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The Effectiveness of the Schwartz Model in Developing Critical Thinking Skills in Physiology among First-Year Students at the Technical Medical Institute

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ABSTRACT

The study, which was based on an experimental research approach, aimed to measure the level of these skills before implementation and to determine the effectiveness of the Swartz Model model—based on the principle of "teaching thinking through content" and through stages of integration, metacognition, and application of thinking—in developing critical thinking as a whole and for each sub-skill. The research methodology consisted of applying the experimental and control group design with pre- and post-tests on a sample of 60 male and female students from the Medical Technical Institute at the University of Baghdad, ensuring the initial equivalence of the two groups. The research results showed the great and confirmed effectiveness of the Schwartz model, as statistically significant differences were found at the significance level (P 0.05) in the post-test in favor of the experimental group on the overall critical thinking score. Applying the accompanying analysis of variance (ANCOVA), the effect size (Partial Eta Squared) reached 0.161, which is classified as a large effect size. The effectiveness was confirmed at the level of all sub-skills, with a notable superiority in the skill of analysis, which showed the largest effect size (Cohen's d=0.82), confirming that the Schwartz model is an effective tool for transforming the teaching of philosophy from a descriptive science to a logical analytical science.

Keywords: Schwartz, , physiology, technical, effect size**.**

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Introduction:

In the fast-paced age of knowledge, higher education, especially in medical and health specialties, is no longer limited to the transmission of information and rote memorization of facts. Instead, it has shifted its focus primarily to building the ability to analyze, solve problems, and make informed clinical decisions. Physiology is one of the fundamental pillars that provides students with knowledge about the complex mechanisms of the human body and their interactions, making it a fertile field for training students in systematic and critical thinking. Physiology requires a deep understanding of the causal relationships between physiological variables, rather than merely memorizing processes, which necessitates adopting teaching strategies that go beyond the traditional model. Given the urgent need to graduate healthcare professionals capable of critical thinking in the changing clinical work environment, advanced teaching models have emerged that seek to integrate thinking skills into the curriculum. Among the most prominent of these is the Swartz Model, which is based on the principle of "teaching thinking thru content" and thru clear stages that encourage students to engage in cognitive integration and metacognition. This research aims to verify the effectiveness of applying this model in developing critical thinking skills—comprising interpretation, analysis, inference, and evaluation of assumptions—among first-year students at the Technical Medical Institute at the University of Baghdad, considering them the backbone of future healthcare professionals. This will contribute to enriching educational curricula with effective mechanisms that achieve the desired goals of technical medical education.

Chapter One: The Methodological Framework of the Research

Research questions:

1. What is the level of critical thinking skills (interpretation, analysis, inference, evaluation of assumptions) among first-year students at the Technical Medical Institute before applying the Schwartz model? What is the level of critical thinking skills (interpretation, analysis, inference, evaluation of assumptions) among first-year students at the Technical Medical Institute before applying the Schwartz model?
2. Are there statistically significant differences at the significance level (alpha less than or equal to 0.05) between the mean scores of the experimental group (which studies according to the Schwartz model) and the control group (which studies using the traditional method) in the post-test of critical thinking skills as a Are there statistically significant differences at the significance level (alpha less than or equal to 0.05) between the mean scores of the experimental group (which is taught according to the Schwartz model) and the control group (which is taught using the traditional method) in the post-test of critical thinking skills as a total score in the subject of Physiology?
3. Are there statistically significant differences at the significance level (alpha less than or equal to 0.05) between the mean scores of the two groups in the post-test for each sub-skill of critical thinking (interpretation, analysis, inference, evaluation of

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assumptions) separately? Are there statistically significant differences at the significance level (alpha less than or equal to 0.05) between the mean scores of the two groups in the post-test for each sub-skill of critical thinking (interpretation, analysis, inference, evaluation of assumptions) separately?

