International Journal on Culture, History, and Religion
https://ijchr.net | eISSN: 3028-1318
Volume 7 Special Issue | https://doi.org/10.63931/ijchr.v7iSI.396

Article

The Impact of KUD Strategy on the Academic Achievement of Intermediate School Female Students in Biology

Wasan Qasim Alwan
University of Misan, Iraq
Correspondence: wasanqaseem@gmail.com

Abstract

The purpose of this study was to examine the influence of the Knowledge-Understand-Do (KUD) strategy on the academic performance of intermediate female students in biology. Preliminary observations showed that 85% of students relied on traditional teaching methods, only 15% used modern approaches, and no science teacher applied the KUD strategy. To address this gap, the researcher employed the constructivist-based KUD strategy to answer the question: What is the impact of using KUD on students' biology achievement? A null hypothesis was formulated, positing no statistically significant differences between the experimental group, taught using KUD, and the control group, taught using traditional methods. The study sample consisted of 68 female students divided equally into two groups of 34, matched for intelligence scores, prior biology knowledge, and midterm biology achievement. A 40-item multiple-choice test was developed, validated, and tested for reliability, with the effectiveness of distractors verified. Pre- and post-tests were administered to both groups, and the data were statistically analyzed. Results revealed that the experimental group achieved significantly higher scores than the control group, indicating that the KUD strategy positively impacts academic performance. Based on these findings, the study recommends adopting the KUD strategy in biology instruction, as it aligns with modern educational theories that emphasize active student engagement, collaboration, and healthy competition. Furthermore, it suggests conducting similar studies to explore KUD's effects on other variables such as problem-solving skills, learning attitudes, and curiosity development, highlighting its potential as an effective teaching approach in science education.

Keywords: *impact, KUD strategy, academic achievement, intermediate school, female students, biology*

Suggested citation:
Alwan, W.Q. (2025). The Impact of KUD Strategy on Intermediate School Female Students' Biology Academic Achievement. *International Journal on Culture, History, and Religion, 7*, 235-253. https://doi.org/10.63931/ijchr.v7iSI.396

Introduction

Statement of the Problem

Biology is a vast, specialized field due to its numerous branches and diversity and its direct connection to human life and society. Consequently, teaching this subject requires attention to reflect this connection and cater to the students' lives and environment. Therefore, students' low achievement in biology is a significant problem that teachers face.

Despite numerous studies on teaching methods, researchers have not fully achieved their aspirations. Stagnation persists in how lessons are presented to many students, without focusing on developing their scientific concepts. It was emphasized in the Second International Scientific Conference of the College of Basic Education at the University of Mosul (College of Basic Education Conference, 2013). Several studies, such as Bilal's study (2019), Bateen's study (2012), and Hassanein's study (2011), have shown deficiencies in academic achievement in biology.

Based on the researcher's examination of the grades records of first-grade intermediate school students in science and discussions with teachers, it was found that most teachers follow traditional methods in teaching biology. It is observed that the integration between the theoretical and practical aspects of the subject is inadequate, and many teachers ignore effective teaching methods, strategies, and models. It has led to a decline in the level of achievement in biology.

Due to teachers' weak reliance on modern teaching strategies in science education, particularly biology, and their limited exposure to new developments, negative results have emerged in solving educational problems. These results include students' weak ability to apply what they have learned in solving problems they encounter daily, in addition to a decrease in achievement. It is confirmed by the reality of teaching in Iraqi schools, where it is observed that most teachers use traditional methods that do not align with the objectives of scientific education, critical thinking, and scientific research.

Therefore, there is an urgent need to change traditional curricula in teaching methods because they cannot perform their role effectively in this field. It necessitates examining the impacts of employing contemporary methodologies and strategies to make a valuable contribution towards enhancing the field of education.

The researcher conducted a questionnaire by distributing 20 copies of the questionnaire to science teachers in schools. The questionnaire included the following questions:

Q1: Do you use the KUD method in teaching biology?

