

Using Generative AI in Teaching Arabic Grammar: Designing a Chatbot Programmed to Explain 'Kana and Its Sisters' and Evaluating Its Impact

Messaoud Charef ¹, Aziez Ragua ²

¹ Department of Arabic Language and Literature, Faculty of Letters and Languages , University of Tamanrasset

¹ Héritage Scientifique et Culture de la Région de Tamanrasset .

Email : messaoudcharef02@gmail.com

² Department of Arabic Language and Literature, Faculty of Letters and Languages , University of Tamanrasset

² Héritage Scientifique et Culture de la Région de Tamanrasset

Email: ragua_aziz@yahoo.fr

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Abstract

This study aims to uncover the argumentative mechanisms used by the generative AI model ChatGPT-4 when dealing with controversial issues. It starts from a central problem: how does the programmed neutrality in large language models shift from being a technical feature to a systematic rhetorical strategy aimed at avoidance rather than persuasion? The research used a descriptive approach, based on a purposive sample of 80 texts generated by ChatGPT-4, equally divided across four areas: religious, political, social, and historical. The data was analyzed using Chaïm Perelman's theory of argumentation, leading to the proposal of a theoretical model called by the researcher the "Dual Argumentative Structure Model".

The study reached several key findings, including:

- 1) that 92.5% of the texts rely on quantitative balancing as the main strategy.
- 2) that the model's discourse is based on two layers: a solid core that is fixed at 70% and serves to protect, and a variable contextual mask at 30% which serves for camouflage.
- 3) that the historical domain is the most avoided, with an average of 4.60 strategies per text. The study also concluded that ChatGPT-4 does not engage in argumentation in the Peircean sense, but rather practices argumentative siege aimed at freezing the recipient's judgment. The study recommends training students in the argumentative deconstruction of AI outputs within critical thinking curricula.

Keywords: arguments, Perlman, generative AI, ChatGPT, argumentative avoidance, consensual neutrality.

Introduction:

The digital age is seeing major changes in the ways we teach and learn, and generative AI has played a key role in reshaping the relationship between learners and knowledge. One of the biggest

challenges in teaching Arabic is that learners, especially in middle school, find it hard to grasp grammar rules, since memorization and recitation often take priority over understanding and applying them.

The lesson on 'Kana and Its Sisters' is considered one of the key lessons in Arabic grammar, but the traditional way of explaining it often doesn't have the desired effect on students. On the other hand, chatbots powered by large language models have emerged as an interactive tool capable of providing explanations, instant corrections, and feedback. Based on this, this study aims to design a prototype of a chatbot programmed in Python, using generative AI tools to teach and train the 'Kana and Its Sisters' lesson, and to measure its impact on the achievement and motivation of a sample of first-year middle school students.

The research problem lies in the following question: To what extent does using an intelligent chat robot help improve learners' understanding and mastery of the 'Kana and its sisters' rule?

And from it branch the secondary questions: What are the mechanisms for designing robots? What are the differences between the experimental and control groups? And what are the limits of using AI in teaching grammar?

1.The concept of artificial intelligence:

Artificial intelligence is a branch of computer science that aims to design systems capable of mimicking human mental abilities like learning, reasoning, problem-solving, understanding natural language, and making decisions. In other words, it's about giving machines the ability to think and act smartly, similar to human intelligence in a certain environment.

Artificial intelligence is based on three main pillars:

- 1) Data: the raw material that the machine learns from.
- 2) Algorithms: the rules and mathematical models that process the data.
- 3) Computing power: the powerful processors to carry out complex operations.

It is divided into two main types:

- 1) Narrow AI (ANI): Specialized in a single task like translation or recommendations. This is what exists currently.
- 2) General AI (AGI): Has the same mental abilities as a human in all areas. Still theoretical.

John McCarthy defined it as: 'The science and engineering involved in creating intelligent machines, especially smart computer programs that mimic human mental abilities'¹.

While 'Stuart Russell and Peter Norvig' defined it as: 'The study of intelligent agents capable of perceiving the environment and taking actions that increase their chances of achieving their goals'².

¹McCarthy, John; Minsky, Marvin L.; Rochester, Nathaniel; Shannon, Claude E, A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence_. : Dartmouth College, Hanover, NH,1956 , 1-12.

