

EFFECTIVENESS OF 4 MAT SUPPORTED BY THE INTERACTIVE CHATS FOR TEACHING CHEMISTRY IN DEVELOPING DEDUCTIVE THINKING AND ACADEMIC ACHIEVEMENT.

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ABSTRACT

This paper aimed to identify the effectiveness of the 4MAT model supported by interactive chats in developing deductive thinking and academic achievement among secondary school female students in the Kingdom of Saudi Arabia. To achieve this goal, a deductive thinking test, an achievement test, a teacher's guide, and an activity book were prepared. The tools were applied to a sample of 59 second-grade female students distributed into two experimental and control groups. The results showed statistically significant differences at the level of ≤ 0.05 in the average scores of the two groups in the post-test of deductive thinking and academic achievement in favor of the experimental group. The model supported by interactive chats also led to the development of deductive thinking and academic achievement among female students significantly. There was also a positive correlation between deductive thinking and academic achievement. The paper recommends adopting the (4MAT) model supported by interactive chats in teaching and developing deductive thinking skills that help female students overcome their daily problems.

Keywords: Academic achievement, deductive thinking, the 4 MAT model, interactive chats, the secondary stage, and chemistry instruction.

INTRODUCTION

Recent changes and improvements in technology have made it harder for educational research to keep up with these changes and meet the needs of human sustainable development. These changes and improvements affect all areas of life, not just education. This development is based on developing education, improving its outcomes, and making the student a thinker who has his own style for the pursuit of knowledge. Science is an important subject because it develops the students' mental abilities and practical skills that enable them to explain the surrounding phenomena and confront the growing problems. Many educational organizations report that Arab and foreign students dislike scientific subjects, such as science and mathematics, despite the numerous studies that addressed raising the level of education and developing students' attitudes towards it. Accordingly, it is necessary to adopt teaching methods, models, and strategies that play an effective role in teaching science (Ahmed and Mohammad 2015)

To deliver the best education, the teacher has to know the characteristics and methods of thinking of the students, taking into account their attitudes and interests. Understanding the learning styles of the students is substantial for the success of teaching and learning (Pashler, McDaniel et al. 2008, Othman and Amiruddin 2010) Identifying learning styles is a tool for discovering individual differences among the students. It trains the brain to think at higher levels and helps memory store and retrieve information (Omar, Al-Shunnaq et al. 2019). Learning style denotes the favorite

method to receive and process information, as each learner prefers a way of learning (Sywelem, Dahawy et al. 2010).

McCarthy developed a system for planning significant learning experiences for all types of learners. McCarthy explained that thinking on the left side of the brain is consecutive and verbal, but the right side needs strategies that focus on composition, mental and exploratory training, and understanding the relationships between the part and the whole (McCarthy 1987). Applying some learning methods to some school students showed that students are distributed according to the four learning methods: imaginative, analytic, logical, and dynamic. Thus, McCarthy categorized learning styles and created the (4MAT) model. This model converts the concept of learning styles into educational strategies that provide students with experience acquisition in line with their learning methods (Şeker and Övez 2018). It provides teachers with a structure to plan learning experiences according to their students' learning styles (Ruangtrakun and Chaiyasang 2019). Moreover, it engages students in the educational situation through four aspects: experiment, images, application, and innovation. These patterns provide answers to questions related to creating personal meaning, building conceptual understanding, developing real-life skills, and making unique or new adjustments (McCarthy and McCarthy 2006).

One of the most promising examples of artificial intelligence (AI) applications is chatbots, which are computer programs that simulate conversations with people. The learner types a question, and the program responds by answering it or offering assistance with a basic task. These applications are regarded as part of the "fourth education revolution" because they give the learner more freedom in consuming knowledge and provide access to high-quality, personalized, inclusive, everywhere, and lifelong education. (Miao, Holmes et al. 2021)

Chatbots can also serve as a virtual assistant to enhance and develop the learning process because their purpose is not to replace teachers but rather to lessen the workload of repetitive, low-level cognitive tasks that instructors perform. (Garcia-Brustenga, Fuertes-Alpiste et al. 2018). This is particularly true when students feel that they need direct guidance from the teacher while completing required tasks, especially when dealing with challenging educational materials that make learners reluctant to study and learn them. (Siegle, Rubenstein et al. 2014)

Since they have an interactive mechanism that supports the educational process in various ways—for example, by giving learners knowledge, acting as a personal assistant to answer questions, and tailoring learning to each learner's unique needs—chatbots have recently drawn the attention of researchers and educators. (Chang, Lin et al. 2023).

The use of chatbots in education has been the subject of numerous research studies, such as those conducted by Garcia-Brustenga, Fuertes-Alpiste et al. (2018), Garcia et al. (2018), Al-Omari (2019), Chen, Vicki Widarso et al. (2020), Al-Rashid (2022); Hindi (2022), which demonstrated the effectiveness of this type of education.

Modern educational trends assert the importance of the learner's role in taking responsibility for learning to develop different thinking skills. They report the teachers' need to adopt the models and strategies that facilitate the process of integrating students into the educational process (Ramesh 2018.) Educators have agreed that the primary goal of the modern school is to create a

person who is able to think of a multicultural world. Thus, students need to learn different thinking skills, such as observation, deduction, and induction, as well as logical interpretation and use of information (Goswami 2010) Deductive thinking, which is one of the most important mental processes that have grabbed the attention of educators and theorists of cognitive psychology, necessitates more development and training (Ayalon and Even 2008). It is a mental process that a learner performs when facing a problem. It helps obtain results from known premises and practice multiple types of mental skills, including deductive reasoning, probabilistic reasoning, representative reasoning, proportional reasoning, variable control, and combinatorial reasoning (Ormerod 2010).

STATEMENT OF THE PROBLEM

Through the researcher's work as a practical training supervisor in the College of Education at Umm Al-Qura University and observing high school students, the author has observed that education emphasizes traditional approaches that disregard individual differences and learners' preferences for using one side of their brains. Moreover, the educational setting, which relies on dialogue and idea sharing, remains inaccessible. To put it another way, the educational process does not take into account involving every pupil (Adams, Onwadi et al. 2021). asserted this observation. Furthermore, the low degree of deductive thinking in general education was noted by Mahmudin, Sumarmo et al. (2020), Teo and Goh (2019), Wissman, Zmary et al. (2018), and Al-Sayed et al. (2016), In order to address the problem, the current study poses the following key query: How well does the McCarthy model (4MAT), which is backed by the interactive chats, teach chemistry to female secondary school students in Makkah?

1. What is the effectiveness of the 4 MAT model supported by the interactive chats in developing deductive thinking among secondary-stage students in Mecca, Saudi Arabia?
2. What is the effectiveness of the (4 MAT) model supported by the interactive chats in developing academic achievement among secondary stage students in Mecca, Saudi Arabia?
3. What is the correlation between deductive thinking and academic achievement among middle stage students in Mecca, Saudi Arabia?

SIGNIFICANCE

The following aspects manifest the significance of the study:

1. It improves chemistry instruction to achieve the desired educational goals at the level of developing thinking, in general, and deductive thinking, in particular.
2. The author prepares teacher guides and learner's material for a unit in the Chemistry course for the 2nd-grade secondary stage students using the (4MAT) model supported by interactive chats, which helps the teacher teach the unit and develops the learners' both sides of the brain.
3. The study directs the attention of the curriculum designers towards the teaching models that consider learning based on both sides of the brain and styles of learning and thinking, such as the (4 MAT) model.
4. Directing the attention of curriculum developers to take advantage of the applications of artificial intelligence technology to build educational chatbots and include them in the curricula as enrichment materials because of their ability to present scientific concepts in accordance with the

abilities of each learner while providing intelligent feedback to each learner according to their abilities and skills in a fun and attractive way.

LIMITS

Objective Limits

1. The second chapter, 'Energy and Chemical Changes,' and the third chapter, 'Speed of Chemical Reactions,' of the chemistry course for the second grade of secondary school.
2. Measuring deductive thinking in the following skills: combinational, deductive, proportional, inductive, and probabilistic.
3. Academic achievement of the (recall, comprehension, and practice) cognitive levels.

Temporal Limits: The study was conducted in the second semester of the academic year 2024.

Human and Spatial Limits: The study was applied to the 2nd-grade secondary stage students in Mecca, Saudi Arabia.

DEFINITION OF TERMS

Effectiveness: It is procedurally defined as the development of deductive thinking and academic achievement among the 2nd-grade secondary stage students (the participants) after studying a unit in their Chemistry course using the (4 MAT) model supported by The interactive chats.

The (4 MAT) model is supported by the interactive chats: It is procedurally defined as an educational model based on combining learning styles, teaching styles, and teaching methods of both sides of the brain supported by an interactive dialogue digital application system in the form of a question and answer to respond and enrich the students' knowledge and experiences in teaching a unit of the Chemistry course for the 2nd-grade secondary stage students.

Deductive thinking: It is procedurally defined as a pattern of thinking where the learner uses his/her information to conclude new results in the Chemistry course using combinational, deductive, proportional, inductive, and probabilistic skills. The author infers it from the 2nd-grade secondary stage student's score on the deductive thinking scale.

