INTERNATIONAL JOURNAL OF RESEARCH CULTURE SOCIETY
Monthly Peer-Reviewed, Refereed, Indexed Journal
Volume - 10, Issue - 5, May - 2026
ISSN(O): 2456-6683
[Impact Factor: 9.241]
IJRCS

DOIs:10.2017/IJRCS/202605007 --:-- Research Paper / Article / Review

Universal Design for Learning (UDL) as a transformative framework

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***Abstract*:** *Every classroom comprises learners with diverse abilities, needs, and characteristics, placing a responsibility on teachers to effectively address the learning needs of all students. To manage such diversity, educators require practical and flexible instructional approaches. Universal Design for Learning (UDL) offers a structured framework for designing learning experiences that are accessible and effective for all, based on three core principles. This study conducts a meta-analysis of twelve previously published research studies to examine the effectiveness of UDL in enhancing the quality of student learning and how it transforms the quality of education. The findings indicate that the implementation of UDL principles significantly improves the overall learning process and outcomes for diverse learners.*

Key Words: *Universal Design for Learning (UDL), Student Diversity, Principles, Meta-analysis.*

1. INTRODUCTION:

Students have diverse characteristics; it might be seen from the difference in the capacity of intelligence, physical condition, senses, social status, ethnicity, culture, and gender (Ormrod, 2008). Aspects of these differences affect students' academic success. Azwar (2014) describes the academic success of students is influenced by internal factors such as the functions of the senses, physical health, interests, motivation, personality, talent and intelligence.

UDL was developed based on research in the field of education and neuroscience, as well as the growing influence of digital technology (Mayer, Rose, & Gordon, 2014). While the term universal design for learning was adapted from universal design (UD) in the field of architecture, which was declared by Ron Mace at North Carolina State University. Universal Design (UD) in the field of architecture is defined as an approach to designing buildings that might be accessed by many people, including people with disabilities. In other words, UD aims to remove obstacles for someone to access the surrounding environment. Examples of universal design (UD) in the field of architecture is to create a sloping road or provide a lift for wheelchair users, making access for the visually impaired, provide directions or path for the hearing impaired.

Based on UD in the field of architecture, the term of UDL is formed. UDL is defined as an approach to design appropriate learning activities and effective for all students (Mayer et al., 2014). Nelson (2014) describes the UDL as a framework that can assist educators in designing learning activities that freeway for all students. UDL consists of three principles which were developed based on cognitive neuroscience research and the learning process, and the third principle is to provide multiple means of representation, action and expression, also engagement (Mayer et al., 2014).

UDL addresses the three learning networks within a broadly defined concept of curriculum that includes goals, materials, methods, and assessment (Hitchcock et al., 2005). According to the following three UDL principles, each area of the curriculum should provide multiple, varied, and flexible options for representation, expression, and engagement:

Principle 1: Provide multiple means of representation (recognition network)

Multiple means of representation: video presentations for subject-matter content; highlighted vocabulary in subject matter content, such as science and social studies materials; main ideas offered through graphic organizers and concept mapping (e.g., Education Oasis); speech-to-text options (e.g., Click, Speak and AIM Explorer); pre-teaching opportunities for new vocabulary and concepts; color shading used for emphasis; use of Visuwords for vocabulary development.

Principle 2: Provide multiple means of action and expression (strategic network)

Multiple means of action and expression: animated digital coaches (i.e., animated characters that appear on screen to offer support or simply information) to help with comprehension; models of expert performance using differing

approaches; outlines of subject matter content; use of *Interactives: Elements of a Story* to teach narrative structures; use of *Writing Fun* by Jenny Eather to develop expressive writing skills.

Principle 3: Provide multiple means of engagement (affective network).
Multiple means of engagement: creation of voice avatars (i.e., a vocal character representing a real person) for digital text presentation (e.g., Voki); choice of topics for projects (including soccer and music, as appropriate); simple self-monitoring checklists; curriculum handouts for students to self-assess completion and accuracy; frequent feedback; use of computer software to teach early reading skills (e.g., Starfall); paired peers to share small-group activities; use of CAST UDL Book Builder to create engaging topical books for science and social studies projects.