Q2: Do you rely on traditional methods in teaching biology?

Q3: Do you support the use of modern approaches in teaching biology?

Importance of Research

Our world today witnesses rapid advancements in various scientific fields. This development is accompanied by an unprecedented explosion of knowledge, requiring learners to make significant efforts to adapt and positively engage with this era. They need to be able to keep up with the vast amount of information and make informed decisions, choosing the best solutions and alternatives that contribute to the progress of their society. Through hard work and organized thinking, individuals can join the march of progress and civilization (Qashta,2008, p. 2).

Using appropriate teaching methods in biology education makes it easier to understand and enjoyable for learners. It is necessary to avoid methods and approaches that cause boredom in the learning process. Training teachers and learners in using modern strategies in biology education significantly enhances learners' abilities to discover, think, and communicate effectively with teachers and each other, thereby improving their academic achievement (Ar-Ruba'i 2016, p. 2).

Numerous conferences held in Iraq have emphasized the need to develop the educational process by utilizing modern teaching methods and approaches to keep up with global advancements in the field. These conferences also highlighted the importance of learner participation in teaching and developing learning capabilities. One such conference was the Thirteenth Scientific Conference (13-14 November 2012) held at Babylon University, which emphasized the development of the educational process through enhancing the capabilities and skills of teachers and raising the level of learners by employing modern educational methods and strategies (Babylon University, 2012, p.181).

Based on the above, the significance of research can be crystallized in the following aspects:

- Please focus on the effectiveness of a modern strategy that has not received significant attention, namely the KUD strategy, and its role in improving academic achievement in biology.
- This research aligns with the recommendations of conferences and seminars that encourage the need for field and applied research to develop biology education.
- No previous research conducted in Iraq or the Arab region has investigated the KUD strategy as an isolated experimental factor concerning the academic performance of intermediate school students in biology.

- Scientific knowledge is used in this research to empower students to face life challenges and make decisions by applying it in specific activities and events.
- The present study, which centers on implementing the KUD strategy to enhance the academic performance of intermediate school students in biology, makes a substantial contribution to advancing instructional approaches and expanding educational resources. This research brings valuable insights for professionals in curriculum development and teaching methods, benefiting their expertise and knowledge base.

Aim

The primary aim of this study is to examine the impact of using the KUD strategy on the academic achievement of intermediate school female students in biology.

Hypothesis

It is assumed that there is no statistically significant difference at the 0.05 level of significance between the average scores of the experimental group, which was instructed using the KUD strategy, and the average scores of the control group, which was instructed using the conventional method, in the achievement test.

Limits

- Human Limit: Second-grade female students.
- Spatial Limit: Al-Khansa Girls Middle School, General Directorate of Education, Maysan Governorate.
- Temporal Limit: Second semester of the academic year 2022-2023.
- Scientific Limit: Biology textbook prescribed by the Iraqi Ministry of Education for students of the second grade in the academic year 2022 (units 1, 2, 3, 4, and 5).

Definition of Terms

Impact

a) Conceptually, Shihata and Zeinab (2003, p.44) define it as the desired and undesired changes that occur in the student because of the learning process. According to Ibrahim (2009, p.30), it is described as the capacity of the variable being examined to yield a favorable result. Nonetheless, if this desired outcome is not attained, the variable could potentially be identified as one of the direct factors leading to adverse consequences.

Al-Saadoun (2012, p.22) defines it as the intended amount of change to be brought about in the dependent variable because of its interaction with the independent variable.

b) Operationally, the researcher defines impact as the extent to which the KUD strategy affects the biology achievement test scores of the research sample, consisting of second-grade female students, during a specified period determined by the researcher. It is measured by individual scores in the achievement test prepared explicitly for this purpose.

