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Exploring the typology of reasoning influencing university teachers' language teaching and learning strategies

Abdulmajeed Alghamdi[1*]

*Correspondence:
ambahes@uqu.edu.sa

[1] Education College, Curriculum and Instruction Department, Umm Al-Qura University, Makkah, Saudi Arabia

Abstract

Despite the critical role of reasoning in shaping language teaching and learning strategies in higher education, prior studies have either separately examined reasoning or focused on one specific type thereof and language teaching and learning strategies. To address this gap, this study took a comprehensive approach by examining various types of reasoning in language instruction and their alignment with language teaching strategies in higher education. It adopted a sequential mixed-methods design through two phases of data collection. The study instruments included a mixed-method questionnaire, interviews, classroom observations, and document analysis. The quantitative phase collected data from 357 university teachers of Arabic-language disciplines at the university level who completed a mixed-methods questionnaire using a 5-point Likert scale and brief written explanation. Exploratory factor analysis, descriptive and inferential analysis of variance and the Scheffé test were used to analyse the quantitative data. In the follow-up qualitative phase, 20 university teachers from the quantitative phase were observed in the classroom and interviewed, and their document tasks were analysed using thematic analysis. The results unveiled four distinct typologies of university teachers' reasoning closely aligned with their language teaching and learning strategies: inductive, abductive, analogical, and deductive reasoning. Notably, these typologies were associated with cognitive, metacognitive, interactional, and Knowledge strategies. Furthermore, the findings highlighted the intricate interplay and mixture of these typologies, indicating that university teachers do not rely solely on one type or strategy. Finally, the conclusion section outlines critical areas for future research concerning reasoning and language teaching and learning strategies in higher education.

Keywords: Reasoning, Language teaching and learning strategies, Higher education

Introduction

Teachers can cultivate their reasoning about the value of a new pedagogical approach, and that reasoning may result in collusion or collision with the new approach (Byrne et al., 2019). This has implications for how the new approach or curriculum model is used in university teaching, either as a new approach to establish new teaching practices or as a tool that affects current practices. Teachers' practices within a given approach

are likely to reflect their reasoning on teaching and learning (Gifford, 1992), and their reasoning is fundamental in providing insight into effective, transformative practices of a new approach (Mulligan, 2015). Fung (2017) asserts that developing research-based educational approaches is not only feasible but also holds the potential for significant transformation. This transformation offers insights into new educational initiatives focused on research- and inquiry-based learning, with the ability to create environments that promote critical dialogue about educational values and openness to fresh ideas (Boden & Nedeva, 2010; Fung, 2017; Hoon & Looker, 2013).

In considering the pros and cons of various forms of reasoning and the inconclusive findings of the current research, some argue for choosing between deductive and inductive teaching methods (Ellis, 2016; Hayes et al., 2010; Housen et al., 2016; Sulaiman, 2012). In contrast, others propose rethinking language instruction, moving beyond the strict binary choice of purely deductive or inductive methods and advocating for abductive or analogical instruction (Behrens, 2017; Bybee, 2010; Holyoak & Morrison, 2012; Oh, 2008). No studies, however, have thoroughly explored and compared the differences among these reasoning types in terms of their influence on language teaching and learning processes, even in the broader literature focusing on teachers' reasoning in language education, especially within the context of Arabic-speaking countries. Furthermore, uncertainty remains regarding whether these reasoning types can demonstrate varying effectiveness and language teaching strategies in such contexts. To address this gap, the current study sought to answer the following research questions:

(1) Which types of reasoning do university teachers adopt in language teaching and learning?
(2) What are university teachers' language teaching and learning strategies?
(3) How and to what extent do university teachers' reasoning types relate to their language teaching and learning strategies?

Theoretical framework

This section first explores the theoretical foundations of reasoning in language teaching and learning and then provides a comprehensive literature review examining the connection between reasoning and language teaching and learning.

Reasoning in language teaching and learning

The diversity and inherent complexity of reasoning make it challenging to provide precise definitions or to delineate its constituent components. Nonetheless, using concrete insights drawn from substantial knowledge of reasoning as applied to a teaching approach empowers the researcher to grasp and address the intricacies of reasoning effectively. Reasoning encompasses the credibility of a claim, the supporting evidence, the method employed to gather that evidence and the attributes of the sources providing the evidence (Kuhn, 2010; Sandoval et al., 2014). Evans (2010) suggests that a greater depth of thought and analysis in a task or problem can lead to a broader spectrum of reasoning paths taken to reach the solution. One remarkable attribute of human language is its capacity to convey information effectively within a given context. Spoken

and written expressions do not have to include every single detail, as listeners or readers can deduce the intended meanings by assuming that the words convey only pertinent information. These inferences in communication are contingent upon the shared presumption and reasoning that speakers provide information to the extent required by their shared knowledge and the specific task (Frank & Goodman, 2012).

Despite the fundamental role of reasoning, there is a significant divergence of opinion regarding whether prelinguistic infants possess the capacity for reasoning or whether it is an attribute exclusive to those with linguistic capabilities (Carey et al., 2020; Johnson & Ma, 1999). This debate forms part of a profound, longstanding discussion of whether abstract thinking precedes language or whether such thinking becomes possible only with the development of natural language in both evolutionary and individual growth (Hume, 2000). Despite this divergence of opinion, the progress made in psychology, philosophy and linguistics has equipped researchers with the means and methodologies to investigate empirical evidence concerning the connection between language and reasoning. This relationship is unique to those possessing linguistic capabilities (Grigoroglou & Ganea, 2022).

When teaching language, it is important to allow students to practice and explain the language tasks under investigation (Ellis et al., 2019). Research- and inquiry-based approaches effectively teach both linguistic content and the nature of language by engaging students in various scientific activities. The significance of engaging in research- and inquiry-based activities lies in their ability to promote learner involvement by encouraging learners to engage in scientific reasoning processes. Researchers emphasise that scientific explanations require three fundamental elements: a claim, supporting evidence and sound reasoning. Evidence comprises data that can strengthen a claim, and reasoning is employed to justify the relationships between the claim and the evidence (Fung, 2017).

Researchers in the field of language learning have also discussed various student practices that are based on different types of reasoning. Specifically, they have classified four types of reasoning in language learning: inductive, deductive, abductive and analogical. Induction is a form of reasoning that entails drawing general principles from specific instances, while deduction, conversely, involves deriving specific examples from general principles (Hayes et al., 2010). Deductive instruction can expedite the development of language learning by enabling learners to identify the structure and characteristics of language (Lardiere, 2004), and it facilitates the transformation of declarative knowledge into procedural and automated skills through practice; a grasp of the rules can indirectly enhance learning by making learners more adept at recognising language forms in subsequent input (Ellis, 2016). Guided induction instruction has been shown to foster a strong awareness of language structure and a noticeable activation of recently acquired knowledge (Housen et al., 2016). Nevertheless, various studies suggest that induction outperforms deductive instruction in various written tasks, such as sentence reconstruction and judgment of grammaticality with error correction (Housen & Kuiken, 2009; Sulaiman, 2012).

Abductive reasoning has emerged as an explicit type of reasoning as an alternative to the inductive and deductive traditions. In abductive reasoning, one draws conclusions based on the most reasonable explanation for one's observations or evidenc (Jovanovic

& Krneta, 2012). Burch (2006) clarifies that it not only leads to the best explanation but also involves clarifying or normalising previously unexpected information. Oh's (2008) study outlines four phases of abductive reasoning: exploration, examination, selection and explanation. In language learning, abductive reasoning involves a dual process of observing particular language traits and formulating conjectures regarding their structure and purpose (Jovanovic & Krneta, 2012).

Recent developments in education promote empowering students to become skilled communicators who exhibit creativity and productivity in their language use. This capability is facilitated by using abstract cognitive processes, including categories, schemas, structures and rules (Bybee, 2010). The acquisition of these cognitive processes hinges on recognising analogies between different constructs, which constitutes analogical reasoning. Acquiring these cognitive processes involves two prerequisites for analogical reasoning that are equally necessary for incorporating new items into constructions: structural alignment and knowledge of relational similarity (Bybee, 2010; Leroy et al., 2012; Markman & Gentner, 1993). Analogical reasoning identifies similarities between topics, facilitating inferences and issue resolution; it often relies on shared resemblances and plays a crucial role in human cognition, encompassing language learning and problem-solving (Holyoak & Morrison, 2012). Analogical reasoning involves three core subprocesses: retrieval, mapping and evaluation. Retrieval refers to recalling similar situations from long-term memory when dealing with a current topic in working memory. Mapping aligns representations and draws inferences from two simultaneous cases in working memory. After mapping, the third process, evaluation, involves assessing the analogy and its inferences (Gentner, 2003). Behrens (2017) determined that analogical reasoning is a significant catalyst in language learning. It enables learners to assimilate new elements into established categories and expand these categories by drawing on similarities and relational analogies.

