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IMPACT OF AN INTERDISCIPLINARY APPROACH PROGRAM ON DEVELOPING ACHIEVEMENT AND ATTITUDES TOWARDS INTEGRATION BETWEEN SCIENTIFIC DISCIPLINES

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Abstract

The current research aimed to investigate the effect of aninterdisciplinary approach-based program on developing achievement and attitudes towards integration between scientific disciplines among first year universitystudents in the health track (public health) at Imam Abdulrahman bin Faisal University in the Kingdom of Saudi Arabia. To achieve this, the quasi-experimental approach was used with its two-group design: control and experimental, with pre- and post-measurements. The measurement tools were an achievement test for the respiratory and urinary systems units, and a scale of attitudes towards integration between scientific disciplines. The research was conducted in a group of (60) students (for the experimental group); in the second semester of the academic year 2024-2025. The research achieved several results, the most prominent of which are: that the program based on the interdisciplinary approach had an impact on developing achievement skills and improving the attitudes of the experimental research group towards integration between scientific disciplines. Considering the results it achieved, the research recommended a set of recommendations.

Research Introduction:

The world is witnessing a multidimensional scientific and technological revolution, embodied in the massive accumulation of knowledge, the proliferation of sciences, and the emergence of precise scientific specializations that fragment knowledge. Barriers have emerged between different branches of knowledge, isolating them from one another. This has deprived knowledge of its comprehensive, integrated perspective. Thus, basic sciences have branched out into several precise specializations.

Many educational program designers have pointed out that "the sciences are not isolated islands, and that interdisciplinary and integrative thinking must be embedded in educational policies. Any call for a single discipline is futile, as addressing problems must encompass more than one discipline and take into account more than one perspective." (Ruan, 2024, p. 280).

Thus, openness to various disciplines and the pursuit of knowledge integration or exchange has become a methodological awareness in global culture, providing opportunities to utilize knowledge tools from other fields. To solve complex problems, after the dominance of specialization in the cognitive arena and the consolidation of boundaries and boundaries between disciplines, and the independence of each, there is now an opposing trend calling for the integration of different sciences with the aim of achieving cognitive integration. New research approaches have emerged, including the interdisciplinary approach, which has become a requirement for many scientific studies (Zaher, 2018; Lazraqi, 2021).

The term "interdisciplinary approach" has become the most widely used in educational research and studies. UNESCO (2023) defined it as: "An approach to curriculum integration that generates an understanding of topics and ideas across related disciplines and their relationship to the real world. It typically expresses process and meaning, rather than product and content, by combining the content, theories, methodologies, and perspectives of two or more disciplines." (Hosaini&Akhyak, 2024, p. 26). The interdisciplinary approach is based on the philosophy of comprehensive education and the problem-solving approach advocated by Dewy. He emphasized that solving any problem requires the interplay of knowledge, skills, and perspectives from different disciplines to arrive at effective solutions. It has become a trend that has proven its effectiveness over decades. (Cai, et al., 2024)

Integrative interdisciplinary research has received special attention, particularly in the first decade of the twenty-first century, which has enriched the field with a vast body of educational writings, which has addressed this approach as an expanded field for integrating two or more fields of knowledge. (Hosaini, &Akhyak, 2024)

In this regard, several educational writings and previous studies have emphasized the importance of the interdisciplinary approach in developing various types of thinking, achievement, and many twenty-first-century skills. These studies include:

- **Rafiq's (2024)** study, which emphasized the importance of interdisciplinary study and thinking in developing an ethical understanding of many ethical issues in the biological sciences. Teaching these issues through the discipline of biology alone is inappropriate for ethical understanding, as this requires examining different perspectivesscientific, geographical, social, political, historical, ethical, legal, or economicprovided by different disciplines and achieving an interdisciplinary understanding of these issues.

- **Wang & Sang's (2024)** study, which recommended reconsidering pre-service teacher preparation programs to include strategies that develop interdisciplinary thinking skills, and training secondary school physics, chemistry, and biology teachers to design activities aimed at developing interdisciplinary thinking skills in their students, while incorporating these skills into the teaching objectives of these disciplines.

