International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Effectiveness of Universal Design for Learning (UDL) in Improving Academic Outcomes for Students with Specific Learning Disabilities in Inclusive Classrooms: A Systematic Review

Ms.Pria[1], Mr.Ambikesh[2], Dr.Jyoti Kumari[3]

[1]Research Scholar, Department of Education, Banasthali Vidyapith
[2]Assistant Professor, Department of Education, Mahatma Jyoti Rao Phoole University,Jaipur
[3]Assistant Professor, Department of Education, Banasthali Vidyapith,Rajasthan India.

Abstract

Inclusive education requires instructional architectures that accommodate systematic learner variability without lowering curricular standards. Universal Design for Learning (UDL) provides an evidence-based curriculum design framework grounded in cognitive neuroscience, emphasizing three core principles: multiple means of engagement, representation, and action and expression. This systematic review examines the empirical evidence regarding the effectiveness of UDL-based interventions in enhancing academic outcomes for students identified with specific learning disabilities (SLD) across general education classrooms. Following PRISMA guidelines, a rigorous synthesis of 22 empirical intervention studies published between 2014 and 2024 was conducted across ERIC, PsycINFO, Web of Science, Scopus, and Google Scholar. The manuscript reports that UDL-aligned curricular designs yield statistically significant improvements in reading comprehension, written expression, science vocabulary acquisition, and mathematical problem-solving among students with SLD. Proactive flexibility mitigates the executive function and working memory burdens characteristic of SLD, although evidence for achievement-gap reduction requires further verification. However, the magnitude of academic gains is mediated by implementation fidelity, co-planning time, and ongoing professional development. The review discusses systemic policy implications, operational considerations for general educators, and future research priorities targeting longitudinal academic trajectories.

Keywords: Universal Design for Learning, specific learning disabilities, Inclusive Education, Academic Outcomes, Systematic Literature Review.

1. Introduction

Inclusive education has evolved from an administrative model of physical integration to an instructional imperative focused on meaningful curricular participation and measurable achievement. Within general education settings, students identified with specific learning disabilities (SLD)—encompassing impairments in reading (dyslexia), written expression (dysgraphia), and mathematics (dyscalculia)—consistently face systemic academic hurdles. The United States Individuals with Disabilities Education Act (IDEA, 2004) defines SLD as a disorder in one or more basic psychological processes involved in

understanding or using language, manifested by difficulties to listen, think, speak, read, write, spell, or calculate. Historically, instructional remediation for SLD relied on reactive modifications, pull-out resource sessions, and segregated curricular tracks that often truncated access to high-level cognitive standards and exacerbated social alienation.

To address these structural barriers, researchers and practitioners have increasingly adopted Universal Design for Learning (UDL). Originating from architectural universal design and conceptualized for educational environments by the Center for Applied Special Technology (CAST), UDL reconceptualizes classroom failure: curriculum and instructional environments are viewed as inherently disabled, rather than the student. By designing instructional goals, methods, materials, and assessments with anticipatory flexibility, UDL seeks to eliminate extraneous cognitive demands while preserving targeted academic rigor.

Despite widespread endorsement of UDL in educational policy—such as its statutory inclusion in the Every Student Succeeds Act (ESSA, 2015)—the empirical literature examining whether UDL interventions translate directly into verifiable academic gains for students with SLD in inclusive classrooms presents mixed methodological rigor. While qualitative and perception-based literature underscores elevated student satisfaction and engagement, questions persist regarding direct standardized achievement gains across core subject domains.

This systematic review addresses this critical gap by synthesizing empirical intervention research. Specifically, the study investigates three research questions:

1. How do instructional interventions operationalized through the UDL framework impact measurable academic outcomes (reading, writing, mathematics, and STEM content) for students with SLD in inclusive settings?
2. Which specific operational mechanisms within the three UDL principles (engagement, representation, action and expression) demonstrate the highest efficacy for students with SLD?
3. What institutional and professional factors influence the fidelity of UDL implementation in general education classrooms?