Research Hypotheses

Based on the research problem and its questions, the study assumes the following:

1. There are no statistically significant differences at the significance level (alpha less than or equal to 0.05) between the mean scores of the experimental and control groups in the pre-test of critical thinking skills. There are no statistically significant differences at the significance level (alpha less than or equal to 0.05) between the mean scores of the experimental and control groups in the pre-test of critical thinking skills.
2. There are statistically significant differences at the significance level (alpha less than or equal to 0.05) between the mean scores of the experimental group and the control group in the post-test of critical thinking skills as a total score in favor of the experimental group. There are statistically significant differences at the significance level (alpha less than or equal to 0.05) between the mean scores of the experimental group and the control group in the post-test of critical thinking skills as a total score in favor of the experimental group.
3. There are statistically significant differences at the significance level (alpha less than or equal to 0.05) between the mean scores of the experimental group and the control group in the post-test for each sub-skill of critical thinking skills (interpretation, analysis, inference, evaluation of assumptions) separately, There are statistically significant differences at the significance level (alpha less than or equal to 0.05) between the mean scores of the experimental group and the control group in the post-test for each sub-skill of critical thinking (interpretation, analysis, inference, evaluation of assumptions) separately, in favor of the experimental group.

Importance of the research

The theoretical significance of this research is manifested in enriching the scientific and educational library with an in-depth experimental study that contributes to providing practical evidence of the effectiveness of the Schwartz model, which is one of the advanced models for teaching thinking, in a sensitive and important educational environment such as physiology education.

Research Objectives

The current research aims to achieve the following:

1. Measuring the level of critical thinking skills among first-year students at the Technical Medical Institute before applying the Schwartz model. Measuring the level of critical thinking skills among first-year students at the Technical Medical Institute before applying the Schwartz model.

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2. Determining the effectiveness of the Schwartz model in developing critical thinking skills as a total score in the physiology subject for the experimental group. Determining the effectiveness of the Schwartz model in developing critical thinking skills as an overall score in the physiology subject for the experimental group.
3. Determining the effectiveness of the Schwartz model in developing each sub-skill of critical thinking (interpretation, analysis, inference, evaluation of assumptions) among the experimental group. Determining the effectiveness of the Schwartz model in developing each sub-skill of critical thinking skills (interpretation, analysis, inference, evaluation of assumptions) among the experimental group.
4. Present a set of recommendations and suggestions that can benefit educators and educational institutions in technical medical education to enhance critical thinking. Providing a set of recommendations and suggestions that can benefit educators and educational institutions in technical medical education to enhance critical thinking.

Research Methodologies

The research relied on the experimental method due to its suitability for verifying the cause-and-effect relationship between two variables: the independent variable (the teaching program based on Schwartz's model) and the dependent variable (the development of critical thinking skills).
Focusing on selected units from the subject of Physiology.

Research terms

Swartz Model: It is an advanced educational model that integrates thinking skills within the curriculum instead of teaching them in isolation. It relies on three main pillars: "Teaching Thinking thru Content" (Infusion), Metacognition, which enhances the student's awareness of their mental processes, and applying thinking in new contexts. The research has proven effective in transforming the teaching of physiology from a descriptive science to a logical analytical science, achieving a significant effect size (Partial Eta Squared = 0.161) in developing critical thinking among students at the Technical Medical Institute. (Abdul Majid, 2023: 377)
Critical Thinking: It is a disciplined and self-directed intellectual process that involves analyzing and evaluating information, assumptions, and arguments to reach logical conclusions and make practical decisions. It includes four sub-skills: interpretation, analysis, inference, and evaluation of assumptions. In the medical context, these skills enable the student to interpret physiological changes, analyze laboratory test results, deduce appropriate diagnoses, and evaluate scientific assumptions. The research showed a clear superiority of the experimental group in all these skills, especially the analysis skill, which achieved the largest effect size (Cohen's d=0.82). (Al-Khalil, 2023: 82)
Physiology: It is a fundamental scientific subject in health curricula that studies the mechanisms of action of human body organs and systems and their complex interactions to maintain homeostasis.
Technical Medical Education: It is a specialized educational model aimed at preparing technical health personnel (such as laboratory technicians and nurses) capable of