Strategy of KUD (Know – Understand – Do)

a) Conceptually, Tomlinson (2005, p.22) defines it as an instructional strategy consisting of three stages, based on identifying learners' prior knowledge and providing diverse activities and steps to build understanding and meaning for the learner, as well as applying the learned concepts in a specific lesson context. According to Abidat and Suhaila (2007, p.117), this strategy is defined as a type of instruction aimed at raising the level of all learners, rather than targeting only those who struggle academically. This strategy aims to achieve that by considering learners' characteristics and prior experiences and enhancing their learning abilities. The key point in this strategy is teachers' expectations of learners and learners' attitudes towards their abilities. It also aims to provide a suitable learning environment for all learners.

b) Operationally, the researcher defines it as a modern learning strategy that includes activities and practical stages comprising identification, understanding, application, utilization, and implementation for the experimental group according to the plans and methods developed by the researcher for this procedure.

Academic Achievement

a. Conceptually, Al-Laqani and Al-Jamal (1999: p.58) define it as the degree to which students grasp the knowledge and skills acquired throughout specific academic courses. This level of comprehension is assessed by evaluating the grades students attain in achievement tests specifically designed for this purpose. Abada (2001, p.146) defines it as the level a student reaches in their academic attainment.

b. Operationally, it is expressed as the degree of students' comprehension of information in the science subject in the second grade of intermediate school, after a specific period, through implementing the KUD strategy in education. This comprehension is assessed through the grades obtained in the performance test prepared by the researcher.

Literature Review

Al-Rubai (2005), Iraq

The primary purpose of this study is to examine the impact of applying the KUD strategy and utilizing multimedia presentations on the acquisition of scientific concepts among fourth-grade elementary school students, with a focus on science. The research was conducted with a sample size of 90 fourth-grade students. The assessment of concept acquisition in science served as the research instrument. Statistical methods such as the difficulty coefficient equation, item discrimination, effectiveness of distractors, chi-square test, SPSS software package, ANOVA for variance analysis, and Tukey's equation were employed. The key findings revealed that both experimental groups, one taught using multimedia presentations and the other based on the KUD strategy, exhibited superior performance in acquiring scientific concepts in science compared to the control group, which was instructed through conventional methods.

Al-Azzawi (2017), Iraq

This study aimed to investigate the impact of integrating the KUD strategy on female students' academic performance and writing proficiency in the second grade of intermediate school, specifically in chemistry. The sample consisted of 61 students from the second-grade level in chemistry. The research utilized the achievement and written communication tests as research instruments. Various statistical methods were employed, including the difficulty of coefficient equation, item discrimination, effectiveness of distractors using the Kuder-Richardson formula, Pearson correlation equation, Levine's test, and the independent t-test. The findings revealed that both experimental groups, one taught with multimedia presentations and the other with the KUD strategy, outperformed the control group instructed with the conventional method of acquiring scientific concepts. It suggests that implementing the KUD strategy positively impacts academic achievement and the development of writing skills among second-grade female students in chemistry.

Al-Saadi (2021), Iraq

This research aimed to examine the effects of incorporating the KUD strategy on the academic accomplishments and inferential thinking abilities of students in the first grade of intermediate school, specifically in the subject of science. The study involved a sample of 61 students from the first intermediate grade. The research utilized the achievement test and inferential thinking test as research instruments. The statistical method used was the independent t-test for two unequal independent samples. The findings revealed a significant impact of the KUD strategy on academic achievement and inferential thinking in science for first-grade middle school students, with the experimental group showing better performance compared to the control group.

Aspects of benefiting from previous studies include:

1. Sample selection method.
2. Understanding how to construct research tools, whether in designing the final achievement test or any other tools used in the study.
3. Utilizing appropriate statistical methods to analyze previous studies' available data and apply them to current research procedures.
4. Analyzing and interpreting the results of the current research.
5. An extensive literature review explored various books, scientific journals, and references that serve the current research.
6. Developing instructional plans consistent with the independent variables identified in this study.