Language teaching and learning strategies

Research on language teaching and learning has identified several strategies, but defining and classifying language learning and teaching strategies requires further in-depth exploration to clarify their distinct characteristics and distinguish them from regular learning activities (Hinton, 2014). Cohen and Dörnyei (2002) outlines three categories of language teaching and learning strategies: language learning strategies encompassing learners' thoughts and behaviours, language-use strategies and self-motivation strategies. In a study including 348 students at a language school in New Zealand, Griffiths (2003) observed that advanced students demonstrated a higher frequency of using strategies related to interacting with others to learn vocabulary, reading and language systems and that they more often exploited available resources than elementary students. Peacock and Ho (2003) conducted a study across various disciplines (including computer studies, engineering, English, math, primary education and science) and found that learners of English exhibited the highest frequency of strategies, including cognitive, metacognitive and social strategies.

Key findings on language teaching and learning strategies in linguistics studies reveal that those strategies also fall into the three categories of cognitive, metacognitive and social. Cognitive strategies involve mental processes for learning language (Van den

Broek & Helder, 2017), metacognitive strategies involve planning, monitoring and evaluating one's learning (Teng, 2020) and social strategies involve interacting and communicating with others to learn the language (Griffiths, 2018). Language teaching strategies should also reflect language's role in expressing thoughts and producing meaning, which is the focus of recent research on language concepts (De Villiers, 2014).

Recent studies on language teaching and learning strategies have highlighted the constructivist approach to language learning (Suhendi, 2018), which posits that language learning is an active process in which the teacher should use practices that encourage students to construct continually and build their knowledge on what they have already learned. The task should be designed to facilitate extrapolation and fill in knowledge gaps (Aljohani, 2017; Quoc & Van, 2023).

Although research on identifying and characterising learning and teaching language strategies is extensive, some studies have adopted a survey approach, with collected data limited to self-reported practices that needed more verification and confirmation (Mills & Gay, 2016). The current study explores the reasoning behind language teaching and learning strategies. A mixed-methods design facilitates such investigations, as it enables the researcher to use quantitative methods to explore teachers' reasoning and language teaching and learning strategies among a large number of participants and use qualitative methods to explore teachers' reasoning and their language teaching and learning strategies in depth at the individual and group levels.

Methodology

This paper investigates how university teachers' reasoning influences their Arabic-language teaching strategies, aiming to develop a conceptual and empirical understanding of various types of reasoning and strategies in Arabic-language teaching and learning. It also delves into the categorisation of reasoning in applying these strategies. Recent revisions to undergraduate and postgraduate programs in Saudi universities have included enhancements to Arabic-language programs to cultivate students' research and analytical skills and teach current advancements in linguistic knowledge and contemporary linguistic thought through research- and inquiry-based learning. This study was conducted at a public university in Saudi Arabia with five campuses, all of which have Arabic-language colleges. All the university teachers and students who participated in the study were well-informed about the research objectives and ethical protocols. The study adopted a mixed-methods approach including quantitative and qualitative data collection (Fig. 1).

To investigate the existing reasoning that influences Arabic-language teaching and learning among university teachers, a mixed-methods questionnaire was distributed in the first stage to university Arabic-language teachers from the faculties of both Arabic language and education ($N = 357$). The questionnaire included close-ended questions on the participants' background, demographic information and their reasoning regarding their current teaching and learning practices. The participants were asked to indicate the weakness or strength of each reasoning statement in language teaching and learning using a 5-point scale ranging from 1 (extremely weak) to 5 (extremely strong). Moreover, they were asked to provide a brief, open-ended written explanation or example of their rating and support for each statement. The procedure

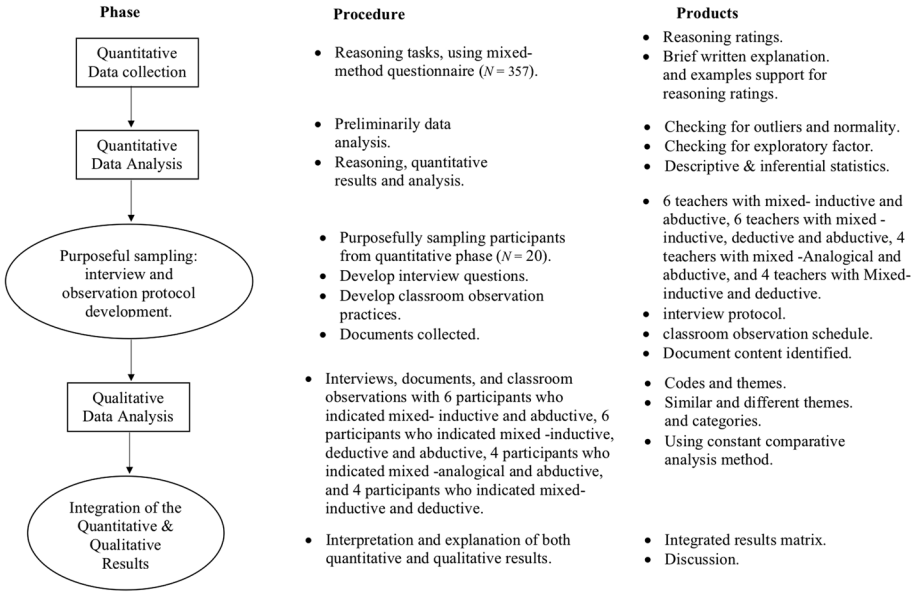

Fig. 1 The sequential study design procedure

took approximately 20 min to complete (both the open- and close-ended items). The questionnaire's close-ended statements were formulated on the basis of a variety of sources, encompassing studies on inductive reasoning in language (Hayes et al., 2010; Housen et al., 2016; Sulaiman, 2012), deductive reasoning in language (Ellis, 2016; Housen & Kuiken, 2009; Lardiere, 2004) and abductive and analogical reasoning in language (Behrens, 2017; Bybee, 2010).

The researcher refined the mixed-methods questionnaire items for contextual relevance, after which the questionnaire underwent a three-step field testing process. In the first step, the validity and reliability of the reasoning questionnaire were pilot-tested with 12 academics currently teaching in the Arabic-language department. In the second step, three psychologists and four education academics experienced in language teaching and learning reviewed the questionnaire item by item and made additional editorial revisions as necessary. Finally, the Cronbach's alpha (α) reliability coefficient was used to measure the questionnaire's reliability and to determine the internal consistency of the extracted factors (which included mixed inductive and abductive; mixed inductive, deductive and abductive; mixed analogical and abductive; and mixed inductive and deductive) as well as the overall item set (Table 5).

The study employed exploratory factor analysis (EFA) to condense a comprehensive set of data items into a more manageable number of factors that were subsequently used for further analysis. EFA is a technique to reveal the underlying relationships among scale items by identifying highly interconnected groups. It involves a series of sequential stages that may be categorised into four primary areas: evaluating the fundamental assumptions in EFA, assessing the data's suitability for factor analysis, executing the factor extraction process and applying factor rotation and interpretation. Commencing this process, the researcher begin by evaluating the appropriateness of the study data for factor analysis. It is essential in EFA that the data meet

specific prerequisites, including having interval variables, lacking outliers and having a substantial sample size, typically exceeding 150 participants (Pallant, 2020).

The Statistical Package for the Social Sciences (SPSS) provides two valuable statistical tools for assessing the suitability of scale items for EFA: the Kaiser–Meyer–Olkin (KMO) test, which evaluates the sample's adequacy for factor analysis and has a recommended minimum value of 0.6 (Tabachnick et al., 2013), and Bartlett's test, which examines the sphericity of the data and should yield a significant result ($p < 0.05$) to validate the appropriateness in factor analysis. These two tools were employed and yielded satisfactory results as presented in the quantitative results section.

