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RESEARCH ARTICLE

UNIVERSAL DESIGN FOR LEARNING IN INCLUSIVE SCIENCE EDUCATION FOR STUDENTS WITH DISABILITIES

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Abstract

Inclusive science education must allow for the ability to access scientific concepts, engage in inquiry, communicate understanding, and demonstrate achievement in learning environments that are meaningful for students with diverse abilities. Barriers that may be encountered in science classrooms by students with disabilities include: text-based materials, inaccessible laboratory setting, lack of alternative communic ation, overly rigid assessment procedures, and one-size-fits-all teaching methods. Universal Design for Learning (UDL) offers proactive strategies to decrease these barriers by creating curriculum, instruction, learning resources, assessment and classroom interaction that are designed for variation in learners from the outset. This review focuses on the relevance and application of UDL in inclusive science education for students with disabilities, specifically, the studies published from 2018 to 2026. Recent writings suggest that when UDL is incorporated meaningfully into instructional planning, instead of simply as a list of accommodation, it provides support for access, participation, engageme nt, scientific achievement, motivation and learner agency. The research literature on science education illustrates the significance of multimoda l representation, inquiry-based learning, the access to technologies, collaborative science discourse, flexibility in assessment, and multiple forms of action and expression. There is also some evidence that teacher knowledge and confidence, professional development, institutio nal support, the availability of technology, and planning time impact successful implementation. The literature is not, however, uniformly supportive, for instance, with respect to long-term outcomes, secondary science education, laboratory learning, students with multiple disabilitie s, and research in low- and middle-income contexts.

According to the review, the concept of UDL needs to be understood as a framework for curriculum design that focuses on what gets in the way of instruction and the environment rather than on a learner's deficit. A conceptual

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model is suggested for bringing together UDL principles and inclusive scientific learning to foster equitable scientific learning for students with disabilities.

Introduction:-

The nature and importance of scientific literacy, problem-solving skills, critical thinking, the development of evidence-based reasoning, and an understanding of the natural and technological world have become increasingly acknowledged as important outcomes of science education, making it a crucial part of general education. But not all learners have equal access to meaningful involvement in science. The scientific concept materials and processes, scientific language, abstract representations, laboratory procedures, visual information, assessment formats, classroom communication, or assumptions about how students are expected to show a scientific understanding can pose a barrier for students with disabilities. Therefore, inclusion in a science classroom is not just about being physically in the classroom with the students, it is about the things that need to be done to make them a part of the science classroom community. It calls for intentional redesign of teaching and learning processes to enable students to access, engage in and contribute to the scientific learning.UDL has become a significant approach to dealing with learner variability in inclusive education. Instead of addressing a learner profile to provide for typical variation and then building accommodations on top of that, UDL asks the UDL teacher to consider variation when designing the curriculum and instruction. According to Capp (2020), UDL is an inclusive pedagogical approach that aims at minimizing barriers to learning for all students and highlights the need for teachers to feel confident and knowledgeable using the principles of UDL. The framework is especially relevant to science education because what science knowledge is communicated is done in different ways, such as through text, diagrams, symbols, models, demonstrations, experiments, numerical representations, oral explanations, and technological simulations.

The conceptual position of UDL has been bolstered by recent developments. The updated UDL Guidelines 3.0 (CAST, 2024) focus on minimizing barriers to learning that are grounded in bias and systems of exclusion, and on fostering learner agency, belonging, multiple ways of knowing, accessible means of communication and flexible forms of action and expression. This is important for special education because it isn't just about making the learning accessible to the individual student; it's about changing the way learning takes place.Pilot studies specific to science have also started to show promise of the uses of UDL. Sebti and Damiani (2021) presented a model that ties inclusive philosophy, science and engineering practices, and UDL, highlighting inclusive scientific communities, big ideas, model-based inquiry, cooperative learning, and science discourse. Likewise, Ruhter (2022) explained how to structure inquiry science learning in inclusive classrooms for students with high support needs. These contributions suggest that UDL can be adapted into a pedagogy of science other than science that is taught in UDL.The aim of this review is thus to explore the potential of UDL to facilitate inclusive science education for students with disabilities, to discuss key evidence that has been found in research conducted between 2018 and 2026, to analyze the challenges faced in implementing UDL, and to suggest future survey and research directions.

Conceptual Foundations of Universal Design for Learning:-

The main premise of UDL is that there is learner variability that can be predicted and can be taken into account when planning curriculum. Rather than differences in learning styles as exceptional and in need of correction, UDL considers variability in learning styles as a normal aspect of classrooms. This view is really applicable to inclusive education as it changes the focus from 'why is it that this learner cannot access this lesson' to 'what is special about this lesson that is creating an unnecessary barrier for this learner'.There are three overarching aspects of UDL: Multiple Means of Engagement, Representation, and Expression and Action. The principles are elaborated upon in the more detailed guidelines found in the 2024 version of the framework, which focus on interests and identities, belonging, multiple ways of representing knowledge, accessible technologies, communication and strategic learning, and learner agency (CAST, 2024).