Methodology

The research methodology refers to the approach, method, or strategy the researcher employs to achieve the intended objective. It involves modifying or correcting the specific conditions of the phenomenon under study, observing the changes, and interpreting them (Abdulrahman, 2007, p. 474). The researcher followed several procedures required for the research, including:

Experimental Design

The choice of an experimental design depends on the objectives, conditions, and variables to be applied. Analyzing the data collected can obtain more accurate, reliable, and objective results (Raouf, 2001, p.179). Therefore, the researcher opted for a *"partially controlled"* experimental design with a post-test. This choice is based on having two groups: one considered the experimental group (EG) exposed to the

independent variable (KUD strategy), and the second group serving as the control group (CG) taught through the conventional method, as shown in Table 1.

Table 1. Experimental design

Group	Equivalence	Dependent Variable	Independent Variable	Post-test
EG	Academic Achievement Previous Knowledge Intelligence	KUD strategy	Achievement	Academic Achievement Test
CG		Conventional method		

Population

The study sample consists of female students in the second grade of intermediate school in affiliated schools of the Directorate of Education, Maysan Governorate, for the academic year (2022-2023).

Sample

It is a subset of the original population that represents it. The sampling process involves employing diverse methodologies to select a group of individuals from the initial population (Al-Dalij, 2010, p.114). A sample of second-grade female students studying at Al-Khansa Girls' Intermediate School, affiliated with the Maysan Governorate Directorate of Education, was used using purposive sampling. Before the experiment, and due to three sections in the second grade of intermediate school, the researcher selected two sections using random sampling. Section (A) represents the experimental group, while Section (C) represents the control group. The experimental group initially consisted of 38 students, while the control group consisted of 35 students. Four repeaters were excluded from the experimental group, resulting in a final count of 34 students. Additionally, one repeater was excluded from the control group, resulting in 34 students. Therefore, the final research sample consisted of 68 female students, with each group comprising 34 students as indicated in Table 2.

Table 2. EG and CG before and after excluding repeaters

Group	Section	Before exclusion	Repeaters	After exclusion
EG	A	38	4	34
CG	C	35	1	34

Total		73	5	68

Equivalence of Groups

Before commencing the experiment, the researcher ensured statistical equivalence between the individuals in both research groups regarding certain variables, such as previous academic achievement (mid-term), prior knowledge (pre-test scores), and intelligence. The results indicate their equivalence in all these variables, as illustrated in Table 3.

Table 3. Statistics of equivalencing groups

Variable	Group	Size	Mean	Variance	Calculated T	Tabulated T	Significance Level
Previous Achievement	EG	34	71.200	122.11	0.26	2.000	0.05
	CG	34	71.64	85.74			
Intelligence	EG	34	34.20	106.50	0.51	2.000	
	CG	34	32.94	100			
Previous Knowledge	EG	34	13	5.45	0.811	2.000	
	CG	34	12.5	7.47			

Instrument

Identification of the Scientific Content

The researcher identified the scientific content that would be taught to the students in both research groups over the duration of the experiment, focusing on the chapters (Taxonomy, how living things are classified, Microorganisms, Plant Kingdom, and Animal Kingdom) from the science textbook for the second grade of intermediate school for the academic year (2022-2023). These chapters would be taught in the first half of the year.

Formulation of Behavioral Objectives

A behavioral objective describes a specific observable behavior or visible pattern of behavior expected to occur in the learner's personality as an outcome of exposure to a particular educational situation or experience (Malham, 2011, p. 59).

After reviewing the general and specific educational objectives of the biology subject in the second grade of intermediate school, and based on reference sources and

literature, as well as surveying the opinions of Biology teachers and teaching methods, the researcher formulated a set of behavioral objectives. One hundred twenty-five behavioral objectives were formulated and will be taught during the experiment. These objectives were formulated using observable and measurable behavioral verbs, and the initial objectives were presented to experts and specialists in teaching methods to ensure their suitability for the objective level, measuring teaching plans.

The lesson plan varies according to the educational objectives, the teacher's skills, school facilities, and the method or strategy adopted in teaching. The plan includes the main activities or practices implemented during the teaching process (Shahata & Zeinab, 2003, p. 177).