Because the reasoning scales measured agreement levels using a 20-point verbal-frequency scale, the questionnaire can be categorised as having an interval variable. No outliers were identified among the items analysed in this study. Furthermore, the data set comprised 357 cases, a sample size sufficient for conducting factor analysis. Consequently, all the necessary conditions for conducting EFA were met in this study. A descriptive statistical analysis of extracted factors, including means and standard deviation, was then conducted for each factor. Inferential statistics from two tests—analysis of variance (ANOVA) and the Scheffé test—were also employed to assess the potential influence of syllabus groups on university teachers' reasoning and teaching strategies.

In the follow-up qualitative phase, a purposefully selected group of 20 university teachers from the quantitative phase were sampled, interviewed and observed. Additionally, their document tasks were analysed to gain insights into their reasoning and language teaching and learning strategies in the classroom. The researcher thematically analysed the interviews, classroom observations and documents to deepen the results of exploring the typology of university teachers' reasoning and their language teaching and learning strategies. The process of thematic analysis was automated using NVivo, a software designed for qualitative data analysis (Jackson et al., 2019). The constant comparative analysis method was followed to identify similarities and differences and to explore codes, themes, categories and associated dimensions (Glaser & Strauss, 2017).

During the inductive qualitative analysis process, following a five-step process outlined by Braun and Clarke (2006), the researcher analysed verbatim transcriptions of interviews, classroom observations, and documents. The researcher strove to maintain a reflective approach during the analysis, refraining from imposing personal interpretations on the data (Patton, 2014). The researcher read and listened to all the recorded interviews, classroom observations, and document transcriptions to gain a comprehensive understanding of the data before proceeding to any sorting or coding. In the second step, the researcher extracted descriptive phrases that pertained to participants' explanations and practices of their reasoning and language teaching and learning strategies. In the third step, the researcher created preliminary codes for the data by segmenting and labeling the extracted phrases and identifying commonalities. In the fourth step, if necessary, the researcher formed categories from the codes by aggregating similar codes. In the fifth step, the themes were identified, where the codes and categories were compared and examined to identify the similarities and differences across the codes and categories.

Moreover, it was crucial to triangulate the researcher's inferences, involving peer debriefing and ensuring inter-coder reliability (Miles et al., 2020). Therefore, an assistant professor, who was not involved in any of classroom observation, interviews, and

document analysis, was recruited and trained to analysis their own. The trained rater and the researcher engaged in multiple discussions regarding the codes and themes derived from the data. The rater and the researcher juxtaposed the themes generated in the analysis with the original statements found in the transcriptions of classroom observations, interviews, and documents. This comparison aimed to provide clarification, elaboration, or challenges to the identified codes and themes throughout the data analysis process.

Results

In this section, the researcher presents the results from the quantitative phase, followed by the results from the qualitative phase.

Quantitative results

This study used a sequential mixed-methods design to investigate how university teachers' reasoning influences their Arabic-language teaching strategies. The study aimed to explore the teachers' types of reasoning, their Arabic-language teaching and learning strategies and the categorisation of reasoning in applying those strategies. This section presents the results and analysis of the quantitative data in two subsections: Preliminary Data Analysis and Quantitative Results, addressing the first question regarding university teachers' types of reasoning (R1).

Preliminarily data analysis

After coding and entering the quantitative data into SPSS, preliminary data analysis was conducted, including checking for outliers and normality and conducting EFA.

Checking for outliers and normality

This study used SPSS to check for outliers and normality by generating histograms and box plots for the study's main variables. These scores were converted to standardised scores to indicate the existence of significant outliers. The scores related to the dependent variables of the current study, including inductive, deductive, abductive and analogical reasoning, indicated the absence of any outliers and were within an acceptable range of − 4.0 and + 4.0. The distribution of the dependent variables can be seen in the histograms as shown in Fig. 2; the scores were normally distributed. The skewness and kurtosis values were also used to statistically examine the normality of distribution. The skewness and kurtosis values as shown in Table 1 were less than 1.0, indicating that the distributions of the dependent variables were normal.

Exploratory factor analysis

To assess the suitability of the data for factor analysis, principal component analysis (PCA) was conducted on 20 measured variables, which were the questionnaire items related to reasoning. The researcher examined the correlation matrix to determine whether the data were factorable. The correlation matrix indicated that a significant proportion of the correlation coefficients exceeded 0.3

In Table 2, it is evident that all additional criteria for the factor analysis were satisfied: the KMO measure of sampling adequacy surpassed 0.6 (KMO = 0.858), and Bartlett's

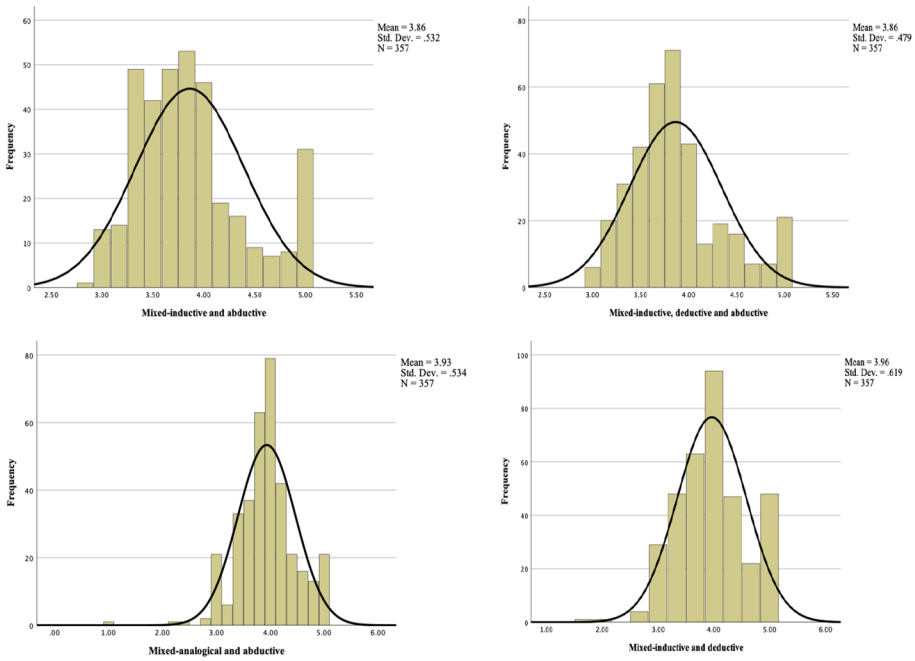

Fig. 2 Distribution of the Dependent Variables

Table 1 Descriptive Statistics for the Dependent Variables (N = 357)

Scale	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Mixed inductive and abductive	2.83	5.00	3.8618	0.53181	0.708	−0.142
Mixed inductive, deductive and abductive	3.00	5.00	3.8641	0.47927	0.757	0.173
Mixed analogical and abductive	1.00	5.00	3.9328	0.53356	−0.393	0.317
Mixed inductive and deductive	1.67	5.00	3.9627	0.61897	−0.050	−0.131

Table 2 KMO and Bartlett's test for the reasoning scale

KMO Measure of Sampling Adequacy		0.858
Bartlett's Test of Sphericity	Approx. chi-square	3012.931
	df	190
	Sig	< 0.001

test of sphericity yielded statistical significance (χ^2 [190] = 3012.931, $p < 0.01$), confirming the suitability of the data for factor analysis.

The findings also indicated that factor analysis could be conducted on the reasoning scale. The actual data and simulative data were subjected to parallel analysis using a syntax written in SPSS. As presented in Table 3, parallel analysis results provide further evidence to determine the number of factors.

Upon examination of Table 3, it is evident that the eigenvalue of the first factor in the actual dataset is 6.618194, whereas in the simulative dataset, it is 1.516579. The eigenvalue of the second factor in the actual dataset is 6. 2.522304, whereas it is 1.418801 in

Table 3 Eigen values of the actual data and the simulative data

Factor	Eigen values of actual data	Eigen values of simulative data
1	6.618194	1.516579
2	2.522304	1.418801
3	1.350751	1.244579
4	1.291508	1.159579
5	0.913404	1.236908
6	0.890000	1.196110
7	0.832129	1.151148
8	0.718852	1.106971
9	0.704259	1.070891
10	0.651486	1.034246
11	0.589840	0.996983
12	0.497902	0.962250
13	0.445318	0.927244
14	0.422947	0.891813
15	0.386906	0.857009
16	0.360765	0.821951
17	0.334864	0.788832
18	0.269065	0.752862
19	0.247507	0.714011
20	0.190099	0.672954

the simulative dataset. The eigenvalue of the third factor in the actual dataset is 1.350751, whereas it is 1.244579 in the simulative dataset. The eigenvalue of the fourth factor in the actual dataset is 1.291508, whereas it is 1.159579 in the simulative dataset. When transitioning from the fourth factor to the fifth, the situation changes. Consequently, the number of reasoning scale factors is decisively restricted to four because the eigenvalue of the simulative data for the fifth factor and subsequent factors is higher than that of actual data.

