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Effectiveness of Integrating the 5E's Learning Cycle Strategy and Stepans' Conceptual Change Model in Enhancing Second-Grade Students' Acquisition of Scientific Concepts and Habits of Mind

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ABSTRACT: The study aims to investigate the effectiveness of integrating the 5E's Learning Cycle Strategy and Stepans' Conceptual Change Model to acquire scientific concepts and develop the habits of mind among second-grade students in Jordan. A quasi-experimental design was employed on 49 second-grade students (male and female) from Al-Hijaz School in Qasaba Amman Directorate during the first semester of the 2024/2025 academic year. The students were randomly assigned into an experimental group (24 students) and a control group (25 students). A teacher's guide for the unit "Interaction of Organisms and the Environment" from the second-grade science textbook was prepared based on the integrated strategy to achieve the study's objectives. In addition, an acquisition test of scientific concepts of 17 multiple-choice questions and a habits-of-mind scale with 24 items were developed, and then their validity and reliability were checked. The results demonstrate the effectiveness of the integrated strategy combining the 5E's Learning Cycle Strategy and Stepans' Conceptual Change Model in acquiring scientific concepts and habits of mind among second-grade students compared to the control group. The study recommends adopting the integrated strategy in science education across all educational stages.

Keywords: integration, 5E's learning cycle strategy, Stepans' conceptual change model, acquisition of scientific concepts, habits of mind.

I. INTRODUCTION

The modern era is characterized by its rapid progress in scientific and technological aspects in all areas of life. The world, including Jordan, is witnessing rapid advancements in education particularly in the field of science, requiring the educational process to accelerate its procedures to bridge the academic gap for learners. This entails connecting the scientific and skill-related aspects and equipping learners with abilities and the habits of mind that enable them to adapt to the transformations occurring in continuous and rapid science and technology. Academic achievement for students is achieved through acquiring thinking skills, which leads to practicing the habits of mind to face the demands of adaptation, societal development, and life challenges.

The most important goal of curricula is to enhance a deep understanding of scientific concepts. To achieve this goal, the active participation of the learner in the learning process is essential, along with providing learners with opportunities to connect new concepts with their prior knowledge and to link their understanding of new scientific concepts with their daily practices [1-2].

Science plays a significant role in the progress of nations and civilizations, providing students with scientific concepts and knowledge in all areas of life. It also equips them with thinking skills and the ability to solve problems, essential for advancing various aspects of individual and societal life. Hence, attention must be given to the depth of knowledge and the guided selection of scientific material. Teaching science requires the practice of learner-centered teaching strategies to develop their intellectual capabilities and thinking skills by integrating life-related scientific concepts with those included in science textbooks. The constructivist theory has offered solutions for educational reform movements through learner-centered strategies and teaching methods to build their personality and correct attitudes.

Both developing and developed societies have worked on improving methods and approaches to teaching science and developing content, educational tools, and evaluation methods, and the teachers teaching science, based on their belief in the importance and role of science in the advancement of nations [3]. Education aims to bring about a fundamental change in learners' lives, which can be achieved by providing appropriate and desired learning experiences. Suitable learning experiences and the desired changes in learners are achieved through the teaching and learning process. Teachers should select appropriate teaching strategies, methods, and techniques to facilitate the delivery of scientific concepts to the learner.

Science teaching strategies and methods work efficiently and achieve their goals if they align with learners' needs. Many teaching methods and strategies have been developed to ensure effective content delivery by teachers and an easy and purposeful understanding of scientific concepts by students. One of the major educational problems may result from the difficulty of learning the scientific concepts in science textbooks across various educational stages, as these concepts require deep intellectual effort from learners, as well as more precision and scientific accuracy. Therefore, finding developed and modern methods and techniques that achieve positive interaction for the learner and help them acquire scientific concepts that can be applied in their daily lives is crucial. The primary stage is a critical phase for forming scientific concepts among the most important pillars of a learner's cognitive structure. This stage allows for organizing concepts and enabling the learner to explore the world around them meaningfully [4].

Scientific concepts hold great importance in all educational stages, as they represent the language of scientists and the key to scientific knowledge. This necessitates creating sustainable educational environments for learning these concepts through teaching methods and techniques that contribute to building and forming scientific concepts for primary-stage students. The goal of teaching science is to build learners' personalities capable of thinking, analyzing, and interpreting. Thus, it is incumbent upon those responsible for education to exert more effort in preparing learners capable of thinking and possessing thinking skills, ensuring they develop proper the habits of mind. Developing learners' habits of mind to enable them to listen attentively and persistently strive for self-comprehension in educational situations, applying their knowledge to various life situations, thinking flexibly, and working with enjoyment. This would develop their knowledge of mental processes, such as remembering, classifying, reasoning, generalizing, experimenting, and evaluating [5].

Mind habits are "an often unconscious pattern of behavior acquired through repetition, thereby being established in mind." Perkins views them as patterns of intelligent individual performance that lead to productive actions. The practice of the habits of mind occurs after learners have developed a complete cognitive pattern, which they repeatedly and automatically practice without effort, with scientific mental control and contextual management to achieve specific and clear cognitive and intellectual outcomes" [6, p. 95]. Costa and Kallick [5] mentioned sixteen the habits of mind, including persistence, managing impulsivity, listening with understanding and empathy, thinking flexibly, thinking about thinking, striving for accuracy, questioning and posing problems, applying past knowledge to new situations, thinking and communicating with clarity and precision, gathering data through all senses, creating-imagining-innovating (renewal), responding with wonderment and awe, taking responsible risks, finding humor, thinking interdependently, and continuous learning. Eight habits were addressed in this study for their suitability to the age stage, as these habits are easily measurable among learners in the academic stages, based on previous studies addressing these habits, such as [7].

Modern educational methods based on the constructivist theory advocate for forming the habits of mind as a main goal in all education stages, starting from primary education. Neglecting to employ thinking skills and use productive habits of mind causes significant shortcomings in the educational process outcomes. The habits of mind involve knowing how to work on and use them, not just possessing information. They are intelligent behavioral patterns that help and guide the learner to produce knowledge, critique it, and reproduce it based on prior patterns [8].

Curricula focusing on students are based on constructivist theories and emphasize active and effective participation of learners in constructing their knowledge through interaction and engagement with their peers, which is formed through their experiences in the environment. Since the early 1980s, constructivist theory has had a significant impact on education in general and science education in particular, as well as on educational policies and classroom practices, becoming a standard for effective teaching. Many countries emphasize the use of various constructivist curricula, as constructivist teaching methods focus significantly on learners, promote collaboration among students, and enhance their academic achievement. One of the approaches that enhance learning through practical and mental activities is the learning cycle in all its forms (3E, 4E, 5E, 7E, and 9E). Karplus and colleagues were among the founders of the learning cycle, which was designed to provide students with inquiry methods and engage them in the educational process while learning. It helps improve students' learning skills over time [9].

The learning cycle is a teaching strategy based on inquiry, aiming to enhance learning through investigation and practical activities by sequencing teaching in phases. Bybee and a team of science curriculum researchers developed the 5E's 5E Learning Cycle (Engagement, Exploration, Explanation, Elaboration, Evaluation) [10]. Each phase serves a function, paves the way, and connects to the subsequent phase to complete the learning cycle and organize the knowledge acquired by students. The 5E's Learning Cycle is the most common in teaching and learning processes. In the engagement phase, teachers can discover what students already know, including misconceptions. This phase should also be used to enhance students' motivation, so they develop a deeper desire to learn more about the issues to be discussed. The exploration phase provides students with direct experiences to investigate scientific concepts and engage in activities that generate investigative ideas. This step aims to facilitate students' understanding of the scientific principles underlying the concepts. In the explanation phase, students are allowed to demonstrate their conceptual understanding of the scientific principles they are dealing with. Teachers are expected to guide learners to derive meaning from their discoveries and address inconsistencies in their arguments.