Academic Achievement: It is procedurally defined as the information obtained by the 2nd-grade secondary stage student after studying the second chapter 'Energy and Chemical Changes' and the third chapter 'Speed of Chemical Reactions' using the (4 MAT) model supported by The interactive chats at the recall, comprehension, and practice levels. It is inferred by the score obtained in the academic achievement test developed by the author.

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

McCarthy designed the (4 MAT) model in the light of human development theories of Dewey, Kolb, and Gustav, as well as brain-based learning studies (McCarthy, Germain et al. 2002). The (4 MAT) is a cognitive teaching model that involves several stages and provides scientific concepts and diverse knowledge depending on the complete function of the two sides of the brain, seeking to achieve growth in the mental processes carried out in a balanced manner to match the diversity of students' learning and thinking patterns (St Germain 2002). According to Ahmad, El-Helaly et al. (2021) and Somsak, Punsrigate et al. (2023), the (4 MAT) model comprises four stages, as follows:

1. *Reflective observation*: The teacher provides the opportunity for students to move from tangible, concrete experiences to reflective observation. It is preferable to begin by indicating the value of learning experiences.
2. *Abstract conceptualization*: The student develops the concept through observation. The teacher adapts the traditional method of teaching.
3. *Active experimentation*: The student moves to experimentation and manual practice. This stage represents the practical aspect of science, where the teacher allows the students to practice using their hands.
4. *Concrete experience*: The student moves to concrete experiences and correlates knowledge with personal experiences, so the previous concepts broaden and the present ones develop. The author adopts these stages of teaching.

McCarthy, Germain et al. (2002) and Ibrahim Hassan Awad (2022) report the fundamentals of the model, as follows:

1. Individuals are different in the way they learn and build meaning.
2. The difference in learning styles is due to the two hemispheres' functions that control learning outcomes.
3. Differences in learning styles are significantly related to personal motivation and performance.
4. The psychological formation of the individual controls beliefs, concepts, and choices.
5. Learning is a continuous lifelong process that occurs in the form of an evolutionary cycle complementary to personality type.
6. The person's multiple experiences increase his growth and understanding of the world.
7. Learners expand and refine adaptive modes by exercising and using appropriate methods and strategies.

Ali (2011) and Essa (2014) that the (4 MAT) model is important because

- It is a tool for designing learning, developing teachers' capabilities, and developing educational units.
- It allows the teacher to study and address the different educational types of learners.
- It achieves balance and integration for the learner through mastering a full course of learning methods.
- It is one of the modern educational models that support brain-based learning and diverse thinking skills.
- It provides learning that brings pleasure to the learner and increases the opportunity to obtain and retrieve information.
- It allows the learner to meditate, ask questions, do activities, and employ learning in life situations, which enhances motivation and attitude towards the learning process.

Various studies examined the effectiveness of the 4MAT model. For example, Ergin and Atasoy (2013) demonstrated the effectiveness of the (4MAT) model in developing the achievement of secondary school students in physics. Metwally (2016) revealed the effectiveness of the strategies of the visual thinking network and (4MAT) model in the development of deductive thinking and

academic self-concept among high school students in the home economics course. Mohamed and Al-Harbi (2017) manifested the effectiveness of the (4MAT) model in developing learning processes and attitudes towards it among 1st-grade middle stage students. Al-Adaili (2017) showed the effectiveness of the 4MAT model in learning retention among the 8th-grade primary stage students in Jordan. Tezcan and Güvenç (2017) investigated the effectiveness of the (4MAT) model and the whole brain model in developing academic achievement in science, They compared it with the effectiveness of inquiry-based instruction. The results showed that the (4MAT) model was more effective than the whole brain model in terms of increasing academic achievement. Muflih and Al-Momani (2018) exhibited the impact of an educational program based on the (4MAT) model in developing achievement and scientific attitudes in biology among the 1st-grade secondary stage students in Jordan. Al-Da'jah (2018) demonstrated the effectiveness of an educational program based on the (4MAT) model in achievement and acquiring scientific concepts and attitudes in biology among the 1st-grade secondary stage students. Al-Jarjari and Younis (2019) indicated the effectiveness of the (4MAT) model in developing thinking among the 5th-grade primary stage students in science. Accordingly, the effectiveness of the (4MAT) model is evident in the development of some variables, such as learning processes, concepts, motivation, and attitudes towards sciences at different academic stages. The study of Abdul-Jawad et al. (2024) concluded that the formative model with interactive chats is effective in developing critical thinking and science achievement. To the author's knowledge, no previous study in science explored the effectiveness of the (4MAT) model in developing deductive thinking.

One kind of thinking that greatly aids in applying knowledge and information to solve difficulties in daily life is deductive reasoning. It represents the pursuit of knowledge and information about how objects and occurrences happen. It is one of the ways of thinking that tries to solve an issue and come to a conclusion. Higher mental processes, including creativity, insight, abstraction, generalization, inference, justification, and critique, must be used to arrive at a conclusion based on a known premise. (Malloy, Lee et al. 2016)

Deductive thinking relies on previous information and premises, adopts logical processes and problem-solving, and involves that the person moves from the known to the unknown. It is fundamental in the processes of distinction, generalization, and creativity. It is characterized by accuracy in defining all the terms included in the premises. It occurs when the person encounters a situation that requires discovering the relationships between information and application in the production of new information. Moreover, it involves productivity or novelty because the results involve new information(Carrier2014), Jarwan (2016) indicated that Deductive thinking has various skills, Alamodi (2011) classified them as combinational, deductive, proportional, inductive, and probabilistic. Gunhan (2014) classified them as induction and deduction skills. Al-Joundy (2016) categorized them to proportional reasoning, probabilistic reasoning, structural reasoning, and hypothetical reasoning, whereas Dnior (2017) classified them to induction, deduction, inference, reasoning, and variable control. Beshay (2019) classified them as induction, deduction, and correlation. The author reports the following skills of deductive thinking:

Combinational reasoning is the ability to think of multiple variables at the same time, define the effect of one or all of them, and exclude the variables that have no effect.

Deductive reasoning aims to address available facts according to specific procedures to reach conclusions.

Proportional reasoning is the ability to characterize functional relationships by comparing different quantities and phenomena using ratio and proportion.

Probabilistic reasoning is the ability to study quantitative relationships between group elements and define and compare their proportions.

Inductive reasoning is the ability to examine a hypothesis, a saying, or an observation and establish generalizations based on the available information.

Al-Hadramia and Ambo Saeidy (2012) and Kelada (2010) report that success in study and career depends on the ability to use deductive thinking that is highly important in science instruction, as follows:

- Deductive thinking is a logical sequence, i.e., it uses both induction and deduction.
- It enriches learning and develops thinking.
- It is a foundation of science instruction. It establishes evidence-based conclusions to make the proper decision.
- It is one of the best factors that predict achievement and problem-solving. It is also a part of critical thinking. From the Gestalt perspective, creativity is a type of deduction.

Several studies addressed deductive thinking skills throughout different educational stages using diverse teaching methods and strategies. For example, Hammoud (2015) demonstrated the effectiveness of multiple intelligences-based strategies in the achievement of chemistry and deductive thinking among the 1st-grade middle stage students. Suliman (2015) showed the effectiveness of the PDEODE strategy in developing deductive thinking and academic achievement. In addition, there was a positive correlation between deductive thinking and academic achievement. Alanzi (2016) demonstrated the effectiveness of the Woods model in developing mind habits and deductive thinking among the 3rd-grade middle stage students. Al-Hafiz and Hussein (2016) indicated the effectiveness of spider map-based teaching in modifying the alternative conceptions of some chemical concepts and the development of deductive thinking among the 4th-grade students. Moreover, Algendi and George (2016) showed the effectiveness of the garden ideas strategy in developing deductive thinking among the 4th-grade students in physics. Afaneh (2016) illustrated the effectiveness of a problem-centered learning strategy in developing learning processes and deductive thinking skills in chemistry among the 9th-grade students. Dnior (2017) revealed that the use of web quests in teaching physics developed achievement and deductive thinking skills among the 2nd-grade secondary stage students. Cansiz and Cansiz (2018) demonstrated the effectiveness of an activity-based approach in developing deduction skills among primary stage students. Shehadeh, Afifi, Gad, and Afifi (2019) demonstrated the effectiveness of the concept acquisition model in developing scientific concepts and deductive thinking skills in science among the 7th-grade students. In addition, Abdesalam, Selim, and Al-Tantawi (2019) showed that the inquiry modl helped first-grade secondary school

students in Libya learn how to use deduction in chemistry. Jreisat's study (2023) also found that a proposed technology-based training program could help college students improve deductive reasoning skills in higher mental processes such as comprehension, discrimination, analysis, criticism, and inference.

HYPOTHESES

1. There are statistically significant differences at the level of ≤ 0.05 in the mean scores of the control and experimental groups in the posttest of the deductive thinking scale (skills and total score) in favor of the experimental group.
2. There are differences between the control and experimental groups in the posttests of the achievement test (domains and total scores) that are statistically significant at the 0.05 level. These differences favor the experimental group.
3. There is a statistically significant correlation between the scores of the experimental group students in the posttest of deductive thinking and academic achievement.

METHODOLOGY

Method

The study adopted a quasi-experimental approach based on the design of independent groups (an experimental group and a control group) that were pre-tested and post-tested.

Variables

Independent variable: The (4MAT) model supported by the interactive chats

Dependent variable: Deductive thinking and academic achievement

Population and Sampling

The population of the study included secondary school students, while the sample included 59 randomly selected secondary school students from a school in the Kingdom of Saudi Arabia.