Multiple means of engagement are about understanding that students have varying motivations, attention, interests, confidence and persistence. Engagement in science classrooms can be fostered using real problems, inquiry, collaborative investigations, choice of learning activities, links to real life, and opportunities to investigate questions that are meaningful to the student.Multiple means of representation acknowledge that students learn in a variety of ways. Representations, therefore, of content that is scientific can be done using the combinations of written language, verbal explanations, diagrams, touchable materials, models, demonstrations, videos, simulations, animation, real objects and easily-accessed digital resources. Such flexibility is particularly important for students with visual, hearing, intellectual, learning, communication, or physical disabilities.

Multiple means of action and expression acknowledge that learning about science may be expressed through various modes of communication and action. Written examinations are thus just one of the possible ways. Students can provide evidence of understanding orally, in a diagram, model, demonstration, digital/DVD presentation, structured experiments, recorded responses, tactile representations and/or assistive communication systems as long as the alternative mode is consistent with the intended learning outcome.This is not a strategy of reducing scientific standards. It, on the contrary, liberates the learning goal from unnecessary obstacles of the approach to accessing or demonstrating the goal. CAST (2024) focuses in particular on the importance of multi-modal communication and accessible technologies, alongside challenges to meaningful learning.

UDL and Inclusive Science Education:-

Implementing UDL in science education is full of opportunities and challenges. Science is a natural process which requires multiple representations and active participation. Conversely, science classrooms might rely primarily on written instructions, pictorial diagrams, symbolized notation, laboratory apparatus, and quick explanations from the instructor. Potential challenges for students with disabilities can thus occur during the various steps of learning.King-Sears and Johnson (2020) studied UDL-based chemistry instruction for students with and without learning disabilities. The study illustrates the usefulness of UDL in contexts of science instruction in secondary schools that involve abstract concepts like molar conversions. The significance of this type of work is it shows that UDL can be used in the content of rigorous disciplines and not just in basic or remedial.Roski, Walkowiak, and Nehring (2021) explored UDL in inclusive science lessons and explored how UDL relates to students' epistemic beliefs. Based on their research, they warn against the belief that more UDL features will lead to better results. The study found no evidence that the more comprehensive an environment, the more effective it was in all outcomes.

This discovery is significant because the goal of effective UDL is not to provide all possible instructional options but to be purposeful and to align with goals of learning.There can be significant language requirements to science learning as well. The authors of Reducing Language Barriers in Science for Students with Special Educational Needs (2021) have found that science teaching can be highly challenging for learners with SEN in terms of reading and language. Multimodal representation, UDL, arts-based approaches and communicative technologies can minimize the language barriers without losing access to the scientific concepts.This is true especially for students with learning disabilities, language difficulties, intellectual disabilities and communication disabilities. A lesson on the water cycle, for instance, might be delivered as a traditional written paragraph but a UDL-oriented lesson might include a tactile or physical model, an animated representation, simplified vocabulary, teacher narration, captioned video, sequencing it in a diagram, and provide chances for students to describe the process orally, by writing, symbols, or an augmentative communication system.

Students with Visual Disabilities:-

Students with visual impairments might have difficulties to access the content of science when it is presented mainly as diagrams, microscopic images, charts, demonstrations, or laboratory procedure presented visually. UDL can overcome these by making tactile diagrams, 3-D models, verbal descriptions, accessible digital materials, tactile graphs, audio explanations, screen-reader compatible resources and hands-on experiences.But the accessibility should not lead to the de-identification of the problem. The ultimate aim should be to enable the same conceptual content to be conveyed in different sensory channels. CAST (2024) underscores the significance of readily available resources and technologies that facilitate navigation, interaction, and participation while retaining the learning challenge.

Students with Hearing Disabilities:-

For students with hearing disabilities, the learning of science based on the methods of oral explanation, group discussion, or video without subtitles can lead to problems in learning. UDL can be used to support participation in the following ways: Captions, transcripts, visual instructions, sign language interpretation (as appropriate), written key concepts, diagrams, simulations and structured peer interaction.The focus should be on the maintenance of access to scientific language and interaction, rather than just translating teacher speech. Communication accessibility is important in science learning, which consists of discussion, argumentation, explanation, and collaborative reasoning.

Students with Intellectual Disabilities:-

Students with intellectual disabilities may need to have explicit learning sequences, explicit vocabulary instruction, repetition, concrete examples, and chances for generalization. AlRawi and AlKahtani (2022) conducted a systematic review of UDL-based interventions for students with intellectual disabilities, which found digital environments, ebooks, shared stories, audio systems, software, and educational activities were all included. The reviewed studies found advantages in academic, social and behavioral outcomes, albeit with authors noting that there was limited evidence and a variety of study methods.With explicit teaching and scaffolding, UDL can then be used in science education. For instance, a lesson on plant growth might include using real plants, providing hands-on experiences, using picture sequences, using simplified text, teacher modeling, student collaboration, and multiple opportunities to demonstrate understanding.

