



Review on the Application of Universal Design for Learning in Classroom Instruction

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Abstract

To comprehensively understand the application of Universal Design for Learning (UDL) in classroom instruction and to pinpoint existing challenges, an extensive literature review was undertaken, utilizing renowned databases such as ERIC, PsycInfo, Social Sciences Index, and Science Direct. This review yielded over 80 peer-reviewed articles encompassing empirical research studies, covering a wide range of educational stages from primary schools to universities. The 62 selected pieces of literature offered a wealth of information, enabling a detailed examination of the application of UDL in real-world classroom contexts. The findings from this review were meticulously organized and subjected to a thorough analytical process, focusing on three key dimensions: the general application of UDL principles, the specific strategies employed for implementation, and the evaluations of these strategies' effectiveness. The analysis revealed a landscape where the adoption of UDL principles is marked by a lack of systematic approaches and a shortage of clearly defined, tailored strategies. This has led to a varied picture in terms of outcomes, with some instances showing promising results while others falling short of expectations. The heterogeneity in the application and the inconclusive nature of the effectiveness underscore the need for further research and the development of more precise, contextually relevant UDL strategies to ensure that the principles of UDL are effectively translated into practice for the benefit of all learners.

Keywords: Universal Design for Learning, Classroom Instruction, Application Review, Special Education, Inclusive Education.

1. Introduction

The collective teaching system was widely promoted and developed in the industrial era in order to rapidly and massively cultivate talents at a considerable level to meet the needs of the industrial society. Undoubtedly, the form of collective teaching has absolute advantages and status in meeting daily teaching needs. However, this "assembly line" training method cannot better focus on students' learning differences and needs (Cui et al., 2019; Fan, 2023). Every individual is different, and this difference and diversity must exist (Commeys, 2024; Kojana, Mukuna, 2024). This also predicts and calls for diversity in education. Moreover, an American educator, John Dewey, also mentioned that the traditional teaching form was designed to serve teachers' rapid and efficient work, rather than students' individual development and growth (Dewey, Dewey, 1915). In the current information age, when material and spiritual resources are greatly abundant, it has

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become an inevitable trend for the development of education and teaching to focus on each student's individual learning needs and characteristics.

Universal Design for Learning (UDL) is considered as an appropriate framework for designing courses in increasingly diversified classrooms, aimed at helping educators improve the learning process (CAST, 2018). Instead of adjusting and modifying the course content and framework during the course management process, UDL focuses on actively building support for course objectives, course resources, teaching practices, and assessments from the very beginning of course design. It emphasizes providing options that can meet the needs of various learners by building flexibility in the curriculum and instruction.

However, issues such as how to apply and evaluate UDL are still under further research and exploration. This study focuses on the following three aspects to systematically sort out and analyze the application of UDL in teaching, aiming to discover patterns and problems, and provide references and suggestions for the application of Universal Design for Learning in classroom teaching in China.

1. Who are the target groups for the application of UDL, and what impact will it have on teachers' teaching?
2. What are the application strategies of UDL? And how do they reflect the principles of UDL?
3. Is there a significant effect of UDL in teaching practice?

2. Methods

Search Strategy

The literature search was conducted using the databases ERIC, PsycInfo, Social Sciences Index, and ScienceDirect. The primary keywords utilized in the search included "universal design for learning," "universal instructional design," "universal design of instruction," and "universal design." Additionally, the secondary keywords "post-secondary," "college," "university," "higher education," "elementary," "middle," "high," and "secondary" were included in all searches. The search scope covered literature published within the last 15 years, resulting in the identification of 89 relevant articles. Through skimming, 62 closely related articles were selected and utilized as the primary sources for this study. The inclusion criterion for these 62 articles is that they have utilized at least one UDL principle in their teaching practices.

Data Analysis

The selected 62 articles were categorized and summarized based on various headings such as research objectives, research methods, research findings and implications, descriptions of research applications, application strategies, and rationales for strategy selection. This systematic categorization aimed to uncover patterns and trends in the application of Universal Design for Learning (UDL) in educational practice. The analysis adheres to academic publication norms and standards.

3. Results

The Connotation and Basic Principles of Universal Design for Learning

UDL was first proposed by CAST in the United States in 1998 (Orkwis, McLane, 1998). It has successfully gone through two models, Universal Design of Instruction and Universal Design for Instruction (Schelly et al., 2011), and undergone multiple revisions and improvements in concepts and principles (CAST, 2018). The latest version defines it as follows: "Universal Design for Learning is a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn" (CAST, 2018). The principle of Universal Design for Learning emphasizes that teaching should precede learning. This approach aims to eliminate obstacles, lags, struggles, and remedial efforts encountered by students during their learning process. To achieve this, teaching must be deliberately designed to offer tailored support in the form of environments, resources, and tools that cater to the diverse needs of students right from the outset of their learning journey. By doing so, it becomes unnecessary to constantly modify or adjust the curriculum or learning environment after its creation to accommodate different learners. This approach ensures that all learners benefit from an optimized and inclusive learning experience (Capp, 2017; Rose, 2000; Skaggs, McMullin, 2024).

