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Applying Universal Design for Learning in Mathematics Instruction for Students with Learning Difficulties

[1]Dr. Asmaa Azeem*

[2]Dr. Sadia Jabeen

[3]Dr. Tanzela Bashir

[4]Syed Zaheer Abbas

[1]Associate Professor (Special Education), Department of Education, School of Social Sciences and Humanities (SSS&H), University of Management and Technology, Lahore, Punjab, Pakistan.

[2]Lecturer, Department of Education, The University of Lahore, Lahore, Punjab, Pakistan.

[3]Lecturer, Department of Education, The University of Lahore, Lahore, Punjab, Pakistan.

[4]PhD Scholar (Education), Department of Education, The University of Lahore, Lahore, Punjab, Pakistan.

[1]asmaa.nouman@umt.edu.pk, [2]Sadia.jabeen@ed.uol.edu.pk, [3]Tanzeela.bashir@ed.uol.edu.pk, [4]Syedzaheer212@gmail.com

Abstract

This research explored how Universal Design for Learning (UDL) could be used in math teaching for learners who have difficulty in learning. The researchers used a quantitative method, and there were 350 math teachers who completed a structured questionnaire. The tool included demographic questions and 40 statements relating to the three main principles of UDL: engagement, representation, and action and expression. The researchers used frequencies percentages means, standard deviations, independent sample t-tests, one-way ANOVA, and reliability analyses for data analysis. The results showed a moderately high level of UDL implementation in math classes. Besides gender school type, school location, training in inclusive education, training in UDL age qualification, and teaching experience were found to be significant factors leading to variations in the results. Those teachers having professional training in inclusive education and UDL were found stronger in their implementation of inclusive practice. The research suggested that UDL is a good tool to help raise the quality of inclusive education in math, and it pointed to the need for specialized teacher training and sufficient resource provision.

Keywords: Universal Design for Learning, mathematics instruction, students with learning difficulties, inclusive education, quantitative research

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Introduction

Mathematics is one of the essential school subjects that not only determine a student's educational path but also help to develop a student's problem-solving skills and facilitate their engagement in daily activities. Nevertheless, quite often for students with learning difficulties, math turns into a source of continuous failures because teaching is typically tailored to a very limited range of learners and only changes after the problems have surfaced. Universal Design for Learning (UDL) is a forward-looking approach to eliminating such obstacles by designing flexible goals materials techniques, and assessments right from the start. Moreover, the latest CAST UDL Guidelines 3.0 focus on issues such as learner diversity, learner empowerment, accessibility, and fairness which is why UDL is especially suitable for math teaching situations where the use of highly conceptual ideas, symbolic language, and fast pace of instruction could lead to the exclusion of students with learning difficulties. In addition, recent studies reveal that teaching in line with UDL principles leads to better academic results in a variety of students; however, the standard of implementation varies significantly from one context to another (CAST, 2024; King-Sears et al., 2023; Greene & Bernacki, 2024).

International interest in inclusive pedagogies is mainly expressed through research combining differentiated supports technology visual resources, teacher assistance, and varied participation structures. The systematic review and bibliometric analysis of 2025 for inclusive mathematics education of students with special educational needs showed increasing publication activities from 2021 to 2024 and identified pedagogical diversity, the use of technology, supporting the teacher as the main intervention themes. In line with that, learning disabilities students' mathematics instruction literature reflects explicit vocabulary teaching, visual representations, manipulatives, and cognitive/metacognitive strategy instruction as evidence-based supports for the students. Jointly, these developments indicate that UDL may be a good way to not only sustainably organize inclusive mathematics practices for students with learning difficulties but also address a major gap, that is, the lack of context-specific research in school systems like Pakistan (Abdulah et al., 2025; Shin et al., 2025).

The foundation of this research stems from the ongoing issue of a gap between learner diversity and traditional mathematics teaching methods. Typically, learners with difficulties need multiple avenues of content presentation, a lot of modeling, step-by-step problem-solving feedback as well as different ways to show their comprehension. Nevertheless, many classrooms still heavily depend on standardized oral delivery, textbook-oriented activities, and a single pace for all students. UDL addresses this issue by turning the focus away from student weaknesses to the design of instructional materials, prompting educators to expect diversity and insert help before a student is left behind. Particularly in math, this is critical as students are often faced with the challenges of symbolic notations, language aspects in word problems, limited working memory, difficulty with abstract concepts, and even anxiety. On the other hand, recent evaluations of UDL have pointed out that although the concept is great, it still suffers from issues such as lack of clear definition, irregular application, and a small number of high-quality experimental studies, therefore substantiating the need for targeted investigations in specific fields like math teaching for learners with difficulties (CAST, 2024; Aftab et al., 2024).