PROCEDURES

First: Selecting the content

The second chapter, 'Energy and Chemical Changes,' and the third chapter, 'Speed of Chemical Reactions,' were selected from the chemistry textbook prescribed for second-grade secondary students (2024 in the Kingdom of Saudi Arabia) for the following reasons:

1. The two chapters comprise substantial concepts, such as passive transport, active transport, phagocytosis, and exocytosis that represent a foundation of knowledge building.
2. The two chapters contain concrete experiences such as calculating the change in enthalpy, how things work, fuel-efficient compounds, collision theory and rate of chemical reaction, factors affecting the rate of chemical reaction, and laws of rate of chemical reaction. The learning cycle of the (4MAT) model is needed to cover topics like chemistry, health, body temperature, and reaction rate. It is supported by interactive chat and a variety of tasks, group activities, and media and sources.
3. • Their content pertains to various situations, problems, and experiences, offering students the chance to engage in numerous activities that foster deductive thinking.
4. The time frame for teaching the two chapters is one month (16 lessons), which is sufficient to develop students' deductive thinking skills.

Second: Preparing the teacher guide

The author has prepared a teacher's guide to guide the teacher while teaching the two classes mentioned above and to create a learning environment that helps to deal with students' learning styles. The guide includes an introduction and philosophy of the 4MAT model, the interactive chats, general instructions for the teacher, the objectives of teaching the two chapters, the time frame for the topics, and the plan for teaching the two chapters. The plan included defining the behavioral objectives for each subject, the educational content and teaching aids, the method of teaching according to the 4MAT model supported by The interactive chats, and evaluation questions. The 4MAT lessons included practical activities, questions, and inquiries that require the practice of deductive reasoning patterns. The guide was reviewed by a number of reviewers specialized in curriculum and education to prepare the final format.

Third: Preparing the student worksheets (activity book)

Student worksheets covering the activities and assignments of the above-mentioned chapters were prepared to help students acquire the concepts according to their learning patterns. Some reviewers reviewed the teacher guide and the activity book. Accordingly, they were modified to be valid for application.

*Fourth: Preparing the tools**- Deductive thinking test*

To prepare the deductive thinking test, the author defined its objective, i.e., measuring the combinational, deductive, proportional, probabilistic, and inductive skills of deductive thinking among the 2nd-grade secondary stage students. Adopting some pieces of literature that addressed deductive thinking, such as Alanzi (2016), Hassan (2013), and Metwally (2016), the test items (multiple-choice questions) were prepared. Each item reflects a problem, situation, or reality. The student should choose the right answer. To verify the validity of the test, some specialists in the curriculum and instruction of science, education, and psychology reviewed the test that was modified according to their views. The author applied the test to a pilot sample of 29 2nd-grade secondary stage students (not the study sample) to estimate the internal consistency and reliability of the test and to define the time required to answer. Moreover, the correlation coefficients between the score of each item and the total score of the skill were estimated. The results are shown in Table 1.

Table (1): Correlation coefficients between the score of each item and the total score of the skill

Skill	Item	Correlation coefficient	Skill	Item	Correlation coefficient
Deductive	1	0.882**	Combinational	1	0.796**
	2	0.879**		2	0.700**
	3	0.790**		3	0.863**
	4	0.850**	Probabilistic	1	0.817**
Proportional	1	0.814**	Inductive	2	0.820**
	2	0.874**		1	0.901**
	3	0.757**		2	0.819**

	4	0.876**		3	0.856**
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**Significant correlation at the level of (0.01)

Table (1) shows that all values of correlation coefficients were positive and significant at the level of (0.01). These values ranged from (0.700) to (0.901), which indicates a strong relationship between the score of each item and the total score of the skill (Murad, 2000). The correlation coefficients between the score of skill and the total score of the test were estimated. The results are shown in Table 2.

Table (2): Correlation coefficients between the score of skill and the total score of the test

Skill	Correlation coefficient
Deductive	0.974**
Proportional	0.918**
Combinational	0.917**
Probabilistic	0.847**
Inductive	0.929**

Table (2) indicates that all values of correlation coefficients were positive and significant at the level of (0.01). These values ranged from (0.847) to (0.974), which indicates a strong relationship between the score of skill and the total score of the test. Test reliability was estimated using Cronbach's alpha and by omitting the score of the item from the total score of the skill. The results are shown in Table 3.

Table (3): Reliability coefficients of the skills and the tool after omitting the score of the item from the total score of the scale or skill.

Skill	Item	Cronbach's alpha when omitting the item	Cronbach's alpha of the skill	Scale	Item	Cronbach's alpha on omitting the item	Cronbach's alpha of the scale
Deductive	1	0.815	0.872	Scale	1	0.949	0.954
	2	0.817			6	0.948	
	3	0.874			12	0.953	
	4	0.837			18	0.949	
Proportional	5	0.821	0.850		5	0.951	
	6	0.777			7	0.951	
	7	0.853			9	0.953	
	8	0.775			14	0.949	
Combinational	9	0.569	0.691		3	0.954	
	10	0.680			4	0.951	
	11	0.394			13	0.952	
Probabilistic	12	-	0.608		2	0.952	
	13	-			8	0.953	

Inductive	14	0.666	0.822		11	0.949	
	15	0.826			16	0.951	
	16	0.762			21	0.951	

Table (3) indicates that the reliability values of the skills ranged from (0.608) to (0.872). The test scored (0.954). These values were highly reliable and statistically valid. In addition, the values of reliability coefficients when omitting an item from the test skills were slightly less than the reliability coefficients of the skill as a whole. For the test as a whole, except for some items, the reliability value for each skill or the test as a whole slightly increased by deleting it, ranging from (0.002) to (0.004). All items of the test are reliable. Accordingly, the 16-item test of deductive thinking with its five domains is highly reliable and valid. The pilot test showed that 45 minutes are adequate for the answer. After verifying test validity and estimating its reliability, the final form comprised 16 items. The maximum score of the deductive thinking test was (16), and the minimum score was (0).

Table (4): Specifications of the deductive thinking test in its final form

Deductive thinking skills	Questions	Number of questions	Relative weight	Total score
Deductive	1-4	4	25%	4
Proportional	5-8	4	25%	4
Combinational	9-11	3	18.75%	3
Probabilistic	12-13	2	12.5%	2
Inductive	14-16	3	18.75%	3
Total	16	16	100%	16

- Achievement Test

To prepare the achievement test, the author set his goal, which is to measure the achievement of second-year secondary school students in the second semester "Energy and Chemical Changes" and the third semester "Rate of Chemical Reactions" at the cognitive levels (remembering, understanding, and practicing) and to study the effectiveness of teaching using the (4MAT) model supported by interactive chats in academic achievement. The test paragraphs were prepared (multiple-choice questions), and each paragraph had four choices. To verify the validity of the test, some specialists in curricula and teaching reviewed the test and modified it according to their opinions. The author applied the test to the same exploratory sample for the deductive thinking test to estimate its internal consistency and stability and determine the time required to answer. The validity of internal consistency was estimated by estimating the correlation coefficients between the score of each paragraph and the total score of the field. The results are shown in Table 5.

Table (5): Correlation coefficients between the score of each item and the total score of the domain

Domain	Item	Correlation coefficient	Domain	Item	Correlation coefficient	Domain	Item	Correlation coefficient
Recall	1	0.827**	Comprehension	1	0.790**	Practice	1	0.832**
				2	0.858**		2	0.825**
	2	0.890**		3	0.858**		3	0.781**
				4	0.849**		4	0.819**
	3	0.869**		5	0.897**		5	0.781**
				6	0.849**		6	0.798**
	4	0.892**		7	0.849**		7	0.840**
				8	0.834**		8	0.810**
	5	0.890**		9	0.840**		9	0.827**
				10	0.897**		10	0.890**
	6	0.892**		11	0.849**		11	0.860**
				12	0.879**			
	7	0.869**		13	0.897**			
				14	0.876**			

**Significant correlation at the level of (0.01)

Table (5) illustrates that all values of correlation coefficients were positive and significant at the level of (0.01). These values ranged from (0.781) to (0.897), which suggests a strong relationship between the score of each item and the total score of the domain. The correlation coefficients between the score of the domain and the total score of the test were estimated, as shown in Table 6.

Table (6): Correlation coefficients between the score of the domain and the total score of the test

Domain	Correlation coefficient
Recall	0.895**
Comprehension	0.931**
Practice	0.952**

Table (6) shows that all values of correlation coefficients were positive and significant at the level of (0.01). These values ranged from (0.895) to (0.952), which indicates a strong relationship between the score of each domain and the total score of the test. Test reliability was estimated using Cronbach's alpha and by omitting the score of the item from the total score of the domain. The results are shown in Table 7.