The researcher prepared daily lesson plans for the topics and subjects to be taught in the experiment; two exemplary plans were presented for the experimental and control groups. The plans were judged by several specialists and experts in curriculum and science teaching methods, in addition to subject teachers. Their feedback was considered in the preparation of the remaining teaching plans.

Achievement Test

The achievement test is considered one of the most important tools to assess students' achievement and is widely used in schools. This test is characterized by its ease of preparation, correction, and implementation (Al-Imam et al., 1990: 59).

The researcher chose to use objective tests with multiple-choice questions because this type of question has many advantages, including ease of correction and proximity to thinking skills. The following are the steps involved in preparing for the achievement test:

Formulation of Test Items

The researcher prepared 40 multiple-choice items for the achievement test.

Test Validity

Test validity indicates the extent to which a test measures what it is supposed to measure (Al-Ghareeb, 1996: 677). The researcher conducted two types of validity for the test. The first type is facing validity, which refers to the overall appearance of the test, such as the type and formulation of the items, clarity, as well as the test instructions and their accuracy (Al-Imam et al., 1990: 130). The researcher achieved this validity by showing the test to a team of experts in Appendix 1. Some of the experts suggested the need to rephrase some items to enhance their clarity.

The other type of validity is content validity, which indicates the degree of alignment between the test items, the curriculum content, and specific teaching objectives (Rodney, 1985: 171). The researcher achieved this by preparing the test blueprint, which revealed that all the achievement test items obtained a percentage of 100%. Thus, the test can be considered valid in terms of its items.

Test Specifications

It is a detailed plan that includes the main topics of the curriculum content and indicates the emphasis given to each part of the content, as well as the number of questions allocated to each part (Adh-Dhahir et al., 2002: 80). The researcher prepared a comprehensive test blueprint for the five chapters in the science textbook for the second grade. Bloom's taxonomy was used to classify the cognitive domain into three levels: remembering, understanding, and applying. Refer to Table 4 for the test blueprint. The preparation of the test blueprint is considered one of the requirements for content validity. The researcher used the following steps to prepare the test blueprint.

A. Calculating the importance ratio of the content to the topic according to the following formula:
B. Importance ratio of content to topic = (Number of sessions required to teach the topic / Total number of sessions) × 100.
C. Calculating the importance ratio of the behavioral objective according to the following formula:
D. Importance ratio of behavioral objectives = (Number of behavioral objectives for each domain / Total number of behavioral objectives) × 100.
E. Calculating the number of questions per content or chapter according to the following formula: Number of questions per level = (Total number of paragraphs × Relative importance of the content) / 100.
F. Calculating the number of questions per cell according to the following formula: Number of questions per cell = (Total number of questions for the specific domain × Ratio of the behavioral objective) / 100.

Table 4. Test specifications

Ser.	Ch.	Lessons	Importance %	Weight of behavioral objective			Number of test items			Total
				Remember %	Understand %	Apply %	Remember	Understand	Apply	

1	5	2	8	6	5	1	1	1	1	3
2	6	5	21	4	6	3	3	4	1	8
3	7	7	29	17	23	8	4	6	2	12
4	8	4	17	5	6	3	3	3	1	7
5	9	6	25	11	20	7	3	5	2	10
		24	100	43	60	22	14	19	7	40

Reliability

Reliability indicates the extent to which a test produces consistent, similar, or identical results when administered multiple times under similar or comparable conditions. The reliability of a test is influenced by its length, with greater reliability achieved when the test contains more items. After administering the test to the pilot sample, the researcher calculated the test's reliability coefficient using the Kuder-Richardson 20 formula, which is used to assess the reliability of multiple-choice items. The reliability coefficient was found to be 0.87.

Pilot Application for Achievement Test

A survey application was conducted to confirm the clarity and validity of the test items and to statistically analyze the items (calculating the difficulty index, item discrimination power, and the effect of incorrect alternatives for each item). Additionally, the test's reliability was examined by administering it to a comparable sample of students from Al-Furat Girls' School, consisting of 100 students.