Students with Learning Disabilities:-
Students with learning disabilities might have problems with reading scientific texts, working memory, mathematical representations, organization and written expression. Cook and Rao (2018) stated that UDL can be systematically integrated with evidence-based practices used with students with learning disabilities by providing flexibility and scaffolds early in the learning process.For science, this might include graphic organizers, vocabulary supports, guided notes, worked out examples, audio versions of texts, concept maps, visual sequences, and flexible response options. These practices have the power to decrease unnecessary obstacles while maintaining scientific reasoning's cognitive challenge.

Students with E.S.N.:-
Pupils with significant support needs are particularly vulnerable to being denied access to an appropriate academic science curriculum of value. Ruhter (2022) showed how UDL could be linked to inquiry-based science teaching with structured supports for students with extensive support needs. This implies that the question of whether students with large support needs can participate in inquiry is not a blanket assumption that should be made in inclusive science education. Rather, activities for inquiry should have easily accessible participation pathways.

UDL and Scientific Inquiry:-
Scientific inquiry is especially compatible with UDL because inquiry is a natural process of asking questions, investigating, observing, gathering evidence, interpreting, explaining, and communicating. Inquiry-based activities, however, may inadvertently exclude students when based on equipment that is inaccessible, or when the verbal exchange is too quick, the written procedures too complicated, or one way of engaging in inquiry is expected.Sebti and Damiani (2021) suggested four practices for universally designed science education: (1) establishing an inclusive community of science learners, (2) planning for the big ideas over time, (3) engaging learners in sense making through model-based inquiry, and (4) engaging in cooperative learning and science talk. These practices serve as helpful examples of how UDL can be useful in the context of contemporary science education.In a study of forces and motion, students might be able to work with real objects, video models, simulations, and tactile models or representations, as well as word-based explanations and graphs. Students could make predictions as a group or independently and present the findings in the form of a written explanation, oral presentation, diagram, model or digital product.The essence of UDL is to expand participation while not losing the authenticity of the discipline. Students with disabilities need to be the consumers of science knowledge, not the producers of it.

Technology and UDL in Science Education:-
The use of digital technology is growing in importance in the field of accessible science education. In their systematic review of the use of digital technology to support science education for students with disabilities, Mikropoulos and Iatraki (2023) noted that digital technology has become relevant and crucial as tools to support science learning and participation.Simulations, interactive diagrams, virtual laboratories, screen-reader compatible materials, captioned videos, speech-to-text tools, text-to-speech applications, digital concept mapping, accessible presentations, and adaptive interfaces are examples of digital tools that can be used to support UDL.But technology isn't equal to UDL. Barriers can be reproduced in a digital resource if it is not accessible or when a student must use it only one way. CAST (2024) notes that accessible technologies should offer meaningful opportunities for interaction and that they should be navigated and communicated in a variety of ways.So, it is not really about how technology can be incorporated into science instruction, but rather how technology can decrease barriers without compromising the scientific learning goal?

Evidence of Effectiveness:-
The amount of information on the effectiveness of UDL has grown in the past decade. AlRawi and AlKahtani (2022) concluded that there were positive results in the research conducted for each of the several UDL-based interventions for students with intellectual disabilities, but stronger and larger-scale research was still needed.Yu et al. (2021) did a two-year effectiveness study of the Science Notebook in a Universal Design for Learning Environment. Importantly, students with disabilities who were treated with the intervention reported significantly

higher motivation in science and science academic achievement than did students in the comparison group with effect sizes ranging from 0.82 to 1.01. This is especially meaningful evidence because the intervention not only paired UDL with a science-learning resource, but looked at outcomes from students with disabilities.A more comprehensive systematic review and meta-analysis from 2023 found that UDL did have a positive impact on student learning, especially when used as an intervention in the classroom and in professional development, but more research is required to determine the efficacy of UDL in different contexts and outcomes.The evidence cannot be assumed to prove that all UDL interventions will have positive academic outcomes. Roski et al. (2021) reported that greater support for UDL in the learning environment did not result in greater success in an inclusive science context. It is assumed that quality, alignment, intentionality, and fidelity of implementation is more critical than the number of UDL features.

