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Universal design learning approach to overcome mathematics learning

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Abstract: The difficulty of learning mathematics can be experienced by anyone from elementary school students to college students. Based on the results of several studies found primary teacher students have difficulty learning mathematics, especially in basic mathematics courses. primary teacher students are prospective teachers so that if the difficulties of learning mathematics are not overcome will affect the quality of education later. Basic mathematics is a mandatory basic competency for students in universities. Research on learning methods to overcome the difficulty of learning mathematics in primary teacher students in basic mathematics courses is still very little. Therefore, this study aims to describe the nature, steps, and weaknesses of universal design learning to overcome the difficulties of learning mathematics in primary teacher students in basic mathematics courses. This research was conducted through a literature study. A literature study is a series of activities related to the method of collecting library data, reading, recording, and processing research materials.

Keywords: Universal design, learning approach, mathematic.

INTRODUCTION

Mathematics learning difficulty literally can be said to be a specific condition faced by students with obstacles in the activity of achieving mathematical learning objectives so that it requires a follow-up to handle it [1] This condition arises because students have difficulty in understanding the content as well as difficulties in mathematical thinking processes that may be caused by previous learning experiences [2] Mathematics learning difficulties are not permanent learning barriers caused by certain mental, intellectual, and disability factors as the main factors, not even infrequently learners with mathematics learning difficulty have cognitive abilities within limits or above normal [3], [4, p. 150] Researchers need to emphasize mathematics learning difficulty in this study is not dyscalculia because (1) the dyscalculia is still being presented whether including learning disability or learning difficulty that is not handicap-related [2], [5], (2) the definition of dyscalculia in DSM-V is a condition of neurodevelopmental disorder(disorder/disability) that causes a person to have difficulty in learning concepts related to numbers or using symbols and functions to perform mathematical calculations [5], [6]

Mathematics learning difficulty can be experienced by anyone from elementary school students to students [2], [7], [8]. Some studies have found that some college students have difficulty learning mathematics, not least Primary teacher students with various factors such as mathematical misconceptions to teaching methods of lecturers [9], [10] The difficulty of learning mathematics in higher education students is certainly contrary to the spirit and framework of "Merdeka Belajar – Kampus Merdeka" echoed by the government. "Merdeka Belajar – Kampus Merdeka" aims to improve the competence of graduates (soft skills and hard skills) so that students are better prepared and relevant to the needs of the times and prepare graduates as future leaders of a superior and personality nation with an emphasis on student-centered learning [11]. To solve the problem of mathematics learning

difficulties Primary teacher students as well as implement the framework "Merdeka Belajar - Kampus Merdeka" required the right learning methods. Learning methods must be inclusive and can accommodate the diversity that students have. Diversity in question is cultural background, cognitive ability, learning interests, learning style, etc.

Universal Design Learning (UDL) is a solid belief in the strengths and abilities of all students and an unwavering commitment to creating classrooms that belong to everyone equally, all the time [12, p. 2]. The National Center on Universal Design for Learning 2011, in [12] defined UDL as a set of principles to follow when developing a curriculum so that the curriculum meets the needs of every student, giving all students equal opportunities to learn. Rapp [12, p. 2] further explained

"UDL provides flexibility in the ways information is presented, how students respond or demonstrate knowledge and skills, and how students are engaged. UDL reduces barriers in instruction and provides appropriate accommodations, supports, and challenges. It also maintains high achievement expectations for all students, including students with disabilities and students with limited English proficiency."

Based on the explanation above, the purpose of this study is to describe the steps of applying the UDL approach to overcome the difficulty of learning mathematics in Primary teacher students in basic mathematics courses within the framework of "Merdeka Belajar – Kampus Merdeka"

METHOD

The method in this research is the literature studies research method. Literature studies can be interpreted as a series of activities related to the method of collecting library data, reading, and recording, and processing research materials [13, p. 3]. There are four main characteristics to consider in literature study research [13]:

1. Researchers do not come face to face with knowledge from the field. Researchers are only dealing directly with text or numerical data.
2. Data obtained is "ready-made" meaning that researchers do not directly experience the field because the researchers are dealing directly with the data source in the library.
3. Data library is a secondary source, in the sense that researchers obtain material or data from the second hand and not the original data from the first data in the field.
4. The condition of library data is not limited by interest and time.