-**Ismail and Ibrahim's study (2022)** concluded in its findings that it is important for teachers, especially biology and physics teachers, to possess interdisciplinary thinking skills. This helps them allocate teaching time to find connections between the

students' major content and the content of other majors and provides learners with diverse analogies that help deepen their understanding of the nature of interdisciplinary interaction. Furthermore, it provides opportunities for teachersregardless of their specializationsto collaborate with one another to support their learners' interdisciplinary experiences.

Interdisciplinary teaching relies primarily on the application of experience-centered activities through discovery, and various types of thinking activities: critical, creative, and problem-solving. It also relies on the use of scientific inquiry into interactions: geological, biological, chemical, and environmental. It also explores human dimensions and societal institutions, as well as realistic assessment strategies, such as performance-based assessment (Chandra, Hitchcock, & Seno-Alday, 2025).

Despite the importance of the interdisciplinary approach, the results of some previous conferences and studies have indicated shortcomings in its application and have recommended its use and application in studying scientific, technological, and environmental issues and problems in society. (Anand & Singh, 2025) Rana, Aitken, &Chimoriya, 2025) (Didham, Fujii & Torkar, 2024)

Hence, the need for this current study emerged. It aims to investigate the impact of using a program based on the integration of biology and chemistry for first-year university students in the health track (public health students) at Imam Abdulrahman bin Faisal University in the Kingdom of Saudi Arabia, as an interdisciplinary program, on developing achievement, thinking skills, and students' attitudes toward interdisciplinary learning and integration.

From here, it was possible to define the following main question: What is the impact of using a program based on the integrated interdisciplinary approach between biology and chemistry on developing achievement and attitudes toward scientific disciplines integration among first-year university students in the College of Public Health at Imam Abdulrahman bin Faisal University? The following questions arise from this research:

1. What is the proposed program for integrating biology and chemistry based on an interdisciplinary approach?
2. What is the impact of the proposed program based on an interdisciplinary approach on developing academic achievement among first-year university students in the health track (College of Public Health) at Imam Abdulrahman bin Faisal University in the Kingdom of Saudi Arabia?
3. What is the impact of the proposed program based on an interdisciplinary approach on developing attitudes toward scientific disciplines integration among first-year university students in the health track (College of Public Health) at Imam Abdulrahman bin Faisal University in the Kingdom of Saudi Arabia?

Research Objectives:

The current research is aimedat:

1. Develop a proposed program based on integration between biology and chemistry that supports an interdisciplinary approach.
2. Develop academic achievement skills among first-year university students in the health track at Imam Abdulrahman bin Faisal University.
3. Develop attitudes toward scientific disciplines integration among first-year university students in the health track at Imam Abdulrahman bin Faisal University.

Research importance:

The importance of the current research is attributed to the following:

Theoretical Significance:

- It highlights the close relationship between the disciplines of biology and chemistry, and emphasizes the interdisciplinary necessity of both, as presented by biochemistry. This is both at the cognitive level, which employs them to achieve deep understanding, and at the comprehensive level of solutions to societal problems and issues.

Applied Significance:

- It presents research experience for university students, based on the integration of biology and chemistry.
- It presents valid and reliable tools: the integration-based achievement test, and the scale of attitudes toward integration.

Research Limits:

This research was limited to the following:

1- Human Limits:

The research was conducted on a group of (120) first-year university students in the health track at the College of Public Health. They were divided equally into two groups: the first: an experimental group, to which the proposed integration program was applied (60 students from groups 3 and 4 of Public Health), and the second: a control group (60 students from groups 1 and 2 of Public Health), to which the program was not applied.

2- Temporal and spatial limits:

The research experiment was implemented during the second semester of the academic year 2024-2025 AD, in the first-year university at the Deanship of the Preparatory Year and Previous Studies at Imam Abdulrahman bin Faisal University, Kingdom of Saudi Arabia.

Research Methodology:

To achieve the research objectives, to identify the effect of the proposed program, based on the interdisciplinary approach, on developing achievement and attitudes toward integration between scientific disciplines for first-year university students. This was achieved using a quasi-experimental design with a control and an experimental group, with pre- and post-tests. This type of quasi-experimental design was chosen to ensure that any differences in the dependent variables (achievement and attitudes toward integration between scientific disciplines) were more accurately attributed to the influence of the independent variable (the proposed program based on the interdisciplinary approach) rather than any other variables.

Research Tools:

The research tools included the following:

1. An achievement test of knowledge and interdisciplinary thinking skills between biology and chemistry.
2. A scale of attitudes toward integration between educational disciplines.

