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Exploring Chinese EFL Teachers' Beliefs about Data-Driven Learning in Language Education: A Q-Methodology Study

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ABSTRACT

Data-driven learning (DDL) has become an important approach in language education, offering innovative ways to enhance teaching and learning. However, little research has examined DDL from the perspective of teachers, particularly their beliefs about its implementation. This study addresses this gap by using Q methodology to investigate the beliefs of 30 Chinese university English teachers about DDL. The analysis uncovered four distinct beliefs: optimistic embrace, which values DDL's ability to foster student autonomy and engagement; goal-oriented caution, which emphasizes the importance of clear boundaries and well-aligned objectives; tech-dependence skepticism, which highlights the indispensable role of teacher guidance while cautioning against over-reliance on technology; and prudent balance, which advocates for a measured and evidence-based adoption of DDL. These findings illuminate the diversity of teacher attitudes and underscore the complexities of integrating DDL into language education.

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In the context of rapid globalization and advancements in information technology, language education methods have been evolving significantly (Wang et al., 2025; Wang et al., 2026). Data-Driven Learning (DDL), an approach that utilizes authentic language data to encourage learners' discovery of linguistic patterns, has gained attention from scholars and practitioners (Pérez-Paredes, 2022; Zare & Aqajani Delavar, 2023). By analyzing large linguistic corpora, students engage in autonomous exploration, moving away from traditional teacher-centered instruction toward more inquiry-based knowledge construction (O'Keeffe, 2021; Zare & Aqajani Delavar, 2024). Although DDL holds theoretical advantages for enhancing learners' grammar, vocabulary, and pragmatic skills, its implementation in real educational settings faces challenges (Lee et al., 2020). Teachers, as key stakeholders, play a crucial role in the adoption and success of DDL, with their beliefs influencing both their acceptance of this approach and its integration into teaching practices (Chen et al., 2019; Lenko-Szymanska, 2017). These beliefs, shaped by teachers' attitudes toward innovation, perceptions of feasibility, and underlying pedagogical values, can either facilitate or hinder the effective implementation of DDL in the classroom (Wang et al., 2024). However, there is still limited research on the specific beliefs that teachers hold about DDL and how these beliefs shape their classroom decision-making and instructional behaviors.

In this context, this study aims to explore language teachers' beliefs about DDL through Q-methodology. Q-methodology is a unique research approach suited to examining participants' subjective views and beliefs, making it particularly valuable for analyzing complex educational belief systems (McKeown & Thomas, 2013). By employing Q-methodology, this study seeks to uncover different types of beliefs teachers hold toward DDL and to examine the potential impact of these beliefs on language education. This research not only enhances understanding of how teachers' beliefs influence the adoption of DDL but also offers theoretical insights and implications for the future development of DDL in language education.

2. Literature Review

2.1. Data-Driven Learning

DDL has become a prominent approach in language education as corpora have enabled learners and teachers to access authentic language use in a systematic way (Pérez-Paredes, 2022). Originating in the work of Tim Johns, DDL emphasizes learners' direct engagement with corpus evidence so that they can notice, compare, and infer linguistic patterns for themselves rather than rely solely on teacher explanation or rule presentation (Boulton & Vyatkina, 2021). In this sense, DDL is commonly associated with the hands-on use of concordances and other corpus tools to support inductive language learning (Boulton, 2011). Its pedagogical rationale is grounded in the noticing hypothesis and discovery-oriented learning, both of which highlight the value of learner attention, exploration, and active meaning-making in language development (Flowerdew, 2015). At the same time, DDL should not be understood as a narrowly fixed technique. Rather, it has developed into a flexible pedagogical orientation that can be adapted to different learners, tasks, and instructional contexts (Boulton, 2017; Gilquin & Granger, 2010).

Existing research has shown that DDL can be used in a range of individual language learning situations rather than only in abstract or highly specialized corpus work. For example, studies have examined how corpus consultation supports second language vocabulary learning and how learner-related factors shape the effectiveness of such engagement (Lee et al., 2020). DDL has also been applied to grammar learning among college EFL students with different proficiency levels, suggesting that its benefits may vary across learner groups and instructional designs (Lin, 2021). In addition, research comparing inductive and deductive DDL has demonstrated its relevance for vocabulary acquisition and retention, showing that corpus-based activities can contribute to measurable language development when tasks are carefully structured (Lee & Lin, 2019). Beyond student learning outcomes, DDL has also been introduced into teacher education and academic

writing instruction, where in-service teachers are required not only to understand corpus tools but also to mediate their use pedagogically (Chen et al., 2019; Leńko-Szymańska, 2017). These studies suggest that DDL is not simply a technological innovation, but a pedagogical approach whose success depends on how learners interact with data and how teachers frame, scaffold, and evaluate that interaction.