The fourth phase, elaboration provides students with additional opportunities to improve their understanding of the scientific concepts under discussion. Students also can conduct further investigations at this stage. The evaluation phase aims to provide students with a means to assess their learning. Assessment can be conducted by the teacher, or the entire class can evaluate each student. Many studies have confirmed the effectiveness of the learning cycle in teaching scientific concepts, enabling learners to explore concepts through activities, exchange ideas, and ensure comprehension of scientific concepts [11].

Another strategy derived from the constructivist theory, which expands learners' knowledge, focuses on knowledge construction and problem-solving, and enables them to research and investigate to correct misconceptions related to the scientific concepts of the study topic, is the Conceptual Change Model by Stepans. This strategy makes science learning meaningful, requiring learners to collect and reorganize their misconceptions, enabling them to absorb, correct, and represent new concepts. The Stepans' Conceptual Change Model consists of the following stages: focusing on outcomes, presenting beliefs, confronting beliefs, representing the concept, expanding the concept, and going beyond the concept. One of the positives of the Stepans' Conceptual Change Model is that it enhances learners' enthusiasm for learning, provides opportunities for interaction with peers, and offers immediate opportunities to address their learning experiences [12].

It is essential to develop science teaching strategies that align with modern advancements, given the pivotal role of science in progressing societies and the increasing demand for specialized scientists, who represent the true future investment. Preparing learners scientifically, in accordance with modern teaching strategies, has become imperative.

Considering developments in the educational process and the pressing need to respond to emerging visions and theories in the education field, empowering the educational process to shape the learner's personality in a manner consistent with societal development paths necessitates focusing on modern scientific methods and strategies. These strategies should be capable of keeping pace with scientific advancements, fostering thinking skills, and equipping learners with the habits of mind.

Many educations experts advocate integrating teaching strategies as integration can achieve multiple objectives. This includes equipping learners with accurate scientific concepts, enhancing their achievement through practicing inquiry, and rectifying misconceptions about scientific concepts [13].

In light of the above, the learning cycle in teaching is considered a good application of Piaget's cognitive development theory, which encompasses educational ideas such as learning is an active process carried out by the individual themselves. Learners experiment, explore, and search for knowledge on their own and compare their findings with the results reached by their peers. As a result of extensive research and studies, this method has gained significant fame in teaching science.

The learning cycle is a method of learning and teaching where students engage in inquiry that leads to learning, as advocated by proponents of constructivist theory. Jean Piaget's research on cognitive development contributed to the creation of the first two phases of the learning cycle: exploration and explanation (concept attainment).

The learning cycle is distinguished from other teaching methods by taking into account the cognitive abilities of learners. It only presents concepts the learner can understand and introduces science as a method of inquiry, moving from parts to the whole. This aligns with the learner's nature, which relies on inductive methods when learning new concepts. It encourages the learner to think by employing the concept of disequilibrium, which serves as the main driver toward seeking more scientific knowledge. The approach also focuses on developing thinking and work-related skills in line with how students learn, offering an excellent framework for effective science teaching and planning.

Additionally, the Conceptual Change Model proposed by Stepans emphasizes meaningful learning in science. It requires the learner to gather, reorganize, or replace misunderstandings to grasp and internalize new ideas.

Stepans' model for conceptual change involves six stages designed to bring about conceptual transformation in the learner through the following steps:

- Engagement with outcomes: Students become aware of their thinking by answering a question, solving a problem, or addressing a challenge.
- Presentation of beliefs: Students share and discuss their ideas, expectations, and justifications with peers before examining their ideas further.
- Confronting beliefs: Students confront their current beliefs through collaborative experiences that challenge their preconceptions, involving hands-on activities, data collection, and consulting resources.
- Concept representation: Students represent a new concept, perspective, or skill by summarizing, discussing, debating, and internalizing the new information.
- Concept expansion: Students connect between the new concept or skill and other ideas or situations.
- Beyond the concept: Students raise new questions, ideas, and problems, pursuing them further.

Stepans' Conceptual Change Model, derived from constructivist theory, aims to correct misconceptions and instill accurate concepts in students. This model is important because it fosters students' enthusiasm for learning, encourages peer learning, and provides immediate opportunities to process learning experiences. It also supports students with different learning styles.

The researcher suggests integrating the 5E's Learning Cycle with Stepans' Conceptual Change Model through stages such as engagement and stimulation, commitment to outcomes, confronting beliefs and exploration, interpretation and concept representation, expansion, and assessment. This integration emphasizes awareness and acknowledgment of students' prior perceptions of new scientific concepts, as well as the connection between prior knowledge and new learning [14]. These combined strategies can enhance the acquisition of scientific concepts by developing students' cognitive structures, particularly for early-grade students. It provides opportunities for them to learn through cooperative learning, sharing ideas with peers, and developing discussion and dialogue skills—critical objectives at this developmental stage that can be achieved through science education.

Given the challenges Jordanian students face due to traditional teaching methods used in science by early-grade teachers, despite curriculum reforms since 2003, international assessments like PISA indicate a decline in Jordanian students' science performance. Developing scientific concepts and cognitive habits cannot be achieved overnight; it requires establishing these foundations from the early grades.

In light of the above, it is essential to adopt modern teaching strategies for teaching science. These strategies help learners acquire scientific concepts, develop their thinking skills, form the habits of mind, and integrate acquired scientific knowledge. Accordingly, this study aims to explore the effectiveness of a strategy that combines the 5E's Learning Cycle Strategy with the Conceptual Change Model by Stepans in developing scientific concept acquisition and the habits of mind among second-grade primary school students.

1. STATEMENT OF THE PROBLEM

The results from the Jordanian National Report on the International Study of Mathematics and Science for 2019 (TIMSS, PISA, 2019) highlighted the necessity of re-evaluating the educational system and developing curricula across all education stages. The aim is to empower teachers to instruct and educate their students effectively, focusing not only on lower cognitive levels (knowledge, recall, and understanding) but also on higher-order thinking skills (application, analysis, synthesis, and evaluation), ultimately fostering sound the habits of mind. The report calls on decision-makers to address this issue, take necessary actions to halt the decline, and improve students' performance and progress [15].

The problem of this study stems from the low achievement and poor performance of learners in science across most educational levels, along with their noticeably low proficiency in higher-order cognitive abilities and evident weaknesses in conceptual understanding. This decline may be attributed to some teaching methods and strategies employed in schools that rely heavily on rote learning, neglecting the role of learners in acquiring scientific knowledge and concepts and developing the habits of mind.

This result has been confirmed by previous studies, such as those by [16] and [17]. It has garnered significant attention from researchers in many developing countries seeking to mitigate its effects. The decline may be due to traditional science teaching methods that fail to engage students in thinking skills, leading to weak the habits of mind and an inability to cope with modern challenges and life skills.

The researcher observed that students, particularly, struggle with acquiring scientific concepts, thinking skills, and the habits of mind. These factors collectively prompted the researcher to explore the impact of a strategy that integrates the 5E's Learning Cycle Strategy with Stepans' Conceptual Change Model on acquisition of scientific concepts and the development of the habits of mind among second-grade students in science.

2. RESEARCH QUESTIONS

This main question branches into the following sub-questions:

1. What is the effectiveness of integrating the 5E's Learning Cycle Strategy and Stepans' Conceptual Change Model in enhancing second-grade students' acquisition of scientific concepts?
2. What is the effectiveness of integrating the 5E's Learning Cycle Strategy and Stepans' Conceptual Change Model in enhancing second-grade students' habits of mind?