Research Hypotheses:

The current research included the following two hypotheses:

1. There is no statistically significant difference at the significance level ($\alpha \geq 0.05$) between the mean scores of students in the experimental and control groups in the post-test of the achievement test for the urinary and respiratory systems units for first-year public health students.

2- There is no statistically significant difference at the significance level ($\alpha \geq 0.05$) between the mean scores of the students in the two research groups: the experimental and the control groups, in the post-test of the Attitudes Toward Integration of Disciplines for first-year university public health students.

Research Procedures:
To answer the research questions and verify its hypotheses, the researchers followed the following procedures:
First: Theoretical framing of the main research variables and analysis of relevant research and studies.
Second: Field framework, including designing a proposed program based on the interdisciplinary approach, preparing research tools, and pre-testing of the research tools.
Third: Implementation of the research experiment and post-testing of the research tools.
Fourth: Presentation, discussion, and interpretation of the research results.
Fifth: Research recommendations.
The following is a detailed presentation of these procedures:

First: Theoretical framing of the research: Interdisciplinary approach:
A. The Historical Origins of the Interdisciplinary Approach:
Educational literature has referred to the term interdisciplinary as a compound term consisting of two parts: inter and disciplinary. The first part, "inter," means "between," and the word "discipline," refers to a specific field of study. In the late 20 years since, many researchers have discussed the interdisciplinary approach, and a trend has emerged toward rejecting the boundaries between disciplines that hinder a comprehensive understanding of societal phenomena and issues. The use of the interdisciplinary approach has gradually evolved in education at all levels.
(Al-Jalawi, 2020) (Abdel-Moneim and Ibrahim, 1999) (Makaki, 2021) (Makroum, 2022)
B. The Concept of the Interdisciplinary Approach:
Educational literature and studies have presented a set of concepts for the interdisciplinary approach under various names, due to the differences in the philosophy and objectives of interdisciplinary education, including:
-**Wang (2024)** defined the term interdisciplinary studies as: "An innovative approach that combines scientific disciplines to solve real-life problems by efficiently utilizing the human and material resources available in educational institutions." (Wang, 2024, p. 240)
-**Shuford (2024)** defined interdisciplinary learning as: "Making connections between two or more academic disciplines through a comprehensive and integrated approach to knowledge construction." (Shuford, 2024, p. 110)
-**Al-Jalawi's study (2020)** used the concept of the interdisciplinary approach, describing it as "constructing curricula based on the integration of scientific disciplines within a unified knowledge framework, to address educational issues, societal problems that are difficult to address within a single discipline, or concepts common to disciplines." (Al-Jalawi, 2020, p. 30)
-**Usmonov's (2025)** study explains this. The combination of two or more disciplines refers to the term "integration," which encompasses all these terms as levels of integration. These concepts share the commonality of learning approaches that seek to develop the learner's personality comprehensively. However, they differ in their thinking strategies, the interconnectedness between disciplines, and the complexity of the contexts through which integration occurs. These levels can be illustrated in Figure (1) below:

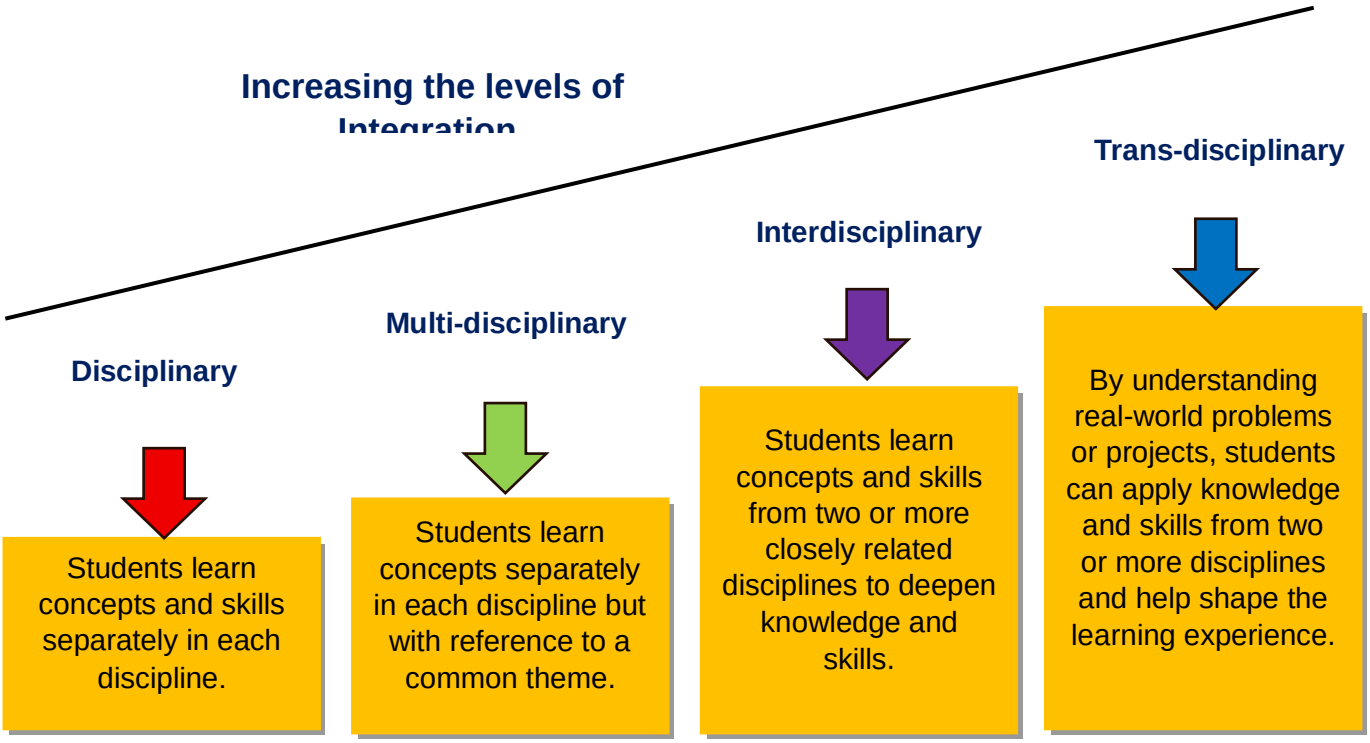

Figure (1) Levels of Integration

From the previous Figure (1), it is noted that:

- Specialization, multiple disciplines, and interdisciplinary disciplines are all integrated, but they are partial, while cross-disciplinary disciplines are fully integrated. The stronger the integration, the more comprehensive, deep, and general perspective it provides.
- Each of these disciplines is important for students' learning of concepts and skills, and for addressing problems. Students choose the type that best suits the goal, the nature of the discipline, and the ability to create connections that achieve integration. This is confirmed by two studies:

(Kolmos, Holgaard & Routhe, 2025) (Yeni, Sand, et al., 2024)

which explained that: Integration is the combination of disciplines to achieve comprehensive knowledge. It proceeds through a continuous series of levels, beginning with integration (the simple combination of the subject areas of a single discipline), then increasing in multidisciplinary, then intensifying in interdisciplinary, until it reaches its highest level in transdisciplinary, where the boundaries between disciplines disappear. Although in the interdisciplinary curriculum, the boundaries between disciplines remain clear, the connections between them become stronger and more evident.

- Interdisciplinary disciplines achieve a high level of integration between disciplines, but it is not as comprehensive as transdisciplinary. Nevertheless, interdisciplinary approaches to integration in education are among the most effective and productive approaches to integration in the context of the modern requirements of teaching and

learning. Especially in developing students' competencies and life skills, compared to the traditional approach based on a single discipline.

The study of Muhammad and Zouin (2016), referred to these terms as perspectives of integration and distinguished between them in detail, as follows:

1- The disciplinary perspective: This refers to what is included in a particular discipline's approach to the problems under study, its perspective, and its discussion of them.

2- The multidisciplinary perspective: This refers to the juxtaposition of several disciplines around a common topic, but each within the boundaries of its own discipline in an isolated manner.

3- The interdisciplinary perspective: This refers to viewing the same topic from the perspective of different disciplines in a way that seeks to integrate them.

The researchers used the concept of the interdisciplinary approach because it aligns with the nature and objectives of the current research. We can define it procedurally as: an organizational framework for constructing and implementing a program based on identifying relationships, linking, and integrating the knowledge, skills, methods, and tools of two disciplines: biology and chemistry, to study the topic of homeostasis in respiratory and urinary systems. To build integrated knowledge, deep understanding, and more effective solutions.