In fact, UDL is proposed based on Universal Design and incorporates knowledge from fields such as education, psychology, and neuroscience, focusing on the three learning networks of the

human brain: the Affective Network, Recognition Network, and Strategic Network, as shown in Figure 1.

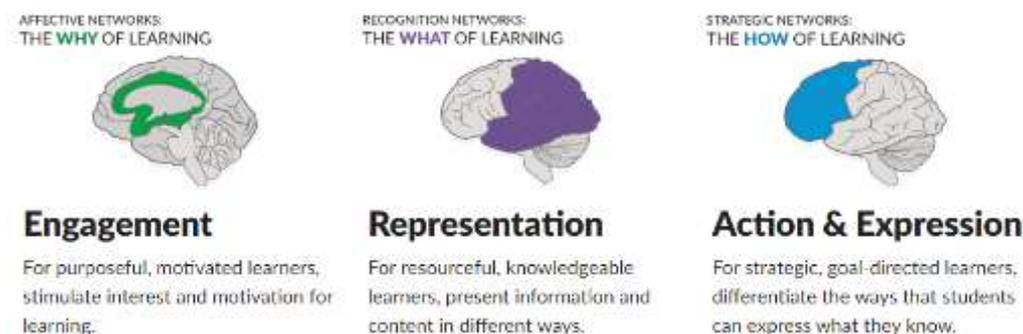


Fig. 1. The Three Learning Networks of UDL (CAST, 2018)

CAST proposed three fundamental principles based on the three learning networks of UDL (CAST, 2018):

Principle 1: Multiple means of engagement

Different learners engage in learning in various ways and are motivated by different factors. Some individuals are naturally active and highly engaged in learning, while others prefer a more quiet and even introverted approach. Some thrive on adventure and challenge, while others prefer to follow a structured approach taught by teachers and learn step by step. In addition to externally increasing student engagement, intrinsic learning motivation is also necessary for students to cope with future life and work. Besides the subject matter taught in school, self-discipline is equally important for students with different emotions and attitudes (CAST, 2018).

Principle 2: Multiple means of representation

Principle 2 corresponds to the Recognition Network, indicating that different learners perceive or understand information in diverse ways. For example, individuals with hearing or visual impairments, aphasia, or intellectual disabilities may need to rely on audio, visual, or other forms of materials to learn. For the majority of the general population, differences mainly manifest in language, cognitive strategies, culture, and history. They require different forms of content representation to deepen their understanding of knowledge. There is no single way of presenting information that suits all students. Therefore, a diverse and rich approach to content presentation and access is crucial. Additionally, the way information is processed, including discovering, creating, using, and organizing information, is also important. As a result, this principle emphasizes teaching methods and technological applications that highlight key information, emphasize important ideas, connect information, and simulate inquiry, ensuring that all students can capture the information (CAST, 2018).

Principle 3: Multiple means of expression

Principle 3 corresponds to the Strategic Network, indicating that different learners express themselves in different ways. Some excel at speaking, while others prefer writing. Some like to present their ideas through multimedia, and even their preferences for types of multimedia vary, such as drawing tools or video editing. Beyond that, a rich array of learning supports that help students express themselves is also necessary, such as pre-project reviews, feedback, and revisions, as well as alternative learning materials tailored to learners of different levels. These supports gradually withdraw as learners' abilities continue to improve (CAST, 2018).

4. Application Status of UDL in Classroom Instruction

Application overview

Target groups

UDL was initially proposed and gradually applied in the development of inclusive education, aiming to enable students with special education needs to receive quality and equal educational services and better adapt to the general educational environment (Ma, 2024). Therefore, its primary target group was initially students with special educational needs. Of course, students in general education will also benefit from it. With the widespread development of UDL, this framework has gradually been applied to general education teaching. Therefore, from a broader perspective, UDL is targeted at students with special educational needs and general education students.

Teachers' role in UDL

In the collected literature on the application of UDL, the number of teachers involved in classroom application of UDL is generally larger than that in the general educational environment. Typically, this includes a main lecturer, a special education teacher, and several teaching assistants (Basham et al., 2010; Browder et al., 2008; Coyne et al., 2012; Kelly, Zakrajsek, 2023). This suggests that while the application of UDL in the classroom can bring numerous benefits to students, it also poses a certain workload for teachers during the initial stages of implementation. Therefore, it is necessary to establish a community of teachers to assist in the application of UDL.