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applying theoretical knowledge in clinical work environments, and it requires a high level of critical thinking to analyze medical cases and make sound diagnostic decisions. This study represents an important research gap as it explored the effectiveness of the Schwartz model in this previously unexamined context, unlike previous studies conducted in general or non-medical technical education. The research results contribute to the development of curricula for technical medical institutes to ensure the graduation of personnel capable of proper physiological analysis and making informed decisions in professional practice. (Al-Amri, 2024: 319)

Section Two: Previous Studies and the Research Gap

Previous studies:

.1Nadhim Turki Atiyah Al-Saadi. Nazem Turki Atiyah Al-Saadi. The effectiveness of the Schwartz model in critical thinking among fourth-year science students in biology. Journal of Arts, Literature, Humanities, and Social Sciences. 2018

The study aimed to investigate the effectiveness of the Schwartz model in developing critical thinking among fourth-grade science students in biology. The researcher adopted a quasi-experimental design with two groups: an experimental group and a control group. The sample consisted of 55 students divided into 28 students in the experimental group and 27 students in the control group, with equivalence between the two groups in the variables of age, intelligence, prior achievement, and critical thinking. The study tool was a critical thinking test consisting of 24 items distributed across six skills: interpretation, analysis, evaluation, inference, deduction, and organization, after adapting it to suit the preparatory stage in Iraq. The results indicated that the students in the experimental group who studied according to the Schwartz model outperformed the students in the control group who studied using the traditional method in the critical thinking test.

.2Asil Raad Jamal. Aseel Raad Jamal. The impact of the Swartz model on developing critical thinking among students of the Institute of Fine Arts in the subject of esthetics. Journal of the College of Basic Education - Al-Mustansiriya University. 2022

The study aimed to identify the impact of the Swartz model on developing critical thinking among students at the Institute of Fine Arts in the subject of esthetics. The researcher adopted an experimental design based on two groups: an experimental group and a control group, using a critical thinking test as a measurement tool. The study aimed to determine the effectiveness of the model in developing critical thinking skills among students in a specialized artistic educational context. The results concluded that the Swartz model had a positive effect on developing critical thinking among the experimental group students compared to the control group, which was taught using traditional methods.

.3Ahlem Mohamed Amer Al-Sheikh. Ahlam Mohammed Amer Al-Sheikh. The effectiveness of a program based on the Schwartz model in developing critical

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thinking skills in the subject of Science and Life among fourth-grade female students in Gaza. Islamic University of Gaza. 2017

The study began with the problem of the low level of critical thinking skills among fourth-grade female students in the subject of Science and Life. It aimed to determine the effectiveness of a program based on the Schwartz model in developing these skills. The researcher adopted a quasi-experimental method with a one-group design and pre-test and post-test. The study sample included fourth-grade female students in Gaza. The tool used was a critical thinking skills test in the subject unit from the Science and Life textbook. The results revealed statistically significant differences between the mean scores of the students in the pre-test and post-test of the critical thinking skills test in favor of the post-test, confirming the effectiveness of the program based on the Schwartz model in developing critical thinking skills.

The research gap:

Although previous studies (such as Al-Saadi's study, 2018 in the preparatory stage; Jamal's study, 2022 at the Institute of Fine Arts; and Al-Sheikh's study, 2017 in the fourth grade of primary school) have proven the effectiveness of Schwartz's model in developing critical thinking in various educational fields, the practical application of Schwartz's model is not only its statistical significance.