C - The Importance of the Interdisciplinary Approach to the Educational Process:

The shift in teaching and learning toward an interdisciplinary approach is of great importance, which can be summarized as follows:

(Ming, van der Veen & MacLeod, 2025). (Podgórska&Zdonek, 2024).

- It helps achieve continuous interaction and participation, sharing power between teachers and between teachers and between teachers and students, and the necessary transparency regarding the objectives to be achieved, compared to the sequential or cumulative approach to the curriculum.

- It contributes to the practice of interdisciplinary thinking skills, which by their very nature rely on the integration of diverse knowledge, tools, methods, and thinking styles from more than one scientific discipline. These skills are critical for addressing the complex and most critical problems facing society today.

Among the studies that have focused on the use of the interdisciplinary approach and proven its effectiveness are the studies of:

-**Usmonov (2025)** used the interdisciplinary approach between physics concepts in teaching some medical subjects, by addressing some common problems such as pressure, equilibrium, hydrogenation, etc. Their results confirmed that interdisciplinary approaches help organize content in a better way, lead to interconnectedness, and form a scientific field whose knowledge is drawn from different specialized fields, using the methodology of observation, experimentation, description, measurement, and classification.

-**Mohammed and Zouin (2016),** whose results confirmed the effectiveness of a proposed interdisciplinary unit in geography and chemistry in developing the skills of interpretation and geographical scientific awareness among first-year middle school students.

-**Mustafa (2017),** whose results confirmed the effectiveness of a climate change unit based on an interdisciplinary approach to science, chemistry, and mathematics in developing problem-solving skills in science for second-year middle school students.

-**Rizk et al. (2021),** whose results confirmed the effectiveness of a proposed unit based on an interdisciplinary approach to science and chemistry in developing the cognitive aspect of environmental awareness. They recommended the use of an interdisciplinary approach at various educational levels and in other subjects to enable students to predict what might happen in the future and find solutions to the problems they face.

Second: The Field Framework of the Research:

To achieve the objectives of the current research, which are to develop both achievement and attitudes toward integration between scientific disciplines for first-year university public health students, the researchers adhered to the following procedures:

- Design a proposed program based on the interdisciplinary approach, in biology and chemistry, in the urinary system and respiratory system units, and address the concept of homeostasis through these two disciplines.
- Prepare and adjust the research tools.
- Implement the research experiment: Details are provided below:

- Design a program based on the interdisciplinary approach:

The program based on the interdisciplinary approach was constructed according to several stages, which can be detailed as follows:

A. Program Foundations:

The program was built on a review of educational literature and previous studies related to this topic. The program components were designed as follows:

- General Program Objectives:

The primary goal of the program was to develop public health students' knowledge through educational content based on the use of an integrative approach between biology and chemistry, as well as to develop their skills and attitudes related to interdisciplinary studies. The general program objectives can be explained as follows:

- Understanding the nature of interdisciplinary studies and their origins.
- Understanding the importance of the interdisciplinary approach to thinking.
- Understanding the nature of hemostasis.
- Understanding the nature of interdisciplinary teaching, its characteristics, importance, and skills.
- Developing the ability to establish relationships between the disciplines of biology and chemistry.
- Employing various thinking styles (scientific, critical, creative, metacognitive) to integrate biology and chemistry to address problems and issues relevant to society.

B- Program Content:

The program content was selected and organized based on the following criteria:

- Appropriate for achieving the program's objectives.
- Achieving interdisciplinary approaches, consistent with the nature of the interdisciplinary approach.
- Emphasizing students' practice of interdisciplinary thinking skills.
- Providing opportunities to develop students' attitudes toward interdisciplinary learning.

C- Teaching and Learning Strategies:

To achieve the program's objectives, a set of strategies were used that are appropriate to its nature and goals, are compatible with learners' abilities and needs, and encourage them to practice interdisciplinary thinking skills. The most prominent of these strategies is active learning, specifically experiential learning strategies, case

studies, discussion, brainstorming, problem-solving, investigation, mind maps, projects, and collaborative learning.

D- Program Implementation Timeline:

Theimplementation timeline was developed to ensure the achievement of its intended learning outcomes, the teaching of its topics, the implementation of its strategies and activities, and the evaluation of its intended learning outcomes. The program implementation period was approximately (16) days during the second semester of the 2024-2025 academic year.