Accordingly, recent scholarship has examined DDL from multiple perspectives, including learners, teachers, technological tools, theoretical foundations, and instructional effectiveness. This body of work has helped clarify the accessibility of corpus platforms, the pedagogical value of corpus-informed activities, and the theoretical significance of pattern noticing and data-based feedback in language learning (Crosthwaite, 2019; Lusta et al., 2023; O'Keeffe, 2023; Van der Kleij et al., 2015). However, the field still appears to be shaped more strongly by questions of learner outcomes and implementation effectiveness than by systematic attention to teachers' subjective understandings of DDL. In particular, while DDL is often associated with learner autonomy and exploratory learning, its classroom use still depends heavily on teacher mediation, instructional judgment, and perceptions of feasibility. For this reason, examining teachers' beliefs is essential for understanding how DDL is interpreted, accepted, and enacted in actual language education settings.

2.2. Language Teacher Beliefs

The concept of teacher beliefs has been approached from multiple perspectives, and its meaning has gradually become clearer through sustained theoretical discussion (Gao et al., 2024; Wang et al., 2024). Early work focused mainly on the origins and nature of teachers' beliefs. Lortie (1975) argued that such beliefs are shaped by teachers' prior experiences as students as well as by wider personal and social influences. Clark and Peterson (1986) further linked teachers' thought processes to planning, interactive decision-making, and broader belief systems, while Nespor (1987) emphasized the affective, evaluative, and narrative dimensions of beliefs and their role in shaping classroom action. Pajares (1992) highlighted the conceptual complexity of teacher beliefs and described them as judgments inferred from what teachers say and do. Later studies distinguished between explicit beliefs, which can be consciously articulated (Johnson, 1992), and implicit beliefs, which may be inferred from practice (Argyris & Schon, 1974; Breen et al., 2001). At the same time, Borg (2001) noted that the boundary between conscious and unconscious beliefs is not always clear. Overall, teacher beliefs are now widely understood as evaluative propositions that guide pedagogical thinking and practice, while remaining dynamic, context-sensitive, and at times internally contradictory (Barcelos & Kalaja, 2011; Borg, 2001; Kalaja & Barcelos, 2003).

Previous research has shown that language teachers' beliefs influence a wide range of educational issues, but several strands are especially relevant to the present study. One important line of inquiry concerns classroom practices, where beliefs shape instructional strategies and classroom interaction (Bao et al., 2021; Cheng et al., 2021). Another closely related strand focuses on technology integration, showing that teachers' beliefs affect whether and how digital tools are adopted in language education (Gao et al., 2024; Lai et al., 2022). Other studies have addressed teachers' beliefs about assessment (Tsunemoto et al., 2023; Vogt et al., 2020), learner autonomy (Almusharraf, 2020; Delos Reyes & Torio, 2021), intercultural and multilingual teaching (Heggernes, 2021; Makhmudov, 2020), and professional development and reflective practice (Bowman et al., 2022; Farrell, 2020). Taken together, this literature suggests that teacher beliefs are particularly important in contexts where new pedagogical approaches require a balance between learner independence and teacher guidance. This issue is especially relevant to DDL, which encourages learners to explore authentic language data while still depending heavily on teacher mediation, task design, and instructional judgment. However, despite extensive research on language teachers' beliefs in general, limited attention has been paid to how teachers specifically understand and evaluate DDL. Exploring such

beliefs is therefore essential for clarifying how DDL may be interpreted and enacted in language education.

3. Methodology

3.1. Research Design

This study aims to explore Chinese teachers' beliefs about DDL in the context of language education. To achieve this aim, the study adopts Q methodology, which is well suited to examining subjectivity and identifying shared viewpoints among participants. In this approach, participants sort a set of statements (the Q-set) according to their level of agreement or disagreement, and these Q-sorts are then analyzed to reveal distinct patterns of beliefs. Q methodology is widely used in educational research because it can capture the diverse and complex nature of personal beliefs and attitudes (Rimm-Kaufman et al., 2006). It is especially valuable in language education, where teachers' beliefs can shape instructional decisions and classroom practices (Watts & Stenner, 2005). Accordingly, the present study uses Q methodology to identify different types of beliefs held by Chinese English teachers regarding DDL in language education. The study specifically addresses the following research question (RQ):

RQ 1: What are the different types of beliefs held by Chinese English teachers regarding DDL in language education?