The number of factors determined with the support of parallel analysis is likely to be observed in a manner consistent with what is seen on the scree plot presented in Graphic 2.

Upon examination of the scree plot in Fig. 3, illustrating the actual data curve, it is obvious that the four-factor construct determined through eigenvalue examination is supported. The graphic shows that the first four factors have higher eigenvalues than the rest of the factors.

In the analysis, 20 variables were included. Using Kaiser's criterion, the PCA (as depicted in Table 4) extracted four factors through a converging rotation process that took seven iterations. These four factors collectively explain 57.723% of the variance.

Every item displayed loadings surpassing the acceptable threshold of > 0.5. Consequently, the reasoning scale is composed of four extracted factors; the details of these factors, including their corresponding variables and loadings, are shown in Table 5.

As presented in Table 5, the EFA revealed four mixed types of reasoning among university teachers in Arabic-language teaching and learning: mixed inductive and

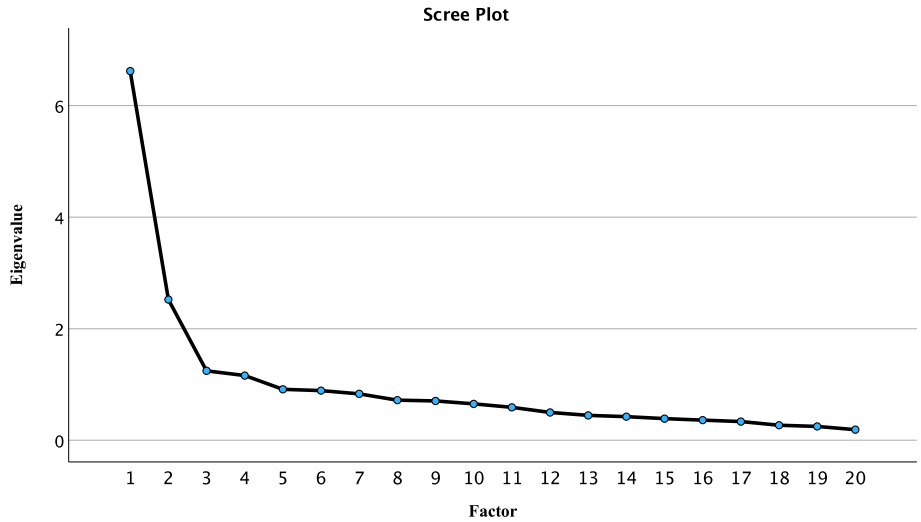

Fig. 3 The Scree Plot of the Actual Data

Table 4 Total variance explained for the reasoning scale

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.618	33.091	33.091	6.618	33.091	33.091
2	2.522	12.612	45.702	2.522	12.612	45.702
3	1.245	6.223	51.925	1.245	6.223	51.925
4	1.160	5.798	57.723	1.160	5.798	57.723
5	0.913	4.567	62.290			
6	0.890	4.450	66.740			
7	0.832	4.161	70.901			
8	0.719	3.594	74.495			
9	0.704	3.521	78.017			
10	0.651	3.257	81.274			
11	0.590	2.949	84.223			
12	0.498	2.490	86.713			
13	0.445	2.227	88.939			
14	0.423	2.115	91.054			
15	0.387	1.935	92.989			
16	0.361	1.804	94.792			
17	0.335	1.674	96.467			
18	0.269	1.345	97.812			
19	0.248	1.238	99.050			
20	0.190	0.950	100.000			

abductive; mixed inductive, deductive and abductive; mixed analogical and abductive; and mixed inductive and deductive.

Factor 1 describes teachers' reasoning practices as a blend of inductive and abductive reasoning. The statements confirm that the teachers used abductive reasoning practices to make unfamiliar information more apparent and understandable for their students.

Table 5 Factors identified in PCA for the types of reasoning

Factored variables	Extracted factor			
	Mixed inductive and abductive	Mixed inductive, deductive and abductive	Mixed analogical and abductive	Mixed inductive and deductive
Reasoning13	0.702			
Reasoning12	0.694			
Reasoning4	0.585			
Reasoning6	0.583			
Reasoning5	0.578			
Reasoning3	0.548			
Reasoning14		0.765		
Reasoning11		0.712		
Reasoning15		0.644		
Reasoning7		0.576		
Reasoning1		0.462		
Reasoning2		0.443		
Reasoning19			0.825	
Reasoning20			0.743	
Reasoning18			0.714	
Reasoning17			0.712	
Reasoning16			0.682	
Reasoning9				0.828
Reasoning10				0.694
Reasoning8				0.615

They also stressed the importance of seeking the best explanations when faced with incomplete understanding. Moreover, the teachers indicated inductive reasoning by acknowledging the significance of infinite word meanings when learning language. They also recognised their students' biases in language learning, such as assuming words refer to whole objects rather than parts, and understood the impact of mutual exclusivity bias on language learning.

In Factor 2, teachers indicated a combination of inductive, deductive and abductive reasoning. They indicated abductive reasoning by the belief that learning should be based on providing data to the students and allowing them to convert it into a problem-solving process. They also indicated that the focus in language learning should facilitate two measurable phases: generating and testing hypotheses. Furthermore, they indicated inductive reasoning by agreeing that, in language learning, students should derive the general principles of language by encountering specific instances of phonemes, morphology, words and sentences. They also indicated that the input structure plays a significant role in language learning. Additionally, they indicated deductive reasoning by suggesting that language learning should begin with a broad concept or theory that is refined into hypotheses.

In Factor 3, the teachers indicated a combination of analogical and abductive reasoning. They strongly emphasised analogical reasoning by recognising the importance of students having and manipulating linguistic information, analysing structures and doing mapping based on relational similarities in language learning. Furthermore,

they stressed that language learning should be grounded in structural alignment and knowledge of relational similarity. They also emphasised abductive reasoning by stating that language learning for students should be contextualised with real-life problems or examples.

In Factor 4, the teachers indicated a combination of inductive and deductive reasoning. They acknowledged that students should learn language through various processes, including observation, pattern detection and hypothesis formulation, as part of inductive reasoning. At the same time, they recognised that students learn language by first understanding rules and then applying them through examples and practice, which are parts of deductive reasoning practice. Overall, the teachers understood that language learning is a complex process that involves deriving specific examples from general principles.

Assessing the reliability of a research scale is a fundamental consideration before conducting any analysis. The evaluation of scale reliability involves scrutinising the internal consistency of the variables within a factor of the scale. This assessment pertains to the extent to which the instrument consistently measures what it is designed to measure as summarised by Cohen et al. (2002). Cronbach's α was used to assess the internal consistency of the four extracted factors; the alpha values are listed in Table 6.

The Cronbach's α reliability coefficients span from 0.718 to 0.836 as shown in Table 5. DeVellis (1991) suggests that reliability levels between 0.70 and 0.80 are acceptable, whereas levels between 0.80 and 0.90 are considered highly acceptable. As per Cronbach (1951), a reliability coefficient (Cronbach's α) exceeding 0.7 is typically deemed acceptable. Hence, the four extracted factors in this study exhibit satisfactory internal consistency.

As described in the previous section, EFA identified four extracted factors related to university teachers' reasoning: mixed inductive and abductive; mixed inductive, deductive and abductive; mixed analogical and abductive; and mixed inductive and deductive. This subsection analyses these four factors that contribute to university teachers' reasoning (Table 7).

