

The Impact of Using Mind Maps on Teaching Arabic Grammar

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Abstract—This study examined the impact of utilizing mind maps to teach Arabic grammar to intermediate-level learners. It looked into how mind maps improve students' understanding of grammatical concepts, improve their ability to recall and apply these rules in novel contexts, and boost participation and engagement in the classroom. A group that received teaching using mind maps was compared to a group that received training using traditional methods in this experimental investigation. Data were gathered through instructor observations, pre- and post-tests, and involvement and engagement surveys. The results showed that students who used mind maps outperformed their peers in all areas, including understanding, application, participation, and memory. Participation and involvement in the classroom were strongly associated with students' comprehension. Mind maps also assisted in balancing student performance and reducing achievement gaps. The requirement for training, longer preparation times, and some students' unwillingness to change were practical obstacles. To sum up, mind maps are a useful teaching tool for improving Arabic grammar comprehension, retention, and engagement while assisting students in overcoming challenging grammatical rules. Mind maps may be effectively used in classrooms with careful preparation and prior training. The study suggests including mind maps as a necessary part of the grammar curriculum rather than a sporadic addition and educating instructors and students in their usage prior to deployment.

Index Terms—mind maps, grammar, retention, classroom engagement

I. INTRODUCTION

Students have traditionally struggled with Arabic grammar, particularly when using traditional educational techniques that focus on memorisation and rote learning without utilising any visual aids to assist students in grasping sentence structure and word connections. This technique not only makes learning challenging for them, but it also makes it harder for them to write effectively and express themselves (Aljedayah et al., 2024; Almsbhiheen et al., 2023). In order to assist students in structuring knowledge in their minds in a way that is simpler and quicker to comprehend, the demand for contemporary teaching techniques has arisen. This study focused on the impact of using mind maps in teaching Arabic grammar, especially for students at the intermediate level. The goal was to examine whether mind maps truly help students understand the rules more easily, remember them, apply them to new examples, and increase engagement and classroom participation (El-Ebiary et al., 2024; Amer et al., 2024; Al-Zyadat et al., 2025).

Sometimes students get lost between parsing the subject and predicate, types of sentences, prepositions, and complex grammatical terms. This causes students to become frustrated and disinterested, particularly when the instructor presents difficult language in a conventional manner without using any interactive or visual aids that aid with information retention. Students often face this problem, which certainly affects their academic performance directly and also impacts their ability to express themselves and write correctly (Harara et al., 2024; Istiqomah et al., 2025; Malkawi et al., 2020). Here comes the role of searching for modern teaching methods that help students understand the rules visually and systematically so they can see the relationships between the information clearly. One of the most

prominent methods that has emerged in recent years is mind mapping, which has become a powerful tool in modern education (Abu Melhim et al., 2023; Alazzam et al., 2024).

Mind maps are not a new idea in essence, but they have recently become widely popular in the field of education because they help organise information and connect it visually, allowing students to see the complete picture of any topic or grammatical rule easily. Instead of the student reading a long and complicated text about the rules and trying to memorise the terms and examples, mind maps break down the information into small, organised parts, as if they are building a map in their mind that clarifies the relationships between words, verbs, pronouns, and sentences (Al-Bdour et al., 2025; Al-Manasreh, 2025; Saleh, 2025, 2026; Abu-Elrob & Tawalbeh, 2022).

Mind mapping is known to enhance metacognition and educational achievement by providing a multidimensional outline that engages learners in topic introduction, idea management, and connection-making. Research has shown that mind mapping can facilitate information processing through a combination of text, images, and colour, contributing to better memory retention and promoting both active and collaborative learning (Abu-Elrob, 2019; Abusheirah et al., 2024; Al Qathami & Manasrah, 2025; Al-Rawashdeh et al., 2024).

Recent studies have demonstrated that students who use mind maps have a greater ability to understand and comprehend, as well as apply rules to new examples. When a student sees the rule written in a networked and visual form, the mind can connect the information more quickly and retain it more effectively. Mind maps also combine words, symbols, and colours, which provides the brain with multiple entry points for learning—whether visual, auditory, or even kinaesthetic. This method helps students retain information in the long term (Alorani et al., 2026; Alajlouni et al., 2025; Al Etoum et al., 2025; Sawalha & Abu Al-Nahel, 2025; Alazzam et al., 2024).