At the international level, inclusive education in many countries has been prioritized in policies and research. UNESCO continues to promote inclusion by giving all children not only the opportunity to go to school but also ensuring that they are educated on an equitable

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basis and that their participation is meaningful. The 2020 Global Education Monitoring Report brought to the attention of the world that learners with disabilities are mostly excluded from education. Therefore, the report calls for a transformation of education systems rather than regarding learners as the ones who must adapt to the existing rigid structures. Mathematics education has also been influenced by the international scene and recent studies show that the issue of inclusive education, in mathematics, is no longer limited to students' physical placement in the general classrooms. Instead, it also covers participation, accessible pedagogy, formative support, and responsive teaching. Moreover, research indicates that many students with disabilities are currently taught mostly in general education settings. This creates a pressing need for regular mathematics teachers to be provided with inclusive instructional approaches. Given these developments UDL becomes quite significant since it is a way to systematically create inclusive teaching in the mainstream mathematics classrooms instead of depending mostly on remedial pull-out support (UNESCO, 2020; Roos, 2023; Shin et al., 2025).

In Pakistan, providing inclusive and adaptable teaching in mathematics is a very urgent issue. A study conducted in rural Punjab revealed that although most children with disabilities in the area were attending mainstream government and private schools, their likelihood of being in school and learning basic literacy and numeracy skills was still significantly lower than their non-disabled peers. Household survey data from four administrative units of Pakistan revealed a two-fold disadvantage for children with disabilities: not only are there barriers to accessing schools, but there is also a concern about the quality of learning for those who are enrolled. Advocacy data at the national level from ASER 2023 have shown that only a limited proportion of surveyed schools report the presence of children with disabilities. Also, inclusive facilities such as ramps, accessible toilets, trained staff and related support continue to be very insufficient. On the other hand, Pakistan's policy environment has begun to recognize these issues and has adopted certain measures such as the Dyslexia Bill, 2023 and the Federal Foundational Learning Policy, 2024. However, pedagogical changes, especially in mathematics, seem to be lagging. Therefore, it is very timely and relevant to explore the potential of UDL (Universal Design for Learning) for enhancing the teaching and learning of mathematics for the learners with learning difficulties in Pakistani schools (Malik et al., 2022; ASER Pakistan, 2024).

While the literature on inclusive education, UDL, and math intervention expanded significantly in 2020-2026, nevertheless there is still a major gap related to the intersection of these three areas. Reviews to date reveal that, on the one hand, UDL research is broader than the math one and on the other hand, math intervention research for students with learning disabilities mostly isolated strategies instead of an entire instructional design framework. Moreover, international reviews have also highlighted that evidence is mainly coming from a few countries, and even subject-specific, school-level implementation evidence is still in the early stages. In Pakistan, available studies mainly highlight the barriers to access, policy issues or inclusive practices in general, while very little empirical research is done on how UDL can be used systematically in math for students with difficulties in learning. Hence, research that directly links UDL principles to math teaching practices and learner needs in the Pakistani context is necessary (Greene & Bernacki, 2024; Abdulah et al., 2025; Aftab et al., 2024).

While advocacy for inclusive education has increased considerably, the reality is that most of the school mathematics instruction still is not accommodating students with learning difficulties in a systematic and proactive manner. Therefore, these learners still

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struggle to understand concepts, solve problems, participate in classroom activities, and show what they know. In Pakistan, the issue is aggravated by a scarcity of inclusive facilities, irregular teacher training, and lack of classroom-level models for implementing inclusive pedagogy effectively. The main issue that this research tackles is that the use of Universal Design for Learning in teaching mathematics to students with learning difficulties is not only inadequately familiar to the students and teachers but also very lightly investigated in the local educational settings where inclusive policy is still a far cry from strong instructional practice (Upadhayay & Kakar, 2024; Shaukat, 2023).

This research focuses on how Universal Design for Learning might help enhance math teaching for students with learning difficulties. The main goals are: (1) to understand the theoretical and actual significance of UDL for inclusive math teaching; (2) to discover the difficulties students with learning challenges face during math instruction; (3) to look at ways in which the UDL principles - engagement, representation, and action/expression - can aid in understanding mathematics and encourage students' participation; and (4) to produce guidance based on empirical data for teachers, schools, and education authorities on enhancing inclusive math teaching practices. The goals of this study are in line with the recent demands internationally for informative and context-sensitive inclusive mathematics studies (CAST, 2024; Abdulah et al., 2025; Shin et al., 2025).

This work has theoretical, practical, and policy relevance, making it significant in all three areas. In a theoretical aspect, it adds to the small share of research that directly connects UDL with math teaching for students with learning problems. On a practical level, it may enable educators to stop delivering one-type-fits-all instruction by providing a concept for creating accessible lessons, changing representations, creating significant student engagement, and offering varied assessments. For school administrators and teacher trainers, the research might be instrumental in continuing teacher education based on the inclusive math teaching methodology. For the policymakers in Pakistan, this research may serve as one of the local documents which can be used to foster the implementation of disability-responsive and foundational learning reforms. In view of the major disparity between the inclusive policy pledges and the actual classroom situation, the research can raise not only mathematics performance but also educational equity for a deeply marginalized group of learners (King-Sears et al., 2023; Aftab et al., 2024).