3.2. Participants

The recruitment criteria for participants in this study were as follows: first, participants must have knowledge of and experience with DDL in their teaching. This criterion was assessed through self-report during recruitment. Second, they should be willing to voluntarily participate after being fully informed about the study's purpose and process. The study involved 30 participants, including 12 male and 18 female teachers. In terms of age, 15 participants were 30 years old or younger, 10 were between 30 and 40, and 5 were over 40 years old. Regarding teaching experience, 8 participants had 5 years or less of teaching experience, 14 had between 5 to 10 years of experience, and 8 had more than 10 years of experience. This participant group provided perspectives on DDL in language education from teachers with varied age ranges and levels of teaching experience.

3.3. Instruments

This study followed a systematic procedure to construct a Q-set that captured Chinese EFL teachers' beliefs about DDL in language education. The development of the Q-set involved three stages. In the first stage, an initial set of 70 statements was generated, drawing on interviews, focus group discussions, and relevant media materials related to DDL, following McKeown and Thomas (2013). The interviews were used to elicit individual views and experiences, whereas the focus groups helped identify shared concerns and recurring themes. These sources were combined to ensure broad coverage of viewpoints on DDL. The second stage involved a review by a panel of three experts in language education, each with extensive experience in DDL and teacher education. The experts assessed the items for redundancy, relevance, and overall coverage, leading to a reduction of the original set to 42 statements. In the third stage, the refined set was pilot tested with a group of five English teachers who were already familiar with DDL. Based on their detailed feedback, 8 ambiguous or redundant items were removed, resulting in a final Q-set of 34 statements. The final Q-set consisted of 34 statements for participants to rank in the Q-sorting process. In line with Q-methodological practice, these statements were developed to represent a range of viewpoints on DDL rather than to form a psychometric scale. A comprehensive list of the Q-set is provided in the Appendix. This rigorous process helped ensure that the final Q-set adequately represented key beliefs about DDL in language education.

3.4. Data Collection

This study employed HTMLQ for the Q-sorting process, with data stored locally to facilitate subsequent analysis. The HTMLQ code was

customized using the EQ-Configurator client from the Q Method website to suit the specific sorting needs of this study. A quasi-normal distribution sorting table was utilized, organized into nine piles ranging from -4 to +4. Participants first read all 34 statements and then sorted them into three preliminary categories: Agree, Neutral, and Disagree. After this initial classification, they were asked to place the statements into the fixed quasi-normal distribution according to the strength of their agreement or disagreement, until all statements had been assigned to their designated positions. Statements with the strongest agreement were assigned a score of +4, while those with the strongest disagreement were given a score of -4. Participants were allowed to review and adjust their sorting before submitting the final Q-sort. The quasi-normal distribution table used in the sorting process has been provided in the Appendix. After completing the sorting, participants were asked to explain their choices, particularly for the statements they strongly agreed or disagreed with. These post-sorting comments were used as supplementary qualitative data in the interpretation phase to help clarify the meaning of each factor and to support the labeling of the extracted belief profiles.

3.5. Data Analysis

The data were analyzed using KADE software, following a structured process based on Q methodology. The analysis was based on the 30 participants' completed Q-sorts. In line with Q-methodological practice, the focus was on identifying shared viewpoints across participants rather than relationships among variables. First, factor analysis was conducted using principal component analysis to extract the factors, retaining those with an eigenvalue greater than 1, as recommended by McKeown and Thomas (2013). These factors were then rotated using varimax rotation to improve interpretability. Next, factor loadings were calculated to determine statistical significance (See Table 1). The factor loadings were calculated by retaining values equal to or greater than $2.58 \times (1/\sqrt{N})$, where N is the total number of Q statements (34 in this study), as outlined by Watts and Stenner (2005). Although eight factors were initially extracted, only four were retained for final interpretation based on three criteria: eigenvalue greater than 1, at least two significantly loading participants, and interpretability. Given that Q methodology is a person-centered approach designed to identify distinct viewpoints, the sample size of 30 participants was considered appropriate for the present study (McKeown & Thomas, 2013). Only factors reflecting the views of at least two participants were retained, and participants whose views spanned multiple factors were excluded from further analysis. Finally, factor interpretation was carried out based on items with the highest and lowest values (+4, +3, -4, and -3), with post-sorting comments used as supplementary evidence to support the interpretation of the retained factors.