3. RESEARCH HYPOTHESES

1. There are no statistically significant differences at (∝=0.05) between the mean scores of second-grade students in the experimental and control groups on the acquisition of the scientific concepts attributable to the teaching method (a strategy integrating the 5E's Learning Cycle Strategy with Stepans' Conceptual Change Model versus traditional methods).
2. There are no statistically significant differences at (∝=0.05) between the mean scores of second-grade students in the experimental and control groups on the habits of mind scale attributable to the teaching method (a strategy integrating the 5E's Learning Cycle Strategy with Stepans' Conceptual Change Model versus traditional methods).

4. SIGNIFICANCE OF THE STUDY

This study derives its theoretical importance from the following areas:

- The Importance of Science in Enhancing acquisition of the scientific concepts: Science plays a key role in effectively utilizing knowledge across various academic fields, especially in the different educational stages. It helps equip students with life skills and enhances their thinking abilities and the habits of mind, particularly in the first three grades.
- Providing a Theoretical Framework: The study provides a theoretical background on the study variables (a strategy integrating the 5E's Learning Cycle Strategy with Stepans' Conceptual Change Model, scientific concepts, and the habits of mind), which can serve as a reference for researchers and scholars.
  Providing Research Tools: The study offers standardized research tools for the acquisition of the scientific concepts and developing the habits of mind among students. Its results will contribute to the field of curricula and science teaching methods.

In addition, this study derives its practical importance from the following points:

- Improving Students' Achievement in Scientific Concepts: The study could help improve students' understanding and acquisition of scientific concepts in the first three grades.
- Supporting Teachers in Adopting Modern Teaching Methods: It may assist teachers in the first three grades in applying modern science teaching methods that integrate the 5E's Learning Cycle Strategy with Stepans' Conceptual Change Model, and in effectively implementing them in the classroom.
- Encouraging Similar Field Studies: The study could lead to similar field studies in this area across different educational stages.

5. STUDY DELIMITATIONS AND LIMITATIONS

- Topic: The study focuses on using a strategy that integrates the 5E's Learning Cycle Strategy with Stepans' Conceptual Change Model to enhance students' understanding of scientific concepts from the unit "Interaction of Living Organisms in the Environment" in the second-grade science textbook (2021-2023 edition), and to develop the habits of mind in science for second-grade students.
- Human: The study was conducted with second-grade students from Al-Hijaz School in the Directorate of Special Education / Amman.
- Time: The study was applied during the first semester of the 2024-2025 academic year.
- Geography: The study was conducted at Al-Hijaz School in the Directorate of Special Education / Amman.
- Generalizability of Results: The study findings will be generalized based on the validity and reliability of the study tools.
- The generalization of the results of this study is determined in light of the validity and reliability of the study tools and the psychometric properties they possess.

6. KEY TERMS OF THE STUDY

- A strategy integrating the 5E's Learning Cycle Strategy and Stepans' Conceptual Change Model: This is an educational strategy consisting of several stages: (1) engagement and stimulation, (2) commitment to outcomes, (3) confronting beliefs and exploration, (4) interpretation and concept representation, (5) expansion, and (6) assessment. In this study, the unit "Interactions of Living Organisms in the Environment." for second-grade science was designed and implemented based on these six stages, providing students with opportunities for research and inquiry while ensuring that their prior scientific concepts are acknowledged.
- Scientific Concepts: Al-Huwaidi [11] defined it as the building unit of science content and the abstract idea of something with a mental image. Procedurally, scientific concepts are defined as the understanding and meaning formed in second-grade students' minds, related to a term, phrase, or specific process during their study of the first chapter of the science textbook on the unit "Interactions of Living Organisms in the Environment." The extent of students' acquisition of scientific concepts is measured by the achieved score on a specially designed scientific concepts test.
- Habits of mind: These are a set of skills, values, and attitudes that provide the learner with the opportunity to create preferences through a range of intelligent behaviors. They rely on a series of stimuli and responses learners encounter, guiding them in selecting a mental process or behavior to respond effectively to a particular situation or problem. The habits of mind support sustained engagement thoughtfully and intelligently [18, pp. 299]. According to [5], the habits of mind are consistent patterns of behavior the mind uses when encountering daily life situations, reflecting intelligent and rational conduct. Operationally, the habits of mind are the selected skills from second-grade students related to cognitive processes in educational contexts while studying the "Interaction of Living Organisms in the Environment" unit in science. The score they receive on the habits of mind scale developed for this study, is used to measure this construct.
- Second-grade students: The students, aged between 7 and 8 years, are enrolled in the first semester of the 2024/2025 academic year at Al-Hijaz School in the Directorate of Special Education in Amman.

II. THEORETICAL FRAMEWORK

Constructivist theory is one of the educational theories aimed at helping students build their knowledge and perceptions independently, as well as acquiring diverse thinking skills and positive attitudes toward learning. This theory focuses on what happens during the learner's thinking process and inside their mind when they encounter educational situations, and their ability to process information, which makes learning meaningful for students by constructing concepts and bringing about changes in their cognitive structure, thus generating knowledge in the learner [19-20]. Many studies have been conducted on the effectiveness of constructivist teaching methods on student learning. Several studies related to the Learning Cycle model have shown that Learning Cycle curricula help students improve academic achievement [21]; critical thinking skills [22-23]; and science process skills [24, 25, 26].

Some studies, such as those by [27, 28, 29, 30], have highlighted the significant impact and effectiveness of the Learning Cycle, which is based on constructivist theory, in increasing students' achievement in science. It helps in forming correct scientific concepts by enabling students to discover and correct their misconceptions, in addition to modifying their attitudes toward science. This, in turn, leads to the development and enhancement of critical thinking skills in students studying science.

A study by [31] was conducted at the Savis School in Turkey. The study aimed to investigate the effect of the 5ES model supported by concept change texts on the achievement of fifth-grade students in relation to heat concepts. A quasi-experimental method was used in the study, with a sample consisting of 42 students. The students were randomly divided into two groups: the experimental group, which was taught using the 5E's model supported by concept change texts, and the control group, instructed using the traditional method. The study results showed statistically significant differences in concept modification related to the topic of heat, with the experimental group showing better results.

Al-Suwailmeen's [32] study aimed to determine the effectiveness of teaching using the 5E's Learning Cycle Strategy in developing science thinking skills among eighth-grade students in Jordan. A thinking skills test consisting of 37 items was applied to a sample of 60 eighth-grade students, who were randomly assigned to an experimental group and a control group. The results revealed a statistically significant difference between the mean scores of the two groups in favor of the experimental group. The study recommended the 5E Learning Cycle Strategy in teaching science and training teachers on its application.

Saavedra, Näslund, and Alfonso's [33] study investigated the impact of the 5E's model on third-grade students in low-income areas in metropolitan Lima across 48 schools. Students were divided into two groups to receive inquiry-based science education. The results showed a 3% increase in science achievement.

Parveen's [34] study aimed to explore the effect of the 5E's model on students' academic achievement and scientific attainment. Students were divided into control and experimental groups, and the results demonstrated the effectiveness of the 5E's model in the post-test on scientific knowledge and students' abilities.

Al-Musha'alah and Al-Qadri's [14] study aimed to investigate the effect of using a strategy based on the integration of the 5E's Learning Cycle and the Conceptual Change Model by Stepans on acquiring life science concepts among first-year secondary school female students, in light of their motivation toward science. The study used a quasi-experimental design, with a sample of 75 female students from Sakeena Secondary School for Girls in Amman. The students were randomly assigned to two groups: an experimental group and a control group. The study results indicated statistically significant differences between the mean scores of the two groups on the concept acquisition test, favoring the experimental group, which was taught using the integrated strategy.

Ikramettin [35] investigated the effect of using a teaching strategy based on the 5E's Learning Cycle, enriched with Conceptual Change texts and collaborative learning, on academic achievement and motivation toward science. The study followed a quasi-experimental design. The sample consisted of 84 seventh-grade students in Turkey, divided into three teaching groups. The first group was taught using the 5E's Learning Cycle, the second group studied with the 5E's Learning Cycle supported by Conceptual Change texts, and the third group followed the traditional teaching methods. The study tools included an academic achievement test (SAT) and a motivation scale. The results indicated no statistically significant differences in the students' academic achievement and motivation toward science, attributed to the teaching strategy used.