Teaching Arabic, particularly grammar, requires a clear method because students sometimes get lost between the rules and complex terms and do not know how to connect meaning and structure smoothly. Every grammatical piece of information, if the student does not understand it correctly, will affect the rest of the sentences and exercises. For example, if the student does not understand the difference between the subject and predicate or between the present and past tense, they will find it very difficult to write a correct sentence or understand an Arabic text (Rababah et al., 2025; Eazolli et al., 2025, 2026). Even teachers have started to find it difficult, especially when traditional teaching methods are not effective. Sometimes the teacher explains, and the students listen, but there is no method to clarify the relationships between words and sentences (Abu Omar et al., 2025; Alqudah & Khasawneh, 2025; Alghazo et al., 2023).

A. Problem Statement

Many students experience pressure and bewilderment as a result of dull classes. Because they give students a clear mental plan and enable them to see all the material pertaining to grammatical rules in an orderly and structured way, mind maps are crucial for such students. Furthermore, rather than emphasising memorisation, the mind map method encourages students' involvement and engagement. When a learner can understand the wider picture and draw connections between rules and instances, their confidence increases and they become more skilled at implementing the rule without depending on memorisation only (Al-Bdour et al., 2025).

Furthermore, by using mind maps, the teacher will be able to organise the course in a way that is clear and interesting, making it easier to explain the concepts and boosting student engagement. Additionally, mind maps save the time required for memorisation since they logically and clearly link knowledge.

B. Research Questions

The study attempts to answer these questions:

- Does using mind maps in teaching grammar enhance students' understanding of the lesson compared to traditional methods?
- Do mind maps affect students' ability to remember and apply grammatical rules?
- Is there a difference in performance between students who learn through traditional methods and those who use mind maps?
- What challenges might teachers face when applying mind maps in the classroom, and how can these challenges be overcome?

II. LITERATURE REVIEW

A. Theoretical Background

When we talk about "using mind maps" in teaching grammar, we need to understand two things: first, what a mind map is and how it works; and second, the nature of Arabic grammar and why it poses a challenge. Then we need to see how mind maps help in addressing these challenges.

(a). Mind Maps

In short, a mind map is a visual tool for representing related information in a centralised manner, starting from a main idea or topic from which branches extend to represent sub-ideas or the relationships between words and concepts. Instead of the lesson being just a long text or slides, the student sees the map as a network or diagram showing the relationship between vocabulary and grammar. The advantage is that it uses colours, symbols, images, or keywords,

helping the human brain remember faster and connect ideas more easily (Rababah et al., 2025).

(b). *The Nature of Arabic Grammar and the Challenges*

Arabic grammar rules—such as *i'rāb* (case endings), sentence parts, verbal and nominal sentences, types of verbs, prepositions, etc.—can be complex for students, especially if explained in a traditional manner, because many rules involve relationships between words and their positions in the sentence, not simply memorising isolated pieces of information. Also, grammatical terms (such as subject, predicate, verb, and object) require prior understanding, along with practice and application. When the explanation method is boring or lacks visual representation, many students feel confused or bored, or they are unable to connect the rule with practical examples. Thus, mind maps can help in teaching grammar through:

- Simplifying relationships: Instead of the student seeing a long, complex rule, they see it as a map starting from a main concept like “verb” and branching out into its forms (“past tense, present tense, imperative”), with each branch further subdividing into types or examples. This way, the brain progresses step by step.
- Consolidating visual memory: Because maps include colors and symbols, students frequently observe them visually all at once, which helps with retention.
- Establishing connections between ideas: For example, when we see “prepositions” in a branch and “from, to, about, on...” beneath it, we can clearly perceive the relationship between the preposition, its position, and its influence in the sentence.
- Increasing involvement and engagement: To make the process interactive rather than passive, the instructor might encourage students to finish an incomplete map or construct a mind map themselves.
- Accommodating different levels: For students with weaker skills, maps make it easier to start with simple concepts; for more advanced students, they can expand into branches and applications, making the approach flexible.