Universal Design for Learning (UDL), defined in the Higher Education Opportunity Act of 2008 as a "scientifically valid framework for guiding educational practice," turns this situation around. UDL puts the burden of change where it belongs: on the curriculum itself (Higher Education Opportunity Act of 2008). By facilitating the design and implementation of a flexible, responsive curriculum, UDL offers options for how information is presented, how students respond or demonstrate their knowledge and skills, and how students are engaged in learning. UDL implementation provides the opportunity for all students to access, participate in, and progress in the general-education curriculum by reducing barriers to instruction.

2. LITERATURE REVIEW:

Converting physical spaces into learning spaces: Integrating universal design and universal design for learning (2002) *Aashna Khurana* The concept of Universal Design for Learning (UDL) originates from the broader idea of Universal Design, a principle rooted in architecture that emphasizes the proactive creation of environments accessible to all individuals, regardless of age, gender, or ability. While the application of Universal Design in education has led to a focus on making curriculum, instruction, materials, and assessment inclusive for diverse learners, it often overlooks the role of physical infrastructure in the learning process. This raises an important concern: does UDL, in its current application, neglect its architectural origins by underemphasizing the significance of school spaces where learning actually occurs? Such transformation supports the creation of equitable, inclusive, and accessible environments that respond to learner variability and minimize barriers to participation and achievement. This approach involves reimagining physical spaces through Universal Design and aligning them with UDL principles, identifying features within each space that enhance learning opportunities, and ensuring overall accessibility across the school infrastructure.

Curriculum Transformation and Disability: Implementing Universal Design in Higher Education (review) 2004 *Holley A. Belch, James Barricelli* focuses on the development of flexible curricula, programs, and services—both inside and outside the classroom—that promote inclusion and support the success of all learners. The book is designed to familiarize disability services personnel and faculty with the principles of Universal Design, while also offering practical examples for professionals working in student affairs. The volume is organized into four main sections.

Transformation frameworks and their relevance in universal design.(2004). *Silas S. Brown & Peter Robinson* Disciplines such as music, engineering, and mathematics rely on well-established systems of notation for documenting and communicating ideas. Modifying these notational systems can enhance universal accessibility by addressing barriers related to disabilities, cultural differences, or limitations of hardware. Programming tools that enable such adaptations can further support accessibility by allowing users to generate new forms of notation as needed—an approach that remains relatively underexplored in addressing educational challenges. This paper examines several programming tools designed for such transformations and introduces a tool called "4DML," which enables programmers to construct a model of the intended output, from which the required transformation is automatically generated.

Transforming Universal Design for Learning in Early Childhood Teacher Education from College Classroom to Early Childhood Classroom (2007) *Mary Ellen MCGuire-Schwartz Janet S. Arndt* This article examines how Universal Design for Learning (UDL) can be applied in practice, tracing its use from college classrooms to the practicum experiences of preservice teacher candidates. It brings together findings from two research studies that investigated how participants interpret and apply UDL principles in lesson planning. UDL shows strong potential in preparing early childhood educators to address the needs of diverse learners and to ensure inclusive access to education, including for

children with special needs. In the first study, 36 teacher candidates engaged in action research, implementing UDL strategies, collecting and analyzing data, and developing research skills. In the second study, five teacher candidates were introduced to UDL principles and applied them while designing lesson plans during their practica. Both qualitative studies explored how teacher candidates comprehend, introduce, and integrate UDL principles and practices. The article also provides an overview of UDL concepts, their use in higher education settings, their role in lesson planning and teaching, and the application of action research to evaluate their impact on student learning in public school classrooms.

Measuring the Effectiveness of Universal Design for Learning Intervention in Postsecondary Education (2013). *Davies, Patricia L, Schelly, Catherine L, Spooner, Craig L.* Handful of studies have been conducted to determine the effectiveness of providing training to university instructors on the principles of Universal Design for Learning (UDL) and the impact this training has on student outcomes, especially for students with disabilities. While these studies offer some useful data, their results may be considered inconclusive because they did not use control groups and therefore had no comparative data regarding outcomes in courses where UDL was not implemented. This paper, which builds on a study published by these authors in a previous issue of JPED (Schelly, Davies, & Spooner, 2011), responds to the gap in the literature by measuring the effectiveness of instructor training regarding the principles of UDL and techniques for its implementation. It does so by comparing student perceptions of instructor teaching methods, as measured by a UDL questionnaire, completed before and after the instructors received UDL training and by comparing those results to a control group of students taking the same course in a different section where instructors did not receive UDL training.