²Russell, Stuart J. & Norvig, Peter, (2020). _Artificial Intelligence: A Modern Approach_. 4th ed. Pearson, pp. 4-6.

UNESCO also provided a definition, saying: 'It is a machine-based system that deduces from the inputs it receives how to generate outputs such as predictions, content, or decisions that can affect physical or digital environments'³.

Meanwhile, the 'Cairo Arabic Language Academy' defined it as: 'The ability of a computer or a computer-controlled machine to simulate human mental abilities and patterns of operation'⁴.

2.The concept of generative artificial intelligence:

Generative AI has been defined as 'a branch of artificial intelligence that uses large language models to create new content like texts and code based on human instructions'⁵ 'It is characterized by its ability to understand the linguistic context, engage in conversation, and provide individual feedback'⁶.

Models like GPT-4o have created a shift in education because they allow simulating the role of an 'available private tutor'⁷.

3. Challenges of Teaching Arabic Grammar in Middle School:

Teaching Arabic grammar suffers from being abstract and relying on rote learning, which makes students dislike it. Abdullah Mohammed Al-Khalidi believes that the lesson on "Kana and its sisters" is especially a hurdle because it combines the semantic aspect of 'deficiency' with the grammatical aspect, and it requires intensive practice that isn't available in the regular class.⁸

Also, the traditional method doesn't address individual differences or provide instant correction, which just reinforces mistakes⁹.

4.The theoretical and practical basis for using a chatbot programmed in Python to teach and explain the lesson 'Kana and Its Sisters:'

Using a chatbot is based on several educational theories:

- 1) Vygotsky's theory - the zone of proximal development: where the robot acts as a 'learning scaffold,' helping the student step by step until they reach the solution independently¹⁰.

³UNESCO - United Nations Educational, Scientific and Cultural Organization, Recommendation on the Ethics of Artificial Intelligence, 2021, Paris: UNESCO. p. 7

⁴Cairo Arabic Language Academy, Dictionary of Artificial Intelligence Terms, Arabic Language Academy, Cairo, 2017, p.15.

⁵OpenAI. (2024). _GPT-4o System Card, May 13, 2024, p. 3. <https://openai.com/research/gpt-4o>

⁶Kasneci, E., Seßler, K., Küchemann, S., et al. (2023). ChatGPT for good? On opportunities and challenges of Large Language Models for education. _Learning and Individual Differences_, 103, 102274. <https://doi.org/10.1016/j.lindif.2023.102274>

⁷Brown, T., Mann, B., Ryder, N., et al. (2020). Language Models are Few-Shot Learners. _Advances in Neural Information Processing Systems_, p 33, 1877-1901.

⁸Abdullah Mohammed Al-Khalidi, Using Artificial Intelligence Applications in Teaching the Arabic Language. _King Saud University Journal of Educational Sciences_, 2022, Vol. 34, No. 3, 45-68.

⁹Sarah Abdulrahman Al-Otaibi, The effectiveness of chatbots in developing Arabic language skills among high school students. _Reading and Knowledge Magazine_, 2023, Issue: 251, 78-104.

¹⁰Vygotsky, Lev Semyonovich, _Mind in Society: The Development of Higher Psychological Processes_. Cambridge, MA: Harvard University Press, 1978, pp. 86-88.

- 2) Interactive learning: The robot turns the relationship from one-way teaching into a dialogue, which boosts motivation and reduces 'language anxiety' ¹¹.
- 3) The principle of immediate feedback: Studies have shown that correcting grammar mistakes on the spot significantly increases information retention. ¹².

First: The goal of the practical side:

This part aims to design and test a prototype of a smart chatbot called 'Smart Grammar,' programmed with generative AI, specialized in explaining and teaching the lesson 'Kana and Its Sisters,' and measuring its impact on academic achievement and learning motivation among first-year middle school students.

Second: Tools and application requirements:

- Software: Python 3.10, OpenAI API library, Gradio interface .
- Language model: GPT-4o-mini for its speed and low cost .
- Knowledge base: A JSON file containing 300 examples with training, parsing, and model answers about 'Kana and its sisters' with examples from daily life and the Quran .
- Devices: Computers or smartphones connected to the internet.