Table 1
Eigenvalues and Explained Variance

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Eigenvalues	9.78	6.95	5.81	2.54	0.99	0.88	0.83	0.68
% explained variance	33	23	19	8	3	3	3	2
cumulative % explained variance	33	56	75	83	86	89	92	94

4. Results

4.1. Optimistic Embrace

Factor 1 explains 33% of the variance, with eleven participants loading significantly on this factor. This group believes that DDL empowers students by fostering autonomy and providing opportunities for enjoyable, self-directed exploration (See Table 2). They view technology as a tool to support learners' individual needs and enhance engagement with tasks. These teachers strongly advocate for creating

space where students can independently explore and find joy in the learning process (30:4). They also acknowledge that students' acceptance of DDL can vary due to individual differences, making personalization a critical factor in its success (22: 4). Furthermore, they support integrating data feedback to help students track progress while combining it with other traditional learning methods to maintain balance and adaptability (14: 3). They emphasize that students might need more technical training to fully utilize the benefits of DDL, indicating a willingness to invest resources in technology training (10: 3). On the other hand, this group dismisses concerns about the excessive energy demands of implementing DDL, arguing that such worries are overestimated (26: -3). Similarly, they do not perceive significant risks associated with data privacy issues or question the relevance of data for complex language tasks, suggesting confidence in the robustness of the approach (11: -3; 27: -4). This optimism reflects a belief in the transformative potential of DDL. This perspective is also reflected in Participant 8's post-sorting comment, which highlights the perceived value of DDL in promoting learner autonomy and enjoyment.

> "I've seen how data-driven learning gives my students the freedom to explore and discover language patterns on their own, which they find enjoyable. With the right technical support, I believe this approach can really enhance their motivation and independence."

Table 2
Statements for Factor 1

No.	Statement	Z-score	Q-Sort Value
Top 4			
30	Data-driven learning provides students with more autonomy to explore, allowing them to find joy in tasks.	1.75	4
22	Students' acceptance of data-driven learning may vary due to individual differences.	1.55	4
14	Data feedback helps enhance students' awareness of learning progress but should be combined with other learning methods.	1.40	3
10	Students require more technical training support in data-driven learning.	1.38	3
Bottom 4			
26	Data-driven learning requires significant effort, exceeding the demands of daily teaching.	-1.43	-3
11	Students' data privacy may be compromised in data-driven learning.	-1.53	-3
27	Language learning is an art, and data cannot capture its complexity.	-1.56	-4
16	Data-driven learning is more suitable for advanced language learners but offers little help to beginners.	-1.89	-4

4.2. Goal-oriented Caution

Factor 2 explains 23% of the variance, with nine participants loading significantly on this factor. This group emphasizes the importance of maintaining clear boundaries and objectives when using DDL (See Table 3). They believe that a well-structured approach ensures that students stay focused on learning goals and avoid potential distractions caused by the openness of data-driven tasks (9:4). They stress that the application of data-driven methods should be clearly delineated to ensure its relevance and alignment with educational priorities (8:3). In addition, they advocate for the moderate

use of DDL, seeing it as a tool to improve students' self-management skills and promote a sense of responsibility in their studies (6:3). However, this group expresses significant concerns about students becoming overly reliant on technology, which they believe could hinder the development of practical language application skills (29: -4). They also point out that students may require a considerable amount of time to adapt to DDL methods, which could impact their ability to fully benefit from this approach in the short term (15: -3). Additionally, they argue that while DDL can be a valuable aid, it should not overshadow the central importance of hands-on practice in language education (24: -4). By exploring the perspectives of these educators, one could gain valuable insights into the importance they place on balancing innovation with the practical realities of classroom learning. The insights shared by Participant 16 reinforce this perspective.

> "In my experience, setting clear boundaries for data-driven tasks ensures students stay focused on the learning goals. At the same time, I worry that if not carefully implemented, it might lead to over-reliance on technology and neglect of practical language skills."