Statistical Analysis of Test Items

Determining the Difficulty Index:

The difficulty index is defined as a measure that identifies the percentage of students who answered a specific item incorrectly on the test. Retaining a question or item is recommended if its difficulty index falls within the range of 20% to 80% (Al-Kubaisi, 2007: 170). According to studies, items with a difficulty index ranging between 20.0 and 80.0, with a mean value of 50.0, are considered acceptable. In contrast, items below 20.0 or above 80.0 are advised to be modified, deleted, or replaced with other items (Ouda, 1999: 129). After calculating the difficulty index for each item in the test using the specified formula, it was found that the difficulty index values ranged from 0.38 to 0.72, indicating that all test items were acceptable and suitable for administration.

Item Discrimination Power

The discriminating power of each of the items in the test can be calculated by determining the difference ratio between the number of students who answered correctly in the upper group and the lower (or lower) group, divided by the number of students in one of the two groups. The minimum acceptable value for item discrimination power is when the discrimination coefficient equals 20.0 or higher. The values of the item discrimination coefficients for the test items ranged from 0.33 to 0.59 (Az-Zaher et al., 2002: 130).

Effectiveness of Incorrect Alternatives (Distractors)

Distractors should be attractive to examinees, especially those in the low-performance group. When the distractor represents the incorrect answer, it is assumed that weak students will choose it. A good and effective distractor is the alternative that has a significant negative attractiveness coefficient. Therefore, any alternative not chosen by any examinees should be reviewed, developed, or replaced, or it should have a positive or zero attractiveness coefficient (An-Nabhan, 2004: 204). After counting the effectiveness of the incorrect alternatives, it was found that they attracted more students in the lower group than in the upper group. Based on this, it was decided to retain these alternatives.

Experimental Application

The researcher experimented in the first half of the 2022-2023 academic year. The experiment was conducted only after the researcher had fulfilled all the requirements for experimenting. These requirements included selecting two groups and ensuring their equivalence. The researcher also determined the scientific material to be studied.

Statistical Methods:

The researcher utilized the following statistical methods to analyze the results:

1. Z-test for two independent equal samples

The test was used to determine the equivalency of the experimental and control groups regarding previous achievement in science, including the intelligence level and prior knowledge test.

2. Item Difficulty Index

This equation is used for objective items in tests. Therefore, the researcher employed it to calculate the difficulty of the items in the achievement test.

3. Item Discrimination Index

This equation calculates the discriminatory power of items in the achievement test.

4. Effectiveness of Distractors

It was used to calculate the effectiveness of incorrect alternatives (distractors) in the test items.

5. Coefficient of Agreement (Cooper's Formula)

It refers to calculating the coefficient of agreement using Cooper's formula.

6. Effect Size for Calculating the Impact of the Independent Variable on the Dependent Variable According to the Following Equation.
7. Formula (Kuder-Richardson 20)
8. Effectiveness (Gain Score Formula)

It refers to the effectiveness of the gain score formula.

Presentation of Results

After completing the research experiment, which followed the steps outlined in the previous chapter, the researcher analyzed the collected data. The purpose was to evaluate the impact of the KUD (Knowledge-Understanding-Application) strategy on the academic achievement of second-grade female students in the subject of Biology. Additionally, the researcher aimed to test the research hypothesis and determine if the findings supported or rejected the hypothesis.

To test the null hypothesis, which suggests that there is no statistically significant difference (at the 0.05 significance level) between the mean achievement test scores of the experimental group students taught using the KUD strategy and the mean scores of the control group students taught using conventional methods in the achievement test, the final achievement test results of both groups were compared.

Upon analyzing the data, it was observed that the experimental group students achieved a mean score of 30.51 with a variance of 12.3. On the other hand, the control group students achieved a mean score of 25.70 with a variance of 42.8. By conducting an independent samples t-test to examine the significance of the differences between these means, it was determined that there were statistically significant variations between the two groups. This finding is illustrated in Table 5.