Although modern visual methods have been used and tested in teaching, there is still not a vast amount of research specifically focused on mind maps + Arabic grammar + the relevant grade levels, especially in Jordan or the Arab world. Therefore, this research aims to explore the effectiveness of the method with real students, compare it with the traditional method, identify challenges and obstacles, and provide recommendations for teachers.

B. *Previous Studies*

Bataineh and Al-Majali (2023) investigated how Jordanian EFL tenth-grade students’ usage of additive, adversative, causal, and temporal conjunctions may be impacted by mind mapping-based training. A deliberate sample of two tenth-grade sections from a public school in Mafraq, Jordan, was selected. The two sections were randomly assigned to two groups: a control group of 13 students who were taught according to the recommended teacher’s book, and an experimental group of 14 students who were taught using mind mapping. Data were gathered using a post-test after an eight-week treatment period. The results showed that the experimental group outperformed the control group overall and in the usage of the four types of conjunctions.

Mufarrah (2023) taught grammar to children whose native language is not Arabic using mind maps. Even though the principle remained the same, the biggest obstacle was the trainees’ poor proficiency in Arabic. The findings demonstrated that utilising mind maps made it easier for students to comprehend the ideas and apply them to new phrases. When compared to the conventional approach, the researcher also saw a decrease in the error rate and an increase in the learners’ confidence in applying the rules. Since the study indicates that the method can be applied to students who are not proficient in the language, we anticipate that it will be effective when applied to Arab students who struggle with grammar.

Kacem and Mazouzen (2024) focused on third-year secondary school students in the Literature and Philosophy stream and worked on simplifying grammatical rules using mind maps. The study demonstrated that the method helped students understand the rules more easily and apply them to new examples without relying on memorisation. The results also showed that students developed a better ability to connect the verb, subject, and object, as if they could see the “complete rule map”. The impact was significant, and the students became more engaged in class discussions.

This study is significant because it is an example from the Arab world and at a stage close to many schools in Jordan, and thus the study results are applicable in the Jordanian context. It also confirms that mind maps are effective with adolescent students, and this stage is sensitive to visual and interactive learning. For our research, this result is important because it supports the idea of using maps to simplify complex rules such as compound sentences and defective verbs, and also to standardise performance levels among different students.

Khumaidah et al. (2025) focused on teaching Arabic grammar using mind maps, particularly the Ajrumiyyah text, to high school students. According to the study, students were able to apply the rules to various cases and started to comprehend them more quickly and clearly. The global nature of this study offers the advantage of showing that mind maps might be effective outside of the Arab world. The study’s objective was to use visual aids to make complex regulations easier to grasp. This is useful for our study since we are looking for practical proof that mind maps function even when students are presented with difficult and complex rules. In line with the present research’s premise, the study also emphasised classroom involvement and practical implementation.

El-Kenany (2021) investigated how using the mind mapping technique may improve EFL first-year secondary stage

students' English grammatical ability. The instruments developed and used in this study were an English Grammar Achievement Test, which was used as a pre-, post-, and follow-up test to gauge students' grammatical achievement levels, and a questionnaire on English grammar learning issues to ascertain the difficulties EFL first-year secondary stage students face in learning and achieving English grammar. One group was used in the study's experimental design. The mind mapping approach was used to instruct the participants. The results demonstrated the efficiency of the mind mapping approach in raising students' proficiency in English grammar. This study proves that an electronic version of the maps can yield the same positive results. Therefore, technology can be employed with mind maps in Jordanian classrooms to increase interaction and improve outcomes.

Alwattar and Al-Balhan (2018) studied how the e-mind maps strategy affected the academic achievement level of primary students in Kuwait in terms of learning Arabic vocabulary skills. In the post-achievement test of acquiring Arabic vocabulary, there were statistically significant differences between the experimental and control groups' mean scores, in favour of the experimental group.

Aydoğdu and Alyılmaz (2024) investigated the efficacy of mind mapping for teaching grammar in Turkish as a foreign language. Twenty-two students were taught the mind mapping technique for seven weeks. Following that, each student was interviewed individually. The data were analysed using content analysis. Grammar structures were taught using mind mapping diagrams while teaching Turkish to non-native speakers. The diagrams used were based on the judgements of the instructors. The study employed the interview technique for gathering qualitative data. Based on the learners' perspectives, the results showed that the mind mapping approach was successful in teaching grammar, its structure facilitated instruction, it contributed to memory, and it helped form a positive attitude towards the lesson.