Table 3
Statements for Factor 2

No.	Statement	Z-score	Q-Sort Value
Top 4			
10	Students require more technical training support in data-driven learning.	1.61	4
9	The openness of data-driven learning tasks may lead students away from instructional objectives.	1.50	4
8	The application scope of data-driven learning methods in language learning needs to be clearly defined.	1.41	3
6	Moderate use of data-driven learning can improve students' self-management skills.	1.40	3
Bottom 4			
14	Data feedback helps enhance students' awareness of learning progress but should be combined with other learning methods.	-1.43	-3
15	Students need a significant amount of time to adapt to data-driven learning methods.	-1.52	-3
29	Data-driven learning makes students overly dependent on technology, neglecting practical language application skills.	-1.72	-4
24	Data-driven learning can be used as an auxiliary tool, but the core of language learning is practice.	-1.81	-4

4.3. Tech-dependence Skepticism

Factor 3 explains 19% of the variance, with six participants loading significantly on this factor. This group critiques the potential over-reliance on technology in DDL, while emphasizing the essential role of teacher guidance in mitigating its shortcomings (See Table 4). They believe that students can benefit from DDL but only under conditions where teacher involvement remains central to the learning process (28: 4). They recognize that this approach helps students focus on specific learning goals and continuously improve through targeted feedback and adjustments (23:3). However, they are cautious about viewing DDL as a comprehensive solution for language education, suggesting that it may fail to address all aspects of linguistic skill development (1:-3). They also worry about the lack of student engagement in data-driven activities, suggesting that such methods might not consistently motivate learners across different contexts (17: -4). This group is particularly critical of

the potential for students to become overly dependent on technology, arguing that such reliance could undermine their ability to develop practical, real-world language skills (29:4). Moreover, they express doubts about the general applicability of DDL across diverse learner profiles, pointing to the need for more nuanced implementation (20:-4). This perspective is also reflected in Participant 10's post-sorting comment, which highlights the usefulness of DDL while emphasizing the continuing importance of teacher guidance.

> "I think data-driven learning is a helpful tool, but it can't replace the role of a teacher in guiding students through complex language concepts. While students benefit from targeted feedback, they still need a human connection to make their learning meaningful."

Table 4
Statements for Factor 3

No.	Statement	Z-score	Q-Sort Value
Top 4			
29	Data-driven learning makes students overly dependent on technology, neglecting practical language application skills.	1.70	4
28	Students can benefit from data-driven learning but still need guidance from teachers.	1.60	4
23	Data-driven learning helps students focus on specific learning objectives and continuously improve.	1.50	3
27	Language learning is an art, and data cannot capture its complexity.	1.37	3
Bottom 4			
18	I am confident enough in operating data-driven learning to implement it smoothly in the classroom.	-1.34	-3
1	Data-driven learning is effective in all language skills learning.	-1.37	-3
17	Most students show high engagement and enthusiasm in data-driven learning activities.	-1.62	-4
20	Data-driven learning can transform abstract language knowledge into concrete language examples.	-1.65	-4

4.4. Prudent Balance

Factor 4 explains 8% of the variance, with three participants loading significantly on this factor. This group adopts a cautious yet balanced approach to DDL, emphasizing the importance of empirical validation and careful implementation (See Table 5). They believe that while DDL has the potential to enhance efficiency, it is not a universal solution for all aspects of language education (12:3). These educators stress that the current enthusiasm for DDL may be exaggerated and that it is essential to approach its adoption with careful consideration and research-based evidence (5:4). They acknowledge that students may benefit from this approach but emphasize the need for further studies to substantiate its effectiveness and long-term impact (21:4). At the same time, they are wary of the additional burden DDL might place on students, particularly in terms of increased workload and complexity (4:3). This group also argues against the universal application of DDL, asserting that its effectiveness depends heavily on specific contexts and learner needs (1:-4). Furthermore, they caution against sidelining traditional methods, advocating instead for a balanced approach that incorporates data-driven techniques as a supplement rather than the core focus of instruction (7:-3). The discussion with Participant 14 highlights and supports this stance.

> "I find data-driven learning promising, but I'm cautious about its long-term effectiveness without more evidence-based research. For

now, I see it as a supplement to traditional methods rather than a comprehensive solution."