Terminology determination

As mentioned earlier, UD (universal design) principles are being applied in educational settings. This has led to the use of various related terms in the literature to describe this application. Some of the most prominent terms are Universal Design for Learning (UDL), Universal Design of Instruction (UDI), Universal Instructional Design (UID), and Learning Universal Design (LUD). We used all of these terms during our literature search. Although different terms refer to the application of UD principles in educational settings, to avoid confusion, this study uses the term Universal Design for Learning (UDL). The inconsistent use of terminology hinders research on the application and effectiveness of UD educational models (Rao et al., 2014).

Application strategies

Generally speaking, the application of UDL in teaching is initiated based on its three principles: multiple means of representation, multiple means of expression, and multiple means of engagement. Researchers aim to accommodate the diversity and differences of students from these three dimensions. However, the application strategies guided by these principles mainly involve supplementary learning materials, task-based learning, online teaching platforms, and mobile learning tools (Garrad, Nolan, 2023; Rao, Tanners, 2011). In other words, the implementation of UDL is addressed through three aspects: learning materials, learning methods, and the application of technological tools. Nevertheless, it is rarely mentioned in UDL-related practical articles whether these strategies correspond to the UDL principles, how they reflect the UDL philosophy, and how they are designed based on the UDL principles. Although all researchers indicate that their application strategies are rooted in the UDL philosophy, there are significant differences in the detailed descriptions of how the components of the application strategies are associated with specific principles (Ok et al., 2016; Thomas et al., 2023). Moreover, no established guidelines specify how guiding principles should correspond to application strategies (Rao et al., 2014). Worse still, some UDL application cases lack specific descriptions of the application strategies, further reducing their referential value (Piticari, 2023; Sokal, Katz, 2015; Watchorn et al., 2013).

Regarding the three principles, more attention has been paid to the first principle. The second principle, which emphasizes that there are multiple ways to present knowledge to students beyond the sole textual form, mainly covers perception, language and symbols, and comprehension methods. Most application strategies targeting this principle involve video games and supplementary materials (Basham et al., 2010; Coyne et al., 2012). These materials provide students with multiple representations and opportunities for repeated practice, resulting in higher levels of student engagement compared to traditional course materials (Dickinson, 2018; Kumar, Wideman, 2014).

The second principle, which focuses on teachers' ability to engage students in learning through various means, addresses emotional factors such as motivation and interest in learning. In other words, it explores the reasons for learning, including emotional motivation for entering learning, beliefs in sustained learning, self-management and self-regulation during learning. There is insufficient recognition and attention to this concept in traditional classroom teaching and UDL application strategies. Many teachers believe learning is a natural obligation for students, but questions such as "Why learn?" "What is the meaning of learning?" "How do you deal with distractions while learning?" "How to persevere in learning for a long time?" and "What to do when encountering problems during learning?" demonstrate the importance of paying attention to students' emotional attitudes. Emotions and beliefs are the driving forces for learning, serving as the starting point and the source of sustained learning efforts (Kumar, Wideman, 2014; Metcalf et al., 2009). Therefore, they deserve teachers' focused attention.

There is a noticeable lack of applications targeting the third principle compared to the second. The third principle is related to action and expression, emphasizing that students can demonstrate their understanding and knowledge through various means, including physical

actions, communication, and execution planning. Compared to teachers' use of multiple means to present knowledge, there are fewer studies focusing on students' ability to express their behaviors and understanding through multiple means (Abell et al., 2011; Kennedy et al., 2014; Marino, 2009). However, acquiring knowledge does not necessarily equate to learning. While the second principle aims to provide students with multiple ways of presenting knowledge, the third principle seeks to provide them with multiple means of "manipulating" knowledge. If the second principle prepares students better for "input" in learning, then the third principle offers multiple paths and means for "output" in learning. Future research should focus more on students' behaviors and expressions related to learning outcomes to demonstrate the effectiveness of UDL in teaching.

Application effect

The application effects of UDL in teaching are mixed. On the one hand, most teaching practice cases of UDL indicate that UDL can improve students' participation in learning, promote learning communication and interaction between teacher-student, and student-student, serving as a teaching method that optimizes students' learning process (Rao et al., 2014; Garrad, Nolan, 2023). On the other hand, some studies have pointed out that while it can optimize students' learning experience, it does not necessarily lead to substantial improvement in academic achievement (Capp, 2017; Hitchcock et al., 2016; Mavrou et al., 2013).

Moreover, some research suggests that the effectiveness of UDL-based teaching varies greatly in many practical cases, with different scopes and degrees of impact (Ok et al., 2016). For instance, when comparing the teaching effects of online and offline courses that have implemented UDL, there are certain differences in teaching effects between special education students and regular education students. Specifically, online courses tend to have better teaching effects than offline courses, and in offline courses, regular education students often outperform special education students (Hall et al., 2015).