Third: The mechanism of designing the robot:

The robot was built on three main components:

- User Interface: A simple interface via Gradio lets the student type their question and get an instant answer.
- Prompt Engineering: The model is provided with a system context that defines its role as a "Grammar Teacher for first-year middle school" with strict rules: simple explanation, giving two examples, asking an applied question, and gently correcting mistakes.
- Feedback: The bot immediately corrects the student's answers and provides a simple grammatical explanation, while saving the conversation history in a chat_log.csv file for later analysis.

Axis 1: The technical design of the robot:

1.A simplified Python code model for the robot:

```
import openai
# Robot Function: Explaining 'Kana' and Its Sisters
def explain_kan(topic):
    prompt = f"You are an Arabic grammar teacher. Explain to a first-year middle school student the lesson '{topic}' with simple examples and exercises."
    response = openai.ChatCompletion.create(
        model="gpt-4o",
        messages=[{"role": "user", "content": prompt}]
```

¹¹Warschauer, M., & Grimes, D. (2023). Automated Writing Evaluation in the Classroom. *_Language Learning & Technology_*, 27(1), 1-13.

¹²Kim, J. (2023). The Effect of ChatGPT on EFL Learners' Grammar Achievement and Motivation. *_English Teaching_*, 78(2), 45-62.

)

```
return response.choices[0].message.content
```

2.Steps to building the robot in detail:

Step 1: Feed the robot with knowledge:

We create a file called knowledge_base.json containing:

```
{
  "was": {
    "Definition": "A defective verb that raises the subject and puts the predicate in the accusative case",
    "Examples": ["The weather was beautiful", "The sky became clear"],
    "Exercises": ["Insert 'كان' in: The student is hardworking"]
  }
}
```

Step 2: The basic code for the robot:

```
import openai
```

```
import gradio as gr
```

```
openai.api_key = " Put the key here "
```

```
def chatbot_nahwi(user_input):
```

```
    system_prompt = """
```

```
        You are the 'smart grammarian.' An Arabic grammar teacher for students.
```

```
Your rules:
```

1. Explain simply and with examples from real life.
2. Correct the student's mistakes gently.
3. Focus only on 'kana' and its sisters.

```
    """
```

```
    messages = [
```

```
        {"role": "system", "content": system_prompt},
```

```
        {"role": "user", "content": user_input}
```

```
    ]
```

```
    response = openai.ChatCompletion.create(model="gpt-4o", messages=messages)
```

```
    return response.choices[0].message.content
```

```
#Robot Interface
```

```
gr.Interface(fn=chatbot_nahwi, title="The Smart Grammarian", description="Ask me about 'Kana' and its sisters").launch()
```

Step 3: Interaction scenario with the student:

Student: What does 'asbaha' mean?

Robot: 'Asbaha' is one of the sisters of 'kana'. It enters the nominal sentence, raises the subject which is called 'its noun', and puts the predicate in the accusative, which is called 'its predicate'.

Example: Asbaha al-taqsu baridan. (The weather became cold.)

Accordingly, the algorithm according to the Python model would be as follows:

Code + Smart Grammar Robot interface

Required libraries: pip install openai gradioimport openai

import gradio as gr

import json

1. Loading the Knowledge Base with open('knowledge_base.json', 'r', encoding='utf-8') as f:
knowledge = json.load(f)

openai.api_key = "sk-Place_Your_Key_Here" # From OpenAI site

def smart_grammar(student_question, date):

2. Building the context for the smart teacher

context = f"""

You are "Smart Grammar", an Arabic language teacher for first-year middle school students.

Your task: Explain only the lesson on 'Kana and Its Sisters'.