Teacher Competence and Professional Development:-

The teacher is an essential part of the successful implementation of UDL. A good tool for change in science education is not enough unless teachers have knowledge, confidence, planning time and institutional support.Capp (2020) examined teacher confidence in adopting UDL principles, guidelines, and checkpoints and emphasized the need for teacher understanding to help make UDL a reality. In a similar manner, studies on teacher candidates suggest that specific UDL training positively affects teacher candidate development of UDL lesson plans. Scott et al. showed that teacher education students benefitted from UDL-related training in creating lesson plans that meet the needs of diverse academic and transition needs.By conducting a systematic review of UDL training courses, Rusconi and Squillaci (2023) studied the impact of professional development on teachers' competence in inclusive classrooms. They reiterate the need to ensure that teachers are continually prepared for UDL through a systematic approach and cannot be expected to acquire this skill through exposure to the strategy.Science teachers, then, would be wise to integrate knowledge of UDL with examples of science content on their own list of goals for professional development.Professional development then, for the science teacher, should include knowledge of UDL and examples of science content. The training should include the concepts of accessible laboratory activities, scientific terminology, inquiry-based learning, assistive technology, accessible assessment, collaborative teaching, and approaches to supporting students with various disabilities.

Understanding the differences between UDL and differentiated instruction.:-

The concepts of UDL and differentiated instruction are often used interchangeably in the field of inclusive education. In the literature there are a number of conceptualizations of the relationship between the two approaches as pointed out by Griful-Freixenet et al. (2020). Their review revealed that UDL and differentiated instruction can be considered complementary, embedded, or not compatible depending upon the interpretation of each framework.The incorporation of differentiation within inclusive science education may be seen as a way of incorporating changes in response to the learning needs of the learner, whereas UDL can be viewed as a proactive design framework. For instance, a teacher might represent a science lesson in many ways and offer the same lesson to all students, but then offer more scaffolding to a student who needs more explicit support.This is significant because UDL does not preclude the need for individualized support. Some students will still need one on one accommodations, assistive technologies, specialized services and individualized education programs. UDL cuts down on needless barriers for the population of the classroom, and individualized support is provided as needed.

Implementation Challenges:-

There are a number of challenges to implementing UDL. In a systematic literature review, Zhang et al. (2024) reported that there were numerous challenges to implementing UDL in educational contexts. The difficulties encountered are conceptual misunderstanding, complexity of implementation, lack of teacher preparation, lack of resources, and the lack of making theory into practice.

- The first problem is the workload of the teacher. Planning multiple representations, response options, accessible resources and pathways to assessment may take a considerable amount of planning time in the beginning.
- The second challenge is knowledge of the profession. Teachers might have an idea of what they represent at a very cursory level, but have difficulty working them into subject-specific teaching choices.
- The third challenge is that of resources. UDL is a challenge to implement where schools have inaccessible digital technologies, laboratory equipment, specialist support or suitable teaching resources.
- The fourth challenge is assessment alignment. Teachers might not be able to be flexible during the learning process, if curriculum objectives focus on scientific reasoning, but assessments are based almost exclusively on the written response.

- The fifth is institutional culture. When school leaders, special educators, science teachers, curriculum developers and technology specialists share responsibility for inclusion, UDL is more sustainable.
- Last but not least, there is a danger of UDL becoming a checklist. The implementation of the model is complex, as pointed out by Zhang et al. (2024), and should not be considered as merely offering various instructional options.

Proposed Conceptual Framework:-

The literature that was reviewed indicates that four interacting components are necessary for the realization of effective UDL science education: learner variability, accessible science curriculum, flexible pedagogy and supportive assessment and technology.