E- Preparing a Faculty Member Guide:

The purpose of the faculty member guide is to help faculty members to know how to implement the proposed program, based on the interdisciplinary approach. It includes a detailed presentation of the general and procedural objectives, teaching and learning strategies and activities used, learning resources and assessment methods.

F- Program Validity and Learning Tools:

The validity of the program and learning tools: the faculty member guide and student guidewere verified by presenting them to a group of referees specializing in curricula and teaching methods, as well as biology and chemistry. Their suggestions and opinions were considered, resulting in the program and learning tools reaching their final form.

- Preparing and Adjusting Measurement Tools:

The research included the following tools:

1. An achievement test for the urinary system and respiratory system, based on an integrated approach to question formulation.
2. A scale of attitudes toward integration between scientificdisciplines.

The process of preparing and adjusting these tools proceeded through the following steps:

First: Preparing the Achievement Test:

The following procedures were followed in preparing the achievement test:

A. Defining the Objective of the Test

The objective of the test was to measure the level of achievement in the urinary system and respiratory system for the program, which is based on an integrated approach to question formulation. The test instructions were formulated with clarity and ease of understanding in mind, including a clarification of the objective of the test, the number and type of questions, and how to answer them, as well as ensuring accurate personal information.

B- Preparing the Initial Form of the Test:

The initial form of the test included (30) items accompanied by answer instructions.

C- Test Validity:

The initial form of the test was presented to a group of expert judges specialized in curricula and teaching methods to verify its validity in terms of the clarity and precision of the wording, the affiliation of the items to the test dimensions, their suitability for the research group, the accuracy of the instructions, and any additional notes, modifications, additions, or deletions. Considering the judges' opinions, appropriate modifications were made to include (30) items.

D- Test Reliability:

The test reliability coefficient was calculated by calculating the percentage of agreement between the examiners using Cooper's equation. The researchers corrected the responses of (10) students in the achievement test, and the agreement coefficient

reached (84.32%). This indicates that the test has an acceptable degree of reliability, and therefore its results can be trusted.

E- Determining the Test Time

The test time was determined by calculating the average time taken to complete the test. This is done by adding up the time spent by each student and then dividing the result by the number of students. The test completion time is set at (60) minutes.

J - Preparing the Final Form of the Test

After verifying the validity and reliability of the test, and calculating the appropriate time for its application, the test, in its final form, is valid for application, containing (30) items. Therefore, the maximum score for the test is (30).

Second: Preparing a questionnaire to measure attitudes toward integration between educational disciplines:

The questionnaire included the following topics: the concept of interoperability learning, its importance, the effectiveness of its use in university teaching, and the challenges of its use in university teaching (45) statements.

A. Formulating the Questionnaire:

After identifying the dimensions of the list of attitudes toward interpersonal learning, the questionnaire's statements were formulated with considerations for clarity, specificity, precision, non-overlap, comprehensiveness of all dimensions of interpersonal learning, and the affiliation of each statement to the dimension it measures.

B. Developing a Scoring System for the Questionnaire

A system was developed to evaluate responses according to a five-point Likert scale: (5) strongly agree, (4) agree, (3) unsure, (2) disagree, (1) strongly disagree.

C. Validity of the Questionnaire:

The questionnaire was presented to a group of referees specializing in curricula and teaching methods to ensure the validity of the initial version of the list for use. They were asked to express their opinions regarding the clarity and precision of the wording of the statements, the affiliation of each statement to the axis it measures, and its suitability for student characteristics. They also included any comments regarding modifications, additions, or deletions. The questionnaire was modified considering the referees' opinions, by rewarding some statements. The final version was then designed, including four axes: It is expressed in (45) statements. Table (1) shows the final form of the questionnaire, as follows:

Axes of the Attitude Scale Questionnaire	Number of Statements	Percentage
Nature of Inter-Learning	9	20%
Importance of Inter-Learning	14	32%
Effectiveness of its Use in University Teaching	11	24%
Challenges of its Use in University Teaching	11	24%

Table (1) Final Form of the Attitude Scale

D - Preparing the Initial Form of the Scale:

The initial form of the scale included (45) items. Students were required to place a check mark (√) in front of each item according to the choice that best expresses their degree of agreement.