Table 5. Statistics of the T-test for two independent samples

Group	Size	Mean	Variance	FD	T value		Significance Level
					Computed	Tabulated	

EG	34	30.51	12.3	66	3.76	2.00	0.05
CG	34	25.70	42.8				

The findings presented in Table 5 demonstrate that the calculated t-value (3.76) surpasses the tabulated t-value (2.00) at a significant level of 0.05 and with 66 degrees of freedom. These results indicate a statistically significant distinction between the mean scores of the two groups in the study, with the experimental group performing better than the control group. Therefore, the null hypothesis was rejected, and the alternative hypothesis was accepted, indicating a statistically significant difference between the mean scores of students in the experimental group taught Biology using the KUD strategy and those in the control group taught using conventional methods in the final achievement test.

Interpretation of the Results

1. The KUD strategy has proven to be effective in capturing the attention of female students and motivating them towards the scientific subject, enhancing their learning process better than the conventional method. Interaction among the students in the experimental group was observed during the distribution of activity sheets by the researcher, which were used to assess their understanding of the topic and enable them to ask questions and receive feedback on their inquiries.
2. The use of the KUD strategy contributed to addressing individual differences and variations among the students, considering the diverse sources and types of these differences, which manifest in various aspects such as interests, attitudes, and abilities. The KUD strategy allows for content and activity adjustments based on the different needs and abilities of the students, thereby facilitating better learning outcomes.
3. Implementing the KUD strategy facilitated the development of cognitive structures in the students by providing a collaborative learning environment within diverse groups, where dialogue and discussion ensured the learning of each student in the group.

These findings are consistent with several previous studies, such as Al-Rubaii (2015), Al-Azzawi (2017), and Al-Saadi (2021), despite differences in the environment, gender, educational level, and subject matter.

Conclusion

Based on the results obtained, the following conclusions can be reached:

1. The KUD strategy has proven effective in teaching Biology to second-grade students, leading to improved academic achievement.
2. The KUD strategy has an impact on the development of scientific thinking.
3. Teaching according to the KUD strategy contributed to students taking responsibility for their learning and relying on a strong knowledge structure, thereby enhancing their acquisition of scientific concepts.

Recommendations:

In view of the current research findings and conclusions, the recommendations below are suggested:

1. Organizing seminars and workshops for teaching Biology using the KUD strategy across all educational levels, as it has shown effectiveness in improving scientific achievement.
2. Encouraging the use of the KUD strategy by Biology teachers, as it focuses on activities, instructional methods, and modern techniques, helps create a democratic learning environment and fosters interpersonal relationships in the classroom, thus raising students' scientific achievement.
3. The Ministry of Education and its directorates should organize training courses for Biology teachers to familiarize them with modern teaching strategies and their implementation in their schools.

Suggestions

The researcher proposes to carry out the following studies:

1. Conduct a similar study on other subjects.
2. Conduct a similar study on different educational levels and both genders.
3. Conduct a similar study on other variables such as different thinking styles (visual, contemplative, etc.), scientific attitudes, problem-solving skills, etc.

Disclosure Statement

The authors affirm that they have no known competing financial interests or personal relationships that might appear to influence the work reported in this article.

Data availability statement

The study participants did not provide written consent to make their data public. Due to the sensitive nature of the research, supporting data are unavailable.

References

[1] Abu Ali. (1989). Evaluation of the mathematics textbook for the secondary stage in Jordan (Unpublished master's thesis). Yarmouk University, Irbid, Jordan.

[2] Abu Al-Raghib, H. (1994). Analysis of the content and questions of the science textbook for the sixth-grade primary school and its evaluation from the perspective of science teachers in the basic stage (Unpublished master's thesis). Mu'tah University.

[3] Abu Halaw. (1995). Social sciences and their teaching methods. Al-Andalus Open University.

[4] Abu-Qahoos, K. A. (n.d.). The biology curriculum in Bahrain secondary school: An evaluation of the third grade. Dissertation Abstracts International, 5(1), 3198-A.