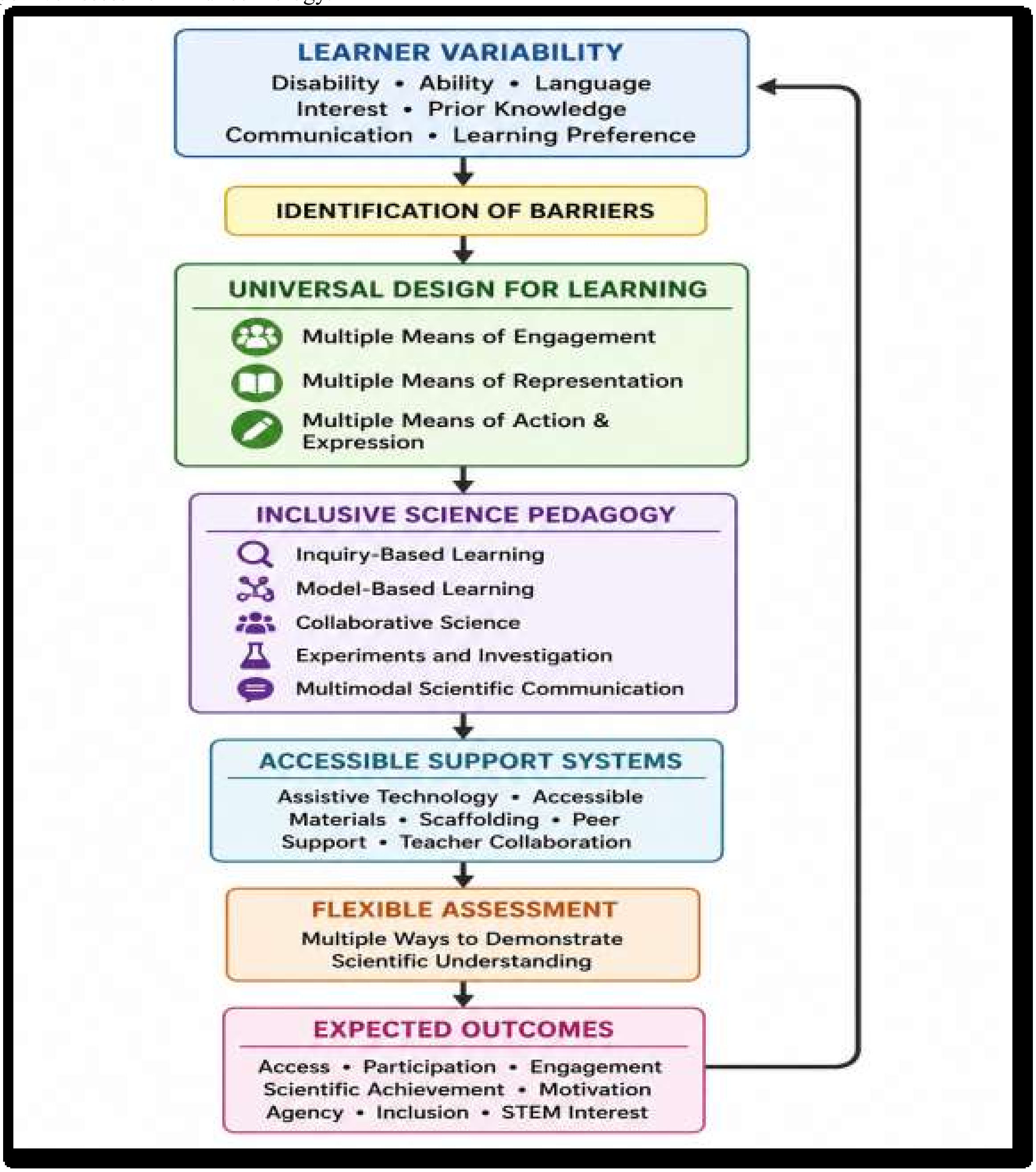

Figure - 1: Conceptual Framework for Universal Design for Learning in Inclusive Science Education

The framework offers ideas that UDL be used as the bridge between learner variability and science pedagogy. It is not intended to respond to hardship or to be a reaction once a problem has arisen but to plan around obstacles when designing curriculum.

Syntheses of recent literature.:-

Table - 1: This selection of literature on UDL and Inclusive Science Education was compiled from the years 2018 to 2026.

Author(s)	Year	Focus	Major Contribution
Tomas, Cross, & Campbell	2018	UDL and special needs	Connected UDL with the ICF framework and inclusion
Cook & Rao	2018	Learning disabilities	Demonstrated how UDL can be integrated with evidence-based practices
Capp	2020	Teacher confidence	Highlighted teacher competence and confidence in UDL implementation
Griful-Freixenet et al.	2020	UDL and differentiated instruction	Examined conceptual relationships between UDL and differentiation
King-Sears & Johnson	2020	Chemistry education	Examined UDL instruction for students with and without learning disabilities
Sebti & Damiani	2021	Science education	Connected UDL with science and engineering practices
Roski, Walkowiak, & Nehring	2021	Inclusive science	Examined UDL intensity and epistemic beliefs
Yu et al.	2021	Science achievement	Reported positive science achievement and motivation outcomes for students with disabilities
AlRawi & AlKahtani	2022	Intellectual disabilities	Synthesized UDL interventions for students with intellectual disabilities
Ruhter	2022	Inquiry-based science	Developed UDL-supported inquiry approaches for extensive support needs
Mikropoulos & Iatraki	2023	Digital science education	Reviewed digital technologies supporting science learning for students with disabilities
Lohmann, Hovey, & Gauvreau	2023	Preschool science	Provided UDL-oriented approaches for inclusive science instruction
Rusconi & Squillaci	2023	Teacher training	Reviewed effects of UDL professional development on teacher competence
Al-Azawei et al.	2023	UDL effectiveness	Reported evidence from systematic review and meta-analysis
Zhang et al.	2024	Implementation challenges	Identified barriers and challenges in UDL implementation
CAST	2024	UDL Guidelines 3.0	Expanded UDL toward learner agency, belonging, accessibility, and reducing systemic barriers
CAST	2026	UDL development	Documented the research-based and community-driven development of UDL 3.0

The literature suggests that there is a shift from conceptual discussion to examination of UDL outcomes over time. In the early studies (from the first few years of the reviewed period) teacher confidence and inclusive frameworks were a key focus, but later research was increasingly concerned with science achievement, motivation, digital technologies, teacher professional development and the challenges of implementation.