Based on the above, data collection in research is conducted by examining and/or exploring several journals, books, and documents (both printed and electronic) and other data sources and/or information that is considered relevant to research or study

RESULT AND DISCUSSION

Universal Design for Learning (UDL)

UDL is a framework for designing instruction in a manner that makes the curriculum more accessible to diverse learners, including students with disabilities [14]. UDL is a framework for instructional design that identifies barriers in the learning environment and curriculum that prevent meaningful access and increase opportunities for learning by providing multiple options to reach and measure goals [15]. Unlike another curriculum in general such as curriculum modification or curriculum adaptation, UDL is the most effective curriculum design in the application in the field with a focus on learning objectives, learning methods, materials used as well as assessment [14].

The UDL framework is based on evidence of neuroscience research in which each learner differs in the way they are motivated (affective network), how they comprehend information (recognition network), and how they express what they know (strategic network). The UDL framework consists of nine guidelines and 31 checkpoints that can be applied flexibly to provide three key UDL principles (multiple means of representation, multiple means of action and expression, dan multiple means of engagement) to minimize barriers and maximize learning [14], [15].

On the recognition networks aspect, the UDL principle of providing multiple means of representation focuses on representation and the importance of providing a wide range of flexible presentation methods while teaching. This UDL principle emphasizes that there is no single teaching methodology to represent information capable of satisfying the needs of every student. Guideline and checkpoints on this principle: (1) provide options for perception [(a.1) offer ways of customizing the display of information, (a.2) offer alternatives for auditory information, (a.3) offer alternatives for visual information], (2) provide options for language & symbols [(b.1) clarify vocabulary and symbols, (b.2)

clarify syntax and structure, (b.3) support decoding of text, mathematical notation, and symbols, (b.4) promote understanding across languages, (b.5) illustrate through multiple media], (3) provide options for comprehension [(c.1) active or supply background knowledge, (c.2) highlight patterns, critical features, big ideas, and relationships, (c.3) guide information processing and visualization, (c.4) maximize transfer and generalization] [16]–[18]

On the strategic networks aspect, the UDL principle of providing multiple means of action &expression focuses on the fact that the learner will look for the learning strategy method that best suits him. Therefore, teaching methods need to be varied. This kind of flexibility is key for teachers to help meet diverse student needs. Guideline and checkpoints on this principle: (1) provide options for physical action [(a.1) vary the methods for response and navigation, (a.2) optimize access to tools and assistive technologies], (2) provide options for expression & communication [(b.1) use multiple media for communication, (b.2) use multiple tools for construction and composition, (b.3) build fluencies with graduated levels of support for practice and performance], (3) provide options for executive functions [(c.1) guide appropriate goal-setting, (c.2) support planning and strategy development, (c.3) facilitate managing information and resources, (c.4) enhance capacity for monitoring progress] [16]–[18]

On the affective networks aspect, the UDL principle provides multiple means of engagement focusing on another important point of convergence: recognition of the importance of engaging learners in instructional tasks. UDL therefore strongly encourages educators to motivate and maintain student engagement through flexible instruction, a purpose that different instructions support very effectively. Guideline and checkpoints on this principle: (1) provide options for recruiting interest [(a.1) optimize individual choice and autonomy, (a.2) optimize relevance, value, and authenticity, (a.3) minimize threats and distractions], (2) provide options for sustaining effort & persistence [(b.1) heighten the salience of goals and objectives, (b.2) vary demands and resources to optimize challenge, (b.3) foster collaboration and community, and (b.4) increase mastery-oriented feedback], (3) provide options for self-regulation [(c.1) promote expectations and beliefs that optimize motivation, (c.2) facilitate personal coping skills and strategies, and (c.3) develop self-assessment and reflection] [16]–[18].