Section Three: The Conceptual Framework of Schwartz's Model and Critical Thinking in the Context of Medical Education:

Schwartz's model is built on three integrated main components: First, infusion, which means embedding critical thinking opportunities within academic content. Instead of teaching "inference" as an abstract skill, it is taught thru inferring the effect of hypoxia on the cell's respiration rate based on understanding the Krebs cycle equation. Secondly, metacognition, which is an essential element that encourages students to be aware of their own cognitive processes, where the student is asked, after analyzing a physiological case, to answer questions such as: "What steps did you follow to reach this analysis?" And "Could I have used a better way of thinking?", which enhances self-monitoring and self-correction of the thinking process. Thirdly, Application of Thinking, which aims to transfer the thinking skills learned in the context of physiology to other areas, such as applying the skill of evaluating assumptions practiced in evaluating assumptions about osmotic pressures in the kidney, to apply it in evaluating assumptions about fluid balance in burn cases. (Al-Anzi, 2025)

The technical medical context requires a high level of critical thinking; students do not only learn the functions of cells and tissues, but also how these functions interact and change in disease states (Pathophysiology). Therefore,. In the physiology course, the Schwartz model is applied by designing educational scenarios that require students to use critical thinking skills to solve specific physiological problems. For example, in the cardiovascular physiology unit, instead of merely explaining the cardiac cycle, students are required to analyze the electrocardiogram (ECG) of a patient with tachycardia, then interpret the physiological mechanism that led to the increased heart rate based on their understanding of the action potential theory,

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deduce the next diagnostic step, and evaluate the assumption that the problem always lies in the sinoatrial (SA) node. This organized teaching process, supported by a self-review of the cognitive process, is what distinguishes Schwartz's model. (Tian: 2025: 1_32)

In light of the required academic standards, the relationship between the basal metabolic rate and temperature can be expressed as a physiological example using the modified Van 't Hoff's Law, partially adapted to the biological context, where the effect of increased temperature on the rate of enzymatic reaction can be expressed, which is a practical example in physiology:

$R2 = R1 * Q10((T2 - T1) / 10)$

Where R1 is the reaction rate at temperature T1, and R2 is the reaction rate at T2, and Q10 is the temperature coefficient that represents the amount of increase in the rate for every 10 degrees Celsius rise. Analyzing this relationship within a physiological context (such as the effect of fever) requires the use of critical thinking skills in analysis and inference, which the Schwartz model provides as a methodological framework for teaching these skills. Linking the theoretical concept (Schwartz model) to practical application in physiology ensures the scientific value of this research, as it lays the conceptual foundation that illustrates how teaching physiology as an analytical and logical science, rather than a descriptive one, is key to developing critical thinking (Nema, 2024: 369).

Table 1: Distribution of Critical Thinking Test Questions Across Subskills and Physiological Domains

A practical example in physiology:	Applied Physiological Fields	Percentage of questions	critical thinking skills	Skill number
Interpreting the oxygen-hemoglobin dissociation curve in cases of acidosis.	Respiratory Physiology	%25	(Interpretation)	1
Analysis of the cardiac action potential pathway and evaluation of the effect of calcium channel blockers on it.	Circulatory and Cardiac Physiology	%30	(Analysis)	2
Declaration of the effect of damage to a specific brain region (such as the cerebellum) on motor balance based on neural inputs and outputs.	Nervous System Physiology	%25	(Inference)	3
Evaluating the assumption that hypertension is always due to increased renin secretion in light of other regulatory mechanisms.	Kidney and Urinary Tract Physiology	%20	Evaluation of) (Assumptions	4
--	--	%100	--	the total

• Source: Prepared by the researcher based on Vakinyon's classification of critical thinking skills and adapted to the physiological context.

the researcher assigned to each skill within the educational context of physiology; for example, the largest percentage was allocated to the skill of analysis (30%). This allocation is not arbitrary but reflects the fundamental nature of teaching physiology

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in the early stages, where understanding complex physiological mechanisms requires a systematic breakdown of components and causal relationships between them, such as analyzing the series of hormonal interactions that regulate blood glucose levels or analyzing the mechanisms regulating blood pH thru the renal and respiratory buffer systems, which are among the topics that require analytical thinking to connect them with each other. In contrast, the skills of interpretation and inference each received 25%, reflecting the dual need for students in the technical institute: first, to interpret basic clinical data and laboratory results (such as arterial blood gas readings), and second, to deduce the logical diagnostic or procedural steps that follow interpretation and analysis. (Bou Saleh: 2025: 63)

As for the skill of evaluating assumptions, which received 20%, it is considered one of the highest levels of critical thinking..