[5] Aisawi, A. R. M. (1975). The problem of evaluation in university education: Its causes and treatment methods. Journal of the Arab Universities Union, (7).

[6] Al-Ahmad. (2003). Teaching methods. Dar Al-Manahij Publishing and Distribution.

[7] Al-Ajili. (2001). The principle of educational measurement and evaluation. Ahmed Al-Dabbagh Office.

[8] Al-Dwikat. (1996). [Unpublished master's thesis]. Yarmouk University, Irbid, Jordan.

[9] Al-Saud, J. E. (2021). Evaluation of the developed science textbook for fourth-grade primary school from the teachers' perspective. Ministry of Education, Abdali, Jordan.

[10] Al-Shibli. (2000). Curricula: Construction, evaluation, and development using models (2nd ed.). Dar Al-Amal for Publishing and Distribution.

[11] Al-Tamimi. (2000). Curriculum evaluation standards in the Ministry of Education in general education. Republic of Iraq.

[12] Ayoub. (1999). Evaluation of the first-grade scientific secondary school physics textbook from supervisors, teachers, and students in northern Palestine (Unpublished master's thesis). An-Najah National University, Nablus, Palestine.

[13] Basharat. (2000). Evaluation of the chemistry textbook for first-grade scientific secondary school from the perspective of science supervisors and teachers in schools in the northern provinces of Palestine (Unpublished master's thesis). An-Najah National University, Nablus, Palestine.

[14] Booth, I. M. (1997). Courses are for inquiry: Dissertation Abstracts International, 58(3), 774C.

[15] Damaa. (1982). The school textbook and its suitability for the learning and teaching processes in the primary stage. Tunisia: Arab Organization for Education, Culture, and Science.

[16] Department of Physics, University of Danver. (199–). Would you believe (Artistic blunders)? The Physics Teacher, 115–117.

[17] Good, L. T. (1988). Assessing potential difficulties in comprehending a fourth-grade science textbook. Science Education, 65.

[18] Hamid Abdul, I. (2015). Evaluation of the content of the Principles of Science textbook for fourth-grade primary school according to TIMSS standards. Journal of Basic Education for Educational Sciences and Psychology, University of Babylon.

[19] Jamil. (2000). Fundamentals of educational curricula and their development methods. Amman, Jordan.

[20] Loveridge, A. I., & others. (197–). Preparing textbook manuscript. UNESCO.

[21] Mulhim. (2002). Measurement and evaluation in education and psychology (2nd ed.). Dar Al-Masira is responsible for publishing, distribution, and printing.

[22] Mur'i. (2000). Modern educational curricula: Their concepts, elements, principles, and processes. Dar Al-Masira for Publishing and Distribution.

[23] Najmi, M., & Mursi, A. (1977). Curricula and educational tools. Educational Library.

[24] Omar. (1980). The school textbook: Its authorship and production. Dar Al-Mareekh Printing Press.

[25] Radwan. (1962). The school textbook: Its philosophy and history. Anglo-Egyptian Library.

[26] Sadeh. (1984). Social research methodologies. Dar Al-Ilm Lil-Malayin.

[27] Saif. (1996). Evaluative study of the mathematics textbook taught to ninth-grade students in Jordan.

[28] Schmidt, E. (1998). Curriculum instructions and practices for students with emotional/behavioral disorders. In Successful instructions for the 21st century (Second CCBD Mini-Library Series). ERIC.

[29] UNESCO. (1970). Final report of the Third Regional Conference of Ministers of Education and Ministers Responsible for Economic Planning in Arab Countries. Marrakech, Morocco.

[30] Yousef. (1994). Evaluation of the biology textbook for the third-grade intermediate school from the perspective of teachers and students in the first Directorate of Education in Al-Rafa Governorate (Unpublished master's thesis)

[31] Zayir. (1999). The impact of constructive therapeutic evaluation methods on the achievement and retention of Arabic language grammar rules for preparatory stage students. Ibn Rushd College of Education, University of Baghdad.