The university teachers generally endorsed all reasoning types, indicating that teaching and learning language should include all types of reasoning ($M = 3.89$, $SD = 0.40$). The mean scores for all types ranged from 3.86 to 3.96. However, a close examination of the mean scores for the items of all types revealed that university teachers strongly agreed with the reasoning that teaching and learning language should seek the best clarification for incomplete understanding ($M = 4.22$, $SD = 0.64$), involve

Table 6 Reliability coefficient of the four extracted factors of reasoning (N = 357)

Scale	Extracted factors	Number of factored variables	Reliability coefficient (α)
Typology of reasoning	Mixed inductive and abductive	6	0.836
	Mixed inductive, deductive and abductive	6	0.779
	Mixed analogical and abductive	5	0.808
	Mixed inductive and deductive	3	0.718

Table 7 University teachers' reasoning

Scale	Item	*M* (*SD*)
Mixed inductive and abductive	Look for the best clarification for incomplete understanding	4.22(0.64)
	Making previously unknown information clearer and readable	4.01(0.66)
	Consider infinite word meanings	3.79(0.75)
	Students approach language learning with mutual exclusivity bias	3.73(0.71)
	Students often assume words refer to whole objects, not parts	3.72(0.74)
	Students approach language learning with particular biases	3.69(0.76)
Total mean		3.86(0.53)
Mixed inductive, deductive and abductive	Enable students to derive the general principles of language by hearing specific instances of phonemes, morphology, words and sentences	3.98(0.71)
	Use multiple ways to generalise from specific facts	3.91(0.72)
	Facilitate two measurable phases: generating hypotheses and testing	3.89(0.65)
	Starts with a broad concept or theory that is refined into hypotheses	3.86(0.67)
	Investigate language tasks with provided data and transform them into problems	3.77(0.62)
	The input structure influences language learning	3.73(0.76)
Total mean		3.86(0.47)
Mixed analogical and abductive	Language learning should be based on knowledge of relational similarity	4.01(0.67)
	Analyse structures and form mappings using relational similarities	3.95(0.68)
	Students in language learning need to both possess and manipulate linguistic information	3.95(0.65)
	Enable language learning based on structural alignment	3.89(0.79)
	Contextualise language learning with real-life problems or examples	3.85(0.74)
Total mean		3.93(0.53)
Mixed inductive and deductive	Involves deriving specific examples from general principles	4.05(0.75)
	Starting with rules, followed by examples and practice	3.93(0.80)
	Encourage learning language through observation, pattern detection and hypothesis formulation	3.90(0.76)
Total mean		3.96(0.61)
All		3.89(0.40)

deriving specific examples from general principles ($M = 4.05$, $SD = 0.75$), make previously unknown information clearer and more readable ($M = 4.01$, $SD = 0.67$) and be based on knowledge of relational similarity ($M = 4.01$, $SD = 0.66$). In summary, the results show that, for each reasoning type, there was strong agreement among the participants.

Typology of reasoning by language syllabus

The participants were categorised into five syllabus groups: syntax, rhetoric, literature, linguistics and discourse. As indicated in Table 8, both ANOVA and the Scheffé

Table 8 Typology of reasoning by language syllabus group

Scale	One-Way ANOVA						Post Hoc Test (Scheffé)		
		SS	*df*	*MS*	*F*	*p*	**Syllabus**	*M*	*SD*
Mixed inductive and abductive	Between groups	6.729	4	1.682	6.302	< 0.001	Syntax	3.79	0.58
	Within groups	93.954	352	0.267			Rhetoric	3.80	0.49
	Total	100.683	356				Linguistics	3.63	0.33
							Lliterature	3.96	0.55
							Discourse	4.10	0.41
Mixed inductive, deductive and abductive	Between groups	0.773	4	0.193	0.840	0.500	Syntax	3.85	0.52
	Within groups	80.999	352	0.230			Rhetoric	3.89	0.48
	Total	81.772	356				Linguistics	3.77	0.30
							Literature	3.87	0.49
							Discourse	3.96	0.48
Mixed analogical and abductive	Between groups	22.959	4	5.740	25.774	< 0.001	Syntax	3.99	0.56
	Within groups	78.388	352	0.223			Rhetoric	3.45	0.48
	Total	101.347	356				linguistics	3.94	0.29
							Literature	3.89	0.47
							Discourse	4.52	0.33
Mixed inductive and deductive	Between groups	3.256	4	0.814	2.152	0.074	Syntax	4.07	0.67
	Within groups	133.135	352	0.378			Rhetoric	4.08	0.44
	Total	136.391	356				Linguistics	3.85	0.36
							Literature	3.89	0.71
							Discourse	3.86	0.52

test were employed to assess the potential influence of syllabus groups on the university teachers' reasoning.

A significant difference was found in the responses of the five syllabus groups concerning the mixed inductive and abductive reasoning typology (F [4,352] = 6.302, $p < 0.05$). Scheffé's post hoc test indicated that the discourse syllabus group was statistically significant ($p < 0.05$), with the result showing that university teachers who followed a discourse syllabus rated the level of mixed inductive and abductive reasoning in language teaching and learning ($M = 4.10$, $SD = 0.41$) higher than university teachers who taught syntax, rhetoric, linguistics or literature.

Similarly, a significant difference was found in the responses of the five syllabus groups regarding the mixed analytical and abductive reasoning typology (F [4,352] = 25.774, $p < .05$). Scheffé's post hoc test indicated that the discourse syllabus group was statistically significant ($p < .05$), revealing that university teachers who followed a discourse syllabus rated the level of mixed analytical and abductive reasoning in language teaching and learning ($M = 4.52$, $SD = 0.33$) higher than those who taught syntax, rhetoric, linguistics or literature.

In contrast, the ANOVA test results demonstrate that there were no significant differences between the five syllabus groups regarding the mixed inductive, deductive and abductive reasoning typology (F [4,352] = 0.840, $p > 0.05$) or the mixed inductive and deductive reasoning typology (F [4,352] = 2.152, $p > 0.05$). These findings suggest that the five syllabus groups perceived similar types of reasoning.

As explained in the Methodology section, five teachers from each category were interviewed, and curriculum documents were analysed to gain further insights into the reasoning behind their practices. These data are presented below in the Qualitative Results section.

Qualitative results

This section addresses the second and third research questions: university teachers' language teaching and learning strategies (R 2), and the relationship between university teachers' reasoning types and their language teaching and learning strategies (R 3). The four factors that were quantitatively identified as distinct reasoning practices are here more profoundly investigated by analysing university teachers' reasoning, which informs their practices. This examination relies on data gathered from qualitative written explanations, interviews, observations and document analysis. Table 9 summarises the typology of university teachers' reasoning, which will be examined individually (mixed inductive and abductive; mixed inductive, deductive and abductive; mixed analogical and abductive; and mixed inductive and deductive), and the corresponding language teaching and learning strategies.

Mixed inductive and abductive reasoning

Saleh and Fhaed taught syntax, Saeed and Waleed focused on rhetoric and Assam specialised in teaching literature. They primarily identified with an inductive approach but also acknowledged their abductive nature. Saleh explained, 'It makes sense to logically progress from specific concepts to broader ones, which can help students remember language topics and avoid rapidly forgetting'. Fhaed indicated that, based on reasoning, he

Table 9 Typology of University Teachers' Reasoning and Language Teaching and Learning Strategies

Type of Reasoning	Strategies in Language Teaching and Learning			
Mixed inductive and abductive	*Cognitive strategies*			
	Recalling language concepts and grammar rules	Relating new concepts to prior concepts	Deeper understanding	Fostering critical thinking
Mixed inductive, deductive and abductive	*Metacognitive strategies*			
	Planning for learning	Selecting an appropriate learning strategy	Managing thinking	Developing concepts
Mixed analogical and abductive	*Interactional strategies*			
	Learning by interaction	Promoting a communicative approach	Contextualising learning	
Mixed inductive and deductive	*Knowledge strategies*			
	Exploring existing knowledge	Bridging gaps between current and new knowledge	Creating knowledge	

tended to encourage students to think about concepts, words and meanings and that he could help them to recall and use those concepts, words and meanings later. Waleed remarked, 'Inductive learning is a practical method for rhetoric subjects due to their prominent features, uniformity and ease of use, and [it promotes] cognitive thinking about concepts'. Similarly, Assam suggested that 'embracing inductive reasoning facilitates a deeper understanding of the literature topics under study'. Naser indicated that students should reflect mentally and connect new concepts to previously acquired concepts and skills. Naser also indicated that he usually allowed his students to keep clarifying their ideas until they became familiar, even if the clarification was sometimes inaccurate. He justified this strategy by explaining that such practices helped students think critically about various ideas.

As indicated in Table 9, the central theme drawn from the qualitative analysis of written explanations, interviews and curriculum content analysis is that teachers with mixed inductive and abductive reasoning focused more on cognitive strategies in language teaching and learning. Saleh, Fhaed and Waleed used cognitive teaching strategies to help their students remember language topics. Table 10 presents an overview of relevant extracts from the transcripts that show the reasoning that informed the teaching strategies of Saleh, Fhaed and Waleed. The table presents curriculum content and teaching episodes from Saleh, who was selected randomly as an example to represent the other two teachers.