Literature Review

Universal Design for Learning (UDL) is a powerful framework for inclusive education that changes the focus from learner's deficits to the design of the learning environment. Rather than waiting for students with learning difficulties to fail and then offering accommodations, UDL motivates teachers to create flexible goals materials teaching methods, and assessments right from the start. This framework is based on the recognition that learner variability is a normal thing and should be considered when planning for a class. In the context of teaching mathematics, this matters a lot since the conventional way of teaching often relies on fixed pacing, uniform verbal explanation, and limited response formats, all of which may put students with learning difficulties at a disadvantage. The latest version of UDL Guidelines 3. 0 also raised the frameworks focus on learner agency, accessibility, and equity, thereby making it even more appropriate for inclusive mathematics teaching (CAST, 2024; Sajjad et al., 2025).

Recent studies have shown that Universal Design for Learning (UDL) has developed from being a mere theoretical concept to a set of classroom practices which have been empirically tested. King-Sears et al. (2023) carried out a meta-analysis that revealed a moderate positive impact of the UDL-based teaching on students' accomplishment thus demonstrating that

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following the UDL principles in designing the classrooms can enhance the learning of different types of learners. Such a result is significant as it bases UDL as an instructional framework on research rather than solely as a philosophical stance towards the inclusion. On the other hand, the same research showed that the effectiveness of UDL largely relies upon the clarity and consistency of its implementation in the classrooms. Hence, implementing UDL in mathematics is not only about being willing to be flexible but also about intentionally planning and designing the instructional supports (King-Sears et al., 2023; Alahmari et al., 2025).

Meanwhile, the literature also identifies quite a few difficulties in implementing UDL. In fact, a systematic literature review revealed that several studies are not only sketchy about the exact definition of UDL but also how they interpret its principles and more importantly how they inform the reader about UDL usage in the classroom. This disparity brings about a real challenge to a comparative study of research results. Consequently, a crucial stumbling block in the method of identification of UDL forms that are most effective particularly in mathematics arises as different studies report on different things. The review additionally pointed out that the quality of implementation is rarely disclosed, which undermines the objective of turning UDL research into practical teaching strategies. Therefore, it is possible to say that although UDL is mostly accepted in theory, the literature still suggests that practically using therefore, it is possible to say that although UDL is mostly accepted in theory, the literature still suggests that practically using UDL in math classrooms calls for more thorough documentation and more in-depth empirical investigation (Zhang et al., 2024; Bagadood et al., 2025).

The need for inclusive instructional design becomes even more crucial when it comes to mathematics since students with learning difficulties in math are not only challenged by one or two aspects of the subject but kept back by obstacles that are complex and multidimensional in nature. The difficulties these students face can be wide-ranging and encompassing areas such as number sense, language of mathematics, symbol recognition, problem solving reasoning memory, and expression of mathematical thoughts. The students with learning disabilities tend to make the most of their learning when teachers use well-planned teaching methods like explicit instruction, visual aids manipulative vocabulary support, and metacognitive scaffolding. The three main principles of UDL, namely multiple means of engagement, representation, and action and expression are in fact closely harmonized with these teaching strategies. So, the research backs up that UDL serves as a great organizational framework to embed effective math support in regular classroom instruction (Naz et al., 2024; Shin et al., 2025).

Another major part of the research studies is inclusive mathematics education in general. A systematic review and bibliometric analysis by Abdulah et al. (2025) reveal an upsurge in international interest in strategies for teaching mathematics to students with special educational needs. Their analysis revealed three major themes in the recent intervention studies: pedagogical diversity, technology integration, and teacher support. These results are very much in line with the UDL principles because they highlight the need for flexibility, a variety of learning tools, and an adaptable teaching environment. The study also verifies that the focus of inclusive mathematics education has shifted more towards instructional design than mere physical presence in the regular classrooms. This point of view makes the case for UDL even more compelling as a comprehensive model for crafting mathematics teaching that addresses the requirements of students with learning difficulties (Aftab et al., 2024; Abdulah et al., 2025).

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Along with UDL-specific research, in fact, intervention studies in mathematics also offer a great deal of evidence supporting this topic. Math interventions considerably enhanced word-problem solving skills among students at the upper elementary and secondary levels with mathematics difficulties. A meta-analysis and reached the conclusion that effects of interventions in mathematics depend on factors like grade level duration group size, and content focus. That research demonstrates that learners with mathematical difficulties can make continuous progress if properly instructed and their instruction is carefully planned and targeted. While these interventions are not always explicitly UDL in the descriptive sense, the results of the studies are compatible with the general UDL principle that thorough and flexible instructional design can facilitate learners' access to and success in math who otherwise may struggle (Hwang et al., 2024; Powell et al., 2023).