Çepni, Şahin, and Ipek [13] measured the effect of integrating the 5E's Learning Cycle Strategy and the Conceptual Change Model on acquiring scientific concepts related to the principle of buoyancy in Giresun, Turkey. The sample consisted of two groups, randomly divided into a control group (23 students) in the eighth grade taught using the 5E Learning Cycle and an experimental group (25 students) taught using the 5E's Learning Cycle Strategy combined with the Conceptual Change Model. The study's results showed statistically significant differences between the control and experimental groups, with the experimental group performing better in analyzing information, acquiring new concepts, and changing their alternative concepts.

Al-Jufri [16] examined the effect of using strange images and creative idea diagrams in teaching science on developing cognitive achievement and the habits of mind among first-year intermediate female students in Mecca. The science material was enriched with images and diagrams of creative ideas. The study tools included a cognitive achievement test and a scale for eight the habits of mind. The study sample consisted of 84 students, with 42 students in each group. The study concluded that there were statistically significant differences in favor of the experimental group between the mean scores of the control group and the experimental group in the post-test application of the "cognitive achievement and the habits of mind" scale at all targeted cognitive levels and the habits of mind.

This study is considered an extension of previous research and shares similarities with some prior studies, such as the studies by [31] and [33]. These studies are similar in terms of the sample and age group of the students, focusing on lower elementary school students. However, there are significant differences, as these studies addressed only the 5E's model, whereas the current study integrates the 5E's model with Stepans' Conceptual Change Model. Additionally, this study differs from the studies by [13, 16, 35] regarding the study sample and the age group of the students, as those studies focused on an older age group compared to the current study. This study is considered an extension of previous studies. There are similarities between it and some of the earlier studies in certain variables, with notable differences in important aspects. These include the study's aim, which is to identify the effectiveness of integrating the 5E's Learning Cycle Strategy and Stepans' Conceptual Change Model in the acquisition of scientific concepts, as well as the habits of mind among second-grade students in Jordan, specifically in teaching the unit on the interaction of living organisms in the environment from the science textbook.

This age group was chosen because it represents a critical stage for forming scientific concepts during science learning. Integrating the 5E's model with Stepans' Conceptual Change Model can improve second-grade students' acquisition and development of scientific concepts while enhancing their cognitive habits and thinking skills. The findings of studies such as [31, 33] highlight the effectiveness of the 5E's model for this age group in improving student learning. Moreover, the results of Jordanian students in the overall ranking of the 2022 PISA test placed Jordan 75th out of 81 participating countries. This weak performance is attributed to the decline in Jordan's performance in the three test domains (reading, mathematics, and science). Thus, it is essential to emphasize teaching science from the first three grades. For this reason, the second grade was selected for this study.

A clear difference lies in the study sample, as it also includes the university and secondary school levels, similar to the study by [14]. However, no studies show the impact of integrating the 5E's Learning Cycle and Stepans'

Conceptual Change strategies in the acquisition of scientific concepts and the habits of mind together for any educational stage, whether in the Arab or Jordanian context. This uniqueness distinguishes this study from others and contributes to its originality and significance.

Through research and investigation, the researcher found that no similar study has been conducted in Jordan or the Arab world. This motivated the researcher to carry out this study in Jordan to explore the integration of the 5E's Learning Cycle and Stepans' Conceptual Change strategies in acquisition of the scientific concepts and the development of the habits of mind among second-grade students in Jordan.

III. METHOD

The quasi-experimental design was used in this study due to its suitability for addressing the research problem and achieving its objectives.

1. STUDY PARTICIPANTS

The study sample consisted of two groups, randomly selected from second-grade students aged between seven and eight years. The total sample size was 49 students from the Directorate of Private Education. One group (24 students) was randomly drawn to represent the experimental group, which learned using the strategy of combining the 5E's Learning Cycle and the Conceptual Change Model by Stepans. The other group (25 students) was selected as the control group, which studied using the traditional method.

2. INSTRUMENT

The researcher developed the following tools to achieve the study's goals:

2.1 Scientific Concepts Test

The test was developed after analyzing the content of the 2021 science textbook for second-grade students, specifically the "Interaction of Living Organisms in the Environment" unit. The initial version of the test contained 17 questions. It was reviewed by university professors to ensure its validity. Consequently, two questions were removed based on the reviewers' feedback, and some items were reworded. The final version of the test consisted of 17 multiple-choice questions, each worth one point.

2.2 Scale of Habits of Mind

The researcher developed this measure based on a five-point Likert scale after reviewing relevant literature and previous studies on measuring habits of mind. The scale consisted of 24 items, distributed across the following dimensions:

Table 1. Dimensions of habits of mind.

Dimensions of Habits of Mind	Item Numbers
Perseverance	1-3
Striving for Accuracy	4-6
Questioning and Problem Posing	7-9
Gathering Data through the Senses	10-12
Thinking Flexibly	13-15
Readiness for Continuous Learning	16-18
Thinking about Thinking	19-21
Controlling Impulsivity	22-24

2.3 Difficulty and Discrimination Indices for the Scientific Concepts Test

The responses of a group outside the study sample (comprising 20 students) were analyzed using the SPSS program to calculate the difficulty and discrimination indices for the test items. The difficulty index for each item was determined by the percentage of students who answered the item incorrectly. The discrimination index for each item was calculated by correlating the item with the total score. Table 2 shows the difficulty and discrimination indices for all the test items.

Table 2. Difficulty and discrimination indices for Scientific Concepts Test.

Item Number	Difficulty Index	Discrimination Index
1	0.55	0.54*
2	0.55	0.58**
3	0.40	0.57**
4	0.55	0.61**
5	0.30	0.49*
6	0.55	0.73**
7	0.50	0.56**
8	0.65	0.60**
9	0.45	0.64**
10	0.45	0.55*
11	0.55	0.48*
12	0.45	0.68**
13	0.35	0.53*
14	0.40	0.55*
15	0.60	0.67**
16	0.55	0.63**
17	0.65	0.58**

*Statistically significant at the 0.05 level. **Statistically significant at the 0.01 level.

It can be seen from Table 2 that the difficulty indices for the items ranged between 0.30 and 0.65, while the discrimination indices ranged between 0.48 and 0.73. Based on the acceptable range for the difficulty index, as noted by [36], which falls between 0.20 and 0.80, and similarly for the discrimination index, an item is considered good if its discrimination index is above 0.39. It is considered acceptable and recommended for improvement if the discrimination index is between 0.20 and 0.39, weak and recommended for removal if the discrimination index is between 0 and 0.19, and negative discrimination items should be removed. Therefore, none of the items were deleted based on their discrimination or difficulty indices.

2.4 Reliability of the Scientific Concepts Test

To verify the reliability of the test, the test-retest method was applied. The test was administered to a different group of 20 students (outside the study sample) after two weeks, and the Pearson correlation coefficient between the scores of the two administrations was calculated, which resulted in 0.89 for the overall test. Additionally, the internal consistency reliability was calculated using the Kuder-Richardson Formula 20, yielding a reliability coefficient of 0.83 for the entire test. These values were considered adequate for this study.

2.5 Construct Validity: Habits of Mind

To establish the scale's construct validity, the correlation coefficients for each item were calculated between the total score, the item's correlation with the domain it belongs to, and the correlation between the domains and the total score. This was done using a pilot sample of 30 students (outside the study sample). The correlation coefficients for the items with the total score ranged between 0.60 and 0.92, and with the domain, they ranged between 0.82 and 0.94. Table 3 below shows these correlations.

Table 3. Correlations between each item, the total score, and related domain.