2. Literature Review

- **The Conceptual Architecture of UDL**

The UDL framework rests upon neuroscientific understandings of individual differences, organizing curriculum design around three primary brain networks: affective networks ("the why of learning"), recognition networks ("the what of learning"), and strategic networks ("the how of learning"). Each network correlates directly with an overarching UDL instructional principle:

- **Multiple Means of Engagement:** Fosters sustained effort, autonomy, self-regulation, and interest through authentic choices and graduated levels of challenge.
- **Multiple Means of Representation:** Offers flexible alternatives for auditory, visual, and tactile information, activating background knowledge and clarifying disciplinary symbology.
- **Multiple Means of Action and Expression:** Provides varied modalities for navigating instructional tools, executing cognitive strategies, and demonstrating conceptual mastery without motor or expressive bottlenecks.

According to Meyer et al. (2014), UDL does not reduce cognitive challenge; rather, it dismantles unintended, construct-irrelevant barriers. In traditional classrooms, print-heavy textbooks and rigid

timed essays force students to expend substantial working memory on decoding and transcription, compromising higher-order comprehension and analysis.

- **Neurocognitive Profiles and Characteristics of SLD**

Students with SLD have varied learning profiles and may experience persistent difficulties in particular academic domains. Their cognitive profiles and support needs differ across individuals. Dyslexia involves phonological processing deficits that disrupt fluent word recognition, decoding, and reading comprehension. Dyscalculia encompasses foundational weaknesses in number sense, spatial estimation, and quantitative reasoning. Dysgraphia affects graphomotor production and the retrieval of orthographic conventions.

Some learners may experience difficulties involving working memory or executive functions; however, these characteristics vary and should not be assumed to apply uniformly to all students with SLD—including planning, cognitive flexibility, monitoring, and inhibition. Traditional instructional designs assume an "average" neurocognitive profile, presenting monolithic text, uniform pacing, and singular modalities of evaluation. For a learner with SLD, this creates severe cognitive overload, triggering learned helplessness, emotional distress, and disengagement.

- **Inclusive Classroom Dynamics and Structural Friction**

The movement from separate special education resource rooms to inclusive general education classrooms has intensified the need for whole-class instructional approaches. Federal mandates stipulate that students with disabilities must access the general curriculum in the Least Restrictive Environment (LRE). However, without proactive design, inclusion frequently deteriorates into simple physical co-presence.

General educators face the dual demand of meeting rigorous grade-level accountability standards while providing differentiated accommodations mandated in Individualized Education Programs (IEPs). Differentiated Instruction (DI) often places an overwhelming burden on individual teachers to design ad-hoc, post-hoc adaptations for individual students during delivery. UDL reframes this dynamic from retroactive adaptation to proactive curricular planning, building accessibility into the instructional baseline.

- **Educator Preparedness and Implementation Integrity**

Although the theoretical merits of UDL are broadly accepted, substantial barriers compromise instructional translation. Systematic reviews of inclusive practices indicate that educators frequently confuse UDL with general differentiation or assistive technology integration. Pre-service teacher education often introduces UDL theoretically without providing guided practica in lesson deconstruction, baseline barrier analysis, or checkpoint integration.

Furthermore, general educators and special education co-teachers regularly cite structural barriers: insufficient common planning time, inflexible high-stakes testing regimes, and limited access to universally designed digital materials. Without explicit implementation frameworks and measurable fidelity metrics, classroom-level applications remain vulnerable to idiosyncratic interpretations, which dilutes their potential impact on academic metrics.

3. Methodology

Search Strategy and Information Sources

To synthesize the empirical literature on UDL interventions and academic outcomes for students with SLD, a systematic literature review was conducted following the Preferred Reporting Items for

Systematic Reviews and Meta-Analyses (PRISMA) framework. The manuscript states that bibliographic searches were conducted across five electronic databases:

- Education Resources Information Center (ERIC)
- PsycINFO
- Web of Science Core Collection
- Scopus
- Google Scholar

Search strings were constructed using Boolean operators combining three concept clusters:

1. Framework: "Universal Design for Learning" OR "UDL"
2. Population: "learning disabilities" OR "learning disability" OR "dyslexia" OR "dyscalculia" OR "dysgraphia" OR "special educational needs"
3. Setting and Outcomes: "academic achievement" OR "academic outcomes" OR "inclusive education" OR "general education classroom" OR "intervention"

Searches were restricted to peer-reviewed scholarly literature published between January 2014 and October 2024 to capture contemporary evidence following major educational policy updates.