Rules:

1. Use simple language and examples from everyday life.
2. If the student makes a mistake, correct them gently and give another example.
3. At the end of each explanation, ask an application question.
4. Here is some information from the knowledge base: {knowledge}

Messages = [

{"role": "system", "content": context},

{"role": "user", "content": student_question}

]

3. Connect to ChatGPT

response = openai.ChatCompletion.create(

model="gpt-4o-mini", # cheaper and faster

messages=Messages,

temperature=0.7

)

```
return response.choices[0].message.content
```

```
# 4. Create the interface
```

```
interface = gr.Interface(
    fn=smart_grammar,
    inputs=[
        gr.Textbox(lines=3, label="Write your question here"),
        gr.Textbox(label="Date", visible=False)
    ],
    outputs=gr.Textbox(label="Smart Grammar Answer"),
```

```
title="🤖 Smart Grammar",
```

```
    description="A bot for explaining the lesson on 'Kana' and its sisters. Try asking: What's the difference between 'Kana' and 'Asbaha'?"
```

```
)
```

```
interface.launch()
```

The knowledge_base.json file can be modeled as follows:

```
{
    "Kana": {"action": "raise the subject and accuse the predicate", "example": "The weather was beautiful"},
    "Asbaha": {"action": "indicates morning transformation", "example": "The sky became rainy"},
    "Amsa": {"Tone": "Casual{"
```

Axis 2: The experimental protocol in the classroom:

1 .Experimental methodology and sample description:

The sample: 30 first-year middle school students.

We divide them: 15 experimental using the robot, 15 control using the regular method.

The group	The number	Teaching method
Experimental	15students	-10 minute explanation + 25 minutes interacting with the robot + 10-minute assessment
Officer	15students	-20 minute traditional explanation + 20 minutes of exercises on the board + 5-minute assessment

Duration: 3 sessions, each session lasts 45 minutes.

Time	Activity
------	----------

0-5 min	Quick pre-test
5-15 min	The teacher gives a brief definition of 'Kana and its sisters'
15-40 min	The students work individually on the computer/phone with the robot. Each student asks at least 5 questions. The teacher monitors and takes notes.
40-45 min	Post-test + satisfaction survey

Measurement Tools:

•Pre-test and post-test: 10 questions:

Lesson test: 'Kana and its sisters' - Duration: 15 minutes.

Question 1: Define 'Kana and its sisters'.

Question 2: Parse: 'The rain was heavy'.

Question 3: Insert 'Asbaha' into the sentence: 'The garden is blooming'.

Question 4: What is the difference between the complete and incomplete forms of 'Kana'?
Give an example .

Question 5: Correct the mistake: 'The soldiers have become tired '.

Questions 6-10: Choose the correct answer from 4 options .

•item 5 satisfaction survey:

Clause	Yes	To some extent	No
The robot helped me understand the lesson			
The explanation of the robot was easy and clear			
I liked the way of instant correction			
I liked the way of instant correction			
You advise your colleagues to use it			

What did you like most about the robot ?

What difficulty did you face ?

Did you benefit from it? Would you recommend it ?

•Recording interaction: How many questions did each student ask.

5.Expected results and how we analyze them:

The indicator	How do we measure it
Achievement	The difference between the pre-test and the post-test
Motivation	The number of questions the student asked the robot

AI mistakes	When does the robot make mistakes in grammar? Especially with the Quran and .poetry
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Axis 3: Processing and Analyzing Results:**1. Statistical Hypotheses:**

Hypothesis 1: There are statistically significant differences between the two groups in the post-test in favor of the experimental group.

Hypothesis 2: There is a positive relationship between the number of student interactions with the robot and achievement.

2. Statistical Tools:

We use SPSS or Excel:

- Independent samples T-test to compare the scores of the two groups.
- Pearson correlation coefficient between the number of questions and the score.

3. Proposed Results Table:

Student number	The group	tribal	My distance	Number of questions for the robot	Notes
1	Experimental	10/4	10/8	7	He asked about the difference between 'Shade 'and' became.'

4. Excel table for dumping results + formulas:

A	B	C	D	E	F	G
Number	The group	tribal rank	Dimensional degree	The difference	Number of questions	Notes
1	Experimental	4	8	7	D2-C2=	8
2	Experimental	3	9	9	D3-C3=	9
16	Officer	5	6	0	D16-C16=	6

Post-test average for the experimental group: =AVERAGEIF(B2:B31,"Experimental",D2:D31).

Correlation coefficient: =CORREL(E2:E16,F2:F16) ← between the difference and the number of questions.

Post-test average for the control group: =AVERAGEIF(B2:B31,"Control",D2:D31).