Item Number	Correlation with Domain	Correlation with Total Score	Item Number	Correlation with Domain	Correlation with Total Score
1	0.83**	0.60**	13	0.90**	0.87**
2	0.94**	0.83**	14	0.88**	0.81**
3	0.91**	0.83**	15	0.91**	0.91**
4	0.93**	0.83**	16	0.83**	0.84**
5	0.94**	0.92**	17	0.89**	0.72**
6	0.91**	0.75**	18	0.92**	0.83**
7	0.83**	0.82**	19	0.91**	0.78**

8	0.94**	0.87**	20	0.82**	0.84**
9	0.90**	0.74**	21	0.89**	0.71**
10	0.93**	0.84**	22	0.87**	0.83**
11	0.88**	0.78**	23	0.85**	0.82**
12	0.90**	0.83**	24	0.85**	0.75**

*Significant at the 0.05 level. **Significant at the 0.01 level.

2.6 Validity of the Construct: Habits of Mind Scale

It should be noted that all the correlation coefficients were acceptable and statistically significant, meaning no items were deleted based on these results. Additionally, the correlation between the domains and the total score, as well as the correlations between the domains, were also calculated. The results are presented in Table 4 below.

Table 4. Correlation coefficients between the domains and the total score.

Domain/Scale	Persistence	Striving for Accuracy	Questioning & Problem Posing	Data Collection with All Senses	Flexible Thinking	Continuous Learning Readiness	Thinking About Thinking	Impulse Control	Habits of mind scale
Persistence	1								
Striving for Accuracy	0.853**	1							
Questioning & Problem Posing	0.837**	0.892**	1						
Data Collection with All Senses	0.872**	0.869**	0.815**	1					
Flexible Thinking	0.886**	0.907**	0.894**	0.893**	1				
Continuous Learning Readiness	0.841**	0.823**	0.734**	0.874**	0.888**	1			
Thinking About Thinking	0.801**	0.797**	0.737**	0.804**	0.817**	0.739**	1		
Impulse Control	0.854**	0.852**	0.786**	0.906**	0.860**	0.776**	0.905**	1	
Habits of mind scale	0.936**	0.943**	0.903**	0.948**	0.963**	0.901**	0.889**	0.934**	1

*Significant at the 0.05 level, **Significant at the 0.01 level

The data in Table 4 indicates that all correlation coefficients are statistically significant and acceptable, suggesting a high degree of construct validity for the habits of mind scale. This reinforces the scale's reliability and validity for measuring the intended constructs.

2.7 Reliability of the Habits of Mind Scale

The test-retest method was employed to verify the reliability of the study tool. The scale was administered to a group of 30 participants from outside the study sample after a two-week interval. Pearson's correlation coefficient was calculated for their scores from both administrations. Additionally, the internal consistency reliability was calculated using Cronbach's Alpha, and the results are presented in Table 5 below.

Table 5. Cronbach's alpha internal consistency and test-retest reliability for the domains and total score.

Domain	Test-Retest Reliability	Internal Consistency (Cronbach's Alpha)
Persistence	0.83	0.77
Striving for Accuracy	0.86	0.85
Questioning & Problem Posing	0.88	0.84
Data Collection with All Senses	0.84	0.82
Flexible Thinking	0.86	0.79
Continuous Learning Readiness	0.82	0.81
Thinking About Thinking	0.85	0.79
Impulse Control	0.82	0.70
Habits of the Mind Scale	0.89	0.85

*Significant at the 0.05 level, **Significant at the 0.01 level

The results indicate that the scale reliability, both in terms of test-retest consistency and internal consistency (Cronbach's Alpha), is acceptable and suitable for this study. The means and standard deviations for the pre-test results of second-grade students in science were calculated according to the group variable (experimental, control) to verify group equivalence. A "t-test" was used to determine the statistical differences between the means, and Table 6 illustrates the results.

Table 6. Means, standard deviations, and t-tests based on the group variable in the pre-test for Scientific Concepts among second-grade students.

Group	N	Mean	Standard Deviation	t-value	Degrees of Freedom	Statistical Significance
Experimental	24	4.63	1.929	-1.419	47	.162
Control	25	5.44	2.083			

*Significant at the 0.05 level, **Significant at the 0.01 level

Table 6 shows there were no statistically significant differences ($\alpha = 0.05$) attributable to the group in the pre-test for Scientific Concepts of second-grade students. This result demonstrates the equivalence of the groups prior to the experimental intervention.

2.8 Group Equivalence: The Habits of Mind Scale

The means and standard deviations for the dimensions and total score of the pre-test scores of second-grade students on the habits of mind scale were calculated according to the group variable (experimental, control) to verify group equivalence. The "t-test" was used to clarify the statistical differences between the means, and Table 7 illustrates the results.

Table 7. Means, standard deviations, and t-test based on the group variable for the dimensions and total score of the pre-test scores of second-grade students on the habits of mind scale.

Dimension	Group	N	Mean	Standard Deviation	t-value	df	Statistical Significance
Perseverance (Pre-test)	Experimental	24	1.06	0.161	0.049	47	0.961
	Control	25	1.05	0.158			
Striving for Accuracy (Pre-test)	Experimental	24	1.10	0.286	0.048	47	0.962
	Control	25	1.09	0.281			
Questioning and Problem Posing (Pre-test)	Experimental	24	1.03	0.094	-0.346	47	0.731
	Control	25	1.04	0.147			
Gathering Data Using All Senses (Pre-test)	Experimental	24	1.14	0.259	0.259	47	0.797
	Control	25	1.12	0.252			

Thinking Flexibly (Pre-test)	Experi-mental	24	1.11	0.212	0.074	47	0.941
	Control	25	1.11	0.209			
Constant Readiness for Continuous Learning (Pre-test)	Experi-mental	24	1.19	0.353	0.382	47	0.704
	Control	25	1.16	0.274			
Thinking about Thinking (Pre-test)	Experi-mental	24	1.18	0.340	0.076	47	0.939
	Control	25	1.17	0.321			
Self-Control (Pre-test)	Experi-mental	24	1.22	0.234	-0.207	47	0.837
	Control	25	1.24	0.354			
Habits of mind scale (Pre-test)	Experi-mental	24	1.13	0.120	0.143	47	0.887
	Control	25	1.12	0.131			

Based on Table 7, there were no statistically significant differences ($\alpha = 0.05$) attributable to the group in all dimensions and the total score of the pre-test on the habits of mind scale. Based on this result, we conclude that the groups are equivalent.

3. *STUDY PROCEDURES*

To implement the study, several procedures were undertaken and summarized as follows:

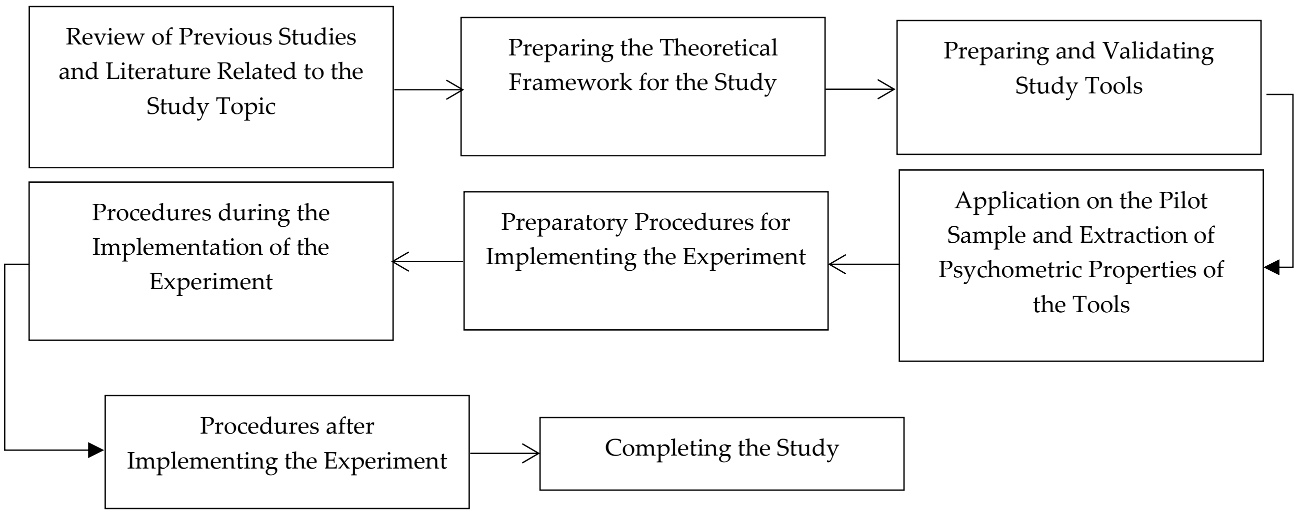

FIGURE 1. Study Procedures.