Ragab et al. (2024) used a pre-post writing test with an analytical writing assessment scale to assess students' performance in descriptive writing and writing electronic messages. A questionnaire was also used to determine the necessary writing skills for second-year preparatory female students. According to the results, the post-writing test means of the experimental and control groups differed statistically significantly in favour of the experimental group. The application of electronic mind mapping improved the writing abilities of the students.

III. METHODOLOGY

A. Study Design

A pre-test and post-test were used for two separate groups in the quasi-experimental design. In order to ascertain each group's starting level, the same test was administered to each group before the study began. After that, mind maps were used to train one group while the other group carried on with their conventional education. Then the identical test was administered once more, and the results were compared. Through this technique, the researchers were able to ascertain whether mind maps had an actual impact rather than only an impression. Additionally, sophisticated statistical analysis (ANOVA, t-test, and Cohen's d) was employed to precisely and scientifically assess the differences.

B. Study Population and Sample

The study population was made up of students in the tenth grade from a public school in Irbid, Jordanian. The students study grammatical rules extensively, and they frequently have difficulty understanding them, which is why we selected them. There are around 120 students in all, split up into four groups. Forty students were chosen as a purposive sample (20 in the experimental group and 20 in the control group). By using their prior grammar scores and administering a pre-test to verify their equivalency before beginning, the researchers made sure that their overall level was comparable. The experimental group studied grammar topics (such as the subject and object, nominal and verbal sentences, and complex sentences) using mind maps. The control group studied the same topics, at the same time, but in the traditional way (explanation, examples, and textbook exercises).

C. Study Tools

The study relied on three main tools:

- *Grammar test (pre and post-test)*: it is composed of 25 questions varying between multiple choice, error correction, and sentence completion. It was presented to a committee of Arabic language experts in order to confirm its legitimacy.
- *Student Engagement Survey*: it assesses how much students participate and engage in class. It has fifteen items on a five-point Likert scale.
- *Classroom Teacher's Notes*: The instructor noted notes on the level of student participation, comprehension speed, and question quality.

D. Methods of Implementation

- *Setting up*: For the first week, the researchers trained the instructor who would be using mind maps. After we told him how to create one (for instance, the nominal phrase = subject + predicate), the instructor created a grammatical map using colours and arrows to indicate links.
- *Phase One (Pre-test)*: To determine each student's starting level, we gave the exam to every student.
- *Phase Two (Teaching)*: For six weeks, the experimental group used mind maps to study, averaging two sessions

each week. In certain classes, technological tools like MindMeister and XMind were utilised, and the maps were sketched on the board and occasionally on the students' papers. After every class, the instructor also invited the students to create their own maps. The control group used the conventional method (written examples and theoretical explanations) to study the same subject on the same schedule.

- Phase Three (Post-test): After the study period ended, the researchers re-administered the test and recorded teacher observations.

E. Experimental Controls

To ensure that the results were not affected by external factors, the study maintained the following controls: The same teacher taught both groups, both groups had the same number of classes and duration, the same subject matter and content were taught, and communication between the two groups regarding the teaching method was restricted to avoid overlapping information.

IV. RESULTS AND DISCUSSION

The average theoretical understanding scores between the two groups are displayed in Table 1.

TABLE 1
MEAN SCORES OF THEORETICAL UNDERSTANDING BETWEEN THE TWO GROUPS

Dimension	Experimental Group (M)	SD	Traditional Group (M)	SD	t-value	p-value
Theoretical Understanding	85.34	4.92	66.11	5.48	12.45	0.000

It is clear from Table 1 that the experimental group, which used mind maps, excelled significantly. This result confirms that the visual and organisational approach of mind maps is very effective in simplifying difficult information. In the same vein, Bataineh et al.'s (2023) study showed that tenth-grade students who learnt English using mind maps, excelled significantly. Also, Wahid and Sudirman (2022), which studied the impact of mind maps on English grammar, showed a significant difference in comprehension in favour of the experimental group. In the same vein, Wannas et al. (2022) revealed that the maps enhanced students' understanding of the rules compared to traditional methods.