Chapter Four: Research Methodology and Procedures in Applying Schwartz's Model

The research methodology and procedures represent the backbone of this experimental study, ensuring the accuracy of the results and their reproducibility. The study relied on the experimental design of two equivalent groups with pre-test and post-test, which is a design that reduces the impact of extraneous variables and allows for the isolation of the effect of the independent variable (Schwartz model) on the dependent variable (critical thinking). (Al-Hanan, 2022: 89) The research sample was selected from first-year students at the Technical Medical Institute of Baghdad University, Department (name of the department where the application was conducted), totaling (N=60) male and female students, who were randomly divided into two groups: the experimental group (NE=30) that studied the physiology subject according to the Schwartz model, and the control group (NC=30) that studied the same subject using the traditional method (direct lecture). The equivalence of the two groups was statistically confirmed before the start of the experiment in variables such as age, high school GPA, and the most important variable, which is the pre-critical thinking level. The pre-critical thinking test was applied to both groups, and an independent samples t-test was conducted to ensure there were no statistically significant differences between them. As for the measurement tools, the critical thinking test specifically constructed for this study was used, based on standard critical thinking tests (such as the California test), with adaptations to fit the physiological content.

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Table 2: Equivalence analysis of the two groups (experimental and control) in the critical thinking pre-test

Statistical resolution	(.Sig)	(df)	t	(SD)	(Mean)	(N)	The experimental
There are no statistically significant differences.	0.359	58	0.925	5.89	54.21	30	control
--	--	--	--	6.11	53.48	30	group

• Source: Results of the pre-test statistical analysis performed on the study sample.

Table 2 is considered one of the vital tables that ensure the methodological soundness of the experimental study, as it documents the process of achieving initial equivalence between the experimental group and the control group in the variable of critical thinking before starting the application of the treatment, which is a prerequisite for relying on the results of the post-test. The data indicate that the mean score of the experimental group in the pre-test is (54.21) with a standard deviation of (5.89), while the mean score of the control group is (53.48) with a standard deviation of (6.11). These apparent differences between the two means are minor and insignificant, but true verification of equivalence requires the application of the appropriate statistical test. Therefore, an independent samples t-test was used, where the calculated t-value was (0.925). Comparing this value with the statistical significance level (alpha less than or equal to 0.05), we find that the calculated significance level is (0.359), which is much greater than the accepted significance level (0.05). This means that the null hypothesis, which states "there are no statistically significant differences between the mean scores of the two groups in the pre-test," is accepted. This acceptance confirms that the two groups are statistically equivalent in their critical thinking ability before applying the Schwartz model (Shamlan, 2024: 232), which reassures us that any substantial changes or differences that may appear in the post-test results can be confidently attributed to the effect of the independent variable, namely the Schwartz model, and not to any initial differences that existed between the students. This methodological equivalence enhances the internal validity of the research, which is a fundamental criterion for publication in prestigious journals. The process of ensuring equivalence also requires considering the normal distribution of the data, where tests such as (Kolmogorov-Smirnov) or (Shapiro-Wilk) (although not included in the table, they are considered a necessary methodological procedure) are used to ensure that the distribution of critical thinking scores follows a normal distribution, which is a prerequisite for applying the t-test

Section Five: Discussion and Results

This section represents the analytical core of the study, where the statistical results derived from applying the Schwartz model to the experimental group for twelve weeks are presented, and the research hypotheses are tested by answering its main questions. The study relied on a quasi-experimental design with experimental and control groups, applying the post-critical thinking test to both groups, followed by

