

Enhancing Inclusivity and Equity through a Broader Understanding of Data-Driven Learning in Pre-tertiary Education: A Mixed-Methods Systematic Review

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Abstract

Data-driven learning (DDL) is a significant approach in computer-assisted language learning (CALL), but its adoption in pre-tertiary education is limited, raising concerns about education equity and inclusivity. This study reviews 39 empirical studies published between 1994 and 2023 to assess DDL's effectiveness, efficiency, learner perceptions. Quantitative findings show a large within-group effect size ($d = 1.77$) and a medium-to-large between group effect size ($d = 0.88$). Qualitative findings reveal that most learners (74%) report positive views. This review confirms DDL's suitability for non-university settings and offers strategies to enhance accessibility, address equity barriers, and promote inclusive practices, ensuring that all pre-tertiary learners, regardless of diverse background or resources, can benefit from DDL.

Keywords: Data-driven learning, language education, pre-tertiary, mixed-method review, inclusivity, equity

Introduction

Over the past decades, DDL has gained increasing attention in language education research (Boulton & Vyatkina, 2021). However, studies on DDL's

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use in pre-tertiary education is still limited (Boulton & Cobb, 2017; Boulton & Vyatkina, 2021; Pérez-Paredes, 2022), highlighting gaps in understanding its accessibility and suitability for younger learners with diverse language skills and learning contexts. Additionally, previous reviews often overlook learners' experiences and practical implementation challenges, such as disparities in technology access that exacerbate equity issues in CALL. This study addresses these gaps by systematically analyzing 39 empirical studies (1994–2023) on DDL at the pre-tertiary level, assessing learning outcomes and learner feedback to promote accessible and adaptable DDL practices that foster inclusivity across varied educational settings.

In line with the aim of this study, the following research questions were formulated to guide the quantitative and qualitative synthesis respectively:

RQ1: To what extent is the implementation of DDL effective and efficient in facilitating language learning and teaching at the pre-tertiary level?

RQ2: How do pre-tertiary students perceive the effectiveness of corpus-based learning?

Methodology

Three databases (Web of Science, the Education Resources Information Centre [ERIC], and Google Scholar) and reference digging (Plonsky & Brown, 2015) were used to search for eligible studies. After selection based on the inclusion and exclusion criteria (Table 1), 39 studies were included in this synthesis.

To answer RQ1, we quantitatively synthesized 24 studies by calculating unbiased Cohen's d for between-group (effectiveness) and within-group (efficiency) studies, following methods from previous DDL meta-analyses (Boulton & Cobb, 2017; Mizumoto & Chujo, 2015; Ueno & Takeuchi, 2023). Outliers were managed through winsorizing method and capped the effect size at 3.0 to enhance the robustness of our results. The 24 studies yielded 40 separate effect sizes. To answer RQ2, we qualitatively synthesized 28 studies using grounded theory (GT), analyzing data on students' perceptions, attitudes, and experiences from observations, interviews, open-ended questionnaires, and other qualitative methods. Thornberg and Charmaz (2014) described GT as the simultaneous collection and analysis of data, blending induction and abduction to form categories. Following Charmaz (2006), we conducted initial coding, focused coding, and axial coding to connect categories and subcategories coherently.

Table 1. Inclusion/exclusion criteria

Inclusion criteria	Exclusion criteria
Studies published between 1994 and 2023	Studies not published between 1994 and 2023
Published empirical articles from journals or books	Not Published empirical articles from journals or books
Text written in English	Text not written in English
Related to corpus technology, DDL, and learning or teaching language	Not related to corpus technology, DDL, and learning or teaching language
Targeting at pre-tertiary level (Articles focusing on non-university teacher education or corpus-based materials development are considered if including pre-tertiary students' involvement)	Not targeting at pre-tertiary level