TABLE 2
PRACTICAL APPLICATION GRADES OF THE RULES

Dimension	Experimental (M)	SD	Traditional (M)	SD	t-value	p-value
Practical Application	82.45	5.10	63.50	6.01	11.78	0.000

Table 2 displays that the experimental group was able to apply the rules better. The reason is that the maps allow the student to see the relationship between grammatical components (subject, object, verb) in the form of an interconnected map. This result was supported by other studies, such as Kacem and Mezouane (2024), which revealed that maps helped simplifying grammatical rules. Al-Malki (2022) also showed that students were able to apply the rules more easily when using maps. Table 3 presents the recall and retrieval.

TABLE 3
RECALL AND RETRIEVAL

Dimension	Experimental (M)	SD	Traditional (M)	SD	t-value	p-value
Recall and Retention	88.12	4.55	65.30	5.72	13.20	0.000

Table 3 revealed that maps not only improved understanding but also reinforced information in the brain more effectively. Students can memorise the rules faster than with the traditional method. Kacem and Mazouzen (2024) revealed that the maps helped students consolidate and easily retrieve the rules. Also, Al-Malki (2022) found that students who used this technique retained the information for a longer period. Sari et al. (2023) emphasised that maps increased recall ability in primary and middle school stages. Engagement and classroom participation are illustrated in Table 4.

TABLE 4
ENGAGEMENT AND CLASSROOM PARTICIPATION

Dimension	Experimental (M)	SD	Traditional (M)	SD	t-value	p-value
Class Participation	91.30	3.80	68.45	5.12	14.50	0.000

Table 4 revealed that the experimental group was more active, and the participation clearly reflected on the achievement. Al-Malki (2022) revealed that maps enhanced student participation. In the same vein, Bataineh et al. (2023) pointed out that participation increased when learning vocabulary with the application of maps. Table 5 presents analysis by age groups.

TABLE 5
ANALYSIS BY AGE GROUPS

Age Group	Experimental (M)	SD	Traditional (M)	SD	ANOVA F	p-value
14–15 years	89.20	4.10	67.50	5.30	18.25	0.000
16–17 years	85.50	4.60	64.80	5.45	15.60	0.000
18 years	82.00	5.00	62.00	6.00	12.40	0.000

Table 5 showed that younger students benefited more. The young learner is more receptive to visual learning. Wannas et al. (2022) pointed out that younger children benefited more from the maps. Table 6 presents the standard deviation.

TABLE 6
STANDARD DEVIATION

Dimension	Experimental SD	Traditional SD
Understanding	4.92	5.48
Application	5.10	6.01
Recall	4.55	5.72
Participation	3.80	5.12

Table 6 revealed that the standard deviation is lower in the experimental group, and the performance has become more homogeneous. This result is in line with Bataineh et al. (2023), which revealed that the maps reduced the differences among students. The effect size (Cohen's) is illustrated in Table 7.

TABLE 7
EFFECT SIZE (COHEN'S)

Dimension	Cohen's d
Understanding	2.15
Application	2.10
Recall	2.25
Participation	2.35

Table 7 revealed a very high value, indicating the effectiveness of the maps. Clearly, the results show that all the values are above 2, and this signals that the impact of the intervention is strong.

TABLE 8
DIFFICULTY OF THE RULES

Grammar Type	Experimental (M)	SD	Traditional (M)	SD	t-value	p-value
Compound Sentences	79.20	5.10	61.50	6.30	11.50	0.000
Defective Verbs	82.40	4.80	63.20	5.90	12.10	0.000
Prepositions	85.50	4.50	65.00	5.80	13.00	0.000

Table 8 showed that when mind maps divide complex rules into smaller, related components, they were more beneficial for the more challenging rules. For instance, the complex sentence becomes easier and clearer when the learner views it as a map containing the verb, subject, and object. Other research, including Kacem and Mazouene's (2024), which showed that the maps made the regulations easier to understand and implement, corroborated this conclusion. Additionally, the findings of Bataineh et al. (2023) and Al-Malki (2022) demonstrated that maps clearly had an influence on complicated regulations as opposed to simpler ones. Table 9 shows the relationship between understanding and involvement.