UDL is an exciting conceptual approach that appears theoretically sound but lacks a solid empirical research foundation (Capp, 2017; Roberts et al., 2011). In the future, it is necessary to conduct more extensive applications of UDL in teaching beyond its basic concepts and theoretical frameworks in order to examine the objective impact of UDL on students' learning outcomes.

5. Implications and Suggestions

Based on the comprehensive review and understanding of UDL's application in classroom teaching discussed above, the following implications and suggestions are proposed to promote the effective implementation of UDL, optimize students' learning process, and bring positive learning experiences to students.

Clarify the characteristics of target learners to provide basic conditions for effective application of UDL

The initial concept of UDL aims to meet the learning needs of every individual student as much as possible. Therefore, collecting and organizing students' learning needs and characteristics is the first step in implementing UDL and serves as fundamental information for others to draw lessons from excellent cases of UDL application. Additionally, a comprehensive description and organization of the characteristics of the target learners are not only necessary to examine the effectiveness of UDL's application in specific groups but also crucial for analyzing and understanding the differences in application effects among different groups, thereby identifying the optimal target groups for UDL and determining which UDL interventions are suitable for which types of students, providing basic information for the widespread application of UDL.

Moreover, as mentioned earlier, the target audience of UDL is not limited to students with special education needs but also includes those in general education. However, compared to students with special education needs, the differences and needs among students in general education are less pronounced. Furthermore, studies have shown that the benefits of UDL-based teaching vary among students in general and special education (Ok et al., 2016). Therefore, it is reasonable to raise the question of whether there are significant differences in the application effects of UDL among students with special education needs and those in general education.

Develop operational UDL application strategies and actively explore their use in teaching

UDL is both a framework for teaching design and an ideal state that cannot be fully achieved. The key to its implementation lies in designing and developing corresponding application

strategies. Currently, the development of UDL application strategies is still in its initial stage, with most strategies being developed individually by teachers based on the learning needs of their specific classes. This approach results in strategies that are not systematic, specific, or easily adaptable for others to learn from. Additionally, developing UDL application strategies can be a significant workload for individual teachers, especially during the initial stages. As mentioned earlier, current applications of UDL often involve multiple teachers working together. Therefore, regarding the future development of UDL application strategies, it is recommended that (1) a community of teachers be established and relevant departments such as educational institutions and enterprises be invited to assist in the strategy development; (2) based on the characteristics of the target learners, developed application strategies should be systematically organized and categorized to enhance the replicability of successful UDL application cases; (3) the relationship between the application strategies and the three principles of UDL should be clearly described, which will not only facilitate further research on UDL applications but also aid other teachers in drawing lessons and references; (4) application strategies should be made as specific as possible, which will not only facilitate their implementation in the classroom and enhance their replicability and reference value but also provide starting points for evaluating the effectiveness of UDL applications.

Moreover, regarding the overall application of UDL, the low popularity of its current applications is due to the lack of excellent and complete UDL application cases for reference. Undeniably, the success of an excellent UDL application case depends not only on the development and application of strategies but also on various factors such as teachers' teaching abilities, students' learning abilities, and interpersonal relationships. Therefore, a complete description of an excellent UDL application case will facilitate the further implementation of UDL in teaching.

Strengthen the evaluation of UDL application effects to promote high-quality implementation in teaching

As mentioned earlier, the effects of UDL's application in teaching are mixed, and not all applications lead to improved student learning outcomes. Therefore, further investigation and analysis are needed to assess the effectiveness of UDL applications. Currently, most UDL application cases focus only on strategy development and application, neglecting the evaluation of their effectiveness in the later stages. Therefore, it is recommended that (1) attention be paid to whether UDL has significant application effects on both students' learning processes and outcomes; (2) investigate in which aspects and under what conditions UDL can improve students' learning experiences; (3) determine whether the application of UDL can facilitate teaching and bring better teaching experiences to teachers.

The purpose of evaluating the effectiveness of UDL applications is not only to assess their educational value but also to obtain feedback that can be used to improve the methods and approaches of UDL implementation, thereby promoting its high-quality development.

6. Conclusion and Prospect

Although UDL has extensive applications abroad, issues such as inconsistent terminology, unsystematic application strategies, and the inability to align application strategies with principles have hindered its further development. Future research should focus on addressing these issues individually. The concept of UDL is based on the acknowledgment of differences among students, but the current application of UDL in teaching lacks a deep understanding of this concept. This is a crucial aspect of the effective application of UDL. In the future, educational researchers and frontline teachers need to change their understanding of teaching conceptually and implement UDL in practice to provide students with a better learning experience.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Conflict of interest statement

The author reports no conflicts of interest.

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