1. Preparation Procedures for Implementing the Experiment:

- Determine the school to be selected and randomly choose the study participants for the two groups (experimetral and control).
- Train the teacher of the experimental class to use the integration strategy in teaching as required. This was done through several steps:
  - The teacher was trained by the researcher on how to use the strategy, its tools, and how to activate it. The teacher was provided with a teacher's guide to review it completely and suggest any modifications or additions.
  - The researcher benefited from the teacher's observations regarding the integration strategy and the study tools and implemented most of her suggestions.
  - The study tools (Scientific Concepts Test and Habits of Mind Scale) were applied to both the experimental and control groups to ensure group equivalence.

- o The researcher made sure to supervise and follow up and collect feedback throughout the experiment's implementation period.

2. Procedures After Implementing the Experiment:

- Apply the study tools (Scientific Concepts Test and Habits of Mind Scale) to both the experimental and control groups.
- Record and input the pre-test and post-test data, collect the data, and perform the necessary statistical treatments to extract the results using the SPSS (Statistical Package for the Social Sciences) program.

3. Teacher's Guide (Integration Between the 5E's Learning Cycle Strategy and Conceptual Change Model by Stepans):

The integration of the 5E's Learning Cycle Strategy and Conceptual Change Model by Stepans is based on the advantages of constructivist theory in teaching, which relies on teaching strategies that combine flexibility and diversity. These strategies can be used either independently or integrated with other strategies, depending on the educational situation. Therefore, recent trends in constructivist teaching aim for meaningful learning in an enjoyable manner Model integration. The researcher developed a strategy combining the 5E's Learning Cycle and Conceptual Change Model by Stepans, consisting of the following phases:

1. Engagement and Elicitation: This phase aims to stimulate the students' curiosity and interest in the lesson topic and reveal their prior experiences related to the subject and connect them to new knowledge.

- Teacher's Role: Generate curiosity, ask questions, encourage predictions, activate students, and draw responses from previous experiences to motivate them to express their feelings toward the new topic.
- Students' Role: Show interest in the concept or topic through self-questioning, such as asking themselves: Why did this happen? What do I already know about this? What can I discover about this concept? How can I learn more about this topic?

2. Commitment to the Outcome: This phase aims to make students aware of their thoughts and beliefs regarding a particular concept.

- Teacher's Role: Ask students questions that require them to make predictions about the outcomes and explain them.
- Students' Role: Make specific predictions about a concept and link it to previous concepts related to it.

3. Confronting Beliefs and Exploration: This phase aims to share ideas and beliefs in collaborative groups as the concept expands. It is about satisfying the students' curiosity through experiences and cooperation to comprehend the concept through a shared base of activities and experiments that aim to establish a common definition for the concept.

- Teacher's Role: Share ideas and beliefs with students after confirming their beliefs, facilitate learning, encourage collaborative work to form common ideas, and guide students during the process.
- Students' Role: Present their beliefs in small groups and later in large groups to include all classmates. Use research and inquiry to satisfy their curiosity about the concept and think freely within the scope of the required activity, form hypotheses, and offer new explanations.

4. Explanation and Conceptual Representation: This phase aims to examine ideas and opinions through activities, experiments, and refining the intended concept.

- Teacher's Role: Guide students to verify their ideas and beliefs through activities and experiments, ask questions to lead students smoothly through their observations and discussions to answer the question "Why?"
- Students' Role: Choose and examine their ideas through activities and experiments, starting to resolve any cognitive conflict between their observations and beliefs.

5. Expansion and Beyond the Concept: This phase aims to discover new applications for the concept or the knowledge and skills developed and interpreted by the students, linking them to real-life problems they face. It involves making connections between concepts and processes and applying the concept in new daily life situations.

- Teacher's Role: Ask students questions to give examples that link the concept to their life situations, encourage them to apply the developed concepts and skills in new, realistic situations, and ask students to pose questions that clarify proof, justifications, or data, such as: What do you already know? Why do you think that? How did you use the acquired knowledge and skills in new situations? Provide feedback.
- Students' Role: Try to connect the concept to existing situations in their minds that they feel expand the concept. Use prior knowledge to pose questions, suggest solutions, design experiments, and provide real conclusions with justifications.

6. Evaluation: This phase aims to encourage students to continue thinking about the concept.
- Teacher's Role: The teacher should motivate students to read, inquire, and expand their understanding of the scientific concept.
- Students' Role: Research the new concept outside of school, answering open-ended questions using prior observations, evidence, and accepted explanations.

The researcher selected the unit on "Interactions of Living Organisms in the Environment" from the science textbook for the second grade (2021-2023 edition) for the following reasons:

1. The unit contains a large number of scientific concepts and processes that help in developing the mental habits that students should acquire.
2. The students have alternative concepts and prior knowledge that need modification and have accumulated over time.
3. General Guidelines for the Teacher Regarding Teaching the Unit on "Interactions of Living Organisms in the Environment" from the Science Textbook for the Second Grade:

- Encourage students to take leadership and engage in cooperative learning.
- Use students' thinking and experiences to guide the lesson.
- Use open-ended questions.
- Encourage students to suggest reasons for events and make predictions.
- Prompt students to justify their conclusions and accept mistakes, helping them correct them, and allow enough time for discovery and problem-solving.

Guidelines for Grouping Students:

4. Divide students into equal groups of 5-6 members.

- Group students by varying levels within the same group.
- Agree on roles within the group, with suggested roles such as Timekeeper, Writer, Decision-maker, Discussion Organizer.

IV. RESULTS AND DISCUSSION

1. FIRST HYPOTHESIS: THERE ARE NO STATISTICALLY SIGNIFICANT DIFFERENCES AT (∝=0.05) BETWEEN THE MEAN SCORES OF SECOND-GRADE STUDENTS IN THE EXPERIMENTAL AND CONTROL GROUPS ON THE ACQUISITION OF THE SCIENTIFIC CONCEPTS ATTRIBUTABLE TO THE TEACHING METHOD (A STRATEGY INTEGRATING THE 5E's LEARNING CYCLE STRATEGY WITH STEPANS' CONCEPTUAL CHANGE MODEL VERSUS TRADITIONAL METHODS)

Through calculating the means, standard deviations, and adjusted mean in the acquisition of scientific concepts among second-grade students in science in the pre-test and post-test measurements based on the teaching method (a strategy that integrates both the 5E's Learning Cycle Strategy and the Conceptual Change Strategy of Stepans, and the traditional method), the validation of this hypothesis was carried out. The results are presented in Table 8.

Table 8. Means, standard deviations, and adjusted mean scores for the acquisition of the scientific concepts (pre-test and post-test) for second-grade students based on the teaching method (integrating the 5e Learning Cycle and Stepans' Conceptual Change Model vs. conventional method).