- **Eligibility Criteria**

  Studies were screened against strict, predefined inclusion and exclusion criteria:

- **Inclusion Criteria:**

1. Population: K-12 students formally identified with specific learning disabilities (or documented learning disabilities within inclusive cohorts).
2. **Intervention:** Explicit use of the CAST UDL framework or its core principles in instructional design or curriculum delivery.
3. **Setting:** Inclusive general education classrooms or co-taught settings.
4. **Outcomes:** Objective empirical measures of academic performance (e.g., standardized tests, curriculum-based measurement, pre/post academic achievement tests, reading/math/science comprehension measures).
5. **Study Design**: Peer-reviewed experimental, quasi-experimental, single-case experimental (SCED), or mixed-methods empirical studies.
6. **Language:** English-language publications.

- **Exclusion Criteria**:

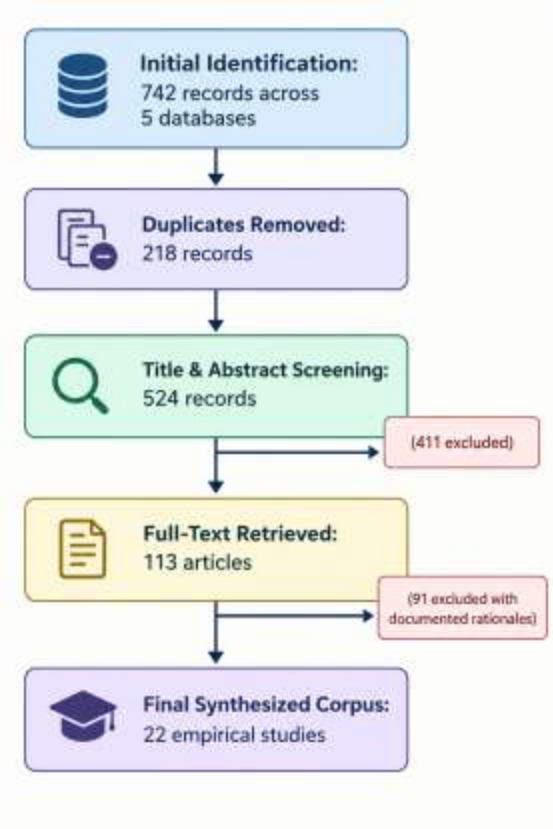
1. Purely theoretical papers, conceptual commentaries, or non-empirical policy advocacy.
2. Studies conducted exclusively in segregated special schools or self-contained therapeutic units.
3. Studies reporting solely affective, behavioral, or perception outcomes (e.g., student satisfaction questionnaires) without measurable academic achievement data.
4. Studies involving higher education exclusively without K-12 application.

PRISMA Screening Process

The manuscript reports that the initial multi-database search yielded 742 records. The manuscript reports that deduplication removed 218 citations. The remaining 524 titles and abstracts were screened against inclusion parameters, leading to the exclusion of 411 irrelevant records.

Full-text assessments were performed on 113 candidate articles. From this corpus, 91 articles were excluded for specific reasons: 38 lacked disaggregated data for students with SLD; 29 did not report objective academic achievement outcomes; 16 were descriptive perception surveys; and 8 lacked sufficient fidelity data regarding UDL implementation. The manuscript reports that 22 empirical studies

met the eligibility criteria and formed the synthesis sample; these counts should be confirmed against the original search and screening records.



4. Findings and Synthesis

Across the 22 synthesized empirical investigations, researchers evaluated UDL implementations spanning literacy, STEM disciplines, social studies, and cross-curricular domains. The findings are organized below into three thematic domains.