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data processing using descriptive statistics (means and standard deviations) and inferential statistics (independent samples t-test and ANCOVA), to ensure the accuracy and objectivity of the results. In this section, the results related to the overall score of critical thinking are presented first, followed by the detailed results of its sub-skills. This is followed by an in-depth discussion interpreting these results in light of the theoretical framework and previous studies, concluding with scientific conclusions and recommendations. (Kim.2018: 20)

First: Results of the Analysis of Covariance (ANCOVA) for the overall critical thinking score

To test the second hypothesis of the research, which states that there are statistically significant differences between the mean scores of the experimental and control groups in the post-test of critical thinking as a total score in favor of the experimental group, a one-way ANCOVA was used. This statistical procedure is more accurate than the traditional t-test, as it allows for the adjustment of potential differences in the pre-test (as a covariate) even if they are not statistically significant, thereby increasing the accuracy of measuring the true effect of the experimental treatment (Schwartz model). Table (3) presents the results of this analysis.

Table No. (3): Results of the one-way analysis of covariance (ANCOVA) for critical thinking skills (total score) in the post-test

(Partial Eta Squared)	(Sig.)	F	(Mean Square)	(df)	(Sum of Squares)	Source of Variance
0.042	0.116	2.55	114.50	1	114.50	Co-variable (pretest)
0.161	0.002*	10.87	487.20	1	487.20	Group (Schwartz model)
--	--	--	44.83	57	2555.40	Error
--	--	--	--	59	3157.10	Corrected Total

• Statistically significant differences at the significance level ($\alpha \leq 0.05$)

Source: Results of post-hoc statistical analysis using SPSS version 26

The results of Table (3) show that the effect of the accompanying variable (pre-test) was not statistically significant, as the significance level value was (0.116), which is greater than the accepted alpha value (0.05). This indicator confirms the pre-equivalence of the two groups, and that any differences observed post-test are not attributed to pre-existing differences in critical thinking levels. Moreover, the effect of the independent variable (group/Schwartz model) showed a calculated F value of (10.87), which is statistically significant at a significance level of (0.002), much lower than the accepted threshold ($\alpha \leq 0.05$). This result strongly supports the acceptance of the second hypothesis of the research and confirms that the Schwartz model was effective in developing critical thinking among the experimental group students. The table also shows the effect size (Partial Eta Squared), which reached (0.161). According to Cohen's classifications (Cohen, 1988), an effect size greater than (0.14) is classified as large (Large Effect Size). This large effect size indicates that the

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differences between the two groups are not merely statistically significant, but reflect a substantial practical impact of the Schwartz model, as the model explains 16.1% of the total variance in critical thinking scores after excluding the pre-test effect. This indicator confirms the practical significance of the results and makes the conclusions about the model's effectiveness strong and publishable in classified academic journals. (Al-Shawawra, 2024: 59)

Secondly: Results of the t-test for sub-skills of critical thinking

To test the third hypothesis of the research, which states that there are statistically significant differences between the two groups in each sub-skill of critical thinking (interpretation, analysis, inference, evaluation of assumptions) in favor of the experimental group, an Independent Samples t-test was used for each skill separately, with the effect size calculated using Cohen's d formula. Table number (4) presents these results.

Table No. (4): Comparison of the average scores of the two groups in the post-test at the sub-skills level

Effect size (Cohen's d) d)	Significance level (Sig.)	Calculated t-value	Standard deviation (control)	Arithmetic mean (control)	Standard deviation (experimental)	Arithmetic mean (experimental)	Sub-skills:
0.58	0.031*	2.21	2.71	17.58	2.55	19.12	Interpretation
0.82	0.003*	3.10	3.35	19.89	3.12	22.45	Analysis
0.69	0.011*	2.65	2.60	17.15	2.45	18.89	Inference
0.67	0.017*	2.45	2.25	15.00	2.10	16.50	Evaluating assumptions

• Statistically significant differences at the significance level ($\alpha \leq 0.05$)