Teaching Method	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Adjusted Mean	Standard Error
Strategy integrating Five-E Learning Cycle and Stebbins' Conceptual Change	24	4.63	1.929	14.46	2.206	14.569	0.415
Conventional Method	25	5.44	2.083	6.16	1.908	6.054	0.406

As shown in Table 8, there were apparent differences between the means and adjusted mean scores for for the acquisition of the scientific concepts in science for second-grade students, comparing the pre-test and post-test scores according to the teaching method (integrating the 5E's Learning Cycle and Stepans' Conceptual Change Model vs. the conventional method).

To confirm whether these apparent differences are statistically significant, a One-Way ANCOVA was conducted for the post-test on the acquisition of the scientific concepts in science, adjusting for the effect of the pre-test scores. The results are shown in Table 9.

Table 9. One-way ANCOVA analysis for the post-test measurement in the acquisition of the scientific concepts among second-grade students in science as a whole, according to the teaching method (a strategy that integrates the 5E Learning Cycle strategy and the Conceptual Change Model of Stepans, and the traditional method), after controlling for the effect of the pre-test measurement.

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F-value	p-value	Eta-squared (η^2)
Pre-test	13.366	1	13.366	3.306	0.076	0.067
Teaching Method	851.258	1	851.258	210.580	0.000	0.821
Error	185.953	46	4.042			

As indicated in Table 9, there were statistically significant differences in the acquisition of the scientific concepts for second-grade students in science based on the teaching method (integrating the Five-E Learning Cycle and Stebbins' Conceptual Change Model vs. the conventional method), with an F-value of 210.580 and a p-value of 0.000. This value is statistically significant. The results show that the differences were for the students who were taught using the integrated strategy, compared to those taught using the conventional method.

Furthermore, Table 9 highlights the large effect size of the teaching method, with an Eta-squared value (η^2) of 0.821, indicating that 82.1% of the explained variance in the dependent variable (post-test the acquisition of the scientific concepts in science) was accounted for by the teaching method. The data from this result can be interpreted to mean that teaching using the integrated strategy led to teaching the concepts in the unit of "Interaction of Living Organisms and the Environment" through a series of sequential and integrated steps. This, in turn, provided the learners with the ability to acquire and distinguish scientific concepts. Additionally, the integration of the 5E's Learning Cycle and the Conceptual Change Model by Stepans' had a positive effect on improving the acquisition of the scientific concepts, encouraging learners to understand concepts, and facilitating the learning process. It also motivated the learners to interact with educational situations, engage in deeper scientific understanding, and distinguish concepts functionally while linking them to their cognitive structure.

This result can be explained by noting that the integration of the 5E's Learning Cycle and Stepans' model works to enhance concept achievement in the unit of "Interaction of Living Organisms" by associating the stages of the 5E's Learning Cycle with the student's prior conceptual knowledge through Stepans' model stages. This achieved the goal and purpose of integrating the 5E's Learning Cycle with Stepans' model. This result aligns with [14] and [31].

2. *SECOND HYPOTHESIS: THERE ARE NO STATISTICALLY SIGNIFICANT DIFFERENCES AT ($\propto$=0.05) BETWEEN THE MEAN SCORES OF SECOND-GRADE STUDENTS IN THE EXPERIMENTAL AND CONTROL GROUPS ON THE HABITS OF MIND SCALE ATTRIBUTABLE TO THE TEACHING METHOD (A STRATEGY INTEGRATING THE 5E's LEARNING CYCLE STRATEGY WITH STEPANS' CONCEPTUAL CHANGE MODEL VERSUS TRADITIONAL METHODS)*

The mean scores, standard deviations, and adjusted means of the second-grade students' scores on the scale of the habits of mind in both pre-and post-tests were calculated according to the teaching method (a strategy integrating the 5E's Learning Cycle and Stepans' Conceptual Change Model, and the traditional method) to verify the validity of this hypothesis, as shown in Table 10.

Table 10. Mean scores, standard deviations, and adjusted means of second-grade students on the scale of the habits of mind for both pre-and post-tests according to the teaching method (a strategy integrating the 5E's Learning Cycle and Stepans' conceptual change model, and the traditional method).

Teaching Method	N	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	Adjusted Mean	Standard Error
Integration of 5E Learning Cycle and Stepans' Model	24	1.13	.120	1.69	.238	1.688	.032
Traditional Method	25	1.12	.131	1.28	.162	1.284	.031

It is evident from Table 10 that there were visible differences in the mean scores and adjusted means for the second-grade students on the scale of the habits of mind in both pre-and post-tests, based on the teaching method (integration of the 5E's Learning Cycle and Stepans' Conceptual Change Model). A one-way ANCOVA analysis was used for the post-test on the scale of the habits of mind, based on the teaching method (integration of the 5E's Learning Cycle Stepans' Model, and the traditional method), after adjusting for the pre-test effect, to check if these differences were statistically significant. The results are presented in Table 11.

Table 11. Results of the one-way ANCOVA analysis for the post-test scores of second-grade students on the scale of the habits of mind based on the teaching method (integration of the 5E's Learning Cycle and Stepans' Conceptual Change Model, and the traditional method), after adjusting for the pre-test effect.

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F Value	Significance Level	Eta Squared (η^2)
Pre-Test	.804	1	.804	32.895	.000	.417
Teaching Method	1.997	1	1.997	81.748	.000	.640
Error	1.124	46	.024			
Total	3.979	48				

The results in Table 8 indicate that the practice of leadership in the Jordanian Ministry of Education regarding From Table 11, it can be seen that there were statistically significant differences at the ($\alpha = 0.05$) level in the second-grade students' scores on the scale of the habits of mind, based on the teaching method (integration of the 5E Learning Cycle and Stepans' Conceptual Change Model, and the traditional method). The F value was 81.748, with a significance level of 0.000, which is statistically significant. These differences favor the group that was exposed to the integrated strategy of the 5E's Learning Cycle and Stepans' Conceptual Change Model when compared to the traditional method group.

Table 11 also shows the large effect of the teaching method, where the value of Eta Squared (η^2) explained 64% of the variance in the dependent variable, which is the scale of the habits of mind.

The means, standard deviations, and adjusted means for the pre-test and post-test measurements of the dimensions of the habits of mind scale were calculated according to the teaching method (a strategy combining the 5E's Learning Cycle and the Conceptual Change Model by Stepans, and the traditional method), as shown in Table 12.

Table 12. Means, standard deviations, and adjusted means for the pre-test and post-test measurements of the dimensions of the habits of mind scale according to the teaching method.

Dimensions	Teaching Method	N	Pre-Test Mean	Pre-Test Std. Dev.	Post-Test Mean	Post-Test Std. Dev.	Adjusted Mean	Standard Error
Persistence	Strategy combining 5E's Learning Cycle and Conceptual Change	24	1.06	.161	1.79	.665	1.799	.103
	Traditional	25	1.05	.158	1.35	.312	1.340	.101

Striving for Accuracy	Strategy combining 5E's Learning Cycle and Conceptual Change	24	1.10	.286	1.65	.585	1.658	.086
	Traditional	25	1.09	.281	1.20	.289	1.195	.084
Questioning and Problem-Solving	Strategy combining 5E's Learning Cycle and Conceptual Change	24	1.03	.094	1.50	.491	1.507	.079
	Traditional	25	1.04	.147	1.17	.274	1.167	.077
Collecting Data Using All Senses	Strategy combining 5E's Learning Cycle and Conceptual Change	24	1.14	.259	1.60	.481	1.587	.075
	Traditional	25	1.12	.252	1.23	.284	1.236	.074
Thinking Flexibly	Strategy combining 5E's Learning Cycle and Conceptual Change	24	1.11	.212	1.67	.450	1.659	.072
	Traditional	25	1.11	.209	1.23	.230	1.234	.071
Constant Readiness for Lifelong Learning	Strategy combining 5E's Learning Cycle and Conceptual Change	24	1.19	.353	1.88	.636	1.870	.102
	Traditional	25	1.16	.274	1.32	.402	1.325	.100
Thinking About Thinking	Strategy combining 5E's Learning Cycle and Conceptual Change	24	1.18	.340	1.71	.532	1.701	.079
	Traditional	25	1.17	.321	1.35	.340	1.354	.077
Self-Control Over Impulsiveness	Strategy combining 5E's Learning Cycle and Conceptual Change	24	1.22	.234	1.74	.529	1.730	.071
	Traditional	25	1.24	.354	1.41	.411	1.419	.069

It is observed from Table 12 that there were apparent differences between the means and adjusted means in the pre-test and post-test measurements of the dimensions of the habits of mind scale, which are due to the difference in the teaching method (a strategy combining the 5E's Learning Cycle and the Conceptual Change Model by Stepans, and the traditional method). To verify the significance of these apparent differences, a One-way MANCOVA was applied, as shown in Table 13.