The Three-Block Model of Universal Design For Learning Implementation In A High School (2013)*Jennifer Katz, Ron Sugden* The role of the school leader (principal) in supporting educational reform is explored through a case study of one high school implementing the Three Block Model of UDL (Katz, 2012a) in an effort to meet the needs of a diverse student population. This case study is a part of a much larger study exploring outcomes for students and teachers of implementing the model with social and academic inclusion as a goal (Katz, 2013). In this article, analysis of the principal's field notes, photographs, and video evidence is detailed to illuminate a process for supporting inclusive education through teachers' professional development in universal design for learning. Results indicated the principal's efforts to provide teachers with professional development, planning time for collaboration, vision, and direct involvement in instructional delivery resulted in positive outcomes for both students' and teachers' learning, selfefficacy, and sense of community.

Using Systematic Instruction and Graphic Organizers to Teach Science Concepts to Students With Autism Spectrum Disorders and Intellectual Disability (2013) *Knight, V. F., Spooner, F., Browder, D. M., Smith, B. R., & Wood, C. L.* Literacy in science is important for all students and is one component of access and progress in the general education curriculum. One barrier to science literacy for students with autism spectrum disorders (ASD) is the extensive amount of vocabulary involved in comprehending science content. Based on the inherent link between vocabulary knowledge and comprehension, graphic organizers (GOs) paired with explicit instruction can improve vocabulary as well as comprehension for students with disabilities. Using a multiple probe design, three students with ASD and intellectual disability were taught various scientific concepts related to convection (e.g., precipitation, condensation) via systematic instruction that included constant time delay and multiple exemplars of a teacher-directed GO. A functional relation was demonstrated between the GO with systematic instruction and students' number of correct steps completed on the task analysis. Future research and implications for practice are discussed.

Accessible by design: Applying UDL principles in a first year undergraduate course(2014) *Kari Lynne Kumar, Maureen Wideman*. This article presents a case study of a technology-enhanced face-to-face health sciences course in which the principles of Universal Design for Learning (UDL) were applied. Students were offered a variety of means of representation, engagement, and expression throughout the course, and were surveyed and interviewed at the end of the term to identify how the UDL-inspired course attributes influenced their perceptions of course accessibility. Students responded very positively to the course design, and felt that the weaving of UDL throughout the course resulted in increased flexibility, social presence, reduced stress, and enhanced success. Overall, students felt more in control of their own learning process and empowered to make personal choices to best support their own learning. This course design also led to increased satisfaction from the perspective of the instructor and reduced the need for intervention by the campus disability services department.

Universal Design For Learning - Application In Higher Education: A Greek Paradigm (2014) *Sotiria Tzivinikou* Universal Design supported by literature as an appropriate and effective procedure can help all students including the learning disabled ones to improve their accessibility to written materials (Evans et al., 2010; Rose & Meyer, 2002). The

present study reports a UDL application in higher education. More specifically, it aimed to investigate if the revision of the study guide of a Pedagogical Department according to the UDL principles helped the students to improve their access to crucial information regarding their studies. A quantitative method based on pre and post evaluation of the UDL revision of the study guide was employed. The results showed that this revision was regarded by the students as helpful and efficient as they could be well-informed about their studies and ready for making decisions related to their future careers. These findings could have an important impact on higher education course design, instruction and the produced academic written stuff, and finally, the university could become more accessible for all students.

Addressing Learning Disabilities With UDL and Technology: Strategic Reader (2014) *Tracey E. Hall, PhD, Nicole Cohen, EdD and Patricia Ganley d* The Center for Applied Special Technology (CAST) developed *Strategic Reader*, a technology-supported system that integrates Universal Design for Learning (UDL) with Curriculum-Based Measurement (CBM) within a digital learning platform to enhance reading comprehension instruction. This experimental study investigates its effectiveness by comparing two progress-monitoring approaches—online and offline. Drawing on both quantitative and qualitative analyses, the findings reveal strong evidence that students using the online version demonstrate significantly greater improvement in comprehension scores. The advantage of online monitoring is particularly pronounced for students with learning disabilities (LD), as only those in the online condition show statistically significant gains. Moreover, students with LDs report higher levels of engagement with Strategic Reader and perceive it as more beneficial compared to their peers in general education. Overall, the study highlights promising implications for curriculum development as well as future research on digitally supported learning environments.