Mathematic Learnings Difficulty

Mathematics learnings difficulty can be interpreted as a condition of an individual experiencing failure to obtain adequate skills in basic mathematical abilities or have academic achievements far below expectations but the main cause is not due to intellectual disability or other internal factors [19]–[22]. Jamaris, M [23, p. 129] adds the difficulty of learning mathematics as "difficulty in thinking and processing mathematically (deductive, rational, and logical thinking) resulting from external factors characterized by low learning outcomes or well below the individual's potential". Students who have difficulty learning mathematics will have (1) difficulty in learning and remembering mathematical facts, (2) difficulty in remembering the principles and rules of numeracy, (3) as well as difficulty in arranging and handling spatial numerical information [4, p. 149]. Marlina [4, p. 150] emphasizes that "the factors that cause a student to have difficulty learning mathematics are external factors such as not getting adequate teaching in his first years, lack of support from family, or not being able to access the curriculum".

The Framework of "Merdeka Belajar – Kampus Merdeka"

The framework of *"Merdeka Belajar – Kampus Merdeka"* is one of the policies of the Minister of Education and Culture of Indonesia, Nadiem Makariem. This framework is issued to prepare students to face social, cultural, a world of work, and rapid technological advances, then the competence of students must be prepared to be able to follow the needs of the times. Link and match not only with the industrial world and the world of work but also with a rapidly changing future. Universities are required to be able to design and implement innovative learning processes so that students can achieve learning achievements covering aspects of attitudes, knowledge, and skills optimally and always relevant. The policy of "*Merdeka Belajar – Kampus Merdeka*" is expected to be the answer to these demands. "*Kampus Merdeka*" is a form of learning in universities that are autonomous and flexible to create an innovative learning culture, not curb, and by the needs of students.

The legal basis of this framework are (1) *Undang-Undang Nomor 20 Tahun 2003, tentang Sistem Pendidikan Nasional*; (2) *Undang-Undang Nomor 12 Tahun 2012, tentang Pendidikan Tinggi*; (3) *Peraturan Pemerintah Nomor 04 Tahun 2014, tentang Penyelenggaraan Pendidikan Tinggi dan Pengelolaan Perguruan Tinggi*; (5) *Peraturan Presiden nomor 8 tahun 2012, tentang KKNI*; (6) *Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 3 Tahun 2020, tentang Standar Nasional Pendidikan Tinggi*

The policy objective of "*Merdeka Belajar - Kampus Merdeka*" is to improve the competence of graduates, both soft skills and hard skills, to be better prepared and relevant to the needs of the times, preparing graduates as future leaders of a superior and personal nation. Experiential learning programs with flexible pathways are expected to facilitate students to develop their potential by their passions and talents [11, p. 3].

Discussion

As explained earlier about the policy "Merdeka Belajar – Kampus Merdeka", the spirit of the policy should be able to be implemented in the classes in universities. Education in college must be "independent" of the mindset and teaching methods that do not pay attention to the diversity of students both in their potentials, weaknesses, and learning needs. Students must be able to express and be entitled to educational services that support their needs and potential. Unfortunately, some studies still find students who have difficulty studying in college, including difficulty learning mathematics [24]–[28]. Studies and research on the mathematics learning difficulty in students are still very limited. The mathematics learning difficulties in students cannot be underestimated, especially for primary teacher students who will later become teachers. In general, the teaching techniques of lecturers in mathematics classes are one-way where the lecturer explains the material, students listen, and then continue by working on the prepared questions. This is certainly contrary to the spirit of the policy "Merdeka Belajar – Kampus Merdeka".

Referring to the framework "Merdeka Belajar – Kampus Merdeka" the UDL approach to overcome the difficulty of learning mathematics in primary teacher students in basic mathematics courses can be implemented. UDL's approach is very appropriate to implement because in principle UDL strives to minimize barriers and maximize the student learning experience in the classroom. UDL's working principle is very concerned about the "Why", the "What", and the "How" aspects of learning. UDL also pays attention and tries to meet the various needs, potentials, and weaknesses that students have. This is certainly in line considering the difficulty of learning mathematics that students have can be due to various factors such as unpleasant learning experiences in high school, interests in learning, misconceptions, different learning styles with lecturer teaching styles, cultural backgrounds, and so on [24], [29], [30]. UDL approach is considered able to accommodate all of this so that it is expected that the obstacles that students have in learning mathematics courses can be minimized and maximize their learning experience [14], [15], [31].