Research Gaps:-

While increasing evidence is emerging, there are areas that are still not well understood:-

- First, few studies have explicitly examined the implementation of UDL in secondary science education with students with varied disability types. Content in the existing literature is mainly focused at certain learning levels and settings.
- Second, more research is needed into laboratory based science education. Laboratory and physical, sensory, communication and safety barriers are not always a part of traditional UDL research.
- Third, pupils with more and more complex needs continue to be underrepresented. While Ruhter (2022) offers a valuable addition, further empirical research is needed to determine best practices in various scientific fields.
- Fourth, more studies are needed to investigate long-term effects. There are numerous studies that only examine achievement, motivation, or perceptions after an intervention. Future studies could assess if UDL has an impact on sustained scientific achievement, self-efficacy, participation in STEM, and educational progression.
- Fifth, there is limited research in developing and culturally diverse educational systems. The majority of the literature published has come from North America, Europe and other areas with relatively good resources.

Additional data from other countries with the potential for severe resource limitations, especially in India, South Asia and Africa, are required.

- Sixth, more research is needed to explore the connection between UDL and emerging technologies like Artificial Intelligence, adaptive learning systems, virtual laboratories, accessible simulations, and multimodal generative technologies. But this research should address issues of access and educational effectiveness, not take for granted that technological innovation will lead to inclusion.
- Lastly, researchers should go beyond mere assessment of implementation of UDL and research what works, what works for whom and under what conditions and how. This should improve access to evidence and support teachers in their decision making about teaching and learning.

Implications for Inclusive Science Education:-

The literature reviewed offers a number of suggestions for practice:-

- First, science teachers need to find out what barriers are present in their science lessons, not after students have failed. A lesson should thus be checked regarding linguistic, sensory, cognitive, physical, technological and assessment-based barriers.
- Second, teachers need to first choose their scientific learning goals rather than deciding on the instructional methods. After the goal has been determined, there are a number of ways to provide students with access to content and opportunities to show understanding.
- Thirdly, the use of multimodal resources should be improved in science classrooms. Models, tactile materials, demonstrations, audio descriptions, captions, diagrams, simulations, accessible texts and real world objects can increase access to scientific concepts.
- Fourth, inquiry should be the focus. Students with disabilities must not be held back from experimentation, questioning, prediction, gathering of evidence and scientific reasoning because they need alternate ways of taking part.
- Fifth, there must be flexibility without compromising the academic rigor in assessment. When aligned with the intended learning outcome, multiple forms of expression are acceptable as evidence for scientific understanding.
- Sixth, Science and special educators should be collaborating routinely in planning for inclusive science. The special educator brings expertise on access to communication, assistive technology, individual supports and learner needs, and the science teacher brings expertise on the science content.
- Seventh, professional development should be “lifelong.” Rusconi and Squillaci (2023) illustrate the importance of UDL teacher training and Capp (2020) highlights the importance of teacher confidence.

Conclusion:-

Universal Design for Learning offers a hopeful model to shift inclusive science education from an accommodating to a proactive model of curriculum design. The published literature from 2018-2026 suggests that UDL can be used to increase access to scientific representations, opportunities for scientific inquiry, opportunities to collaborate, flexible communication, and alternative assessments for students with disabilities.The best evidence comes when UDL is used alongside science teaching and learning, instead of being treated as an add-on to science. The work on science notebooks, chemistry pedagogy, inquiry science, model-based inquiry, technology, and inclusive science classrooms shows that children with disabilities can be engaged in high-quality science learning when barriers to learning are purposefully considered. However, the evidence is not strong enough to support the claim that UDL is the universal prescription that leads to better outcomes. Roski et al. (2021) show that more intense UDL doesn't ensure better learning outcomes and Zhang et al. (2024) explain the complexity of implementation. Thus, thoughtful alignment of learning goals, learner variability, pedagogy, technology, assessment, and classroom context are required for successful UDL.The most significant conceptual impact of UDL for special education is the change of viewpoint. Rather than question the ability of a student to learn science, educators are encouraged to ask the question: does the science learning environment offer adequate opportunities for access, participation, engagement, communication and expression? This is in line with the modern inclusive education where disability is seen not only as a property of the individual but also as a barrier in the environment and in teaching.The future of UDL for inclusive science education is to take the general and abstract level of UDL to a more specific and evidence-based application at the discipline level. Laboratory access, secondary science, students with high levels of support needs, accessible STEM pathways, teacher preparation and emerging technologies, and research in different educational contexts should be more thoroughly addressed. UDL 3.0 builds on the following components of this direction: belonging, learner agency, multiple ways of knowing, accessible communication, and the elimination of exclusionary practices (CAST, 2024).Inclusive science education should not simply be a place where students with disabilities are given a seat at the table in the science classroom. It should allow them to interact with scientific concepts, carry out investigations, explain, discuss and collaborate with others, solve problems and become a valid part of science. This vision is achieved with the help of UDL.