Recently, there have been more clear interpretations of how Universal Design for Learning (UDL) could be applied specifically to mathematics instruction. Lambert (2021) emphasized that using UDL in math should not be equated to dumbing down the subject for lower achievers, but rather it should entail designing various accessible options that enable students to engage in genuine mathematical reasoning. This perspective is critical as it safeguards the core learning principles of mathematics teaching while at the same time enhancing reach and inclusiveness. The paper pointed out that truly effective math access calls for deliberate aid, diverse content delivery methods, and students performing in different ways to show their knowledge. This kind of strategy is a step ahead for learners struggling with the traditional methods of expressing their understanding as it makes full use of their math competencies while making explanation a part of the learning process (Lambert, 2021; Bashir et al., 2024).

More recent publications have broadened the debate around UDL in math by linking it to the issues of identity, equity, and students feeling a sense of belonging in the classroom. Yeh et al. (2024) have endeavored to develop culturally sustaining universal design for math learning, stating that aside from considering students cognitive access, mathematics teaching that is inclusive should also pay attention to student's identities and experiences. It is a fact that students with learning difficulties are the focus of great attention from the point of view here as they are not only excluded due to inaccessible tasks but also perceived as deficient and subjected to low expectations. Hence a classroom that complies with UDL principles would not simply free the content from barriers but would be an environment where all students are acknowledged as capable mathematical thinkers. This extended meaning of UDL, among other things, enables a mathematics learning environment which attends far more to the social and emotional dimensions of learners (Yeh et al., 2024; Ashfaq et al., 2024).

The literature also indicates that teacher training is a major factor in the effectiveness of inclusive mathematics teaching. The joint position statement issued by the National Council of Teachers of Mathematics (NCTM) and the Council for Exceptional Children (CEC) stated that students with disabilities should be exposed to grade-level mathematics through effective teaching, collaboration, and the provision of suitable help. This stance is consistent with a wider change in literature which considers special education teachers as the only ones responsible for inclusion. Rather, mathematics teachers in general are increasingly being recognized as having knowledge of how to create and deliver teaching that is accessible to students with different needs. When it comes to UDL, this implies that teachers should have professional expertise in how to differentiate teaching, employ various forms of representation, and allow different methods of participation and assessment in mathematics

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classrooms (National Council of Teachers of Mathematics & Council for Exceptional Children, 2024; Afzaal et al., 2022).

International policy documents are a major source for discovering reasons to use UDL in math teaching. UNESCOs Global Education Monitoring Report on inclusion made the point that education systems must change to the needs of the learner instead of forcing learners to adapt to the rigid systems. This concept very well agrees with the spirit of UDL as it considers variability of learners as a usual factor in education planning. Usually, math teaching should focus on the obstacles/perceptual difficulties students encounter, as well as the limitation of curricula, educative methods, learning materials, and tests. Such a broad, systemic view of inclusion is a good reason why UDL currently is a very effective framework for educational research and teaching (UNESCO, 2020; Alsraisri & Amjad, 2025).

Maths learning difficulties have become a hot topic for researchers lately. The learning disabilities in mathematics are a serious problem for many children of school age and they also cause academic and emotional issues that last a lifetime. In their review of the literature, they found increased research interest in the field of math learning disabilities, especially in the investigation of cognitive processes, intervention development, and teaching support. This growing body of knowledge is crucial because it shows that math learning difficulties are not sporadic problems but a major worldwide educational issue. With increased research being done, we get a better picture of the problem, and it becomes clear that frameworks like UDL are urgently needed. UDL can combine research on cognition intervention instructional design, and learner support into a single model of inclusive instruction. (Li & Wang, 2025; Almulla & Amjad, 2025).

According to research carried out in Pakistan, the education of students with disabilities and learning problems is still an area of concern. The latest ASER Pakistan (2024) study found that children with disabilities still being deprived of their basic educational rights as many schools do not have facilities that are accessible and the necessary support systems as well. Policy instruments such as the Dyslexia Bill and the Federal Foundational Learning Policy 2024 are examples of the change in mindset towards inclusive education and the meeting of foundational learning needs still there is very little evidence of how these concerns are being addressed in mathematics classrooms. This is a very significant gap because simply recognizing the situation at the policy level is far from ensuring the effective implementation of the teaching methods. Consequently, there is a compelling need for indigenous research studying the application of UDL in the teaching of mathematics for students with learning difficulties in Pakistan (ASER Pakistan, 2024; Ministry of Federal Education and Professional Training, 2024).

Most of the studies in the review indicated that the UDL (Universal Design for Learning), the teaching of mathematics and the students with learning difficulties form a triple intersection that is still largely unexplored. The UDL research tends to generalize inclusion without giving special attention to the mathematics part, on the contrary, the studies on mathematics interventions generally isolate some strategies without relating them to a broader design framework such as UDL. In the same way, the studies on inclusive education in the developing regions mostly focus on the issues of access, enrolment or policy rather than on instructional design at the classroom level. Consequently, a significant literature gap has been identified, especially in contexts such as Pakistan, where the inclusive mathematics teaching from the perspective of UDL is a very rarely researched topic. Accordingly, literature provides a good basis for research that focuses on the implementation

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of UDL in mathematics instruction for students with learning difficulties (Abdulah et al., 2025; Zhang et al., 2024).