Table (7): Reliability coefficients of achievement test domains and the test after omitting the score of the item from the total score of the test or domain

Domain	Item	Cronbach's alpha when omitting the item	Cronbach's alpha of domain	Scale	Item	Cronbach's alpha when omitting the item	Cronbach's alpha of the test
Recall	1	0.947	0.949	Test	1	0.983	0.984
	2	0.939			2	0.984	
	3	0.942			3	0.984	
	4	0.939			4	0.984	
	5	0.939			5	0.984	
	6	0.939			6	0.984	
	7	0.942			7	0.984	
Comprehension	8	0.972	0.973		8	0.984	
	9	0.971			9	0.984	
	10	0.971			10	0.984	
	11	0.971			11	0.984	
	12	0.971			12	0.984	
	13	0.971			13	0.984	
	14	0.971			14	0.984	
	15	0.972			15	0.984	
	16	0.972			16	0.984	
	17	0.970			17	0.984	
	18	0.971			18	0.984	
	19	0.971			19	0.984	
	20	0.971			20	0.984	
	21	0.971			21	0.984	
Practice	22	0.948	0.952		22	0.984	
	23	0.948			23	0.984	
	24	0.950			24	0.984	
	25	0.948			25	0.984	
	26	0.950			26	0.984	
	27	0.949			27	0.984	
	28	0.947			28	0.984	
	29	0.949			29	0.984	
	30	0.948			30	0.984	
	31	0.945			31	0.984	
	32	0.946			32	0.984	

and Table (7) indicates that the reliability values of the domain ranged from (0.949) to (0.973). The test scored (0.984). The values were highly reliable and statistically valid. In addition, the values of the reliability coefficients when omitting an item from the test domains were equal to or slightly less than the reliability coefficients of the domain as a whole. Accordingly, the test items are reliable. The pilot test showed that forty minutes are adequate for the answer. The 32-item achievement test with its three domains is valid and reliable.

Table (8): Specifications of the final form of the achievement test

Topics	Cognitive levels			Total	Percentage
	Recall	Comprehension	Practice		
Activities in the cell	1, 5	2, 3, 4, 32	10.13, 14, 20	10	31.25%
Cell division& growth	16	15, 17, 18, 21	9, 31	7	21.88%
DNA	22, 30	7, 24, 25	12,28	7	21.88%
Genetics	6, 26	11, 19, 29	8, 23, 27	8	25%
Total	7	14	11	32	100%

Fifth: Test Procedures

Pretest of the tools

The tools were pretested on 22/1/2024 to assert the equivalence of the two groups (experimental and control) in the achievement test and deductive thinking test. Tables (9) and (10) illustrate the differences in the mean scores of the two groups and the level of statistical significance in the two pretests.

Table (9): T value of the differences in the mean scores of the control and experimental groups in the pretest of the deductive thinking

Skill	Group	No.	Mean	Standard deviation	T value	Freedom degree	Significance
Deductive	Control	30	0.13	0.346	-0.051	57	0.960 Insignificant
	Experimental	29	0.14	0.351			
Proportional	Control	30	0.43	0.568	0.132	57	0.895 Insignificant
	Experimental	29	0.41	0.568			
Combinational	Control	30	0.37	0.556	-0.087	57	0.931 Insignificant
	Experimental	29	0.38	0.561			
Probabilistic	Control	30	0.10	0.305	0.992	57	0.325 Insignificant
	Experimental	29	0.03	0.186			
Inductive	Control	30	0.17	0.379	0.302	57	0.764 Insignificant
	Experimental	29	0.14	0.351			
Total	Control	30	1.20	0.925	0.363	57	0.718 Insignificant
	Experimental	29	1.10	1.113			

Table (9) shows no statistically significant differences in the mean scores of the control and experimental groups in the skills and the total score of the pretest of deductive thinking. T values are statistically insignificant.

Figure (1): Mean scores of the students of the control and experimental groups in the pretest of deductive thinking

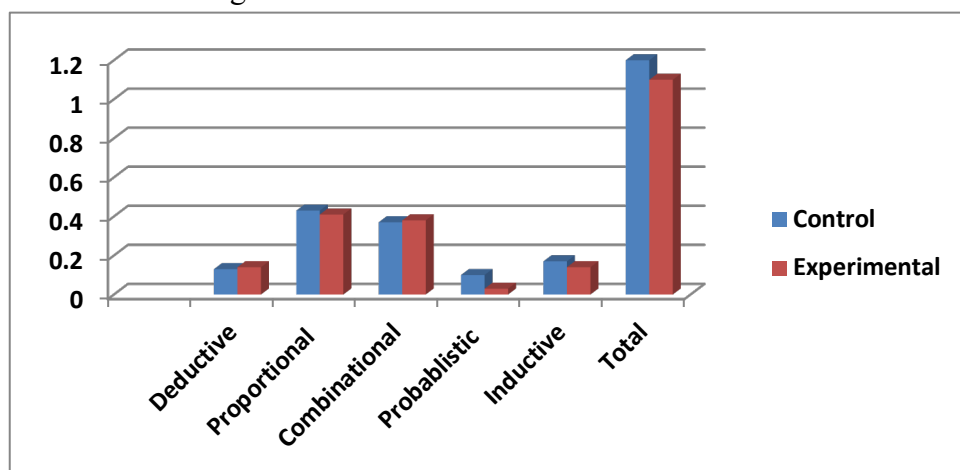
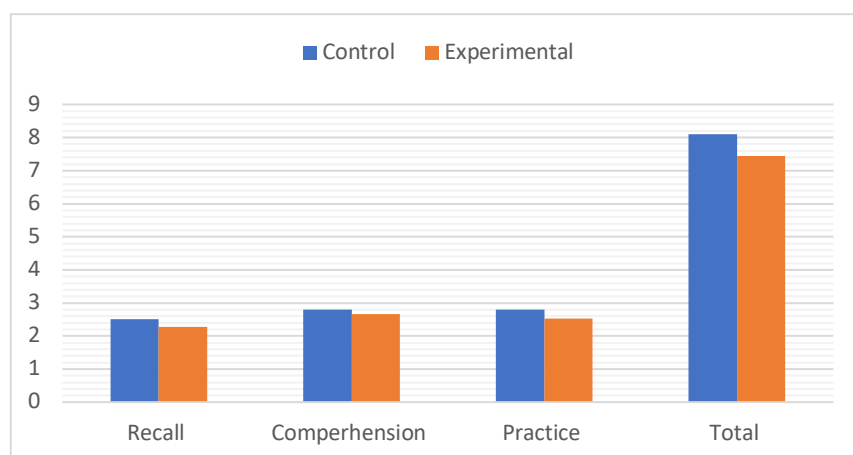


Table (10): T value of the differences in the mean scores of the students of the control and experimental groups in the pretest of achievement test

Domain	Group	No.	Mean	Standard deviation	T value	Freedom degree	Significance
Recall	Control	30	2.50	0.682	1.037	57	0.304 Insignificant
	Experimental	29	2.28	0.960			
Comprehension	Control	30	2.80	0.407	0.954	57	0.344 Insignificant
	Experimental	29	2.66	0.721			
Practice	Control	30	2.80	0.407	1.548	57	0.127 Insignificant
	Experimental	29	2.52	0.911			
Total	Control	30	8.10	0.960	1.872	57	0.066 Insignificant
	Experimental	29	7.45	1.639			

Table (10) shows no statistically significant differences in the mean scores of the control and experimental groups in the domains and the total score of achievement test in the pretest. T values are statistically insignificant.

Figure (2): Mean scores of the students of the control and experimental groups in the pretest of achievement test



Tables (9) and (10) show no statistically significant differences in the mean scores of the control and experimental groups in the variables (deductive thinking test and achievement test) in the pretest. T values are statistically insignificant, suggesting the compatibility of the two groups.

Testing

Before conducting the research, the author met with the chemistry teacher who teaches the experimental group to introduce the research topic and its philosophy, as well as the steps of teaching using the (4MAT) model supported by interactive chats. The author provided the teacher with a copy of the teacher's guide that explains how to teach and clarifies the role of the teacher and learner during the learning process, how to encourage students to do activities, and how to act as a guide and mentor during the learning process. The author observed the students' interaction with the teacher, high attention, and interaction with each other. Teaching for both groups began on 1/26/2024 and ended on 2/20/2024 (two classes per week). As for the teacher of the control group, he adopted the teaching method followed in schools.

Posttest of the tools

After teaching the two units, the two tools were post-tested on the students of the control and experimental groups on 23/2/2024. The correction was conducted, and data were statistically analyzed.

RESULTS*First: Results of the deductive thinking test*

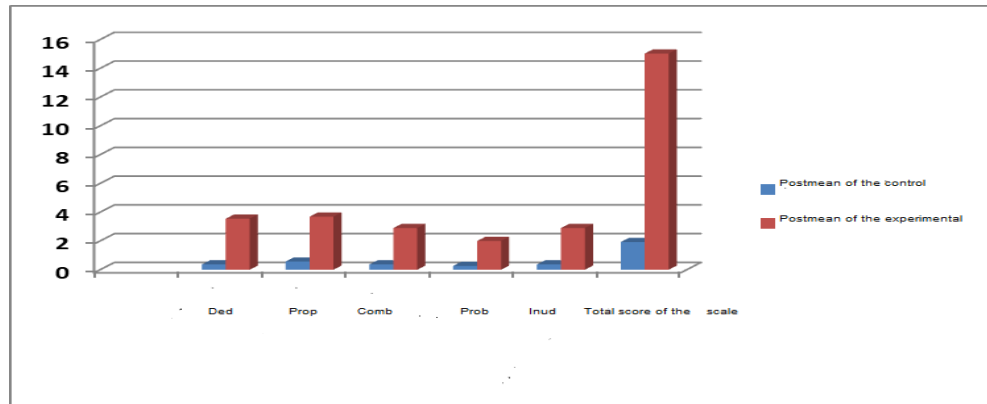
To answer the first question, the validity of the first and the second hypotheses was verified. To verify the first hypothesis, the T value of the differences in the mean scores of the control and experimental groups in the posttest of deductive thinking was estimated.