Table 5
Statements for Factor 4

No.	Statement	Z-score	Q-Sort Value
Top 4			
21	Students may benefit from data-driven learning but need more research to support the effectiveness of this approach.	1.77	4
5	The current effectiveness of data-driven learning might be exaggerated and should be adopted cautiously.	1.67	4
12	Data-driven learning can improve learning efficiency but cannot solve all problems.	1.52	3
4	Data-driven learning methods may increase the learning burden on students.	1.36	3
Bottom 4			
7	Data-driven approaches should serve as auxiliary tools in teaching rather than the core of instruction.	-1.23	-3
15	Students need a significant amount of time to adapt to data-driven learning methods.	-1.55	-3
1	Data-driven learning is effective in all language skills learning.	-1.72	-4
17	Most students show high engagement and enthusiasm in data-driven learning activities.	-1.91	-4

5. Discussion

This study employed Q methodology to explore teachers' beliefs about DDL in language education and identified four distinct viewpoints. Rather than representing simple differences in level of acceptance, these belief types reveal different ways in which teachers interpret the pedagogical value, constraints, and conditions of DDL use. Across the four factors, the findings suggest that teachers do not view DDL as either wholly beneficial or wholly problematic. Instead, they evaluate it in relation to learner autonomy, teacher guidance, practical applicability, and the need for evidence-based implementation. In this sense, the present study extends existing DDL research by showing that teachers' responses to DDL are differentiated and internally reasoned, and that the adoption of DDL is shaped not only by its technical affordances but also by how teachers position it within their broader pedagogical beliefs.

The first belief type, optimistic embrace, reflects a strong confidence in the potential of DDL to promote learner autonomy and engagement. Teachers holding this view see DDL not merely as a technological tool, but as a means of encouraging students to explore language patterns independently and to participate in learning more actively. This interpretation is consistent with Zare and Aqajani Delavar (2024), who show that data-driven tasks can enhance learner motivation when they are meaningfully structured. At the same time, the present finding adds an important nuance: these teachers' optimism is not based on an uncritical acceptance of technology, but on the assumption that students can benefit from DDL when sufficient technical support is available. In this respect, their position differs from concerns raised by Kellerer et al. (2019) and Lin et al. (2014), which emphasize the constraints associated with technical complexity and implementation barriers. What distinguishes this factor is that such challenges are not denied, but interpreted as manageable rather than prohibitive. The contribution of this belief type, therefore, lies in showing that some teachers frame DDL primarily as an enabling resource for learner agency, provided that the necessary support conditions are in place.

The second belief type, goal-oriented caution, emphasizes the importance of establishing clear objectives and boundaries when applying DDL. These teachers believe that without a structured approach, the openness of such methods might distract students from achieving targeted goals. Their perspective resonates with the findings of Contreras (2016), who argues that clearly defined tasks are critical for keeping students focused and maintaining effectiveness in data-driven approaches. However, the present study shows more specifically that these teachers interpret structure not simply as a matter of classroom management, but as a necessary condition for aligning DDL with instructional objectives. Teachers in this group are particularly concerned about the potential for students to become overly reliant on technology, a concern echoed by Farrokhnia et al. (2024), who warns about diminishing practical application skills. In contrast to Fajari (2021), where openness is more closely associated with creativity and critical thinking, the present findings suggest that these teachers do not view openness as pedagogically desirable in itself. Instead, they evaluate DDL in terms of whether it can remain goal-directed and educationally productive. This helps explain why support for DDL may coexist with reservations about its unconstrained use.

The third belief type, tech-dependence skepticism, reflects skepticism toward excessive reliance on technology, emphasizing the indispensable role of teacher guidance. Teachers in this group recognize the benefits of data-driven methods, such as targeted feedback and improved focus on learning goals, but maintain that human interaction is essential for creating meaningful learning experiences. Gentile et al. (2023) support this view, emphasizing the irreplaceable role of teachers in facilitating nuanced understanding that technology alone cannot achieve. This contrasts with proponents of fully automated learning systems like Rawas (2024), who argue that technology can independently deliver high-quality language education. However, the present finding is not simply a rejection of technological innovation. Rather, it suggests that these teachers distinguish between using DDL as a pedagogical aid and allowing it to become the central driver of learning. Their skepticism is therefore directed less at DDL itself than at forms of implementation that weaken interaction, practical language use, or teacher judgment.

The fourth belief type, prudent balance, represents a measured and evidence-oriented perspective on DDL. Teachers associated with this factor do not dismiss the potential value of DDL, but they are reluctant to endorse it strongly in the absence of clearer empirical support and contextual fit. This perspective aligns with O'Keeffe (2021) and Zare and Aqajani Delavar (2023), who call for more empirical research into the long-term impacts of DDL and its adaptability to diverse educational settings. In contrast, advocates for rapid adoption like Pérez-Paredes (2022) and Zare and Aqajani Delavar (2024) argue that educators should embrace such innovations more readily to stay ahead in modern language education. The present findings add to this discussion by showing that some teachers' hesitation is rooted not in resistance to change, but in a preference for cautious and context-sensitive implementation. In other words, these teachers appear willing to consider DDL, but only as part of a gradual and evidence-based pedagogical process. This factor is important because it highlights a form of professional judgment that values innovation, yet resists adopting it uncritically.