The literature seems to indicate that UDL is not only an effective but also an evidence-based way of promoting inclusive mathematics education. Besides, the literature suggests that to effectively teach students with learning difficulties, teachers should offer diverse and adaptable teaching methods that remove obstacles to understanding, interest, and self-expression in the classroom. Intervention studies, systematic reviews, policy documents, and mathematics-specific scholarships serve as the pool of evidence that emphasizes the fact that intentionally developing inclusive math teaching to address the diversity of learners at the beginning is the best way to arrive at an effective inclusive mathematics instruction. Nonetheless, to get a good grasp on meaningful application of UDL in actual classrooms, especially in local educational settings, context-specific research is needed. This is why this study is timely and relevant (CAST, 2024; King-Sears et al., 2023; Shin et al., 2025; UNESCO, 2020).

Research Methodology

This chapter deals with how we carried out our research on using Universal Design for Learning (UDL) in mathematics teaching to students with learning difficulties. The methods were planned to guarantee that the data would be collected, analyzed, and interpreted methodically and according to the standards of quantitative research.

Research Design

The research used quantitative methods to investigate how Universal Design for Learning (UDL) practices were related to the teaching of math for students struggling with learning. A descriptive survey approach was chosen as it gave the researcher the opportunity to gather numerical information from many participants and study patterns, trends, and relationships in an objective manner. This approach was deemed suitable as it made it possible to evaluate the teachers' activities, their views, as well as the level of UDL incorporation in math classes via the use of well-organized tools. Besides, quantitative methods allowed running statistical tests to help make broadly applicable inferences.

Population of the Study

The study population is composed of all teachers of mathematics in public and private secondary schools whose students had learning difficulties. They were the target selection as delivering mathematics instruction and implementation of inclusive teaching was their direct responsibility. Moreover, teachers from urban and rural schools were part of the population which was a way of guaranteeing diversity in teaching contexts and classroom environments.

Sample and Sampling of the Study

A sample of 350 mathematics teachers was drawn from the target population. The research employed a stratified random sampling method to guarantee representation from various types of schools (public and private) as well as locations (urban and rural). First, the population was divided into different strata according to these categories, and then subjects were randomly chosen from each stratum. By doing so, the sample accurately represented the entire population, and sampling bias was reduced to a minimum.

Instrument Development

The tool that was employed to gather the data was a structured questionnaire prepared by the researcher. The content of the questionnaire was shaped around the major elements of Universal Design for Learning i. e. multiple means of engagement, representation, and action and expression. There were two major parts to it:

1. Demographic information (e.g., gender, teaching experience, school type)

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2. UDL practices in mathematics instruction, measured through Likert-scale items (e.g., strongly agree to strongly disagree)

The items were created based on a thorough examination of the relevant literature and existing UDL frameworks to make sure they precisely mirrored the constructs being studied. The questionnaire was formulated to record teachers' practices, beliefs, and obstacles in the context of introducing UDL in math classrooms for students with learning difficulties.

Validity of the Research Instrument

To make sure that the tool was valid first, content validity was set through expert review. The questionnaire was sent to the panel of experts from the education field, special education, and mathematics instruction. These experts rated the relevance, clarity, and appropriateness of each of the items mapped to the study objectives. Following their comments, major changes like rephrasing unclear items and deleting duplicated statements were made. This gave rise to an instrument covering yet to be UDL and teaching mathematics to students with learning difficulties.

Reliability of the Research Instrument

The reliability of the instrument was assessed via a pilot study with a small number of respondents (who were not part of the main sample). Cronbach's Alpha, a statistical tool for assessing the internal consistency of a measurement, was applied to the gathered data. The questionnaire's overall reliability coefficient was 0.87, which means it has a very good reliability level. The finding showed that the instrument yielded consistent and stable responses over various items.

Data Collection Procedure

To collect data first the researcher got the necessary permission from school authorities. Then, the researcher made a personal visit to the chosen schools and handed out the questionnaires to the participants. The reason for conducting the study was told to the respondents, and they were promised that their confidentiality and anonymity would be maintained. Obviously, the participants were given enough time to fill out the questionnaire, and the finished forms were gathered either on that very day or within the agreed period. This method guaranteed a great response rate and reliable data collection.

Data Analysis Procedure

The collected data was coded and then entered Statistical Package for Social Sciences (SPSS) for analysis. Descriptive statistics were used to summarize the data, which included frequency percentage mean, and standard deviation. To check if there were differences among the groups based on demographic variables, t-tests and ANOVA were used as inferential statistics. Besides that, correlation test was also carried out as a way of figuring out if UDL practices and mathematics instruction for students with learning difficulties are related. The findings were shown in tables and interpreted according to the research objectives.