TABLE 9
THE CORRELATION OF ENGAGEMENT WITH UNDERSTANDING

Relationship	R-value	p-value
Engagement × Understanding	0.82	0.000

Table 9 demonstrated correlation is very strong. A student's comprehension of the rule increased as they engaged in more class activities. Mapping is only one aspect of participation; conversation and practical implementation are equally important. Wahid and Sudirman (2023), who found that active engagement is linked to better comprehension, as well as Bataineh et al. (2023), who found that the most engaged students had higher marks, corroborated this finding. Table 10 presents the difficulties and useful insights.

TABLE 10
CHALLENGES AND PRACTICAL OBSERVATIONS

Challenge	Percentage	Additional Notes
Need for additional training	35%	Students and teachers require basic technical skills for map drawing.
Longer preparation time	40%	The first few lessons take longer to plan than traditional methods.
Student resistance to change	25%	Some students prefer rote memorization and resist new strategies.

Table 10 demonstrated that each new approach frequently encounters opposition, and this study emphasized the useful advantages and disadvantages. To solve these problems, pre-training for educators and students is crucial.

Wannas et al. (2022) emphasized the need for prior training in order to adapt to maps. It is normal for students to be resistant to change; thus, supportive tactics are required. Time and training were an obvious problem in the classroom, according to Bataineh et al. (2023). A multiple regression model for understanding score prediction is shown in Table 11.

TABLE 11
MULTIPLE REGRESSION MODEL (PREDICTING UNDERSTANDING SCORE)

Independent Variable	Beta (B)	SE (B)	t	p
(Constant)	5.12	1.28	4.00	0.000
Classroom Engagement	0.62	0.07	8.86	0.000
Pretest Score	0.41	0.05	8.20	0.000
Age (Years)	-0.35	0.12	-2.92	0.004
Use of Mind Maps (dummy: 1=Yes)	6.45	0.88	7.33	0.000

* $R^2 = 0.68$, Adjusted $R^2 = 0.66$, $F(4,195) = 104.5$, $p < 0.001$

Table 11 showed that the most important inputs explaining student understanding are classroom engagement (strongest effect), pre-test score, and then the use of mind maps as an independent variable with a significant and stable impact. Age is slightly negative — meaning younger students improved more. The R^2 is around 0.68, meaning 68% of the variance in understanding scores is explained by this factor — a strong number indicating the model's value.

This result is consistent with Bataineh et al. (2023) and Kacem and Mazouzen (2024), who found that engagement plus maps are the key to improvement, and also Al-Malki (2022), who saw that prior background is important, just as it appeared in our case. Table 12 presents RM-ANOVA (pretest–posttest–follow-up) on recall by group.

TABLE 12
RM-ANOVA (PRETEST — POSTTEST — FOLLOW-UP) ON RECALL BY GROUP

Source	df	F	p	Partial η^2
Time (pre/post/follow-up)	2,390	182.6	0.000	0.48
Group	1,195	154.3	0.000	0.44
Time $\times$ Group	2,390	98.4	0.000	0.34

Table 12 shows that there is a clear time difference: everyone improved after the intervention, but the group that used the maps maintained the benefit for follow-up after two months significantly, and the interaction (Time $\times$ Group) is strong, meaning the map's effect is not just temporary but stable. The effect sizes (partial η^2) are large and indicate a practical educational impact. Our results align with El-Kenany (2021) and Kacem and Mazouane (2024), who observed stability in recall after applying maps or electronic copies. However, the present study's difference is bigger because the design included longer follow-up and multiple measures. Table 13 presents an ANCOVA: comparison of understanding (posttest) scores between the two groups after controlling for the pretest.

TABLE 13
ANCOVA: COMPARISON OF UNDERSTANDING (POSTTEST) SCORES BETWEEN THE TWO GROUPS AFTER CONTROLLING FOR THE PRETEST

Source	DF	F	p	Partial η^2	Adjusted Mean (Experimental)	Adjusted Mean (Control)
Group	1,193	198.2	0.000	0.51	86.30	64.90
Pretest (Covariate)	1,193	72.5	0.000	0.27	—	—

After controlling for the pretest as a variable, we are still looking for a significant difference between the two groups: the group that used maps has an adjusted mean score of ~86 compared to ~65 for the traditional group. The effect (partial $\eta^2 = 0.51$) is substantial, which confirms that the difference is not just due to initial variation but rather a result of the teaching strategy. Studies like Bataineh et al. (2023) and Al-Malki (2022) noticed differences after controlling, but we have a larger effect size, possibly because we integrated engagement and modelled it more accurately. Table 14 displays reliability and confirmatory factor analysis (CFA) loadings for study measures.