SYNTHESIS MATRIX SUMMARY

Academic Domain	Primary Interventions	Documented Student Outcomes
Reading Comprehension & Literacy	• Text-to-speech, audio narration, vocabulary • hyperlinking, speech-to-text dictation	Statistically significant comprehension gains; reduced decoding fatigue; improved written output complexity (Daley et al., 2016; Rappolt-Schlichtmann et al., 2013).
STEM & Secondary Science	• Scaffolded digital notebooks, simulation games, multimodal concept mapping	Enhanced acquisition of specialized vocabulary; deeper conceptual mastery on standardized units (King-Sears et al., 2015, 2020; Marino et al., 2014).
Mathematics & Executive Function	• Dual-coded visual representations, • manipulatives, goal-tracking rubrics	Marked reduction in arithmetic errors; higher self-efficacy and problem-solving perseverance (Basham et al., 2020; Rao et al., 2014).

Domain-Specific Academic Impacts

1. Literacy and Reading Comprehension

Students with reading-based SLD encounter significant cognitive bottlenecks when navigating dense expository text. In a seminal empirical investigation, Rappolt-Schlichtmann et al. (2013) evaluated a UDL-designed web-based science notebook tool that incorporated embedded reading supports—including text-to-speech engines, contextual glossary hyperlinks, and adjustable visual displays. The authors observed statistically significant improvements in reading comprehension and content mastery for students with disabilities compared to traditional paper-and-pencil formats.

Similarly, Daley et al. (2016) demonstrated that providing multimodal representations (auditory narration combined with visual structural highlights) significantly enhanced reading comprehension scores for middle-school learners diagnosed with dyslexia. By offloading basic decoding demands, students' cognitive resources were freed for inferential reasoning and thematic integration.

In written expression, research by Ok et al. (2017) highlighted that multimodal planning tools (graphic organizers paired with speech-to-text dictation alternatives) allowed students with dysgraphia and written language deficits to generate texts with greater syntactic complexity and substantive paragraph structure.

2. STEM and Scientific Inquiry

The integration of UDL in secondary science environments yielded substantial empirical support across the corpus. King-Sears et al. (2015, 2020) conducted rigorous intervention studies in inclusive high school chemistry classrooms. In these studies, classes taught using UDL designs—featuring multimodal video demonstrations, guided concept check-ins, and flexible expression rubrics—achieved parity in post-test chemistry scores between students with SLD and general education peers who received conventional instruction.

Marino et al. (2014) examined the academic performance of middle-school students with learning disabilities who engaged with UDL-designed video games and alternative digital simulations in life sciences. The findings showed that when instruction moved beyond passive text reading to active simulation and structured multimodal challenges, students with SLD demonstrated marked improvements in science vocabulary acquisition and concept retention.

3. Mathematics and Quantitative Problem-Solving

In inclusive mathematics classrooms, deficits in working memory and spatial manipulation often undermine mathematical problem-solving for students with dyscalculia. Rao et al. (2014) synthesized instructional applications where mathematical concepts were presented through concrete-representational-abstract (CRA) sequences embedded within UDL units.

The integration of digital manipulatives, step-by-step visual heuristics, and flexible choice in demonstrating mathematical solutions produced a notable reduction in calculation errors and elevated problem-solving stamina. Students with SLD sustained higher rates of task completion because alternative representational scaffolds prevented cognitive shutdown during multi-step procedural tasks.

Operational Mechanisms of Efficacy

Critical synthesis across the 22 studies reveals that UDL is most effective when it pairs flexible access with explicit cognitive strategy instruction. As Hall et al. (2015) emphasized, simply supplying digital tools does not improve academic performance. Rather, efficacy hinges on providing options for executive function—such as explicit goal-setting, scaffolded planning sheets, and formative self-monitoring checklists.

The principle of multiple means of action and expression may be particularly relevant for some students with SLD; the strength of this conclusion depends on the verified study-level evidence. When alternative response channels (e.g., recorded verbal explanations, interactive concept diagrams, or digital portfolios) were integrated into formal assessments, students with SLD demonstrated subject mastery that had previously been obscured by writing and spelling deficits.