Taken together, these four belief types suggest that teachers' views of DDL are shaped by different assumptions about autonomy, structure, mediation, and evidence. On this basis, the study offers several implications that are closely grounded in the findings. First, the results indicate that DDL implementation is unlikely to be effective if teachers and students are expected to use it without sufficient preparation. This implication is especially supported by the optimistic embrace and goal-oriented caution factors, both of which point to the importance of technical and pedagogical support. Second, the findings suggest that DDL tasks need to be designed with clear pedagogical purposes while still allowing room for exploration. This implication follows particularly from the contrast between

optimistic embrace and goal-oriented caution, which together show that learner autonomy is valued, but not when it leads to loss of instructional focus. Third, the results underline that teacher guidance remains central even in data-rich learning environments. This point is most clearly reflected in tech-dependence skepticism and prudent balance, where DDL is viewed as useful only when it is mediated by teacher judgment and adapted to learner needs. Rather than advocating a generic embrace of DDL, the present study suggests that its pedagogical value depends on how teachers interpret and position it within their existing instructional beliefs and classroom priorities.

6. Conclusion

This study utilized Q methodology to explore teachers' beliefs about DDL in language education, uncovering four distinct attitudes toward DDL: optimistic embrace, goal-oriented caution, tech-dependence skepticism, and prudent balance. Teachers with an optimistic embrace appreciate DDL's potential to foster student autonomy and engagement. Those with a goal-oriented caution emphasize the importance of clear boundaries and well-defined objectives in implementing these methods. Teachers who are critical of tech dependence highlight the indispensable role of teacher guidance while expressing skepticism about excessive reliance on technology. Finally, educators with a prudent balance advocate for a measured and evidence-based approach, stressing the necessity of empirical validation before widespread adoption. These findings reveal the diversity of teacher attitudes and demonstrate the complexity of integrating DDL into language education. This study advances understanding by showcasing the varied ways teachers perceive and engage with innovative methods, offering practical insights for the thoughtful design and implementation of DDL strategies.

This study has certain limitations that should be acknowledged. First, as a cross-sectional study, it captures teachers' beliefs about DDL at a single point in time, which limits its ability to explore how these beliefs may change or adapt over longer periods. Second, the sampling was relatively narrow, focusing on a specific group of educators, which may not fully represent the diversity of language teachers across different cultural, institutional, or geographic contexts. These limitations suggest valuable directions for future research. Longitudinal studies could be conducted to track how teachers' beliefs evolve as they gain more experience with DDL or as new technologies emerge. Furthermore, expanding the research to include educators from different educational systems or cultural settings would provide a richer and more comprehensive understanding of the factors influencing these beliefs, contributing to a more global perspective on data-driven language education.

Declaration

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Ethical Statement

This study was approved by the Ethics Review Committee, School of Foreign Studies, Xi'an Jiaotong University (Approval No. XJTUSFSREA [2024]-1-001). All participation was voluntary, anonymous, and non-incentivised, with participants retaining the right to withdraw at any time.

AI Disclosure Statement

The authors declare that no artificial intelligence (AI) tools were used in the preparation of this manuscript.

Conflict of Interest Statement

The authors declare no conflict of interest.

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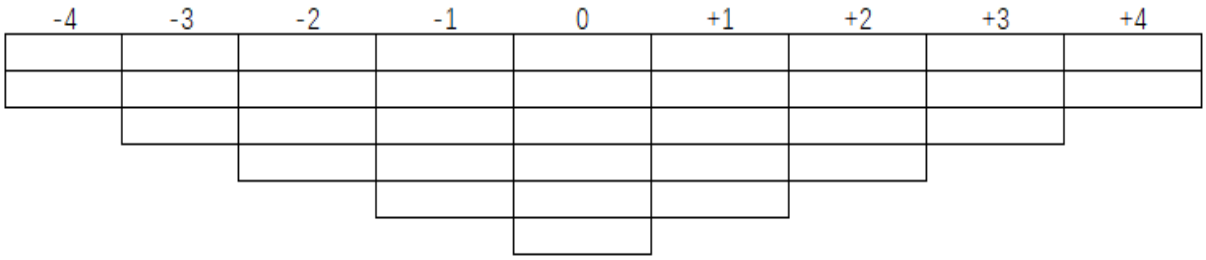
Appendices