As shown in Table 10, the cognitive strategy used in the lesson was to check on the recall of grammar rules. For instance, in line 1, Salah asked students a cognitive explanatory question—'How do we explain this sentence structure? "The lesson is learnt by students"'—to elicit the first responses from students. He then moved from this simple question to employ cognitive thinking questions. He asked his students to explain and provide reasons—'How and why do we use passive voice?' (line 3),—asked for in-depth explanations—'This is not enough. We need more in-depth explanation' (line 5)—and asked them to clarify and differentiate between grammar rules 'So, how does active voice differ from passive voice?' (line 9).

Table 10 Selection of curriculum content/teaching episodes of saleh

Line	Speaker	Activity	Strategy used	Reasoning type
1	T	Now, how do we explain this sentence structure? 'The lesson is learnt by students'	Checks recall of grammar rule	Inductive
2	S1	It uses the passive voice		
3	T	How and why do we use passive voice?	Promotes cognitive thinking with 'how' and 'why' questions	
4	S2	We usually use passive voice when there is a need to shift the focus of the clause		
5	T	This is not enough. We need more in-depth explanation		Abductive
6	S3	It is not like active voice		
7	T	Do you mean it is the opposite of active voice?		
8	S3	Yes, it is a different rule		
9	T	So, how does active voice differ from passive voice?	Clarifies and checks recall of grammar rule	Abductive
10	T	Please take sentence by sentence and check the similarity and difference between them 1. 'The lesson is learnt by students' 2. 'Students learn the lesson'		Inductive
11	S4	Yes, in the second sentence, I can see that the subject is performing an action ('Students learn the lesson'), while the first sentence focuses on the action over the subject ('The lesson is learnt by students')	Answers his question	
12	T	Excellent; in the second sentence, I can see that the subject is performing an action ('Students learn the lesson'), while the first sentence focuses on the action over the subject ('The lesson is learnt by students')		

These findings indicate that Salah initiated his lesson by asking questions regarding the topic without considering the student's prior knowledge. As described by Van den Broek and Helder (2017), such initiated questions have become routine in teaching and stimulate cognitive processes.

Mixed inductive, deductive and abductive reasoning

Ahamed, Anas and Khalid taught linguistics, Ali, Yazid and Basim taught syntax and rhetoric and Masfar specialised in teaching literature. They identified with a combination of inductive, deductive and abductive reasoning. Ahamed and Khalid emphasised that they normally planned for student learning and believed that this is the priority approach. Anas indicated that teachers need to look at how students learn rather than focusing on their thinking, which helps them know when their students better understand the text. Yazid and Masfar highlighted that current students should be able to evaluate their learning processes. Yazid explained that comment by emphasising the importance of encouraging students first to assess their thinking levels. They should then improve their thinking while engaging in various literature, research and other texts. Similarly, Masfar highlighted the importance of keeping students updated with

knowledge, but he recommended that students go through the process of self-evaluating their current thinking proficiency. Basim indicated that he preferred to motivate his students to use high-quality resources. However, he strongly indicated that such an approach required assisting them in managing their own learning and access to resources.

Table 9 shows that the qualitative analysis reveals that the participants who combined mixed inductive, deductive and abductive reasoning focused on metacognitive strategies. Ahamed and Khalid employed their teaching strategies by planning for learning, Masfar and Yazid employed their practices by managing thinking, Anas employed his practices by focusing on learning styles and Basim employed the approach of managing students' independent learning. Table 11 presents an overview of relevant extracts that illustrate this group. The selection of curriculum content and teaching episodes is from Yazid, who was selected randomly as an example of this group.

As demonstrated in Table 11, Yazid's approach incorporated metacognitive strategies. For instance, in the lesson 'emphasis phrases', he began by asking students to develop their lesson plan with clear objectives, such as 'learn how to use language to confirm ideas' and 'learn sorts of words or phrases to convince others'. He used positive language, such as 'excellent', to motivate students to achieve their learning objectives and select appropriate learning strategies. He also initiated the lesson by referring to the topic 'emphasis phrases' but without any more details, which is an example of common deductive practice.

After encouraging students to set their learning objective for the lesson, Yazid engaged them in inductive reasoning by asking them to draw general principles regarding emphasis phrases from specific sentences as in line 7. This activity was supported abductively by identifying students' areas of weakness and conjectures—'Don't worry, just let me know what [you] guess first, even if you make a mistake' (line 9)—and asking them to reflect on their thinking (line 11), which led the teacher to adjust his teaching strategy (line 12).

In line 16, Yazid also asked students to look at the previous sentences without emphasis phrases, omitting each emphasis phrase from the sentences. This strategy is considered useful for developing concepts.

Mixed analogical and abductive reasoning

Mohannad and Salem taught linguistics, and Hasan and Samir taught literature and discourse. They identified with a combination of analogical and abductive reasoning. Mohannad, Mohannad and Salem emphasised that they allowed their students to engage in communicative practice. Mohannad claimed that employing a communicative approach aligns with the overall purpose of language learning, which prepares students to engage in effective and meaningful communication while learning language topics.

> *When we look at the overarching goal of learning any language, it is undoubtedly to assist our students in communicating effectively and meaningfully with each other. Therefore, we must align our teaching with this objective by encouraging students to learn linguistic rules while communicating and interacting with others. (Mohannad, Int. L 34)*

Table 11 Selection of curriculum content/teaching episodes of Yazid

Line	Speaker	Activity	Strategy used	Reasoning type
1	T	Now, let's start with identifying what we will learn today and set our plan together. The topic is related to what phrases or words we use in language to emphasise the importance of the statements we make	Planning for learning	Deductive
2	S1	I think I will learn how to use language to confirm ideas	Setting goals	
3	T	Yes, excellent, but we need more objectives		
4	S2	We might learn sorts of words or phrases to convince others	Setting goals	
5	T	Yes, that is also crucial, but we must contemplate how to achieve such goals before the end of the lesson. Some of you may find reading a text helpful, while others may learn better through visual or auditory methods or cooperative learning	Selecting appropriate learning strategy	
6	S3	I like reading first		
7	T	Excellent, let's start with reading the following statements: 1. 'The student himself had never studied grammar before' 2. 'This particular student had never studied grammar before' 3. 'Indeed, this student had never studied grammar before'		Inductive
8	S3	Oh, it's a bit hard to identify the difference between three statements		
9	T	Don't worry, just let me know what [you] guess first, even if you make a mistake	Identify conjectures and areas of weakness	Abductive
10	S4	I see all the sentences nearly talk about one student	Answers his question	
11	T	Could you tell us what … your focus and thought process are when you read them? Please examine the vocabulary of each sentence	Asking students to reflect on their thinking	
	S5	Yes, I see there are different words used in these three statements, and the structure of each is slightly different		
12	T	Excellent, let's listen to this audio together and think how each statement is [stated] differently	Adjusts strategy	
13	S6	Yes, I see and hear the difference now. I can hear that they put emphasis more on certain words like *himself*, *this particular* and *indeed*		
14	T	Excellent. OK, now, look at the same sentences without these emphasising words		
15	S7	Yes, the previous sentences are more emphasised. Therefore, we call these words or phrases emphasis phrases		

Table 11 (continued)

Line	Speaker	Activity	Strategy used	Reasoning type
16	T	Exactly, we call them emphasis phrases. But I want you to look also at the following sentences and identify sentences that match emphasis phrases: 1. 'This student certainly had never studied grammar before' 2. 'This student, who attended the lesson, had never studied grammar before' 3. 'This student absolutely had never studied grammar before'	Developing concept	
17	S8	I think sentences 1 and 3 include emphasis phrases		
18	S9	I agree with him		
19	T	When the sentence includes words like 'himself,' 'indeed', 'certainly', and 'absolutely' and phrases like 'without a doubt', we call them emphasis phrases, because they convey to the reader or listener what's significant in that sentence or paragraph	Concept completion	

Salem also focused on interaction and a communicative approach when teaching functional grammar. Salem's beliefs reflected his awareness that this communicative approach pays more attention to the functional and structural aspects of language. He stated:

> *I always tend to facilitate interaction and communication between students, because such a strategy is compatible with functional grammar and other structural aspects of language. (Salem, Int. L 28)*

In contrast, Hasan's teaching strategies aligned a communicative approach with contextualising learning because, as they justified, both the communicative approach and contextualising learning support language use. Both endeavoured to guide students' classroom practices to communicate with each other but not focus on one language structure. For example, Hasan stated:

> *I encourage my students to learn by communicating with each other and advise them to bring real-life examples and use any language rules or information they can think about. I avoid task-based learning, because such [a] practice forces students to use certain tasks, grammar or purpose, which is against our natural way of learning and using language. (Hasan, Int. L 16)*

Similarly, Samir promoted a communicative approach and contextualising learning, as he believed these practices enable students to apply what they have learned in real-life situations and focus more on the formation and functionality of language. He stated:

> *We should keep our practice in the way of using a communicative approach and learning in the real context. I can see how such practices help my students use*

what they have learned in real circumstances and shift their attention to how language is formed and works in different contexts. (Samir, Int. L 16)

Table 12 presents an overview of relevant extracts that illustrate this group. The selection of curriculum content and teaching episodes is from Hasan, who was randomly selected as an example of this group.