E - Developing a scoring system for the scale:

A five-point Likert scale was used to score positive items; in the case of negative items, the weights were reversed.

F - Validity of the Scale:
The extent to which the scale items represented the objectives for which they were designed was verified through content validity. By presenting the initial version of the scale to a group of arbitrators to verify its validity, the scale included (45) items.

J- Pilot experiment of the attitude scale:
The scale was applied to a group of first-year public health students in the second semester of the 2024/2025 academic year. The research group consisted of (15) students. The Microsoft Forms application was used to calculate the following:

1- Scale reliability:
The scale's reliability was calculated using the Cronbach's alpha equation. The reliability coefficient value was (0.89), indicating that it has a high degree of reliability and can be applied to the research group.

2- Scale time:
The response time to the scale was calculated by determining the average time students took to answer the scale. The average time to complete the scale was (30) minutes.

3- Preparing the final version of the scale:
After verifying the validity and reliability of the scale, and calculating the appropriate time for its application, the scale in its final form became valid for application.

Third: Presentation and interpretation of the research results:
To calculate the research results and the statistical methods used to verify the research hypotheses, the SPSS statistical software package, version (20), was used. These results were interpreted considering what was confirmed by educational literature and the results of studies and research included in the theoretical framework of the research. Finally, some recommendations were presented, detailed below:

(1) Results of verifying the first hypothesis, which states: There is no statistically significant difference at a significance level of ($\alpha \geq 0.05$) between the average scores of students in the experimental and control research groups in the post-measurement of the achievement test. The t-test for independent groups was used to determine the significance of the difference between the average scores of students in the control and experimental research groups. For the achievement test, as shown in the following Table (2):

Group	Test Score	Mean	Standard Deviation	"t" Value	ŋ 2	Significance	Effect Size Level
Control	30	14.5	6.72	37.89	0.96	Significant at the 0.05 level	Significant
Experimental		27.1	10.09				

Table (2)

T-values and their significance for the difference between the mean scores of the two groups: the control and experimental, in the post-test of the achievement test, and the effect size calculation, where n = 60 students for both groups.

It is clear from Table (2) above:

- The calculated "t" values exceeded the tabular "t" values at a significance level of ($\alpha \geq 0.05$), indicating a statistically significant difference between the mean scores of the students of the two research groups in the post-test of the achievement test, in favor of the mean scores of the students of the experimental group. Therefore, the null hypothesis was rejected and the alternative hypothesis was accepted, which states:

There is a statistically significant difference at a significance level of ($\alpha \geq 0.05$) between the mean scores of the students of the two research groups, the experimental and control, in the post-test of the achievement test, in favor of the mean scores of the experimental group. The effect size value using η^2 for the test was(0.96), indicating a significant effect size for the proposed program on developing achievement and interdisciplinary thinking skills. This confirms that the proposed program, based on the interdisciplinary approach, has brought about a significant and significant change in the development of achievement skills and interdisciplinary thinking among students in the experimental group.

This result, in the researchers' view, is attributed to:

- The program based on the interdisciplinary approach provides opportunities for students to engage in interdisciplinary thinking and develop its skills. The approach is based on the philosophy of interdisciplinary thinking, which is represented by identifying relationships, linking, and integrating the knowledge, skills, methods, and tools of the two disciplines of biology and chemistry, thus achieving cognitive mastery and higher-order thinking skills.
- Content selection and organization. The interdisciplinary approach focused on selecting content that connects two different disciplines, namely the topic of hemostasis. Which requires identifying relationships, linking and integrating the sciences of biology and chemistry. Achieving this integration requires identifying the network relationships between the knowledge of these sciences, and these relationships are the essence of thinking processes in all its forms and skills. Indeed, thinking is an awareness of the relationships between elements and subjects, between cause and effect, and between the known and the unknown, which is consistent with the study of Abdel-Razzaq et al. (2022).

Integration also requires linking general thinking skills and thinking patterns specific to each scientific field, which contributed to the formation of biochemistry. Thus, biochemistry supports the practice of inter-thinking skills; biology is linked to the practice of scientific and metacognitive thinking, and even works to develop it, which is consistent with the study of Alwan (2020), as well as creative thinking, which is consistent with the study of Al-Sarhan (2022), and critical thinking; This is consistent with Shehab's (2019) study, which all relate to interdisciplinary thinking skills. Chemistry is also linked to the practice of scientific thinking, as confirmed by Al-Maamari and Al-Masrouri (2019), as well as creative thinking, as confirmed by Hilat's (2013), and critical thinking, as confirmed by Ibrahim's (2015) study.