Appendix A. Quasi-normal Distribution Table Used in the Q-sorting Process



Appendix B. Factor Scores for the 34 Q-Set Statements Across the Four Factors

No.	Statement	Z-score			
		F1	F2	F3	F4
1	Data-driven learning is effective in all language skills learning.	0.08	-0.36	-1.37	-1.72
2	Data-driven learning is an inevitable trend in the development of language education.	0.02	0.99	-0.17	-0.08
3	The proficiency in using data-driven learning tools determines the actual effectiveness of students' learning.	-0.72	0.92	-0.06	-0.8
4	Data-driven learning methods may increase the learning burden on students.	-0.23	-0.38	0	1.36
5	The current effectiveness of data-driven learning might be exaggerated and should be adopted cautiously.	-0.44	0	-1.14	1.67
6	Moderate use of data-driven learning can improve students' self-management skills.	0.98	1.4	0.3	-0.31
7	Data-driven approaches should serve as auxiliary tools in teaching rather than the core of instruction.	0.92	1.36	0.69	-1.23
8	The application scope of data-driven learning methods in language learning needs to be clearly defined.	1.24	1.41	1.28	1.14
9	The openness of data-driven learning tasks may lead students away from instructional objectives.	-1.15	1.5	-0.97	-0.29
10	Students require more technical training support in data-driven learning.	1.38	1.61	0	-0.2
11	Students' data privacy may be compromised in data-driven learning.	-1.53	1.18	0.46	1.06
12	Data-driven learning can improve learning efficiency but cannot solve all problems.	0.53	-0.43	-0.98	1.52
13	Students may feel confused by the complexity of data-driven learning operations, losing interest in learning.	-0.57	0.68	0.11	0.2
14	Data feedback helps enhance students' awareness of learning progress but should be combined with other learning methods.	1.4	-1.43	0.47	0.68
15	Students need a significant amount of time to adapt to data-driven learning methods.	-0.96	-1.52	0.77	-1.55
16	Data-driven learning is more suitable for advanced language learners but offers little help to beginners.	-1.89	-1.39	-0.52	0.14
17	Most students show high engagement and enthusiasm in data-driven learning activities.	-0.04	-0.34	-1.62	-1.91
18	I am confident enough in operating data-driven learning to implement it smoothly in the classroom.	1.07	0.66	-1.34	-0.92
19	Through data-driven learning, students can develop critical thinking skills.	-0.36	-0.06	-0.53	-1.18
20	Data-driven learning can transform abstract language knowledge into concrete language examples.	-0.83	0	-1.65	0.85
21	Students may benefit from data-driven learning but need more research to support the effectiveness of this approach.	0.21	0.8	0.6	1.77
22	Students' acceptance of data-driven learning may vary due to individual differences.	1.55	0.34	-0.24	1.11
23	Data-driven learning helps students focus on specific learning objectives and continuously improve.	0.41	-1.05	1.5	0.36

24	Data-driven learning can be used as an auxiliary tool, but the core of language learning is practice.	0.79	-1.81	-1.32	0
25	Data-driven learning can provide valuable feedback to students but cannot fully replace traditional teaching methods.	0.66	0.46	1.12	0.43
26	Data-driven learning requires significant effort, exceeding the demands of daily teaching.	-1.43	0.16	1.13	0.56
27	Language learning is an art, and data cannot capture its complexity.	-1.56	0.48	1.37	-1.2
28	Students can benefit from data-driven learning but still need guidance from teachers.	0.9	-0.05	1.6	0.73
29	Data-driven learning makes students overly dependent on technology, neglecting practical language application skills.	-0.1	-1.72	1.7	0.38
30	Data-driven learning provides students with more autonomy to explore, allowing them to find joy in tasks.	1.75	-1.01	0.12	-0.92
31	Data-driven learning tends to take up too much time when implemented in the classroom.	-0.77	-1.12	-0.96	-0.12
32	I believe that the teacher's mastery of data-driven learning directly affects classroom outcomes.	-0.3	-0.36	0.94	-0.43
33	Data-driven learning can reduce learning gaps among students.	-1.25	-0.6	-0.82	-0.61
34	Data-driven learning requires more teacher training to ensure effective guidance for students in using these tools.	0.24	-0.32	-0.47	-0.49