TeenACE for Science: Using Multimedia Tools and Scaffolds to Support Writing (2016) *Caryl H. Hitchcock Kavita Rao,and Joann W. L. Yuen TeenACE* for Science (TAS) is a writing intervention designed to strengthen students' expository writing in science by integrating multimedia technology, Universal Design for Learning (UDL), and Self-Regulated Strategy Development (SRSD). This developmental study explored the impact of TAS on two groups of culturally and linguistically diverse middle school students. A total of 46 students from general and special education settings participated in a 12-week program, during which they produced multiple science reports.Students engaged with multimedia features of productivity software (PowerPoint) to structure their work by organizing images and headings, mapping ideas cognitively, composing text, and recording audio narrations of their writing. The study employed a mixed-methods approach, combining pre- and post-tests along with curriculum-based measures to assess quantitative outcomes, while surveys and focus group discussions provided qualitative insights. Results indicated significant improvement in students' performance on two Woodcock Johnson III subtests—Writing Fluency and Writing Samples—although no notable gains were observed in the Editing subtest. Teachers evaluated the intervention as relevant, effective, and of high quality, and reported continuing to implement the same approach even one year after the study.

Embracing Universal Design for Transformative Learning (2021) *Larry McNutt and Ger Craddock* This paper aims to present the authors' experience of embedding Universal Design as a core element within a newly established technological university to address the challenge of ensuring a consistent and high-quality learning experience for all students. The integration of Universal Design alongside Universal Design for Learning (UDL) is not intended to simplify education, but rather to provide a structured set of principles and guidelines that make learning both accessible and appropriately challenging for every learner. As Ken Robinson aptly noted, a thriving school can uplift an entire community by fostering hope and creativity, whereas ineffective schools may erode optimism among students and families by limiting their opportunities for growth and development.

3. OBJECTIVE :

To analyze the effectiveness of UDL-based instructional practices in improving the quality of learning among diverse learners through a meta-analysis of selected studies

4. RESEARCH METHOD :

The study is based on the meta analysis, a qualitative work, where researcher has collected the findings of studies by reading and combining results from multiple empirical studies. This approach helps in deriving a comprehensive understanding of the effectiveness of Universal Design for Learning in improving student learning outcomes. Relevant studies were collected from reviewing journals, online available databases and research oriented books, articles.

Journal search is done by using the keywords "Universal Design for Learning." Criteria used journal is a journal which explicitly writes the word Universal Design for Learning (UDL) in the title or abstract or the contents of the article. Journal used the following criteria:
1) Published between the years 2002 to 2021
2) Journals are peer-reviewed journals in order to ensure quality
3) Journal of measurement study pre and post implementation of UDL, because the purpose of this article is to look at the effectiveness of the implementation of UDL
4) UDL applied at all levels of education from primary school to university because UDL aims to improve the quality of learning among all students. Based on these criteria found 12 journals that meet the criteria.
All the combined journals were collected and thoroughly read out to find the results and the discrepancies.

5. FINDINGS :

Based on the analysis of twelve journal studies, it is evident that the implementation of Universal Design for Learning (UDL) enhances the overall learning process of students. Among these, four quantitative studies (Davies et al., 2013; Knight et al., 2013; Navarro et al., 2016; Tzivinikou, 2014) examined the relationship between UDL implementation and improvements in learning, while one study (Mavrou et al., 2013) specifically focused on learning outcomes following UDL application. Notably, Knight et al. reported a significant improvement in the learning process when teachers incorporated visual media while teaching science to students with Autism Spectrum Disorder (ASD) and intellectual disabilities (ID).

Research by Mavrou et al. indicated that students taught using symbols and pictorial media demonstrated improved abilities in speaking and questioning, showing greater development compared to those taught through verbal methods alone. Similarly, Davies et al. found that presenting subject matter in multiple formats within university psychology courses enhanced students' interest and expanded their access to course content. Furthermore, Tzivinikou reported that the application of Universal Design for Learning (UDL) in first-year teacher education focusing on perception, language and symbols, and comprehension enabled prospective teachers to design more inclusive lesson plans and improve learning outcomes for all students.