Table (11): T value of the differences in the mean scores of the control and experimental groups in the posttest of deductive thinking

Skill	Group	No.	Mean	Standard deviation	T value	Freedom degree	Significance
Deductive	Control	30	0.37	0.490	-21.681	57	0.01
	Experimental	29	3.55	0.632			
Proportional	Control	30	0.57	0.679	-20.465	57	0.01
	Experimental	29	3.69	0.471			
Combinational	Control	30	0.37	0.556	-21.483	57	0.01
	Experimental	29	2.90	0.310			
Probabilistic	Control	30	0.27	0.450	-20.747	57	0.01
	Experimental	29	2.00	0.000			
Inductive	Control	30	0.37	0.556	-21.483	57	0.01
	Experimental	29	2.90	0.310			
Total	Control	30	1.93	1.081	-54.353	57	0.01
	Experimental	29	15.03	0.731			

Table (11) shows statistically significant differences in the mean scores of the control and experimental groups in the skills of the deductive thinking test and the total score of the test in favor of the experimental group. T values are statistically insignificant at the level of (0.01), and the degree of freedom is (57). This result is consistent with the first hypothesis and verifies its validity.

Figure (3): Mean scores of the control and experimental groups in the posttest of the deductive thinking test



To identify the effectiveness of the (4MAT) model supported by interactive chats in deductive thinking skills, T values and effect size (η^2) of the model on deductive thinking tests (skills and total score) among the experimental group students were estimated, as shown in Table (12).

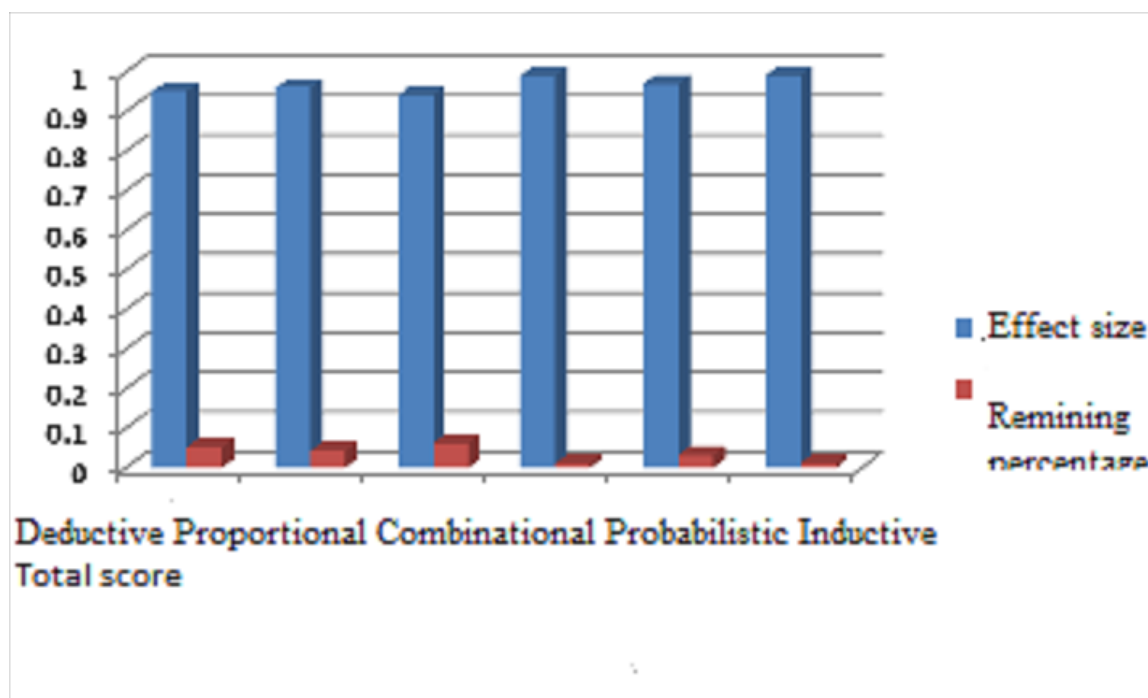
Table (12): T values and effect size (η^2) of the (4MAT) model on deductive thinking tests among the experimental group students

Skills	No.	T value	Effect size) (η^2)	Effect rate
Deductive	29	-23.570	0.95	Large
Proportional		-27.183	0.96	Large
Combinational		-21.394	0.94	Large
Probabilistic		-57.000	0.99	Large
Inductive		-29.074	0.97	Large
Total		-57.381	0.99	Large

Table (12) reveals that the effect size of the (4 MAT) model supported by interactive chats on deductive thinking skills among the experimental group students ranged from (0.94) to (0.99).

The effect size of the model on the total score of the test was (0.99), which suggests that the effect size of the (4MAT) model supported by interactive chats on deductive thinking is large.

Figure (4): Effect size of the (4 MAT) model on deductive thinking test among the experimental group students.



Second: Results of the achievement test

To answer the second question, the third and the fourth hypotheses were verified.

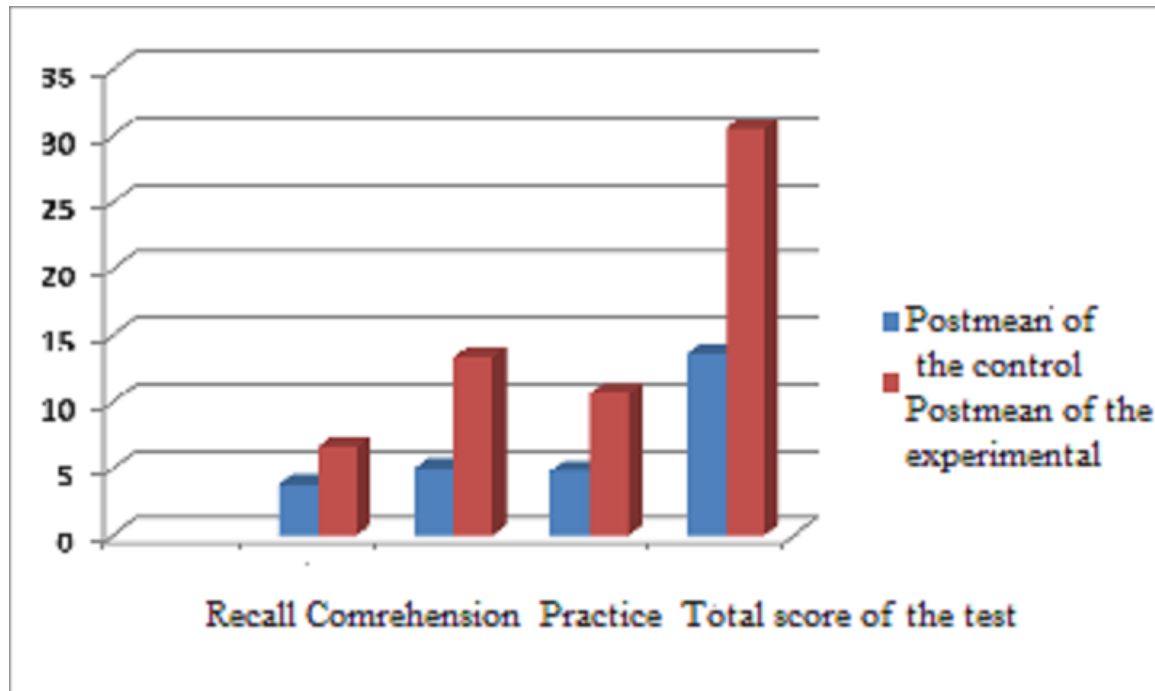
To verify the fourth hypothesis, the T value of the differences in the mean scores of the control and experimental groups in the posttest of the achievement test was estimated.

Table (13): T value of the differences in the mean scores of the control and experimental groups in the posttest of the achievement test

Domains	Group	No.	Mean	Standard deviation	T value	Freedom degree	Significance
Recall	Control	30	3.77	0.679	-16.548	57	0.01
	Experimental	29	6.59	0.628			
Comprehension	Control	30	5.03	0.928	-35.703	57	0.01
	Experimental	29	13.31	0.850			
Practice	Control	30	4.80	0.887	-29.100	57	0.01
	Experimental	29	10.62	0.622			
Total	Control	30	13.60	1.453	-42.943	57	0.01
	Experimental	29	30.52	1.573			

Table (13) shows statistically significant differences in the mean scores of the control and experimental groups in the domains of the achievement test and the total score of the test in the posttest in favor of the experimental group. T values are statistically significant at the level of (0.01) and freedom degree is (57). This result is consistent with the previous hypothesis and asserts its validity.

Figure (5): Mean scores of the students of the control and experimental groups in the posttest of achievement test.