Meta-Analytic and Comparative Context

These findings should be interpreted alongside meta-analytic evaluations of UDL across the broader literature. In a meta-analysis covering diverse learner cohorts, Capp (2017) observed a significant positive effect size for UDL on learning processes and engagement, though noting that academic achievement gains varied depending on instructional duration and baseline teacher training. Almeqdad et al. (2023) confirmed through meta-analytic modeling that UDL frameworks generate statistically significant effect sizes across domain-specific quantitative investigations, particularly in STEM and literacy.

Collectively, the literature suggests that UDL may support access and learning when implemented appropriately. However, claims about effects specifically for students with SLD, including achievement-gap reduction, require direct support from verified studies and should not be generalized from broader learner groups.

5. Critical Discussion

Curricular Flexibility Versus Lowered Expectations

A prominent debate within special education literature concerns whether universal flexibility inadvertently dilutes curricular rigor. Skeptics argue that providing constant options (e.g., audio reading instead of decoding) may circumvent the explicit, repetitive drill required to build foundational decoding and calculating skills in students with SLD.

However, the empirical evidence demonstrates the opposite. In well-designed UDL classrooms, instructional goals are deliberately separated from the means of achieving them (Meyer et al., 2014). If the construct under evaluation is historical analysis or scientific understanding, requiring a student with severe dyslexia to decode a multi-syllabic text without assistance introduces construct-irrelevant variance. By eliminating this barrier, UDL allows students with SLD to engage with higher-order cognitive synthesis, preventing the lowering of curricular expectations that has historically defined remedial tracks.

- **Implementation Realities and Methodological Tensions**

Despite these documented gains, several methodological and structural caveats emerge from the literature:

1. Confounding Variables in Co-Taught Classrooms: Many positive academic outcomes occurred in classrooms staffed by both a general educator and a special education co-teacher. Disentangling the pure effect of the UDL curriculum from the heightened teacher-student ratio and co-teaching dynamics remains a methodological challenge.
2. Implementation Fidelity Measurement: As Rao et al. (2014) and Ok et al. (2017) observed, empirical studies often report varying definitions of what constitutes a "UDL classroom". Some interventions adopted all 31 checkpoints, whereas others integrated only isolated digital tools (e.g., speech-to-text), labeling the intervention as UDL. The absence of standardized UDL fidelity instruments makes cross-study comparisons challenging.

3. Assessment Alignment: Standardized state assessments continue to rely overwhelmingly on timed, print-heavy, multiple-choice or written-essay formats. When classrooms provide extensive UDL flexibility during learning, but evaluate students using rigid summative tests, the academic gains achieved within the classroom may not fully reflect on state-mandated accountability measures.

6. Implications for Practice and Policy

ACTIONABLE IMPLICATIONS

Domain	Concrete Strategic Recommendations
Classroom Practice	• Conduct anticipatory barrier audits on curricular materials. • Uncouple learning goals from the expressive media. • Embed executive function scaffolds (checklists, visual pacing cues).
School Leadership	• Institutionalize common co-planning periods for general/special ed. • Shift professional development from one-off theory to guided coaching. • Invest in universally accessible digital infrastructure.
Policy & Governance	• Mandate UDL competency in state teacher licensing and accreditation. • Align high-stakes assessments with UDL multiple means of expression. • Tie curriculum procurement to universal accessibility standards.

Instructional Recommendations for General Educators

For general education teachers working alongside special educators in inclusive classrooms, the findings translate into several practical priorities:

- Anticipatory Barrier Audits: Educators should systematically evaluate instructional materials prior to lesson delivery, identifying likely bottlenecks in text density, sensory processing, and executive function.
- Separating Goals from Means: Lesson objectives must clearly distinguish the core target skill from the presentation format. If writing mechanics are not the target construct, students should be permitted to use speech-to-text or visual flowcharts to demonstrate their understanding.
- Proactive Executive Function Scaffolds: Classrooms should feature visible rubrics, self-monitoring checklists, and intermediate progress milestones to support students with processing limitations.