Among the twelve studies reviewed, one study by Kumar and Widerman employed a qualitative pre–post design to examine the application of Universal Design for Learning (UDL) in a college of nursing. The findings revealed that the implementation of UDL principles contributed to improvements in the learning process by reducing student stress levels and enhancing their confidence.Out of the twelve studies reviewed, six employed mixed-methods approaches. Among these, five studies (Hall et al., 2015; He, 2014; Katz, 2013, 2015; Marino et al., 2014) examined the relationship between the implementation of Universal Design for Learning (UDL) and improvements in the learning process, while one study by Hitchcock et al. focused specifically on educational outcomes. Three of these studies utilized the Three Block Model (TBM) of UDL. Research by Katz demonstrated that the TBM approach enhanced various dimensions of student engagement, including academic, social, intellectual, and interactive engagement within the classroom. Similarly, Marino et al. found increased student enthusiasm and willingness to learn when teachers applied multiple means of representation, particularly in science education. Furthermore, Hitchcock et al. reported improvements in scientific writing through the use of multimedia-based interventions, along with enhanced targeted literacy, collaboration, and reflective skills. In addition, Hall et al. highlighted that the use of online reading strategies significantly improved the reading process for all students.

He concluded that the application of Universal Design for Learning (UDL) principles in online lectures for undergraduate and postgraduate students positively influenced their self-confidence in learning, enhanced their confidence in delivering online instruction, and strengthened overall self-efficacy. Furthermore, across these six mixed-methods studies, additional benefits of UDL implementation included greater flexibility, diversified learning materials, increased collaboration, improved teacher–student relationships, enhanced access to content through effective and sustainable use of technology, and notable improvements in reading skills.

6. DISCUSSION :

Based on the review of twelve research studies, it is evident that the application of Universal Design for Learning (UDL) principles in instructional practices enhances the overall learning process of students. The following discussion

highlights the effectiveness of specific UDL principles, beginning with the principle of **multiple means of representation**, which is grounded in the idea that knowledge can be presented to learners in diverse ways to improve understanding.

Research by Marino et al. explored the use of video games and supplementary reading materials, beyond traditional textbooks, to increase engagement and interest among secondary school students facing learning difficulties in science subjects. The findings revealed that such varied instructional media effectively support different ways of presenting and conveying knowledge, resulting in higher levels of student engagement compared to reliance on textbooks alone.

Similarly, Hall et al. examined the use of online reading strategies to support literacy development among middle school students. Their study demonstrated that providing multiple avenues to access reading materials—such as digital texts and online resources—enhanced students' reading experiences and outcomes. This highlights the direct applicability of UDL in technology-supported learning environments. Further, Tzivinikou focused on the implementation of multiple means of representation in early coursework, finding that students were able to effectively apply UDL principles while designing inclusive lesson plans.

The second principle, **multiple means of action and expression**, is based on the premise that learners should be provided with varied opportunities to demonstrate their understanding of content. This principle recognizes that students differ in how they process information and express what they have learned, thereby emphasizing flexibility in assessment and response formats.

Findings from Katz examined the impact of the Three-Block Model (TBM) within Universal Design for Learning (UDL) on both academic and social engagement. The UDL approach was shown to support teachers in creating inclusive classroom environments while enhancing overall student participation. In particular, Katz (2015) reported that the implementation of UDL principles significantly improved student engagement and peer interaction. Likewise, He found that online instruction grounded in UDL principles contributed to increased student self-confidence and self-efficacy.

Further, research by Navarro et al., which investigated training in lesson planning based on UDL principles among student teachers, revealed a marked improvement in the application of all three UDL principles in instructional design. Similar findings were reported by Tzivinikou, where teacher training programs focusing on UDL principles led to enhanced integration of these principles in lesson planning. Collectively, these studies indicate that UDL-focused training enables educators to present information in multiple ways, offer diverse methods for students to express their learning, and foster greater engagement among all learners in classroom activities.

7. CONCLUSION :

Based on the analysis of journals known that the application of the principles of UDL proven effective in improving the quality of learners' learning process. UDL should have applied in usual schools, and inclusive schools can be used to teach students from children to adults such as college students and might have used for a wide variety of characteristics and abilities of students. Strategies that might have done so that teachers can use UDL in their teaching activities is by providing training on the principles of UDL.

8. LIMITATIONS:

- The study is limited to a small sample of twelve research articles, which may restrict the generalizability of the findings.
- Variations in research design, sample characteristics, and contexts across the selected studies may affect the consistency of results.
- The study relies on secondary data, which limits control over the quality and methodology of the included research.

9. RECOMMENDATIONS:

- Educational institutions should promote the integration of Universal Design for Learning (UDL) principles in curriculum design and classroom practices to enhance inclusive learning.

- Teacher training programs should incorporate structured modules on UDL to improve educators' competence in addressing diverse learner needs.
- Further research should be conducted with larger and more diverse samples to strengthen the generalizability of findings related to UDL effectiveness.

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