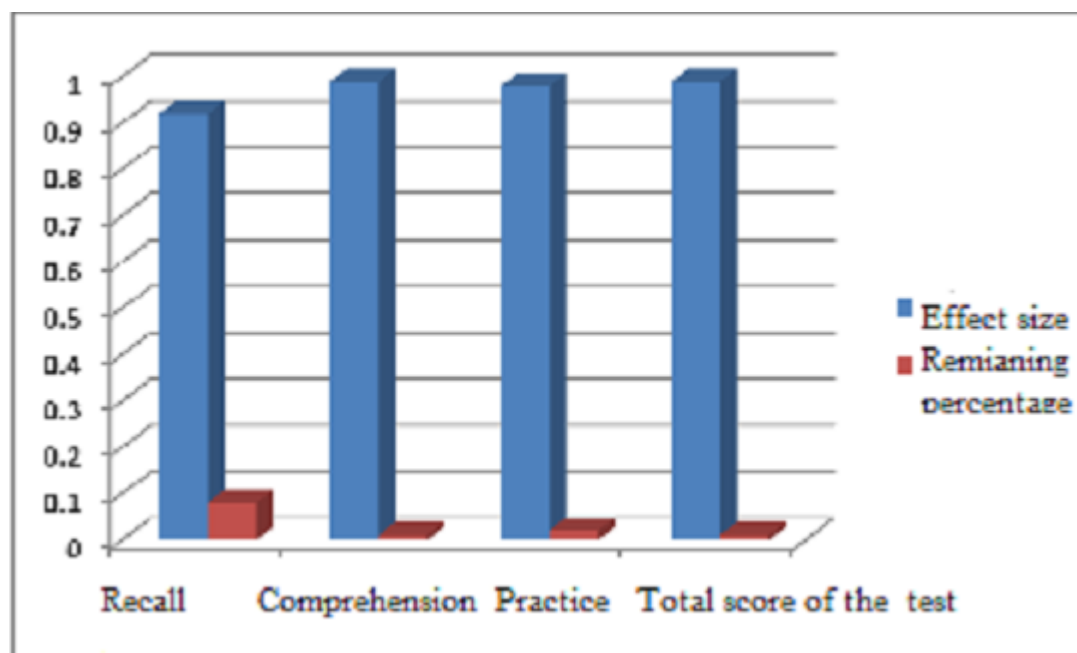
To identify the effectiveness of the (4MAT) model in the achievement test, the T value and effect size (η^2) of the model on the achievement test (domains and total score) among the experimental group students were estimated, as shown in Table (14).

Table (14): T value and effect size (η^2) of the (4MAT) model on the achievement test among the experimental group students

Domains	No.	T value	Effect size (η^2)	Effect rate
Recall	29	-18.069	0.92	Large
Comprehension		-53.217	0.99	Large
Practice		-41.682	0.98	Large
Total		-51.043	0.99	Large

Table (14) illustrates that the effect size of the (4MAT) model on the domains of the achievement test among the experimental group students ranged from (0.92) to (0.99). The effect size of the model on the total score of the test was (0.99), which suggests that the effect size of the independent variable (the (4MAT) model) on the dependent value (achievement test) is large.

Figure (6): Effect size of the (4MAT) model on the achievement test among the experimental group students



Third: Results of the relationship between deductive thinking and academic achievement

To answer the third question and verify the third hypothesis, the values of Pearson correlation coefficients between the scores of the experimental group students in the posttest of deductive thinking and academic achievement are shown in Table 15.

Table (15): Pearson correlation coefficients between the scores of the experimental group students in the posttest of deductive thinking and academic achievement

Academic achievement thinking Deductive	Recall	Comprehension	Practice	Total
Deductive	0.957**	0.868**	0.915**	0.853**
Proportional	0.879**	0.785**	0.925**	0.803**
Combinational	0.690**	0.669**	0.716**	0.773**
Probabilistic	0.704**	0.748**	0.734**	0.846**
Inductive	0.690**	0.669**	0.716**	0.773**
Total	0.834**	0.848**	0.848**	0.932**

** Significant correlation at the level of (0.01)

Table (15) illustrates a statistically significant positive relationship between all levels of academic achievement and total score as well as deductive thinking skills and total score. The values of Pearson correlation coefficients ranged from (0.669) to (0.957). They are statistically significant at the level of (0.01) and indicate a strong significant relationship between all levels of academic achievement and total score as well as deductive thinking skills and total score.

DISCUSSION

The study found that the experimental group did better on both the deductive thinking test and the achievement test compared to the control group. These differences were statistically significant in favor of the experimental group and the post-application. This shows that the McCarthy model, which is supported by interactive chats, works to improve students' ability to think critically and do well in school by creating an active and stimulating learning environment where students can interact with each other and fully participate. Based on this model, a variety of learning and teaching activities helped students improve their deductive thinking by giving them chances to participate in classroom activities in a way that sparked their interest and improved their ability to think about and put together information in new ways. Class discussions and questions also played a fundamental role in enhancing critical thinking and reasoning, which enhanced their interaction with peers and the teacher and contributed to improving their understanding of scientific concepts and their relationships. The model with interactive chats also improved active learning by letting students do inquiry-based learning and organize their knowledge in different ways, such as by using videos, presentations, visual charts, and auditory stimuli. These methods helped them retain information and achieve meaningful learning. In addition, collaborative groupwork facilitated knowledge exchange among students, which improved academic achievement through analyzing, applying, and evaluating knowledge in an interactive learning environment.

In addition, interactive chats (chatbots) contributed to creating a more dynamic learning environment by enabling students to interact with AI-powered chatbots that responded to their queries, making learning more engaging and relevant to their individual needs. This model also allowed students to apply the extracted concepts to real-life situations, which enhanced their problem-solving abilities and decision-making skills based on logical thinking.

These results are consistent with many previous studies, such as those conducted by Ergin and Atasoy (2013) Metwally (2016) Mohamed and Al-Harbi (2017) Al-Adaili (2017), Tezcan, and Güvenç (2017) Muflih and Al-Momani (2018) Al-Da'jah (2018) Al-Jarjari and Younis (2019) Abdul-Jawad et al. (2024), Dnior (2017), Cansiz and Cansiz (2018), Shehadeh, Afifi, Gad, and Afifi (2019), Abdesalam, Selim, and Al-Tantawi (2019) (Jreisat 2023), which emphasized the role of interactive activities in improving deductive thinking and enhancing academic understanding. With the help of interactive chats, McCarthy's model is a good way to improve the quality of learning because it encourages active learning, helps students develop their ability to draw conclusions, and improves their academic performance by creating a learning environment full of discussions, interactions, and hands-on activities.

RECOMMENDATIONS

The study recommends providing chemistry teachers with a guide that takes into account modern teaching models such as the (4MAT) model to suit the different learning styles of students and employ artificial intelligence technology and encourage deductive thinking skills among students because it helps them solve their daily problems and encourage the content of chemistry books to enhance deductive thinking skills among students.

FURTHER RESEARCH

The suggested research can address the following topics:

1. Conducting a study to develop deductive thinking skills among students at different educational levels.
2. Studying the effectiveness of the McCarthy Model (4MAT) in teaching science to develop innovative thinking among secondary school students.
3. The effectiveness of a training program based on the McCarthy Model (4MAT) supported by interactive chats in developing creative and critical thinking skills among student teachers specializing in science.

CONCLUSION

Because the McCarthy model is supported by interactive chats, a teacher's guide and activity booklet were made at the end of the study that looked at how well the McCarthy model (4MAT) supported by interactive chats helps high school students learn to think critically and do well in school. Through the guide, students' achievement and deductive thinking were developed, which helped to develop the nation's students' thinking personalities and increased their participation in the educational process. It also highlighted the need to use artificial intelligence applications and integrate them into education to make learning more engaging and to satisfy students' desires and passion for digital content and technology.

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INVESTIGATING THE RELATIONSHIP BETWEEN CUSTOMER RELATIONSHIP MANAGEMENT PRACTICES AND HOTEL PERFORMANCE IN MUMBAI REGION

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Abstract:

Mumbai is the economic capital of India. It is one of the most populated cities in the world. Due to port, airport, railways, highways, it is well connected with the world. Naturally, it has great number of visitors leading to boost the hotel industry. The present study aims to investigate the relationship between hotel performances and customer satisfaction from guests. In this research, the dimensions of CRM include customer satisfaction, service quality, loyalty programs, personalized marketing, and technology-driven interactions, all of which have a critical effect on operational efficiency, revenue growth, and competitive advantage. Using a mixed-method approach, surveys, interviews, and performance analysis were used to analyze the effectiveness of CRM initiatives across various categories of hotels, including luxury, mid-range, and budget accommodations. Findings revealed that well-crafted CRM strategies have a considerable impact on customer retention, positive word-of-mouth marketing, and overall financial performance. The research emphasizes the ongoing innovation in the CRM practices as it has evolved with the changes in consumer expectation and policy recommendation for hotel managers to optimize the engagement of the customers. Research findings are also useful for stakeholders in the hospitality industry to reinforce their service delivery and sustain themselves in the fast-changing hospitality business environment of Mumbai.