References:-

1. Abdulraqeb ; Dr. J Sujathamalini ; Tarak Halder . "Vocational Training Functional Skill Assessment for Students with Visual Impairment: Case Study Report" Iconic Research And Engineering Journals Volume 7 Issue 4 2023 Page 420-428
2. Adaikalam, R., Sujathamalini, J., & Halder, T. KNOWLEDGE ON NEMETH AND SCIENTIFIC NOTATIONS AMONG PROSPECTIVE SPECIAL EDUCATION TEACHERS.
3. Akash S , Tarak Halder , Dr. J Sujathamalini "The Kolam Tradition: A Tradition of Figure-Drawing in Tamil Nadu" Iconic Research And Engineering Journals Volume 7 Issue 4 2023 Page 56-60
4. 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), 2218191. https://doi.org/10.1080/2331186X.2023.2218191
5. AlRawi, J. M., & AlKahtani, M. A. (2022). Universal design for learning for educating students with intellectual disabilities: A systematic review. International Journal of Developmental Disabilities, 68(6), 800–808. https://doi.org/10.1080/20473869.2021.1900505
6. Baglieri, S. (2020). Toward inclusive education? Focusing a critical lens on Universal Design for Learning. Canadian Journal of Disability Studies, 9(5), 42–74. https://doi.org/10.15353/cjds.v9i5.690
7. Boyle, S., Rizzo, K. L., & Taylor, J. C. (2021). Reducing language barriers in science for students with special educational needs. Asia-Pacific Science Education, 6(2), 364–387. https://doi.org/10.1163/23641177-BJA10006
8. Capp, M. J. (2020). Teacher confidence to implement the principles, guidelines, and checkpoints of Universal Design for Learning. International Journal of Inclusive Education, 24(7), 706–720. https://doi.org/10.1080/13603116.2018.1482014
9. Cook, S. C., & Rao, K. (2018). Systematically applying UDL to effective practices for students with learning disabilities. Learning Disability Quarterly, 41(3), 179–191. https://doi.org/10.1177/0731948717749936
10. Dalton, E. M., Lyner-Cleophas, M., Ferguson, B. T., & McKenzie, J. (2019). Inclusion, universal design and Universal Design for Learning in higher education: South Africa and the United States. African Journal of Disability, 8, 519. https://doi.org/10.4102/ajod.v8i0.519
11. Delaney, T. A., & Hata, M. (2020). Universal Design for Learning in assessment: Supporting ELLs with learning disabilities. Latin American Journal of Content & Language Integrated Learning, 13(1), 79–91. https://doi.org/10.5294/laclil.2020.13.1.5
12. Griful-Freixenet, J., Struyven, K., & Vantieghem, W. (2021). Toward more inclusive education: An empirical test of the Universal Design for Learning conceptual model among preservice teachers. Journal of Teacher Education, 72(3), 239–253. https://doi.org/10.1177/0022487120965525
13. Griful-Freixenet, J., Struyven, K., Vantieghem, W., & Gheyssens, E. (2020). Exploring the interrelationship between Universal Design for Learning and differentiated instruction: A systematic review. Educational Research Review, 29, 100306. https://doi.org/10.1016/j.edurev.2019.100306
14. Halder, T., & J, S. (2025). Role of Art Education Techniques in Early Childhood Care and Education. South India Journal of Social Sciences, 23(4), 58-61. https://doi.org/10.62656/SIJSS.v23i4.1968
15. Kapil, Y., Sujathamalini, J., & Halder, T. (2024a). Universal Design for Learning (UDL) Based Inclusive Classrooms: A Sustainable Pathway for Children with Mild Intellectual Disabilities. International Journal of Advanced Research, 12(09), 745–751. https://doi.org/10.21474/IJAR01/19510
16. Kapil, Y., Sujathamalini, J., & Halder, T. (2024b). Universal Design for Learning (UDL) in The Classroom. PARIPEX INDIAN JOURNAL OF RESEARCH, 155–159. https://doi.org/10.36106/paripex/1708785
17. 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/10.1177/0741932519862608
18. King-Sears, M. E., Stefanidis, A., Evmenova, A. S., Rao, K., Mergen, R. L., Owen, L. S., & Strimel, M. M. (2023). Achievement of learners receiving UDL instruction: A meta-analysis. Teaching and Teacher Education, 122, 103956. https://doi.org/10.1016/j.tate.2022.103956
19. McKenzie, J. A., & Dalton, E. M. (2020). Universal design for learning in inclusive education policy in South Africa. African Journal of Disability, 9, 776. https://doi.org/10.4102/ajod.v9i0.776
20. Mikropoulos, T. A., & Iatraki, G. (2023). Digital technology supports science education for students with disabilities: A systematic review. Education and Information Technologies, 28, 3911–3935. https://doi.org/10.1007/s10639-022-11317-9