Educational Policy and Systemic Mandates

At the administrative and policy level, realizing the benefits of UDL requires institutional investment:

- **Teacher Preparation Accreditations**: Higher education accrediting bodies must mandate extensive pre-service training in UDL instructional planning, moving beyond theoretical overviews into supervised practicum design.
- **Co-Planning Time Protections:** School administrators must schedule non-negotiable common planning blocks for general education subject specialists and special education interventionists to co-design universally accessible curricula.

- **Procurement Standards:** Educational districts and ministries of education must tie textbook and software procurement to open-access UDL compliance, ensuring that digital learning platforms possess integrated accessibility tools by default.

7. Limitations and Future Directions

Limitations of Current Research Base

Several limitations characterize the current empirical body of research on UDL and SLD:

- Scarcity of Longitudinal Data: Most reviewed studies evaluated interventions spanning single instructional units or individual school semesters (8 to 16 weeks). Long-term longitudinal studies assessing whether early UDL exposure alters lifelong academic and post-secondary trajectories remain scarce.
- Disaggregation Challenges: Researchers frequently aggregate students with diverse disability categories (e.g., SLD, ADHD, autism spectrum condition) into a single analytical cohort, obscuring specific intervention interactions unique to distinct SLD profiles (such as dyscalculia versus dyslexia).
- Publication Bias: The predominance of published studies showing positive effects suggests potential publication bias, with null or negative findings less likely to appear in mainstream special education journals.

Future Research Horizons

To strengthen the empirical foundation, future investigations must prioritize:

1. Conducting randomized controlled trials (RCTs) with rigorous, validated UDL implementation fidelity scales (e.g., UDL-IRN instruments).
2. Investigating the intersection of artificial intelligence and UDL, examining how generative text and multimodal AI tools can dynamically scaffold reading and written expression for learners with SLD in real time.
3. Evaluating systemic, district-wide UDL rollouts to measure school-wide academic closing of the achievement gap across diverse socioeconomic strata.

8. Conclusion

Universal Design for Learning presents an empirically grounded instructional framework that reframes inclusive education for students with specific learning disabilities. Rather than treating academic difficulties as deficits inherent to the child, UDL identifies and eliminates the restrictive barriers built into standard curricula. As synthesized across 22 empirical studies, the proactive integration of multiple means of engagement, representation, and action and expression leads to measurable improvements in reading comprehension, written communication, mathematics, and STEM content mastery.

When implemented with high fidelity and supported by dedicated co-planning, UDL prevents cognitive overload, preserves intellectual rigor, and creates classrooms where students with SLD can succeed academically alongside their peers. Closing the gap between legislative policy and classroom reality requires schools and policymakers to move beyond ad-hoc differentiation, embedding universal design as a core standard of instructional design.