UDL framework can be applied in both curriculum and daily teaching. The application of UDL principles in a mathematical context such as basic mathematic courses can be seen in the table below.

Tabel 1. The Application of UDL Principles

Providing Multiple Means of Representation	
Options for Perception (Mathematics content may be presented in different ways to allow students to access and comprehend the same information through different modes of perception)	For students with difficulties in math: • Presentation of the information using multiple perceptual modalities such as graphic, verbal, and tactile [12], [18] • Coding information verbally and nonverbally results in richer mental representations that strengthen learning [14] • For example, content can be presented using graphic organizer, concrete or virtual, manipulatives and video, screencasts or pen-casts [12]
Options for language and symbols (Mathematical information is often presented through language and symbols. Providing a variety of representations and additional supports may be necessary)	For students who struggle in math: • Use a traditional or technology-enhanced dictionary such as a word wall, cue cards, charts of mathematical expressions and symbols, peer-mediated learning, and text-to-speech for mathematical language and notation [14]

Provide Multiple Means of Action and Expression	
Options for comprehension (Comprehension in mathematics involved tasks, provide with options for developing comprehension to make learners more actively assimilate new information into prior knowledge)	For students who have difficulties in math: • Use a pre-teaching vocabulary and critical prerequisite concepts including the use of demonstration or models in pre-teaching of vocabulary and concepts, highlighting or color-coding key elements in word problems or equations, etc. [14] • Giving explicit prompts for each step in a sequential problem-solving process [15] • Use of strategies such as concrete-representational-abstract [32]
Options for physical action (Often, in mathematics, students demonstrate what they know via written text. However, there are other ways students can demonstrate what they know)	Alternative ways to navigate mathematic materials and express what they have learned. • Using assistive technology that provides such adaptations as speech, switch activation, alternative keyboards, text-to-speech, specialized writing, and seating equipment and video magnifiers [14]
Options for expressive skills and fluency (Use expressions include increasing opportunities to respond and interact)	For students who struggle in mathematics [14] • Use a technology-based practice. • Peer-mediated learning. • Scaffolds that can be faded as learners make progress support independence. • Foster development and practice in critical thinking skills
Options for executive functions (Executive function is the cognitive capacity to plan, organize, monitor, and evaluate progress toward goals [14])	For students who struggle in mathematics use such as [14] • Checklist and graphic organizers • Strategy instruction • Digital text for students with print disabilities • Calculator to manage computation and opportunities for self-reflection and evaluation.
Options for recruiting interest. (Recruiting interest focuses student attention on the task at hand and is crucial for engaging students' cognition)	For students who have difficulties in mathematics: • choices in how learning objectives can be reached can help them develop autonomy [14] • Learners attend more when a material is personally relevant [12], [33] • In math, real-world problems such as anchored math, situating students on opposing sides of math disagreements, and including culturally relevant instructional material [14], [31] • An accepting and supportive classroom facilitates engagement [17]

Provide Multiple Means of Action and Expression	
Options for sustaining their effort and persistence. (Sustained effort and persistence in mathematics are required to develop expertise)	For students with challenges in math: [14], [17], [31] • Reiterating the goal • Breaking the long-term objective into shorter • More approachable tasks • Teaching students how to establish and monitor progress toward reachable deadlines. • Giving feedback that is timely and specific
Options for supporting self-regulation. (Options for self-regulation help learners effectively manage their engagement, affect, and goal attainment)	For students who struggle in mathematics • Activities that encourage self-reflection include the identification of personal goals, the use of a checklist, diaries, and online options for self-management [14], [16]

CONCLUSION

The steps that can be applied with UDL's approach to overcoming the difficulty of learning mathematics in Primary teacher students in basic mathematics courses within the framework of "Merdeka Belajar – Kampus Merdeka" is to know the potentials, weaknesses, and learning needs of students. By knowing these three things, teachers can create: 1) a learning plan with a two-way learning strategy for teachers and students actively involved; 2) using learning media that can help learners understand the concept of the topic being discussed; 3) make assessment measuring instruments relevant to the daily lives of learners.