21. Mr. R. Adaikalam, Mr. Tarak Halder, Dr. J. Sujathamalini. “A Case Study Analysis on Foundational Literacy Skill Among Children with Intellectual Impairment”, INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN TECHNOLOGY (IJIRT), ISSN: 2349-6002, Volume 10, Issue 1, June 2023, IJIRT 160265, Page(s): 107 – 110, https://www.ijirt.org/Article?manuscript=160265
22. Mr. Tarak Halder, Mr. G. Ravichandran, Mr. R. Adaikalam, Dr. J. Sujathamalini. "THE IMPORTANCE OF WOMEN'S WITH DISABILITIES EMPOWERMENT IN INDIA", International Journal of Creative Research Thoughts (IJCRT), ISSN:2320-2882, Vol.11, Issue 5, pp.k735-k739, May 2023, URL : http://www.ijcrt.org/IJCRT23A5278
23. Orndorf, H. C., Waterman, M., Lange, D., Kavin, D., Johnston, S. C., & Jenkins, K. P. (2022). Opening the pathway: An example of Universal Design for Learning as a guide to inclusive teaching practices. CBE—Life Sciences Education, 21(2), ar28. https://doi.org/10.1187/cbe.21-09-0239
24. P Puspha, Tarak Halder, Dr. J Sujathamlini. “Attitude towards Traditional Methods and Modern Methods of Teaching Students with Visual Impairment” Bharatiya Shiksha Shodh Patrika. 2023. Volume- 42, Issue- 1(iii), Pages- 112-116
25. Pastor, C. A. (2018). Universal Design for Learning: A didactic model to provide learning opportunities to all students. Journal of Parents and Teachers, 374, 21–27. https://doi.org/10.14422/pym.i374.y2018.003
26. Rogers-Shaw, C., Carr-Chellman, D. J., & Choi, J. (2018). Universal Design for Learning: Guidelines for accessible online instruction. Adult Learning, 29(1), 20–31. https://doi.org/10.1177/1045159517735530
27. Roski, M., Walkowiak, M., & Nehring, A. (2021). Universal Design for Learning: The more, the better? Education Sciences, 11(4), 164. https://doi.org/10.3390/educsci11040164
28. Ruhter, L. (2022). Using the UDL framework in inquiry-based science teaching to support students with extensive support needs in inclusive classrooms. Journal of Science Education for Students with Disabilities. https://doi.org/10.1177/27324745221093766
29. Rusconi, L., & Squillaci, M. (2023). Effects of a Universal Design for Learning training course on the development teachers' competences: A systematic review. Education Sciences, 13(5), 466. https://doi.org/10.3390/educsci13050466
30. Schreffler, J., Vasquez, E., Chini, J., & James, W. (2019). Universal Design for Learning in postsecondary STEM education for students with disabilities: A systematic literature review. International Journal of STEM Education, 6, 8. https://doi.org/10.1186/s40594-019-0161-8
31. Scott, L. A., Thoma, C. A., Puglia, L., Temple, P., & D'Agostino, S. (2019). Teacher candidates' abilities to develop Universal Design for Learning and Universal Design for Transition lesson plans. International Journal of Inclusive Education, 26(4), 333–347. https://doi.org/10.1080/13603116.2019.1651910
32. Sebti, L., & Damiani, M. L. (2021). Engaging students with disabilities in universally designed science education. Journal of Science Education for Students with Disabilities, 24(1), Article 13. https://doi.org/10.14448/jsesd.13.0013
33. Tarak Halder, J. Sujathamalini, G. Ravichandran. According to NEP 2020, the role of art education techniques in school level for inclusion of students with disabilities. International Journal of Research and Review. 2023; 10(3): 370-373. DOI: https://doi.org/10.52403/ijrr.20230343
34. Tarak Halder; R. Adaikalam; Dr. J. Sujathamalini; Dr. K. Gunasekaran. "Inclusive Development of Children with Disabilities." ,Volume. 8 Issue. 5, May - 2023 , International Journal of Innovative Science and Research Technology (IJISRT), www.ijisrt.com. ISSN - 2456-2165, PP :- 1979-1982. https://doi.org/10.5281/zenodo.8001653
35. Tomas, V., Cross, A., & Campbell, W. N. (2018). Building bridges between education and health care in Canada: How the ICF and Universal Design for Learning frameworks mutually support inclusion of children with special needs in school settings. Frontiers in Education, 3, 18. https://doi.org/10.3389/feduc.2018.00018
36. Yu, J., Wei, X., Hall, T. E., Oehlkers, A., Ferguson, K., Robinson, K. H., & Blackorby, J. (2021). Findings from a two-year effectiveness trial of the Science Notebook in a Universal Design for Learning environment. Frontiers in Education, 6, 719672. https://doi.org/10.3389/feduc.2021.719672