Table 12 Selection of curriculum content/teaching episodes of hasan

Line	Speaker	Activity	Strategy used	Reasoning type
1	T	Imagine first that you are communicating with someone, and they say the following sentence: "Student was paying on the table." Upon analyzing and explaining this sentence, and you know what happened, you might realize that there is a grammatical error. In this sentence, paying should be replaced with "playing" to make the sentence grammatically correct. However, you may not have all the information, as this case is isolated from its context. Still, it is also important to remember that grammatical correctness may not be necessary for basic comprehension while communicating	Promoting a communicative approach	Inductive
2	S1	Could you please explain it further?		
3	T	Yes. For instance, a student learning a language may make grammatical mistakes; however, their statements would still be comprehensible to the listener. Therefore, it is recommended that you summarise key points from your grammatical references and memorise and comprehend them thoroughly. Be prepared to apply these grammar rules in various oral and written contexts	Contextualising learning	
5	T	Work together and look at every aspect of this attached picture of a garden … can you write a descriptive or literary text based on it? 	Promoting student interaction within contextualising learning	
6	S2/S3/S4	Here, trees emerge as eloquent symbols of giving		
7	T	Excellent. Let's delve deeper into the word 'eloquent' as a group. How can we draw an analogy between this description of a tree and eloquence? Consider the aspects that make those elements relate to eloquence. Additionally, as we analyze the picture, can we draw analogies between the depicted culture, values, social habits, and types of interaction between people and other known scenarios or cultures? Identifying these analogies can enhance our understanding and interpretation	Asking students in the same group to elaborate and provide deep cultural knowledge	Analogical

As demonstrated in Table 12, Hasan's approach incorporated interactional strategies. For instance, he began by emphasising a communicative approach, urging students to prioritise comprehension while communicating as in lines 1 and 3. He justified this by stating that 'a student learning a language may make grammatical mistakes; however, their statements would still be comprehensible to the listener' (line 3). This does not imply neglecting the importance of learning grammar. Hasan advised his students to condense key points from their grammatical references, memorise and thoroughly comprehend them and then apply those grammar rules in various oral and written contexts (line 3).

Hasan also promoted student interaction within contextualising learning. To underscore the importance of understanding the context and culture, he tasked students with studying public spaces to comprehend the meanings of culture, values, social habits and interaction patterns and to incorporate such knowledge into their learning process (line 7).

Mixed inductive and deductive reasoning

Talal and Faiz taught linguistics and discourse, and Bender and Jasser taught literature, discourse and rhetoric. They identified with a combination of inductive and deductive reasoning. All the participants in this group integrated the exploration of existing knowledge into their teaching strategy, a practice that helps teachers recognise their students' thinking levels and enables them to build upon them throughout the learning progression. For example, Talal claimed that 'beginning with an exploration of existing knowledge contributes to the growth of knowledge and ideas' (Talal, Int. L 23). Faiz expanded on this strategy by emphasising the importance of bridging the gap between current and new knowledge. He stated:

> *We can't teach students how to learn, but we can motivate them within their existing understanding to help them comprehend the relationship between their current understanding of language concepts and new concepts. (Faiz, Int. L 23)*

Bender and Jasser believed that employing inductive and deductive processes helped them create knowledge by establishing a connection between prior knowledge and new learning. For example, Bender stated:

> *Knowing students' existing knowledge helps to establish new learning, and that can also motivate students to create knowledge in a way that addresses a sense of dissatisfaction in the students' prior or current knowledge. (Bender, Int. L 16)*

Jasser also indicated that using a strategy to elicit students' current knowledge and alternative conceptions could promote conceptual development, create new ideas and enable them to reconsider their existing knowledge in the learning process.

As indicated in Table 9, the central theme drawn from the qualitative analysis of written explanations, interviews and curriculum content analysis is that teachers with mixed inductive and deductive reasoning focused more on knowledge strategies in language teaching and learning. Table 13 presents an overview of relevant extracts that illustrate this group. The selection of curriculum content and teaching episodes is from Jasser, who was randomly selected to represent the other two teachers.

Table 13 Selection of curriculum content/teaching episodes of Jasser

Line	Speaker	Activity	Strategy used	Reasoning type
1	T	I would actually [like to] know what … you already know about argument. What [has] been learned about it? Do [you] think argument is similar to discussion? By examining specific examples, we can then draw broader insights about the nature of argument	Exploring existing knowledge	Inductive
2	S1	I think argument is different from discussion		
3	T	How?	Asking the student to clarify and elaborate, promoting thinking with the question 'How?'	
4	S1	Discussion is more positive and open to other ideas		
5	T	OK, I want you to read the text in on page 143. By systematically analyzing the content, determine whether the text can be classified as an argument, a discussion, or something else based on your prior knowledge		Deductive
6	S2	The interlocutor in this text give others opportunity to express their opinions freely, didn't interrupt them and listens to them more than speaks		
7	T	Excellent; could you come to the front and, using the same text presented here on the smartboard, highlight these points and explain them again to the classroom?	Asking the student to share his knowledge with other students	
	S2	*The student went to the front and used the text presented on the smartboard to share his explanation with the entire classroom*		
8	T	Excellent; now, let's go back to what [name of student] mentioned about the discussion as more positive	Bridging the gap between current and new knowledge	
9	S3	So, in discussion, I can accept other ideas, even if they are not my own, but I should work hard to convince others about my opinion in argumentation		
10	T	Here is a task that helps us to learn and distinguish between debate, discussion, and argument. You'll use online resources to summarise existing insights on the three concepts and then write three essays on the [natural] environment: one for discussion, one for a debate, and one for an argument	Creating knowledge through research, defining and applying concepts and classroom discussions	

As shown in Table 13, Jasser's approach involved using knowledge strategies. For instance, he started by using open-ended questions to explore the students' existing knowledge as observed in line 1. Subsequently, he bridged the gap between current and new knowledge by expanding on and building on students' previous responses as illustrated in line 8. This process included circling back to the first student's response about the discussion, elaborating further and drawing comparisons with the argument.

Jasser also used a sequence of tasks to encourage students to create knowledge through research, define and apply concepts in written and supportive essays and engage in classroom discussions for generating and reflecting on new knowledge (line 10).

Discussion

This study contributes to the literature by (a) identifying types of reasoning in university language teaching and learning, (b) exploring university language teaching and learning strategies and (c) synthesising two research strands to investigate the relationship between types of reasoning and language teaching and learning strategies by employing a sequential mixed-methods design that built on the quantitative and qualitative results. The present study identified four types of reasoning among university teachers to characterise the four groups discussed in this section. Table 14 summarises the components that form each group and addresses the correspondence between university teachers' reasoning and their language teaching and learning strategies. The quantitative results indicate that the university teachers strongly endorsed all reasoning types, and the reasoning types that constitute the four groups are interrelated and mixed, which suggests that the reasoning of university teachers is not always one type or another; rather, it seems that all types of reasoning are important and useful when used together in language teaching and learning. These findings align consistently with those of transformative scholars (Behrens, 2017; Bybee, 2010; Holyoak & Morrison, 2012; Oh, 2008), who reject the binary either/or choice in reasoning within language instruction.