REFERENCES

H. Hafid, K. Kartono, S. Suhito, and K. Suhito, "Remedial Teaching Untuk Mengatasi Kesulitan Belajar Siswa Pada Kemampuan Pemecahan Masalah Matematika Berdasarkan Prosedur Newman," *Unnes J. Math. Educ.*, vol. 5, no. 3, pp. 257–265, 2016, doi: 10.15294/ujme.v5i3.12310.

J. Lithner, "University Mathematics Students' Learning Difficulties," *Educ. Inq.*, vol. 2, no. 2, pp. 289–303, Jun. 2011, doi: 10.3402/edui.v2i2.21981.

P. Scherer, K. Beswick, L. DeBlois, L. Healy, and E. M. Opitz, "Assistance of Students with Mathematical Learning Difficulties — How Can Research Support Practice ? — A Summary," in *Proceeding of the 13th International Congress on Mathematical Education*, 2017, pp. 249–259, doi: 10.1007/978-3-319-62597-3.

Marlina, *Asesmen Kesulitan Belajar*. Jakarta: Prenada Media Group, 2019.

N. Soares, T. Evans, and D. R. Patel, "Specific learning disability in mathematics : a comprehensive review," *Transl. Pediatr.*, vol. 7, no. 1, pp. 48–62, Jan. 2018, doi: 10.21037/tp.2017.08.03.

D. Penesetti, "What Is Specific Learning Disorder?," *American Psychiatric Association*, 2018. https://www.psychiatry.org/patients-families/specific-learning-disorder/what-is-specific-learning-disorder (accessed Nov. 13, 2020).

S. T. Kane, S. Roy, and S. Medina, "Identifying College Students At-Risk for Learning Disabilities: Evidence for Use of the Learning Difficulties Assessment in Postsecondary Settings," *J. Postsecond. Educ. Disabil.*, vol. 26, no. 1, pp. 21–33, 2013.

S. Klymchuk, T. Zverkova, N. Gruenwald, and G. Sauerbier, "University Students' Difficulties in Solving Application Problems in Calculus," *Math. Educ. Res. J.*, vol. 22, no. 1, pp. 81–91, 2010, doi: 10.1007/BF03217567.

J. P. Purwaningrum and H. S. Bintoro, "Miskonsepsi matematika materi bilangan pada mahasiswa calon guru sekolah dasar," in *Prosiding Seminar Nasional MIPA 2018*, 2018, no. November, pp. 173–180.

A. N. K. Rosyidah, M. A. Maulyda, and I. Oktaviyanti, "Miskonsepsi Matematika Mahasiswa PGSD Pada Penyelesaian Operasi Hitung Bilangan Bulat," *J. Ilm. Kontekst.*, vol. 2, no. 01, pp. 15–21, 2020, doi: 10.46772/kontekstual.v2i01.244.

Direktorat Jenderal Pendidikan Tinggi, *Buku Panduan Merdeka Belajar - Kampus Merdeka*, Satu. Jakarta: Direktorat Jenderal Pendidikan Tinggi Kemdikbud RI, 2020.

W. H. Rapp, *Universal Design for Learning in Action: 100 Ways to Teach All Learner*. New York: Paul H Brookes Publishing Co., 2014.

M. Zed, *Metode Penelitian Kepustakaan*, Ketiga. Jakarta: Yayasan Pustaka Obor Indonesia, 2014.

C. N. Thomas, D. Van Garderen, A. Scheuermann, and E. J. Lee, "Applying a Universal Design for Learning Framework to Mediate the Language Demands of Mathematics," *Read. Writ. Q.*, vol. 31, no. 3, pp. 207–234, 2015, doi: 10.1080/10573569.2015.1030988.

J. R. Root, S. K. Cox, A. Saunders, and D. Gilley, "Applying the Universal Design for Learning Framework to Mathematics Instruction for Learners With Extensive Support Needs," *Remedial Spec. Educ.*, vol. 41, no. 4, pp. 194–206, 2020, doi: 10.1177/0741932519887235.

T. Hall, N. Strangman, A. Meyer, and G. Vue, "Differentiated instruction and implications for UDL implementation. Effective Classroom Practices Report.," *Natl. Cent. Access. Gen. Curric.*, no. 2004, 2014.