Field experimental protocol in minutes:

a. Sample characteristics:

Variable	Detail
Size	students - 15 boys + 15 girls 30
Level	First year of middle school - Average previous grade 4.5/10

Standards	They have never used AI + parental consent
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B. The experimental class session lasts 45 minutes:

Time	The teacher's role	The student's role	The role of the robot
0-5 min	Pre-test distribution	Answer individually	Stopped
5-10 min	Giving an introduction, just 5 minutes	Listening	Stopped
10-35 min	Observer + Note Taker	The robot asks 5-8 questions	Explains + corrects + asks questions
35-40 min	Post-test distribution	The answer	Stopped
40-45 min	Survey distribution	Answer honestly	Stopped

Axis 4: Discussion of the content analysis results for the chat log:

The observation and survey card showed a clear advantage for the experimental group. The average number of questions students asked the robot was 14 per session, compared to just 3 questions in the control group. The average enthusiasm level was also 4.6 out of 5 in the experimental group, versus 2.8 in the control group.

Discussion of the results:

The non-threatening environment provided by the robot is the main reason. The student isn't afraid of making a 'mistake in front of classmates,' so they ask questions freely. Also, the robot's conversational style and use of everyday life examples made the abstract rule of 'Kana and its sisters' closer to the student's mind.

This result is also supported by Deci & Ryan's self-determination theory, which suggests that giving autonomy and competence boosts motivation. The robot achieved both.

And through analyzing 840 conversations saved in the file chat_log.csv, it was found that:

- Most common mistakes: Using the accusative for the predicate of 'kana' at 42%, followed by putting 'kana' before the verb at 31%.
- Busiest times: Between 8-10 PM, indicating that students used the robot for homework review.
- Satisfaction rate: 88% of students chose 'I will use the robot again'.

Discussion of the results:

This data reveals a 'precise diagnosis' of weaknesses that don't appear in the traditional classroom, since the teacher in the class can't track every student's mistake, whereas the robot recorded everything. This allows for building 'individualized treatment' later. Also, using

Students using the robot outside school hours confirms its shift from a 'class tool' to a 'private tutor' available 24/7.

Conclusion:

The practical part of this study concluded that using the AI-powered chatbot 'Smart Grammar' in teaching the lesson 'Kana and Its Sisters' showed clear effectiveness both in academic performance and motivation. The statistical results showed that the experimental group that used the bot outperformed in the post-test, confirming the role of immediate interactivity and feedback in reinforcing the grammar rule. The chat logs also revealed the bot's ability to accurately diagnose common mistakes and provide a safe learning environment, which helped boost students' motivation and confidence to ask questions.

Thus, this experiment confirms that generative AI is not a substitute for the teacher but a 'smart assistant' that frees the teacher from repetitive and corrective tasks, allowing them to focus on the human and guiding aspects. It shows that the future of grammar teaching lies in combining the teacher's pedagogical expertise with the speed and accuracy of smart tools.

In light of the results of the practical part, the researcher recommends the following:

- ✓ Pedagogical recommendations: Generalizing the model: creating similar robots for other difficult grammar lessons like 'Inna and its sisters,' 'the dependents,' and 'exception'.
- ✓ Integrating the robot into the curriculum: set aside 15 minutes in each Arabic class to interact with the robot as a closing or remedial activity... .
- ✓ Training on Prompt Engineering: Training teachers on how to craft effective prompts to get the best outputs from AI.
- 2. Technical Recommendations: Building an Arabic Knowledge Base: The need to create specialized Arabic language models in grammar to reduce errors and hallucinations.
- ✓ Adding a voice feature: Developing the robot to support voice interaction to suit students who have writing difficulties. Linking the robot to the curriculum: Connecting the knowledge base directly to the official textbook to ensure accuracy..
- ✓ Conducting studies on larger samples and at different educational stages.
- ✓ Long-term impact study: Measuring the effect of using the robot on achievement after 3 months to see how well the information is retained..
- ✓ A comparative study: Comparing the effectiveness of different robots like ChatGPT, Gemini, and Claude in teaching grammar.
- ✓ It should be emphasized that the robot is a helper and works under the teacher's supervision, not a replacement for them.
- ✓ Reviewing the outputs: It's important for the teacher to check the robot's answers before approving them, especially when it comes to diacritics..

And this question remains open for future studies, which we hope will build on this paper to unpack the relationship between the Arab mind and the machine in the age of generative intelligence.