The relationship between university teachers' reasoning and their language teaching and learning strategies emerged from synthesising the quantitative and qualitative findings regarding their reasoning and their teaching strategies. Group 1 combined inductive and abductive reasoning, indicating that the teachers used abductive reasoning practices by making unfamiliar information more apparent and understandable for their students and encouraging students to seek clarification when faced with incomplete understanding. This validates previous research emphasising the importance of abductive reasoning as an explicit type of reasoning that not only leads to the best explanation but also involves the clarification of previous information (Burch, 2006).

Additionally, the teachers employed inductive reasoning practices by acknowledging the importance of infinite word meanings when learning a language task. They also recognised their student's biases in language learning, such as assuming words refer to whole objects rather than parts, and understood the impact of mutual exclusivity bias on the language learning process. This is in line with previous studies (Giorgou Tzampazi, 2019) that show the significance of mutual exclusivity bias as the principle that guides inductive reasoning in the presence of known words and grammar instruction. The qualitative results indicate that the university teachers in this group used cognitive strategies, including recalling language concepts and grammar rules, connecting new concepts to prior concepts, promoting deeper understanding and fostering critical thinking. The types of reasoning and cognitive strategies that Group 1 demonstrated tend to correspond to what is highlighted in Klauer and Phye's review study (2008), which concludes that inductive reasoning promotes the use of cognitive processing.

This study's quantitative findings also reveal significant differences between the five syllabus groups (syntax, rhetoric, linguistics, literature and discourse) concerning the

Table 14 Integrated results matrix

Group	Quantitative results			Qualitative results			
	Type of reasoning (EFA)	**Level of reasoning *M*(*SD*)**	**Typology of reasoning and language syllabus, ANOVA and Scheffé tests**	**Reasoning and language teaching and learning strategies**			
1	Mixed inductive and abductive	3.86(0.53)	Significant differences were found between the five syllabus groups (F [4,352] = 6.302, $p < 0.05$) University teachers who taught a discourse syllabus rated the level of reasoning higher ($M = 4.10$, $SD = 0.41$)	Cognitive strategies			
				Recalling language concepts and grammar rules	Relating new concepts to prior concepts	Deeper understanding	Fostering critical thinking
2	Mixed inductive, deductive and abductive	3.86(0.47)	No significant differences between the five syllabus groups (F [4,352] = 0.840, $p > 0.05$)	Metacognitive strategies			
				Planning for learning	Selecting appropriate learning strategy	Managing thinking	Developing concepts
3	Mixed analogical and abductive	3.93(0.53)	Significant differences were found between the five syllabus groups (F [4,352] = 25.774, $p < 0.05$) University teachers who taught a discourse syllabus rated the level of reasoning higher ($M = 4.52$, $SD = 0.33$)	Interactional strategies			
				Learning by interaction	Promoting a communicative approach	Contextualising learning	
4	Mixed inductive and deductive	3.96(0.61)	No significant differences were found between the five syllabus groups (F [4,352] = 2.152, $p > 0.05$)	Knowledge strategies			
				Exploring existing knowledge	Bridging gaps between current and new knowledge	Creating knowledge	

mixed inductive and abductive reasoning typology. The results show that university teachers who taught a discourse syllabus rated the level of mixed inductive and abductive reasoning higher than university teachers who taught syntax, rhetoric, linguistics or literature. Thus, university teachers who taught discourse tended to employ mixed inductive and abductive reasoning. These findings are consistent with those of previous studies (Kuhn & Modrek, 2018; Kuhn et al., 2015) that indicate that choosing multiple types of reasoning is preferred when teaching argumentative discourse.

Group 2 primarily employed a form of reasoning that combines inductive, deductive and abductive principles. They employed abductive reasoning by providing students with data and allowing them to convert it into problems within focused language learning that facilitated two measurable phases: generating and testing hypotheses. They also employed inductive reasoning practices, indicating that students can derive general principles of language by encountering specific instances of phonemes, morphology, words and sentences and emphasising the importance of the structure of the input in language learning and acquisition. This result aligns with the findings of Housen et al. (2016), who stress the significance of guided induction instruction, wherein teachers structure student language learning. Deductive reasoning practices suggest the importance of beginning language learning with a broad concept or theory that is refined into hypotheses. This finding is corroborated by Hayes et al. (2010), who highlight that the characteristics of deduction involve deriving specific examples from general principles. The qualitative results indicate that the university teachers in Group 2 applied metacognitive strategies, including planning for learning, selecting appropriate learning strategies, managing thinking and developing concepts, which is consistent with previous studies (Teng, 2020).

Group 3 employed a form of reasoning that involves a combination of analogical and abductive reasoning. The analogical reasoning highlights the importance of students having and manipulating linguistic information, analysing structures and doing mapping based on structural alignment and knowledge of relational similarity in language learning. This finding aligns with the perspectives of those who emphasise the analogical reasoning process (Holyoak & Morrison, 2012). The qualitative results indicate that the university teachers in Group 3 applied interactional strategies, including learning by interaction, promoting a communicative approach and contextualising learning. This result corresponds to what Griffiths (2018) describes as 'social teaching strategies'.

This study's quantitative findings also reveal significant differences between the five syllabus groups (syntax, rhetoric, linguistics, literature and discourse) concerning the mixed analogical and abductive reasoning typology. The result show that university teachers who taught a discourse syllabus rated the level of mixed analogical and abductive reasoning in language teaching and learning higher than university teachers who taught syntax, rhetoric, linguistics or literature. These findings are consistent with those of previous studies (Kuhn & Modrek, 2018; Kuhn et al., 2015) indicating that, in teaching argumentative discourse, there is no dominant type of reasoning. Therefore, choosing multiple types of reasoning is preferred when teaching discourse.

Group 4 employed a combination of inductive and deductive reasoning in their teaching practices. They acknowledged that students learn language through various processes, such as observation, pattern detection and hypothesis formulation. This

finding agrees with previous research (Ellis, 2016) that advocates for inductive reasoning practices. Along with inductive reasoning practices, the teachers highlighted the importance of students learning language by first understanding rules and then applying them through examples and practice and engaging in a complex process that involves deriving specific examples from general principles. These conceptions are part of deductive reasoning practices and align with the findings of previous research (Hayes et al., 2010). The qualitative results indicate that the teachers in Group 4 applied knowledge strategies, including exploring existing knowledge, bridging the gap between current and new knowledge and creating knowledge. This result aligns with the findings of recent studies (Aljohani, 2017; Quoc & Van, 2023) suggesting that the focus in language learning should move to designed tasks that facilitate extrapolation and fill in knowledge gaps.

Conclusion

This study employed a sequential mixed-methods design through two phases of data collection. Phase 1 included a mixed-methods questionnaire with 357 Arabic-language teachers. Phase 2 involved interviews, classroom observations and document analysis with 20 Arabic-language teachers to explore their reasoning and teaching strategies.

The present study offers several important findings. First, it shows that teachers strongly endorsed all reasoning types as important, which reflects their willingness to apply all types of reasoning in language teaching and learning. Second, the reasoning types that constitute the four groups identified in this study are interrelated and mixed, which indicates that university teachers' reasoning is not dominated by one type but includes multiple types of reasoning in language teaching and learning. A third significant finding is that the results indicate a correspondence between university teachers' reasoning and their language teaching and learning strategies. These findings indicate links between mixed inductive and abductive reasoning and cognitive strategies. Furthermore, connections were found between mixed inductive, deductive and abductive reasoning and metacognitive strategies. Additionally, the findings indicate links between mixed analogical and abductive reasoning and interactional strategies as well as between mixed inductive and deductive reasoning and knowledge strategies. Further research could apply the methodology used in this study to explore teachers' reasoning and teaching strategies in other disciplines.

Fourth, among the quantitative findings of this study was the significant difference discovered in the responses of the five syllabus groups regarding the mixed analogical and abductive reasoning typology and the mixed inductive, deductive and abductive reasoning typology. The results show that university teachers who taught a discourse syllabus rated the level of those types of reasoning higher than those who taught syntax, rhetoric, linguistics or literature. Further research on reasoning and teaching discourse could be conducted to provide an in-depth understanding of these typologies and the relationship between reasoning and teaching discourse.

Author contributions
Abdulmajeed Alghamdi designed the study, contributed to the literature review, collected and analyzed the data, and wrote the manuscript.

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Availability of data and materials
The data supporting this study's findings are available from the corresponding author upon reasonable request.

Declarations

Ethical approval and consent to participate
The author declares that no potential conflict of interest is reported in this article's research.

Competing interests
The authors declare no competing interests.

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