to 3.654 at a degree of freedom of 60, which is greater than the tabular. The significance level is less than 0.05, and therefore there are differences in the two groups regarding the achievement test.

Table 9: Final achievement test scores for female students in the two research groups

Significance level0.05	**T value**		**Degree of freedom**	**variance**	**Standard Deviation**	**Average**	**number**	**Group**
	Tabulation	**Calculated**						
Statistically	2.000	3.654	60	26.440	5.142	27.774	31	**Experimental**
				50.922	7.136	22.000	31	control

Effect size = 0.809136771 ≅ 0.81, large

• Does predictive thinking affect female students' achievement in physics in the fourth year?

To verify this, the effect size coefficient was calculated and the following was found:

Table 10: The effect of predictive thinking skills on female students' achievement

Amount	**Effect size**	**T value**	**Degree of freedom**
large	0.809136771 0.81≅	3.654	60

THE CONCLUSION:

In this research, the predictive thinking skills of female students in physics in the fourth year were identified. A sample of 62 female students was selected and distributed into two groups, experimental (N=31) and control (N=21), and tests were conducted to measure the impact of predictive thinking skills among female students on their achievement. Conducting an achievement test in physics. The differences between the experimental and control groups were verified through a t-test, and the following results were reached:

• Post-tests showed that there were statistically significant differences between the experimental and control groups in the physics achievement test for female students.

• The effect size coefficient in the achievement test was equal to 0.81, which is of great value.

• Predictive thinking plays an important role in raising female students' achievement in physics.

The Recommendations:

1. Conduct more studies on methods for developing students' predictive thinking skills.

2. Identify the role of predictive thinking skills in increasing female students' achievement in other subjects such as mathematics and science.

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