Defining the relationships, connections, and integration between biology and chemistry requires integrating the thinking patterns involved in both; this explains why students' study of the proposed program contributed to developing their achievement and interdisciplinary thinking skills. The program's teaching and learning strategies contributed to developing achievement and interdisciplinary thinking skills. Such as problem-solving, peer tutoring, collaborative learning, research projects with interdisciplinary tasks, discussion that enabled the practice of critical thinking skills, and investigation that directed students to search for knowledge from the disciplines of biology and chemistry, and to identify, connect, and integrate relationships between them. This is consistent with studies by:(Usmonov, 2025) (Yeni, et al., 2024) (Shuford, 2024) (Didham, Fujii & Torkar, 2024)

(2) - Results verifying the second hypothesis, which states: There is no statistically significant difference at the significance level ($\alpha \geq 0.05$) between the average scores of students in the experimental and control research groups in the post-test of the scale

of attitudes towards integration between educational disciplines, using the t-test for independent groups. To determine the significance of the difference between the average scores of students in the post-test, measuring students' attitudes toward interdisciplinary integration, and calculating the effect size of implementing the proposed program based on the interdisciplinary approach on developing students' attitudes toward integration between scientific disciplines, the following Table (3) illustrates:

Group	Score	Mean	Standard Deviation	"t" Value	ŋ 2	Significance	Effect Size Level
Control	225	109.96	4.02	76.83	0.99	Significant at the 0.05 level	**Significant**
Experimental		185.56	3.58				

Table (3)

T-values and their significance for the difference between the average scores of the two groups: the control and experimental, in the post-test to test attitudes toward integration, and calculating the effect size, where n = 60 students for both groups.

It is clear from the previous Table (3):

- The calculated "t" values exceeded the tabular "t" values at a significant level of ($\alpha \geq 0.05$); This indicates that there is a statistically significant difference between the average scores of the students of the two research groups in the post-test of the students' attitudes towards integration, in favor of the average scores of the students of the experimental group. Therefore, the previous null hypothesis was rejected and the alternative hypothesis was accepted, which states: There is a statistically significant difference at a significance level of ($\alpha \geq 0.05$) between the average scores of the students of the two research groups, the experimental and the control, in the post-test of the students' attitudes towards integration scale, in favor of the average scores of the experimental group.

The effect size value using $\eta^2$for the scale was (0.99), indicating a significant effect size for the proposed program in developing students' attitudes toward integration and interdisciplinary learning. This confirms that the proposed program, based on the interdisciplinary approach, brought about a significant change in improving the attitudes of students in the experimental group toward integration between scientific disciplines.

This result, in the view of the researchers, is attributed to:

- The proposed program, based on the interdisciplinary approach, provides students with opportunities to develop their attitudes toward integrationby targeting the academic, personal, and social development of students, raising their level of proficiency in interdisciplinary teaching, and informing them of these goals and the importance of the program in achieving them. This is consistent with the study of (Anand & Singh, 2025) (Abdul Razak et al., 2022). The program includes strategies and learning activities that rely on active learning among students, such as problem-solving strategies, project-based learning, inquiry-based learning, discussion, and case studies. These all contribute to the formation of positive beliefs and attitudes toward interpersonal learning, as learners are active, enjoy using their minds, practice diverse thinking skills, discover their abilities and skills in searching for information and arriving at solutions, and practice several social skills that stimulate learning. This is consistent with studies by:

(Ming, van der Veen, & MacLeod, 2025); (Kolmos, et al., 2025); (Usmonov, 2025); (Ruan, Xu & Su, 2024); (Hassan, Ibrahim, & Hussein, Hisham, 2022); (Atallah & Al-Jaber, 2017). (Faqihi, Yahya, and Al-Maliki, 2021)

Fourth: Research Recommendations:

Considering the findings the researchers recommend the following:

- Develop professional development programs for biology and chemistry teachers, based on an interdisciplinary approach, allowing for the development of achievement, thinking skills, and attitudes toward integration between scientific disciplines.
- Benefit from the interdisciplinary approach in developing students' skills, which contributes to improving their future professional performance and achieving better learning outcomes.

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