Findings

Quantitative synthesis

The aggregated effect size for all the within-group studies is 1.77, 95% CI [1.10, 2.43] ($p < 0.01$, $I^2 = 91\%$), and the aggregated effect size for all the between-group studies is 0.88, 95% CI [0.46, 1.29] ($p < 0.01$, $I^2 = 87\%$). Plonsky and Oswald (2014) highlight the need to contextualize Cohen’s d within specific academic disciplines and propose adjusted benchmarks for second language research: small ($d = 0.40$ for between-group, $d = 0.60$ for within-group), medium ($d = 0.70$ for between-group, $d = 1.00$ for within-group), and large ($d = 1.00$ for between-group, $d = 1.40$ for within-group) effects. According to these benchmarks, our within-group effect size is extremely large, while the between-group effect size is medium to large.

Compared to previous studies, within-group effect sizes range from 0.9 (Mizumoto & Chujo, 2015) to 1.50 (Boulton & Cobb, 2017), with Liu and Ma (2025) reporting 1.43. The present study’s within-group effect size ($d = 1.77$) is the highest, indicating greater efficiency. Between-group effect sizes range from 0.71 (Liu & Ma, 2025) to 0.95 (Ngo & Chen, 2024), with our study’s $d = 0.88$ falling in the middle, suggesting moderate effectiveness consistent with prior findings.

Qualitative synthesis

This qualitative synthesis analyzed 433 initial codes from student perceptions of DDL at the pre-tertiary level, revealing a predominance of positive (74%, 319 codes) over negative (26%, 114 codes) feedback. The perceptions were organized into eight categories and 30 sub-categories, with positive categories including “positive feelings,” reflecting learners’ excitement and enjoyment from DDL’s novelty and game-like designs; “efficacy,” highlighting its usefulness in simplifying complex concepts and improving skills; “autonomy,” showing increased motivation and independent learning through collaboration; “cognitive enhancement,” indicating improved language awareness and meta-cognitive skills via concordancing; and “combination with other learning resources,” noting benefits from integrating other tools such as dictionaries. Negative categories included “challenges,” addressing skills gaps and technical issues; “negative feelings,” capturing overwhelm and monotony among some learners; and “habits,” revealing a preference for traditional methods due to familiarity and test-focused learning styles.

DDL is valued by students for its innovative and enjoyable approach, enhancing learning effects, simplifying complex concepts, and boosting student autonomy and cognitive skills. However, it faces challenges including a lack of skills, language difficulties, insufficient teacher support, technical issues, and some students’ preference for traditional methods, leading to stress and reduced engagement. These perceptions underscore DDL’s potential to promote inclusivity and equity through positive learner engagement, while also revealing areas where technology access and support are essential to mitigate negative experiences.

Discussion

The quantitative results confirm DDL’s effectiveness and efficiency in pre-tertiary language education, showing its potential to improve language learning while supporting equity. Qualitatively, overall positive student attitudes reinforce these results. However, negative feedback highlights challenges such as limited DDL skills, negative feelings, and a preference for teacher-centered instruction and deductive approaches (e.g., using dictionaries or grammar notes). These challenges often stem from inequities in technology access, a key concern in inclusive CALL, where disparities in digital resources can hinder participation for underrepresented or resource-limited learners. To address these concerns inclusively, practical strategies identified through qualitative synthesis include pre-editing DDL materials, teacher supervision, multi-modal

resources, diverse activities, and scaffolding prompts. These approaches not only enhance accessibility but also promote equity by accommodating diverse learner needs, such as varying levels of technological proficiency and socioeconomic backgrounds, thereby aligning DDL with inclusive CALL principles. Ultimately, these strategies aim to bridge research and practice, ensuring equitable opportunities for all learners to benefit from DDL.

Conclusion

Despite the successful implementation of DDL, its adoption has yet to become mainstream and has remains limited to certain contexts. It necessitates a period of adjustment and dedicated effort to fully integrate DDL into existing practices. To promote greater educational equity and inclusivity, future research should aim to broaden its scope and support a wider range of educations in adopting and implementing DDL across diverse educational settings.

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