Table 13. One-way MANCOVA analysis of the effect of teaching method on post-test measurement for each dimension of the habits of mind scale after controlling for pre-test effects.

Source of Variance	**Pre-Test (Covariate)**	**Post-Test (Dependent Variable)**	**Sum of Squares**	**df**	**Mean Square**	**F**	**p-value**	**Effect Size (η^2)**
Perseverance Pre-Test (Covariate)	Perseverance Post-Test	0.650	1	0.650	2.546	0.119	0.061	
Striving for Accuracy Pre-Test (Covariate)	Striving for Accuracy Post-Test	0.231	1	0.231	1.317	0.258	0.033	
Questioning and Problem Posing Pre-Test (Covariate)	Questioning and Problem Posing Post-Test	0.343	1	0.343	2.320	0.136	0.056	
Gathering Data with All Senses Pre-Test (Covariate)	Gathering Data with All Senses Post-Test	0.594	1	0.594	4.383	0.043	0.101	

Thinking Flexibly Pre-Test (Covariate)	Thinking Flexibly Post-Test	0.082	1	0.082	0.668	0.419	0.017
Readiness for Continuous Learning Pre-Test (Covariate)	Readiness for Continuous Learning Post-Test	0.679	1	0.679	2.719	0.107	0.065
Thinking about Thinking Pre-Test (Covariate)	Thinking about Thinking Post-Test	1.846	1	1.846	12.439	0.001	0.242
Self-Control of Impulsivity Pre-Test (Covariate)	Self-Control of Impulsivity Post-Test	1.684	1	1.684	14.168	0.001	0.266
Teaching Method	Perseverance Post-Test	2.549	1	2.549	9.992	0.003	0.204
Hotelling's Trace = 2.199	Striving for Accuracy Post-Test	2.582	1	2.582	14.743	0.000	0.274
P = 0.000	Questioning and Problem Posing Post-Test	1.393	1	1.393	9.429	0.004	0.195
	Gathering Data with All Senses Post-Test	1.490	1	1.490	11.005	0.002	0.220
	Thinking Flexibly Post-Test	2.187	1	2.187	17.716	0.000	0.312
	Readiness for Continuous Learning Post-Test	3.599	1	3.599	14.418	0.000	0.270
	Thinking about Thinking Post-Test	1.450	1	1.450	9.772	0.003	0.200
	Self-Control of Impulsivity Post-Test	1.168	1	1.168	9.825	0.003	0.201
Error	Perseverance Post-Test	9.950	39	0.255			
	Striving for Accuracy Post-Test	6.830	39	0.175			
	Questioning and Problem Posing Post-Test	5.761	39	0.148			
	Gathering Data with All Senses Post-Test	5.281	39	0.135			
	Thinking Flexibly Post-Test	4.815	39	0.123			
	Readiness for Continuous Learning Post-Test	9.735	39	0.250			
	Thinking about Thinking Post-Test	5.789	39	0.148			
	Self-Control of Impulsivity Post-Test	4.636	39	0.119			
Total Corrected	Perseverance Post-Test	14.934	48				
	Striving for Accuracy Post-Test	12.395	48				
	Questioning and Problem Posing Post-Test	8.667	48				
	Gathering Data with All Senses Post-Test	8.948	48				
	Thinking Flexibly Post-Test	8.308	48				
	Readiness for Continuous Learning Post-Test	16.948	48				

Thinking about Thinking Post-Test	10.889	48
Self-Control of Impulsivity Post-Test	11.778	48

Table 13 shows statistically significant differences at ($\alpha \leq 0.05$) based on the effect of the teaching method (a strategy combining the 5E's Learning Cycle and Stepans' Conceptual Change Model, and the traditional method) across all dimensions. The differences were in favor of the individuals who were exposed to the strategy combining the 5E's Learning Cycle and Stepans' Conceptual Change Model, compared to those in the traditional method group. It is noted that the effect size across the dimensions was large, ranging from 19.5% to 31.2%.

This result is attributed to the fact that the integration helped connect learners' prior knowledge with the new knowledge and concepts being studied. Positive participation during science lessons, research, and thinking about scientific concepts contributed to the development of habits of mind (perseverance, striving for accuracy, questioning, and problem-solving, collecting data through the senses, thinking flexibly, being always ready for continuous learning, thinking about thinking, and self-regulation).

The integration of the 5E's Learning Cycle and the Stepans' model helped stimulate the learners' intelligent behavior in addressing educational situations and choosing thinking methods that align with different educational contexts. The stages of integration and stimulation enhanced the habit of perseverance, constant readiness to learn, and controlling impulsiveness by encouraging learners to strive to acquire accurate scientific information. The stages of commitment to outcome, exploration, interpretation, and concept representation trained learners in the habit of being constantly prepared for continuous learning and promoting teamwork among them to reach solutions, explain concepts, and link scientific facts to their lives. This led to the reinforcement and development of thinking habits within organized and sequential steps. Additionally, the expansion stage and going beyond the concept, along with assessment, contributed to developing flexible thinking habits and collecting data using the senses. These results are consistent with the findings of [16, 17], who demonstrated the possibility of using certain strategies in science teaching to develop mental habits among students.

V. RECOMMENDATIONS AND SUGGESTIONS

In light of the study's findings, which indicated a positive impact of teaching using a strategy that integrates both the 5E's Learning Cycle strategy and Stepans' Conceptual Change Model in the acquisition of scientific concepts and the development of thinking habits, the following recommendations can be made:

- Use the integrated strategy of combining the 5E's Learning Cycle and Stepans' Conceptual Change Model, given its effectiveness in acquiring scientific concepts.
- Use the integrated strategy of combining the 5E Learning Cycle and Stepans' Conceptual Change Model, given its impact on developing thinking habits.

The study suggests that:

- Educational curriculum designers and science textbook authors should develop curricula and textbooks for the lower grades that adopt the strategy integrating the 5E's Learning Cycle and Stepans' Conceptual Change Model. Additionally, a teacher's guide should be provided to clarify how to implement this strategy in science teaching.
- Educational supervisors should organize training courses and workshops for first-grade teachers to train them on how to apply the integrated strategy of the 5E's Learning Cycle and Stepans' Conceptual Change Model in science teaching for lower grades. They should also encourage teachers to use this strategy through field visits and individual meetings with teachers.
- Further studies in the field of science be conducted on broader samples and different age groups, as well as other educational stages.
- The teacher's guide will benefit from this purpose and be distributed to science teachers to help them prepare lesson plans based on the integrated strategy of the 5E's Learning Cycle and Stepans' Conceptual Change Model.
- Studies be conducted to improve thinking habits among elementary school students through other academic curricula.

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Author contribution

This research was solely conducted by the author. The author was responsible for conceptualizing the study, designing the methodology, collecting and analyzing data, interpreting results, and drafting and revising the manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

Data Availability Statement

Data are available from the author upon request.

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