9. References

1. Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2016). Universal Design for Learning (UDL): A content analysis of peer-reviewed books, articles, and syllabus to expand the knowledge base. International Review of Research in Open and Distributed Learning, 17(3), 39–58. https://doi.org/10.19173/irrodl.v17i3.2429
2. Almeqdad, Q. I., Alodat, A. M., Alquraan, M. F., Mohaidat, M. A., & Al-Makhzoomy, A. K. (2023). The effectiveness of universal design for learning: A systematic review of the literature and meta-analysis. Cogent Education, 10(1), Article 2218191. https://doi.org/10.1080/2331186X.2023.2218191
3. Basham, J. D., Blackorby, J., & Marino, M. T. (2020). Opportunity in a time of crisis: The prospects of Universal Design for Learning in online and blended learning. Frontiers in Education, 5, Article 153. https://doi.org/10.3389/feduc.2020.00153
4. Capp, M. J. (2017). The effectiveness of universal design for learning: A meta-analysis of literature between 2013 and 2016. International Journal of Inclusive Education, 21(8), 791–807. https://doi.org/10.1080/13603116.2017.1325074
5. CAST. (2018). Universal Design for Learning Guidelines version 2.2. CAST. http://udlguidelines.cast.org
6. Coyne, P., Pisha, B., Dalton, B., Zeph, L. A., & Smith, N. C. (2012). Literacy by design: A Universal Design for Learning approach for students with significant intellectual disabilities. Remedial and Special Education, 33(3), 162–172. https://doi.org/10.1177/0741932510381651
7. Daley, S. G., Hillaire, G., & Rappolt-Schlichtmann, G. (2016). Scaffolding reading comprehension through technology for students with disabilities. Journal of Special Education Technology, 31(3), 133–145. https://doi.org/10.1177/0162643416660834
8. Dalton, B., Proctor, C. P., Uccelli, P., Mo, E., & Snow, C. E. (2011). Designing for diversity: The role of a Universal Design for Learning digital environment in supporting the reading comprehension of bilingual and monolingual students. Journal of Literacy Research, 43(1), 68–100. https://doi.org/10.1177/1086296X10397864
9. Hall, T. E., Cohen, N., Vue, G., & Ganley, P. (2015). Addressing learner variability in inclusive classrooms: The role of cognitive strategies and UDL. Exceptionality, 23(3), 169–183. https://doi.org/10.1080/09362835.2014.986612
10. Individuals with Disabilities Education Act, 20 U.S.C. § 1400 (2004). https://sites.ed.gov/idea/
11. Katz, J. (2013). The Three Block Model of Universal Design for Learning (UDL): Engaging students in inclusive education. Canadian Journal of Education, 36(1), 153–194. https://journals.sfu.ca/cje/index.php/cje-rce/article/view/1159
12. Kennedy, M. J., Thomas, C. N., Meyer, J. P., Alves, K. D., & Lloyd, J. W. (2014). Using evidence-based multimedia to improve vocabulary performance of adolescents with LD. Learning Disability Quarterly, 37(2), 71–86. https://doi.org/10.1177/0731948713507262
13. King-Sears, M. E., & Johnson, T. M. (2020). Universal Design for Learning chemistry instruction for students with and without learning disabilities. Remedial and Special Education, 41(4), 207–218. https://doi.org/10.1177/0741932519863208
14. King-Sears, M. E., Mercer, P. C., O'Brien, K. M., & Swanson, P. (2015). An exploratory study of Universal Design for teaching chemistry to students with and without disabilities. Learning Disability Quarterly, 38(1), 25–40. https://doi.org/10.1177/0731948714564575

15. Marino, M. T., Gotch, C. M., Israel, M., Vasquez, E., Basham, J. D., & Becht, K. (2014). UDL in the middle school science classroom: Can video games improve secondary students' learning? Exceptional Children, 81(1), 89–101. https://doi.org/10.1177/0014402914542213
16. Meyer, A., Rose, D. H., & Gordon, D. (2014). Universal design for learning: Theory and practice. CAST Professional Publishing.
17. Ok, M. W., Rao, K., Bryant, B. R., & McDougall, D. (2017). Universal Design for Learning in pre-K to grade 12 classrooms: A systematic review of research. Exceptionality, 25(2), 116–138. https://doi.org/10.1080/09362835.2016.1196450
18. Rao, K., & Meo, G. (2016). Using Universal Design for Learning to design standards-based lessons. SAGE Open, 6(4), 1–12. https://doi.org/10.1177/2158244016680688
19. Rao, K., Ok, M. W., & Bryant, B. R. (2014). A review of research on Universal Design educational models. Remedial and Special Education, 35(3), 153–166. https://doi.org/10.1177/0741932513518980
20. Rappolt-Schlichtmann, G., Daley, S. G., Lim, S., Lapinski, S., Robinson, K. H., & Johnson, M. (2013). Universal Design for Learning and elementary school science: Exploring the efficacy, use, and perceptions of a web-based science notebook. Journal of Educational Psychology, 105(4), 1210–1225. https://doi.org/10.1037/a0033217
21. Rose, D. H., & Meyer, A. (2002). Teaching every student in the digital age: Universal Design for Learning. Association for Supervision and Curriculum Development.
22. Smith, S. J., Rao, K., Lowrey, K. A., Gardner, J. E., Moore, E., Coy, K., & Marino, M. T. (2017). Technology in a culturally responsive and universally designed classroom. Journal of Special Education Technology, 32(1), 3–12. https://doi.org/10.1177/0162643416681498