E. M. Dalton, M. Lyner-Cleophas, B. T. Ferguson, and J. McKenzie, "Inclusion, universal design and universal design for learning in higher education: South Africa and the United States," *African J. Disabil.*, vol. 8, pp. 1–7, 2019, doi: 10.4102/ajod.v8i0.519.

CAST, "Universal Design for Learning Guideline version 2.2," 2018. https://udlguidelines.cast.org/?utm_source=castsite&lutm_medium=web&utm_campaign=none&utm_content=aboutudl.

E. M. Yeni, "Kesulitan Belajar Matematika Di Sekolah Dasar," *JUPENDAS*, vol. 2, no. 2, pp. 1–10, 2015.

E. Rosita, "Diagnosis kesulitan belajar," *Univ. Negeri Yogyakarta*, vol. I, no. 09403241034, pp. 19–26, 2010.

P. Westwood, *What teachers need to know about: Learning difficulties*. Victoria: ACER Press, 2008.

P. Westwood, *Commonsense Methods for Children with Special Needs*, Sixth. New York: Routledge, 2015.

M. Jamaris, *Anak Berkebutuhan Khusus*. Jakarta: Penerbit Ghalia Indonesia, 2018.

A. Kumalasari and Sugiman, "Analisis Kesulitan Belajar Mahasiswa Pada Mata Kuliah Kapita Selekta Matematika Sekolah Menengah," *J. Ris. Pendidik. Mat.*, vol. 2, no. 1, pp. 16–27, 2015, [Online]. Available: http://journal.uny.ac.id/index.php/jrpm/index.

D. Nugraheni, "Analisis Kesulitan Belajar Mahasiswa pada Mata Kuliah Mekanika," *J. Pendidik. Sains Mat.*, vol. 5, no. 1, 2017.

R. Novita, R. C. I. Prahmana, N. Fajri, and M. Putra, "Penyebab kesulitan belajar geometri dimensi tiga," *J. Ris. Pendidik. Mat.*, vol. 5, no. 1, p. 18, May 2018, doi: 10.21831/jrpm.v5i1.16836.

Analisa Fitria, "Miskonsepsi Mahasiswa Dalam Menentukan Grup pada Struktur Aljabar Menggunakan Certainty of Response Index (CRI) di Jurusan Pendidikan Matematika IAIN Antasari," *J. Pendidik. Mat.*, vol. 01, no. 2, pp. 45–60, 2014.

J. Afriadi, "Identifikasi Kesalahan dan Miskonsepsi Mahasiswa Calon Guru Matematika Pada Topik SPLDV," *Math Educ. J.*, vol. 2, no. 2, pp. 231–243, 2018.

R. S. Setianingrum, S. Syamsuri, and Y. Setiani, "Analyzing students' learning difficulties in algebra," *J. Mat. dan Pembelajaran*, vol. 8, no. 1, pp. 19–34, Jun. 2020, doi: https://doi.org/10.24252/mapan.2020v8n1a2.

M. Peters, "Using cognitive load theory to interpret student difficulties with a problem-based learning approach to engineering education : a case study," *Teach. Math. its Appl.*, vol. 34, no. 1, pp. 1–10, Feb. 2015, doi: 10.1093/teamat/hru031.

J. Schreffler, E. Vasquez, J. Chini, and W. James, "Universal Design for Learning in postsecondary STEM education for students with disabilities: a systematic literature review," *Int. J. STEM Educ.*, vol. 6, no. 1, 2019, doi: 10.1186/s40594-019-0161-8.

M. E. King-Sears and T. M. Johnson, "Universal Design for Learning Chemistry Instruction for Students With and Without Learning Disabilities," *Remedial Spec. Educ.*, vol. 41, no. 4, pp. 207–218, 2020, doi: 10.1177/0741932519862608.

N. Stylianidou, A. Sofianidis, E. Manoli, and M. Meletiou-Mavrotheris, "'Helping Nemo!'—Using Augmented Reality and Alternate Reality Games in the Context of Universal Design for Learning," *Educ. Sci.*, vol. 10, no. 4, 2020, doi: 10.3390/educsci10040095.