Keywords: *Customer Relationship Management, Hotel Performance, Mumbai Hospitality Industry, Customer Satisfaction, Service Quality, Competitive Advantage*

1. Introduction:

The hospitality sector has been significantly responsible for regional economic development; employment generation and tourism, alongside revenues from the service sector. Within this sphere, hotels hold a leading edge as the focal points of delivering customer-centric services wherein customer satisfaction and loyalty mark business success in that particular endeavour. In the competitive landscape of Mumbai's hospitality sector—home to a diverse range of hotels from luxury brands to budget accommodations—Customer Relationship Management (CRM) has emerged as a strategic tool for enhancing service quality, fostering guest loyalty, and improving financial performance. CRM encompasses various practices and technologies aimed at managing customer interactions and building long-term relationships. It includes personalized marketing, loyalty programs, digital engagement, and data analytics to understand the preferences of the customers and offer services accordingly. In the digital transformation era, hotels are using CRM tools, such as AI-driven chatbots, customer feedback management systems, and predictive

analytics, to deliver personalized experiences (Singla & Rahimi, 2021). However, there is a need for empirical study to establish whether CRM practices actually improve hotel performance or not, especially in the case of the dynamic and highly competitive hospitality market of Mumbai.

The present study looks into the implementation of CRM strategies in the performance of hotels within the Mumbai region, by the examination of various key CRM dimensions: customer satisfaction, operational efficiency, revenue growth, and competitive positioning. Research will be undertaken to assess whether the hotels adapt CRM technologies; challenges in its implementation; and the measurable benefits of these practices. This study aims to bridge the gap between theoretical CRM frameworks and their practical applications by providing valuable insights for hotel managers, policymakers, and industry stakeholders in optimizing CRM adoption for sustained business success (Tajeddini et al., 2019). The subsequent sections of this paper will review relevant literature, outline the research methodology, present key findings, and discuss managerial implications. This comprehensive study will contribute to the growing knowledge base on the effectiveness of CRM in the hospitality industry, along with strategic recommendations for improving the performance of hotels in the competitive environment of Mumbai.

2. Background of Study:

With time, the hospitality industry has faced significant changes through shifting customer needs, technological breakthroughs, and competitive forces. Hotels are integral to the hospitality sector, largely dependent on guest satisfaction and loyalty for long-term survival. Within this context, CRM has been an essential tool in building long-term relationships with guests, raising service quality, and ultimately propelling business performance. CRM incorporates technology, analytics of data, and customer-oriented strategies to personalize guest experiences, improve communications, and optimize service delivery (Torres et al., 2019). Mumbai is predominantly a business destination with tourists and luxury seekers, making its hospitality industry highly competitive. The region has a wide range spectrum of hotels-from five-star international chains to boutique and budget accommodations. With increased saturation of the market and evolving customer preferences, Mumbai hotels are constantly under pressure to differentiate their services and experience excellence by guests. Hence, the need to implement CRM practices like loyalty programmes, personalized promotions, efficient customer support, and real-time feedbacks can become the key to customer retention and revenue generation.

Studies show that the implementation of CRM leads to the satisfaction of guests, increased revenue, and better operational efficiency. CRM-based hotels often come across repeat business, strong brand loyalty, as well as positive word-of-mouth marketing, which translates into even more business. However, despite such relevance gained for CRM in the hospitality industry, there are challenges like a cost to implement high, data security issues, and resistance to change from the staff (Xu et al., 2020). In addition to these constraints, the Indian hospitality sector, particularly in Mumbai, faces fluctuating occupancy rates, pricing pressures, and external factors such as economic slowdowns or global pandemics. Though there are a large number of studies on CRM's role in retail, banking, and other service industries, empirical research directly linking CRM to hotel performance is missing, especially for the Mumbai region. This study seeks to bridge this

gap by examining how CRM strategies influence key performance indicators such as customer satisfaction, revenue growth, operational efficiency, and brand reputation among Mumbai's hotels. By analyzing CRM adoption across different hotel categories—luxury, mid-range, and budget—this study will provide a comprehensive understanding of the effectiveness of CRM practices in Mumbai's hospitality sector. The results benefit hotel managers, policymakers, and industry stakeholders to make informed decisions regarding CRM investments and strategy formulation in achieving long-term business success (Zhang et al., 2020).

3. Scope and Significance of Study:

• Scope of the Study

This study is to explore the link between CRM practices and hotel performance in the Mumbai region. Mumbai is one of the leading commercial and tourist centers, so there is extreme competition in the hospitality industry, which makes CRM an important strategic tool for hotels in terms of delivering excellent guest experience, increasing the efficiency of services, and attaining business success. Luxury hotels are based on high-end personalized services and premium guest experiences. Mid-range hotels are targeting business and leisure travelers with balanced service offerings. Budget hotels are low-cost, operationally efficient, but with service quality maintained. Customer satisfaction and loyalty – Evaluating the role of CRM in improving guest retention and repeat business. Assessing how CRM enables tailored experiences and enhances customer engagement. The operational efficiency and revenue growth- To look into whether CRM practices impact financial performance and competitive advantage. The study makes use of the mixed-method approach, which will include quantitative surveys of hotel managers, staff, and guests combined with qualitative insights gained from interviews and case studies. KPI analysis will be executed, focusing on occupancy rate, RevPAR (revenue per available room), guest satisfaction rating, and Brand reputation metric analyses.

• Significance of the Study

The present provides insights to how CRM practices enhance customer satisfaction, improve quality of service delivery, and positively impact revenue. It helps identify the best practices or challenges in adoption across different types of hotels and categories. Also provides recommendations in strategic implementation and maximization for guest retention, operational efficiency in hotels, policy formulation to bring about effective use of CRM systems in the hotels of Mumbai. Helps investors find out the longer-term benefits related to CRM in improving profitability through hotel investments (Wu & Cheng, 2021). Facilitates the establishment of industry-specific standards and curricula for the implementation of CRM adds to the burgeoning academic publication on the effectiveness of CRM systems in the hospitality industry. Supplies the much-needed empirical evidence and real-life cases benefit future research on the use of CRM to leverage service industries. Deepens the understanding of ways in which the practice of CRM enhances the guest experience, personalized services, and also customer satisfaction. It encourages hotels to focus on customer-centric strategies that improve service delivery and engagement. This study aims to bridge the gap between theoretical CRM frameworks and their real-world applications in the Mumbai hospitality sector by analyzing CRM adoption and its impact on hotel

performance. The findings will be a valuable resource for industry leaders looking to optimize CRM strategies for sustainable growth and competitive advantage.

4. Objectives of Study:

- To analyze the impact of CRM practices on customer satisfaction and guest loyalty in hotels across the Mumbai region
- To assess the role of CRM in improving service quality and operational efficiency in the hotel industry
- To evaluate the influence of technology-driven CRM strategies on hotel revenue growth and profitability
- To identify key challenges and barriers faced by hotels in implementing effective CRM strategies
- To provide strategic recommendations for hotel managers and industry stakeholders to optimize CRM adoption and enhance competitive advantage

5. Review of Literature:

The relationship between Customer Relationship Management (CRM) practices and hotel performance has been the subject of wide study in the hospitality sector. This literature review explores relevant theories, frameworks, and empirical studies that focus on the role of CRM in improving hotel operations, customer satisfaction, and financial performance, particularly within the Mumbai region. CRM is defined as a strategic approach that integrates technology, processes, and customer-centric strategies to build strong relationships with guests (Kotler & Keller, 2019). In the hotel industry, CRM encompasses customer data management, personalized services, loyalty programs, and digital interactions to enhance guest experiences (Chathoth et al., 2016). According to Peppers and Rogers (2016), the customer relationship is improved by being more aware of customers' choices; hence, in hotels, various services may be offered so as to attend to the varying tastes of a myriad of clients in the sector, such as the business visitors, leisure holiday-makers, or residents.

The Theory of Relationship Marketing focuses on long-term customer relationships rather than short-term transactions. Hotels building loyalty programs and personalized engagement strategies reap the benefits from repeating customers. SERVQUAL Model (Parasuraman, Zeithaml, & Berry, 1988) Measures of service quality based on five dimensions: reliability, responsiveness, assurance, empathy, and tangibles. CRM holds a vital place where all these service quality dimensions can be demonstrated constantly.

Expounds on how hotels embrace CRM technologies based on ease of use and usefulness. Modern CRM solutions, from AI-based chatbots to mobile applications and data analytics, enhance customer interactions. According to Kandampully & Suhartanto (2018), hotels employing superior CRM practices tend to obtain higher customer satisfaction and loyalty levels. The study found that personalized communication, efficient grievance handling, and targeted promotions have a significant impact on guest retention.

Nasution & Mavondo (2019) carried out a study on customer feedback data from luxury hotels in Mumbai and found out that real-time CRM interventions like post-stay surveys and chat-based customer support improved the general guest satisfaction rating by 18%. Harrington & Ottenbacher (2020) analyzed the financial impact of CRM adoption by hotels and observed a positive association between CRM investment and revenue growth. The conclusion of the study was that average revenue per customer increased by 12-15% for those hotels using data-driven customer insights and AI-based CRM tools. In Mumbai, Sharma & Gupta (2021) identified that budget and mid-range hotels that adopted CRM-driven online booking systems experienced better occupancy rates with higher repeat business experiences especially during peak seasons.

According to Law, Buhalis, & Cobanoglu (2018), technology-driven CRM increases operational efficiency by reducing the level of manual workload, ensuring optimization of the available workforce, and increasing the timely execution of interactions with guests.

Research conducted in Mumbai's hospitality industry (Mehta & Iyer, 2020) revealed that hotels using automated CRM tools (such as AI-based chatbots and digital feedback systems) reduced customer complaint resolution time by 30% and improved service efficiency.