TABLE 14
RELIABILITY AND CONFIRMATORY FACTOR ANALYSIS (CFA) LOADINGS FOR STUDY MEASURES

Scale	Cronbach's α	Number of Items	Mean Factor Loading (CFA)
Understanding	0.92	8	0.78
Application	0.90	7	0.81
Recall	0.91	6	0.84
Engagement	0.87	5	0.75

CFA model fit indices were as follows: CFI = 0.96, TLI = 0.95, RMSEA = 0.038 (90% CI: 0.032–0.044), and SRMR = 0.035.

Every scale showed outstanding factor loadings (> 0.75) and great reliability ($\alpha > 0.87$). The items assess the target constructs with good accuracy and reliability, as indicated by the CFA model's strong fit (CFI/TLI above 0.95 and RMSEA below 0.05). Few mind-mapping research use sophisticated CFA, despite the fact that many claim favourable results. This level of structural and reliability analysis is not usually present. In contrast to other studies (e.g., Bataineh et al., 2023; Kacem & Mazouane, 2024; Al-Malki, 2022), the present study adds methodological value by statistically confirming the instruments. The biggest predictors of grammar knowledge were found to be classroom participation and the usage of mind maps; this association is confirmed by the high R^2 (~0.68).

RM-ANOVA demonstrated that the benefit continued over the course of the follow-up period, suggesting that the improvement was long-lasting. Even after accounting for pre-test results, mind maps still had a significant influence; ANCOVA provides strong evidence of this actual difference. The Alpha coefficients and CFA loadings increased the credibility of the data, and the measurement tools were dependable.

With more methodological depth (longer follow-up period, larger effect sizes, and use of CFA), the current study shows a similar tendency to recent Arab and global studies (e.g., Bataineh et al., 2023; Kacem & Mazouane, 2024; Al-Malki, 2022; El-Kenany, 2021). The study demonstrated the value of mind maps in all areas, including comprehension, application, retention, engagement, and managing difficult rules.

The current findings are consistent with previous research, which greatly validates the usage of mind maps in educational settings. With a discernible improvement in achieving consistent performance levels, mind maps had the greatest effect on younger pupils and complex regulations. The substantial correlation between participation and understanding highlights the importance of combining hands-on activities with visual learning. With the right preparation, practical challenges like time, training, and student resistance may be addressed.

V. CONCLUSIONS AND RECOMMENDATIONS

The findings demonstrated the effectiveness of mind maps. The findings showed that students who used mind maps performed better than those taught using traditional methods in terms of theoretical comprehension, practical application, and grammatical memorization. Students can better understand the connections between words and phrases by using mind maps. When handling complex structures like prepositions, compound phrases, and defective verbs, this approach works better. By dividing complex information into manageable bits, mind maps are supposed to assist students in comprehending and applying challenging content without feeling overwhelmed or confused. Users using mind maps were more focused and engaged in class, which enhanced their comprehension and memory.

One example of practical contact that greatly enhanced the method's effectiveness was creating maps. As seen by the decrease in the experimental group's standard deviation, the maps assisted all students—strong and weak—in reaching closer levels of success, which is essential for reducing educational disparities in the classroom. Understanding and engagement were strongly correlated: The significant connection ($r = 0.82$) between rule comprehension and class engagement highlights the benefits of integrating hands-on activities with visual assistance. With proper planning, practical challenges including the need for teacher and student training, preparation time, and initial student resistance may be overcome.

The study recommends providing teachers and students with prior training in using mind maps, integrating mind maps consistently, not occasionally, into the grammar curriculum, taking age and academic level into account during implementation, promoting interactive classroom engagement, as it is linked to improved comprehension and performance, focusing on complex grammatical concepts and compound sentences through mind maps, allocating additional preparation time initially, with the expectation that it will decrease once teachers become accustomed to the method.

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