Table 1: ***Demographic Characteristics of the Respondents (n = 350)***

Variable	Category	f	%
Gender	Male	162	46.3
	Female	188	53.7
Age (years)	20–30	74	21.1
	31–40	128	36.6
	41–50	96	27.4
	51 and above	52	14.9
Qualification	Bachelor	72	20.6

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	Master	181	51.7
	MPhil	71	20.3
	PhD	26	7.4
Teaching Experience	1–5 years	88	25.1
	6–10 years	112	32.0
	11–15 years	93	26.6
	16 years and above	57	16.3
School Type	Public	196	56.0
	Private	154	44.0
School Location	Urban	208	59.4
	Rural	142	40.6
Training in Inclusive Education	Yes	149	42.6
	No	201	57.4
Training in UDL	Yes	118	33.7
	No	232	66.3

The data in the table shows the demographics of the respondents across various variables. Most respondents were female (53.7%), master's degree holders (51.7%), and public-school teachers (56. 0%). Also, most participants were aged between 31 and 40 years (36.6%). Regarding the professional background of the respondents, most of the teachers had been teaching for 610 years (32.0%). There were more teachers working in urban schools (59.4%) than those in rural areas. More so, the highest proportion of respondents had not undergone training in inclusive education (57.4%) or UDL (66.3%), which points to a substantial lack of professional development around inclusive teaching practices.

Table 2: ***Independent Samples t-Test for Demographic Variables on Overall UDL Practices (n = 350)***

Variable	Category	n	M	SD	t	df	p
Gender	Male	162	3.68	0.50	-2.41	348	.017
	Female	188	3.81	0.47			
School Type	Public	196	3.70	0.51	-1.98	348	.048
	Private	154	3.81	0.45			
School Location	Urban	208	3.79	0.48	2.26	348	.024
	Rural	142	3.67	0.50			
Inclusive Education Training	Yes	149	3.89	0.43	5.21	348	< .001
	No	201	3.63	0.50			
UDL Training	Yes	118	3.97	0.41	7.03	348	< .001
	No	232	3.62	0.48			

The table displays the outcomes of independent samples t-tests that were carried out to find out whether overall UDL practices differed across various demographic variables. The first three variables were gender, school type, and school location; training in inclusive education and UDL were the last two variables. It is interesting to note that the teachers that were female, those that remained in private schools, the ones from urban areas, as well as the ones that had training (inclusive education and UDL) had higher mean scores in terms of the use of UDL practices than their respective peers. The differences in training variables, especially UDL training, were of a much higher magnitude, suggesting that professional development is a significant factor in the effective implementation of UDL for math instruction.

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Table 3: ***One-Way ANOVA for Demographic Variables on Overall UDL Practices (n = 350)***

Demographic Variable	Source	SS	df	MS	F	p
Age	Between Groups	2.84	3	0.95	4.12	.007
	Within Groups	79.69	346	0.23		
	Total	82.53	349			
Qualification	Between Groups	3.17	3	1.06	4.56	.004
	Within Groups	80.11	346	0.23		
	Total	83.28	349			
Teaching Experience	Between Groups	4.26	3	1.42	6.18	< .001
	Within Groups	79.53	346	0.23		

The table presents the findings of the one-way ANOVA analysis comparing the influence of three demographic factors age, qualification, and teaching experience on overall UDL practices. All three demographic variables showed statistically significant differences, which means that people doing UDL were different in these categories. Specifically, age saw the biggest changes ($F(3, 346) = 4.12$, $p = .007$), qualification second biggest ($F(3, 346) = 4.56$, $p = .004$), and teaching experience third ($F(3, 346) = 6.18$, $p < .001$). While age and qualifications had similar F-values, teaching experience was the highest one, showing a strong group difference. Teachers age, academic qualification, and teaching experience could therefore be factors modulating their use of UDL methods in math instruction for students with learning difficulties.

Post Hoc Analysis

Table 4: ***Tukey HSD Post Hoc Test for Teaching Experience***

Comparison group	Mean difference	p
1–5 years vs. 6–10 years	-0.09	.318
1–5 years vs. 11–15 years	-0.18	.041
1–5 years vs. 16+ years	-0.24	.006
6–10 years vs. 11–15 years	-0.09	.287
6–10 years vs. 16+ years	-0.15	.048
11–15 years vs. 16+ years	-0.06	.622

Post hoc analysis revealed that teachers who are 16 years and more have scored quite significantly higher than those with 1-5 years and 6-10 years of experience. A significant difference between 1-5 years and 11-15 years' groups was also found. Therefore, these results imply that teachers with more experience were inclined to report higher implementation of UDL practices than their less experienced counterparts.

Domain-Wise Reliability and Descriptive Summary

Table 5: ***Subscale Means, Standard Deviations, and Reliability***

Subscale	Items	M	SD	α
Engagement	13	3.78	0.56	.86
Representation	14	3.69	0.61	.88
Action and Expression	13	3.74	0.58	.84
Overall	**40**	**3.74**	**0.49**	**.87**

The table presents the meaning, standard deviation, and reliability coefficients of the three UDL subscales. Representation had the highest reliability value (.88), while action and expression had the lowest, though still acceptable, coefficient (.84). The results confirm that

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all subscales were reliable and that teachers reported moderately high use of UDL practices across all domains.