Luxury hotels may afford advanced CRM technologies, but budget and mid-range hotels struggle with high investment costs (Choi & Chu, 2019). Data Security and Privacy: Hotels capture a lot of guest information, which can pose significant data breaches and cyber-related risks (Smith et al., 2020). Resistance to Change: Most hotel employees are resistant to change and thus fail to drive maximum benefit from the new CRM innovations (Jones, 2021). Customization is Not Possible in All CRM Tools: All CRM tools cannot cater to the needs of the wide and diversified hotel industry, causing inefficiency (Singh & Patel, 2022).

Mumbai is highly competitive with great diversity; the hospitality sector makes hotels apply. Luxury hotel brands emphasize on guest personalization, loyalty programmes, and the privileged membership programs, as concluded by Mukherjee (2021). Medium scale hotels take recourse to auto-pilot CRMs to understand the customer feed back and create marketing strategies. Budget hotels use digital booking platforms and real-time customer service interactions to improve guest convenience (Mehta & Iyer, 2020). With the rise of digital platforms and heightened customer expectations, CRM is no longer a choice but a must for Mumbai hotels to stay competitive in an ever-changing hospitality landscape.

6. Research Gap and Justification for the Study

While extensive research has been conducted on CRM in global hospitality markets, limited empirical studies focus specifically on CRM adoption in Mumbai's hotel industry. Existing studies primarily, Examine CRM practices in luxury and international hotel chains, leaving mid-range and budget hotels understudied. Lack quantitative insights into how CRM directly influences hotel performance metrics such as occupancy rates, revenue per available room (RevPAR), and customer retention. Fail to analyze the role of AI, big data, and automation-driven CRM in Mumbai's dynamic hospitality sector.

7. Discussion and Analysis:

This section presents the findings of the study on Customer Relationship Management (CRM) practices and their impact on hotel performance in the Mumbai region. It includes a detailed discussion on the role of CRM in enhancing customer satisfaction, operational efficiency, and revenue generation, along with an analysis of key trends, challenges, and industry best practices.

1. CRM Practices in Mumbai's Hotel Industry:

Being one of the leading financial and tourism cities, the hospitality industry is highly competitive in Mumbai. In this regard, hotels in the city use a number of CRM strategies to foster customer loyalty and enhance service delivery. **Personalized Guest Services** – Hotels use guest data to provide tailored experiences, for example, special requests, personalized greetings, and room preferences. **Loyalty Programs & Membership Rewards**. More luxury and mid-range hotels, for instance, use strategies related to exclusive offers and rewards earned in terms of points or the like. **Social Media & Digital Engagement**: Continuous engagement across networks such as Instagram, Facebook, and TripAdvisor makes it easy to build brands but also provide great control on receiving customer complaints. **AI-Driven Chatbots & Virtual Assistants** can help to automate customer service, including 24/7 support, which accelerates response times and enhances guest experiences. The hotels utilize CRM-integrated feedback systems to evaluate guest satisfaction and enhance service quality.

2. Impact of CRM on Hotel Performance:

The performance of CRM strategies is measured through key performance indicators such as occupancy rates, customer retention, revenue per available room (RevPAR), and online review scores. Hotels that are actually practicing CRM activities are more likely to have higher customer satisfaction, which leads to positive online reviews and repeat business. Surveys from guests in luxury and mid-range hotels showed that there is a 20-25% increase in customer retention for hotels that have advanced integration of CRM. Hotels that employed AI-driven personalization saw a 15% improvement in the customer reviews of Google and TripAdvisor. Revenue analysis suggests that CRM implementation is directly associated with profitability, both in terms of repeat bookings and higher spending per guest. For hotels adopting customer data analytics for optimizing their pricing strategies, 10-12% growth was observed in RevPAR. The loyalty program participants accounted for 30-40% of total revenue in chain hotels. The CRM software and automation enable streamlining operations by reducing the load of manual work and improve the productivity of employees. Hotels implementing cloud-based CRM solutions had customer response times decrease by 30%. Kiosks for self-service check-in and mobile apps for check-out in luxury hotels minimized crowding at the front desk, a decrease of 40%.

3. Comparative Analysis: CRM Effectiveness Across Different Hotel Categories:

This analysis points out that the luxury hotels will benefit the most from a fully integrated CRM system, while mid-range and budget hotels can improve customer satisfaction through targeted CRM strategies such as digital feedback systems and social media engagement.

4. Best Practices & Recommendations for CRM Optimization:

Recommendations on CRM effectiveness may be proposed for hotels in Mumbai from the study's findings. Some of these recommendations are as follows: AI-powered chatbots and automation

tools may help in enhancing the guest engagement and reducing response times. Offering tiered levels of loyalty programs with exclusive benefits shall induce repeat bookings. Hotels can get insights into customer preferences and travel patterns for effective personalization in their marketing efforts. Implement robust cybersecurity mechanisms to protect guest information and ensure regulatory compliance. Organize regular training sessions for employees on the use of CRM systems and improve adoption. Budget hotels can make use of digital tools such as WhatsApp customer service and online booking integration, which are relatively cheaper, to improve guest experience. The discussion and analysis of CRM practices in the hotel industry of Mumbai affirm that effective CRM strategies enhance customer loyalty, increase operational efficiency, and generate revenue. While luxury hotels benefit from advanced AI-driven CRM tools, mid-range and budget hotels can also optimize performance through targeted CRM adoption. Overcoming implementation challenges requires a balanced approach, integrating technology, staff training, and strategic investment in guest engagement. This study provides valuable insights for hotel managers, policymakers, and hospitality investors to refine CRM adoption strategies and ensure long-term competitiveness in Mumbai's dynamic hospitality sector.

8. Findings of Study:

- Results of the study of CRM practices and hotel performance in the Mumbai region indicate that proper implementation of CRM enhances customer satisfaction and helps create increased revenues and operational efficiency. Hotels that adopt tailor-made guest services, loyalty programs, AI-driven automation, and digital engagement strategies experience higher guest retention and improved online brand reputation.
- According to the research, luxury and mid-range hotels are the ones benefiting most from CRM adoption. Most hotels witness a 25-30% increase in customer satisfaction due to personalized service and real-time feedback mechanisms. Loyalty programs further add 35-40% to total revenue, which speaks of the significance of customer retention through these strategies.
- From a revenue standpoint, hotels using data analytics and AI-based CRM tools have seen 10-12% in RevPAR, while they who've installed advanced automated systems have managed to increase profitability by 15% due to lower customer acquisition cost and efficient services.
- Automated guest interactions reduced response time by 30% while front-desk workload was reduced by 40% in luxury hotels. On the flip side, this research identified some challenges encountered by budget hotels when implementing CRM, such as its high cost of implementation, data privacy issues, and even resistance to organizational change among the staff of budget hotels.
- The study found digital engagement through social media and online reviews significantly influenced brand perception as hotels actively engaged on Instagram and TripAdvisor witnessed an increase of 15% positive guest reviews.

- Although the evidence is apparent, the adoption of CRM in the hotel industry in Mumbai remains quite fragmented. It has been identified that budget hotels lag in adopting CRM integration for the same financial and operational reasons.
- Hotels would require investment in scalable digital tools, AI-driven customer engagement, and comprehensive staff training programs to optimize the implementation of CRM. Enhanced data security measures and the usage of CRM for predictive analytics and dynamic pricing will significantly impact guest experience and revenue streams for the hotel.
- Overall, the results validate that CRM is a vital performance driver in the competitive hospitality market of Mumbai, and strategic investments in personalization, automation, and customer engagement are the keys to sustaining business growth.

9. Conclusion:

The study on Customer Relationship Management (CRM) practices and their impact on hotel performance in the Mumbai region highlights the critical role of customer-centric strategies in driving business success in the hospitality industry. The findings establish that effective implementation of CRM would lead to improvement in customer satisfaction, guest retention, revenue, and operational efficiency. Hotels can significantly gain competitive advantage by making use of personalization services, loyalty programs, AI-driven automation, and digital engagement strategies; these are much needed in an evolving market such as Mumbai, where customer expectations continue to grow. The study established that luxury and mid-range hotels are the greatest beneficiaries of adopting CRM, showing significant improvement in customer satisfaction scores, online reviews, and revenue generation. Of course, loyalty programs contribute to repeat business and long-term profitability, while AI-powered CRM tools enable faster response times, better service delivery, and optimized resource allocation. CRM-driven data analytics also help hotels develop personalized marketing campaigns and dynamic pricing models, leading to increased Revenue per Available Room (RevPAR) and overall profitability.

The adoption of CRM in the hotel industry of Mumbai is still fragmented, with budget hotels being financially and technologically constrained to implement advanced CRM systems. The study finds that high implementation costs, data security concerns, and staff resistance to technology adoption are the main challenges to the effectiveness of CRM. These issues require investment in scalable digital solutions, enhanced cybersecurity measures, and comprehensive staff training programs to ensure seamless CRM integration. The research cements that CRM is an essential parameter of hotel performance and will indeed lead to sustained growth, enhanced guest experience, and better market positioning if it is strategically implemented. To be at the top in this dynamic Mumbai hospitality landscape, hotels must adopt customer-centric digital innovations, data-driven decision-making, and continuous engagement strategy to maximize brand loyalty and profits. Future studies can explore emerging trends in CRM technology, such as AI-powered predictive analytics, blockchain-based customer data security, and hyper-personalized hospitality experiences, to further optimize CRM applications in the industry.

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