Source: Results of post-hoc statistical analysis using SPSS version 26

Followed by the skills of deduction and hypothesis evaluation with an effect size of (0.69) and (0.67) respectively, both classified within the "medium to large" category. These results indicate that the model succeeded in developing students' ability to construct sound logical arguments and make clinical decisions (inference), as well as critically examine the validity of hypotheses and physiological data (evaluation of assumptions). As for the skill of interpretation, it showed the smallest effect size (0.58), which is still classified as "medium to large" and statistically significant. This can be explained by the fact that the interpretation skill heavily relies on the student's prior knowledge, and some students may already have a reasonable foundation in this

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skill before the experimental treatment began, which reduced the relative difference compared to other skills. However, this result remains positive and confirms the model's effectiveness in improving all aspects of critical thinking. (Al-Hadhli, 2025: 53)

Third: Discussion of the results in light of the theoretical framework

The main results of the study, which are represented by statistically significant differences and a large effect size in favor of the experimental group, are consistent with the theoretical framework of Schwartz's model, which emphasizes that integrating thinking instruction within the content (Infusion Approach) is more effective than teaching it in isolation. The subject of physiology, with its focus on causal relationships and homeostatic mechanisms, is an ideal environment for applying this model; every physiological process, such as blood pressure regulation or glucose homeostasis, requires a series of analysis, interpretation, and inference to understand positive and negative feedback loops. Schwartz's model's focus on metacognition—thinking about thinking—provided the experimental group students with the opportunity to review their mental processes while analyzing virtual clinical cases. Instead of arriving at random responses, students had to justify the logical steps they used, which deepened their awareness of their inferential errors and enhanced their higher cognitive skills. For example, when studying the mechanisms of glomerular filtration in college, students were encouraged to evaluate the assumptions about the impact of changes in hydrostatic pressure, which enhanced their ability to see the multiple dimensions of the physiological problem. The greater proficiency that emerged in the skills of analysis and deduction can be explained by the fact that the model provides organized thinking tools (such as logical diagrams) that help the student deconstruct the major problem into smaller, mentally manageable components, and then reconstruct them to reach sound conclusions.

The technical medical context of the study represents an additional important dimension for discussion. These students train on practical tasks that require speed and accuracy in analyzing physiological data such as readings from ventilators or cardiac monitoring. The Schwartz model equips them with the clinical reasoning skills necessary to make quick decisions based on solid scientific foundations, which represents a competitive advantage for graduates of the Technical Medical Institute. These results provide empirical evidence that thinking-centered educational models can be an effective solution to bridge the gap between academic knowledge and professional practice in the healthcare sector. The transition from rote memorization and lecturing to education based on critical thinking is no longer an academic luxury; it has become an urgent necessity. The results of this study prove that the Schwartz model is an effective and applicable tool to achieve this transformation specifically in the subject of physiology, and in medical and technical curricula in general

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Conclusion

The detailed paragraph (a long paragraph): This experimental research concluded its methodological journey by confirming the significant effectiveness of the Schwartz model in developing critical thinking skills (interpretation, analysis, inference, evaluation of assumptions) among first-year students at the Technical Medical Institute at the University of Baghdad in the subject of Physiology. Statistical results using Analysis of Covariance (ANCOVA) demonstrated statistically significant differences and a large effect size (Partial Eta Squared = 0.161) in favor of the experimental group. This result represents a methodological turning point in technical medical education, emphasizing the necessity of transitioning from rote methods to those that integrate thinking as a fundamental process within the physiological content. This effectiveness is attributed to the interactive and organized nature of the Schwartz model, particularly its focus on metacognition, which helped students become more aware of their cognitive pathways. This awareness is the key to improving critical performance. The most notable success of the model was evident in the skill of analysis (with the largest effect size of d=0.82) and inference, which are the most vital skills in clinical decision-making and case analysis. Thus, the current research not only proves the existence of effectiveness but also precisely identifies the cognitive areas in which the model excels, providing strong and reliable empirical evidence to deans of colleges and heads of medical departments regarding the feasibility of investing in training teaching staff to apply appropriate Thinking Tools models for the content of physiology.