Table 6: ***Correlation Among UDL Domains and Overall UDL Practices***

Variable	1	2	3	4
1. Engagement	—			
2. Representation	.71**	—		
3. Action and Expression	.68**	.73**	—	
4. Overall UDL Practices	.89**	.92**	.88**	—

The table illustrates very strong positive correlations between each UDL domains and the total UDL practices score. Representation was most connected to the overall score ($r = .92$, $p < .01$), with engagement coming next ($r = .89$, $p < .01$). These results show that all three domains are quite closely related and work together to form the larger concept of UDL practice.

Findings

The research showed that the 350 people who participated in the study represented a good mix of demographic characteristics. Female teachers were a little more than male teachers, 31-40 years' age group was dominant; more than half respondents were master's degree holders; largest percentage had 6-10 years of teaching experiences. Most of the respondents worked in public schools and in urban locations. The demographic profile also revealed that most of the respondents did not have formal training in inclusive education or Universal Design for Learning (UDL), which indicates a professional development gap around inclusive mathematics instruction.

The reliability analysis proved that the questionnaire had internal consistency and was quite suitable for quantitative analysis. Overall Cronbach's alpha value was 0.87. The subscales of engagement, representation, and action and expression also showed good to excellent reliability. Hence, the data collection tool was a reliable measure of teacher's perceptions and practices about the implementation of UDL in math teaching to students with learning difficulties.

The descriptive analysis showed a rather high overall average score of UDL practices in math teaching. Of the three components, multiple means of engagement scored the highest mean, then action and expression, whereas multiple means of representation scored the lowest mean. This indicated that teachers seemed more of the time able to encourage students and give the students different ways of participation than to change the ways in which the math content was displayed. The independent samples t-test indicated that there are significant differences in overall UDL practices based on gender, school type, school location, training in inclusive education, and training in UDL. Female teachers had a higher average score for UDL practices than male teachers. Teachers from private schools were only marginally higher than those in public schools, and urban teachers reported more frequent use of UDL practices compared to rural teachers. The largest differences were associated with training factors, revealing that teachers who had received training in inclusive education and particularly in UDL reported greater levels of UDL implementation in their mathematics classrooms.

The one-way ANOVA findings showed that there were significant differences between the groups of UDL performers in terms of age, level of academic qualifications, and category of teaching experience. Among the three variables, teaching experience was the most significant factor that caused differences among the groups. After a detailed examination of the groups, it was found that teachers with more experience usually referred to greater

engagement in UDL activities compared to teachers with less experience. In other words, it seems that a teacher's professional development and exposure to classrooms could be factors leading to a more effective use of inclusive teaching methods.

Correlation analysis revealed that the three domains of UDL, namely representation, engagement, and action and expression, had strong positive interrelationships with the overall UDL practices score. Besides, each of the three elements was very closely linked to the general UDL construct. This showed that the three dimensions operate collectively as related features of inclusive mathematics teaching. It was confirmation that the efficient UDL practice in mathematics is a concept with many facets and not merely a single activity in the classroom.

Discussion

The discovery that teachers reported a moderate level of exposure to UDL practices implied that inclusive education was starting to change paradigms in the teaching of math. Nevertheless, its enactment was at different levels across the five dimensions of UDL. The highest average mark for engagement reflected that teachers felt their ability to inspire learners, facilitate participation, and build a friendly environment was relatively high. Yet, the lesser mark for representation indicated that teachers probably did not change the style of presenting math concepts. This scenario is quite natural because math is a language consisting of abstract ideas, uses symbols, and has very specific procedures. Without special training and availability of other resources, it is generally a matter of great difficulty to diversify the content. In fact, articles that have been recently published pointed out that children with learning disabilities get a lot of help from opening the vocabulary first, using images, providing hand-on aids, and scaffolding the cognitive process through structured support, all of which are the traits of the representation mode of UDL (Aftab et al., 2024; Shin et al., 2025).

Significant differences in training for inclusive education and universal design for learning (UDL) were among the most important findings of the study. Teachers who had closed the training gap through relevant training showed a stronger UDL implementation than those who had not. This finding is strongly in line with previous research which has shown that when teachers understand how to implement UDL, it leads to better learning outcomes. King-Sears et al. established the effectiveness of UDL-based teaching on students' achievement, but they also acknowledged that in some cases, differences in UDL implementation were leading to inconsistent outcomes. Similarly, Zhang et al. point out that in UDL research, definitional ambiguity and uneven classroom enactment make gathering evidence challenging. This research contributed to that line of thinking by demonstrating that teachers who have received training are more proficient in implementing UDL in their mathematics teaching (King-Sears et al., 2023; Zhang et al., 2024).