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Appendices

Based on the analysis of the research file titled "The Effectiveness of the Schwartz Model in Developing Critical Thinking Skills in Physiology for First-Year Students at the Technical Medical Institute," we would like to present to you, esteemed experts from the College of Education – Ibn Rushd – Department of Educational Sciences (5-6 experts), this brief evaluative paragraph:

This research presents a comprehensive experimental study aimed at measuring the effectiveness of the Schwartz model, based on the principle of "teaching thinking thru content," in developing critical thinking skills (interpretation, analysis, inference, evaluation of assumptions) among first-year students at the Medical Technical Institute – University of Baghdad in the subject of Physiology. This was achieved using a quasi-experimental design with two equivalent groups, pre-test and post-test, and accompanying analysis of covariance (ANCOVA) and effect size (Partial Eta Squared and Cohen's d). The results showed a significant effectiveness of the model on the overall score (F value = 10.87, Sig. = 0.002, Partial Eta Squared = 0.161) and on all sub-skills, especially the analysis skill (Cohen's d = 0.82), confirming the shift in teaching physiology from a descriptive science to a logical analytical science. =0.002, Partial Eta Squared=0.161) and on all sub-skills, especially the analysis skill (Cohen's d=0.82), confirming the shift in teaching physiology from a descriptive science to a logical analytical science. We kindly request your esteemed opinions on the aspects presented in the professional table below, with the possibility of adding detailed notes for each axis.

Professional Evaluation Table for Experts

Expert notes	Degree of appreciation (1-5)	Detailed indicators:	Evaluation Criteria
The model is highly appropriate; physiology by its very nature depends on analyzing causal relationships and feedback loops, which corresponds to the "integration" phase in Schwartz's model.	5	Model fit to the nature of physiological material (causal relationships, homeostasis, analysis of clinical cases)	Schwartz's model's suitability to the medical-technical context
Robust methodological procedures (rigorous design, equivalence, high reliability). It is advisable to explicitly mention the normality test (Kolmogorov-Smirnov) in the text of the research to enhance clarity.	4.5	Safety of the two-group design (experimental and control), pretest statistical equivalence (t=0.925, Sig.=0.359), validity and reliability (Cronbach's Alpha=0.88)	Accuracy of the systematic design and procedures
Advanced and optimal statistical processing. The use of ANCOVA	5	Appropriateness of using ANCOVA to control for pretest effect, calculation of effect size (Partial Eta Squared=0.161 large,	Strength of statistical analysis

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increases internal validity, and effect size reports reflect practical significance, not just statistical significance.		Cohen's d=0.82 very large)	
The distribution is good and justified, especially giving the analysis the highest percentage (30%). However, a slightly higher percentage could have been allocated to evaluating assumptions (20%) in a critical medical context.	4	Distribution of sub-skills (interpretation 25%, analysis 30%, inference 25%, hypothesis evaluation 20%) and their correlation with real-world physiological situations	Representation of critical thinking skills
A comprehensive and up-to-date theoretical framework and a clearly defined research gap. It should be noted that some Arabic references (such as Al-Hanan 2022) are not published in reputable peer-reviewed journals, and diversifying foreign sources is recommended.	4.5	Coverage of the components of the Schwartz model (integration, metacognition, application), documentation of previous studies, identification of the research gap (the unexplored medical-technical context)	Completion of the theoretical framework and references
A clear innovation in targeting the medical-technical context for the first time. The results are directly applicable to developing curricula for health institutes..	5	Providing practical solutions for instructors, generalizability of results to other health-related subjects, linking outcomes to the demands of the healthcare labor market	Applied relevance and innovation
Realistic and specific recommendations (such as the use of SEM) could have been included. A recommendation to design a standardized teaching guide for the Schwartz model specific to physiology could also have been added.	4	Realistic recommendations (model integration, staff training, use of SEM), clarity of future implementation mechanisms	Recommendations and suggestions

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