It may be that the higher scores of urban teachers and private school teachers over rural and public-school teachers is a result of different levels of institutional support, access to teaching resources, class size, and exposure to professional learning opportunities. Indeed, urban and private schools often have better infrastructure, more access to digital tools, and are more in touch with current pedagogical trends. Given that the implementation of UDL requires based on flexible materials, multimedia resources, and adaptive classroom planning, these local advantages may have led to better implementation. Besides, this line of reasoning fits well with the general body of literature on inclusive mathematics which highlights that technology use, pedagogical diversity, and teacher support are the key elements of successful inclusive mathematics settings (Alahmari et al., 2024; Abdulah et al., 2025).

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The large variation by age, learning level, and teaching experience reveals that UDL applications might be changing, and more mature, academic and professional teachers are getting the most benefit. The theory is that a veteran teacher has accumulated more last year to have a wider range of skills for managing the classroom, more flexibility and a better understanding of student differences. In the same way, teachers with high levels of qualifications might have had more access to the latest teaching methods and inclusive practices. Besides, the post hoc analysis that revealed that experienced teachers scored higher than less experienced ones further support this notion. In fact, these results reflect the association of inclusive education of mathematics is not only a matter of the policy but also the level of pedagogical expertise, the attitude of the teacher and his or her in-depth practice (National Council of Teachers of Mathematics & Council for Exceptional Children, 2024; Amjad & Aslam, 2025).

The highly positive interrelations among engagement, representation, and action and expression indicate that UDL serves as a comprehensive educational framework rather than a set of separate, disconnected methods. Changes in teacher methods concerning students' motivation and participation were frequently accompanied by changes in content delivery and student response methods. This aligns with the theoretical base of UDL, which views the three principles as different sides of a single coin when it comes to accessible and inclusive teaching. The need for such a holistic approach is even greater in the case of mathematics as students with learning disabilities require assistance with concept comprehension, attention retention, and expression of their thoughts simultaneously. Furthermore, recent literature on mathematics specifically points out that genuine access to the subject is contingent upon the preservation of the discipline's challenge coupled with the offering of multiple kinds of entry points and ways of participation (Lambert, 2021; Yeh et al., 2024).

Overall, the results back the idea that UDL is an appropriate and useful framework for inclusive math teaching, although it still needs a more robust systemic support in the solution segment. The study revealed that teachers' practices differed in the extent they implemented UDL and factors training and context significantly influenced them. Such help explains why international literature has agreed with the fact that, while UDL is a promising approach, its success depends on the quality of the implementation, readiness of teachers and the provision of resources for addressing learner variability in real-life classroom situations (CAST, 2024; Zhang et al., 2024).

Conclusion

The authors of the paper consider the Universal Design for Learning (UDL) as a promising and suitable approach to improve math teaching to students with learning difficulties. They have found a moderate level of implementation of UDL by teachers, which means that the presence of inclusive practices in math lessons was detected However there is room for further development. In terms of the three domains, the teachers were more capable of applying strategies for engaging students and for allowing students to show their learning through different means. On the other hand, the aspect of presenting the mathematical content was comparatively less addressed and therefore, is a major area that requires attention.

The research also found that demographic and professional characteristics had a considerable effect on the realization of UDL teaching strategies. Distinctions were made in terms of gender, school type, school location age qualification, and teaching experience. Nevertheless, it was the training-related factors that appeared to be the primary determinants. The teachers trained in inclusive education and UDL implemented their

activities at a higher scale substantially than the ones without such induction, pointing to the essential role of professional development in advocating for inclusive instruction methods.

The study found that teachers with more experience and higher qualifications usually implement UDL strategies more efficiently during their math lessons. The implication is that a teacher's years of teaching and academic background lead to a better grasp of learner diversity and the employment of adaptable teaching methods. Besides, the contrasts noticed between schoolteachers from urban and rural areas as well as between those from public and private schools pointed towards the influence of environmental elements like resource availability and support from the institution.

All in all, the research determined that for UDL to be effectively used in teaching math it is necessary that it be done through a school wide approach, the training of teachers and giving them the relevant teaching materials. Even though teachers have a positive attitude towards the use of inclusive education, their ability needs to be further enhanced especially in using different and easy-to-understand methods in presenting the concepts of math. Hence, equipping teachers with necessary knowledge and skills as well as providing them with a conducive environment for teaching will be very helpful in bringing about successful inclusion of students with learning difficulties in math education.

Recommendations

1. Around-the-clock training programs on Universal Design for Learning (UDL) and inclusive mathematics teaching are a must for teachers to enhance classroom practices.
2. Schools must offer visual aids, digital devices, and differentiated instructional materials to assist a variety of learners in mathematics.
3. Teachers need to be proficient in using multiple methods of presenting mathematical concepts for the sake of students with learning difficulties.
4. Extending the teachers' support with more resources and training especially those working in rural and public schools, can be a very effective way to minimize the implementation gaps
5. Alongside the pre-service and in-service teacher education programs, the UDL principles should be progressively embedded to create a sustainable inclusive teaching force.
6. By researching the effects of UDL on students' math achievement utilizing experimental and longitudinal research methods, further investigations can be carried out.

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