HNUE JOURNAL OF SCIENCE
Natural Sciences 2025, Volume 70, Issue 3, pp. 83-94
This paper is available online at http://hnuejs.edu.vn/ns
DOI: 10.18173/2354-1059.2025-0039

# EZMATH: DEVELOPING DIGITAL METHODS, A WEBSITE-BASED APPROACH TO SUPPORT TEACHING MATH WITH FIRST-GRADE VIETNAMESE CHILDREN WITH DYSCALCULIA

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Received May 29, 2025. Revised September 8, 2025. Accepted September 30, 2025.

**Abstract.** Dyscalculia is a term used to describe specific learning disabilities related to understanding numbers that affect the ability of children of all ages to understand, learn, and perform mathematics and number-based calculations. Estimates of the prevalence of dyscalculia range from 3% to 6% of the population, indicating the need for timely support solutions for teaching mathematics to students with mathematical difficulties. Therefore, the general objective of this study is to develop a digital tool in the form of an interactive learning website that provides many features and flexibility for children with dyscalculia. The solution was surveyed with 73 people working in and researching education for children with dyscalculia. The results show that the proposed solution is initially assessed to be appropriate and to offer an opportunity for developing a potential learning method to support children with dyscalculia.

***Keywords***: dyscalculia, learning disabilities, support, inclusive education.

## 1. Introduction

During acquisition and development, fundamental mathematical skills are considered a prerequisite for growth and a foundation for further development of high-level cognitive thinking. Notwithstanding, acquiring basic mathematical knowledge can be challenging for children with dyscalculia. According to the Individuals with Disabilities Education Act (IDEA), dyscalculia is a specific disorder in one or more areas of the psychological process related to understanding and using spoken or written language, leading to impaired ability to listen, think, speak, read, write, spell, or do math [1]. In particular, children who are first approaching math have difficulties such as reading and writing numbers, understanding basic arithmetic concepts, and using their fingers to solve simple calculations [2].

According to Professor Brian Butterworth, estimates of the prevalence of dyscalculia range from 3% to 6% of the population [3], [4]. In Vietnam, according to the 2016 survey results of the School Education Quality Assurance Program (SEQAP), conducted in 30 primary schools in Kien Giang and Lao Cai, the rate of dyscalculia is about 10% [5]. Nonetheless, this only stops at building electronic lectures and does not meet the needs of the supported subjects. Therefore, teachers need to apply information technology (IT) more effectively, encouraging and helping students to receive knowledge more actively. According to a survey at inclusive schools, 47% of children with disabilities can access computers during their IT studies or at home. This is a favourable condition if information technology is applied in teaching children with dyscalculia [6]. Nonetheless, teachers rarely use IT because of the lack of teaching software and the limited ability of several teachers to use IT.

Technology is increasingly developing, and at the same time, its application is becoming more and more suitable to the wishes of the majority of users, providing an opportunity for education in general and education for children with special needs in particular [7]-[8]. Technology has provided products and applications that create many benefits for the learning process, such as attracting the attention of learners [9], [10], building motivation and enjoyment [11], [12], or being a tool to create a collaborative environment between students and students and students and teachers [8], [13]. By combining information technology, the study proposed "Developing digital tools to support teaching math in grade 1 for students with learning disabilities" to create a flexible and effective learning environment. In terms of knowledge content, on the one hand, the solution closely follows the content of the 2018 general education program [14], digitizing three sets of books: Knowledge Connection [15], Kite [16], and Creative Horizon [17], with each knowledge topic content linked to three sets of books compiled by the Ministry of Education and Training. This helps create a system of reference exercises from the three sets of books that allow teachers to choose and use.

On the other hand, the solution provides a digital method for automatically generating exercises compiled from three sets of books from the 2018 general education program, allowing teachers to create their own exercise systems in various forms of expression. This makes student support activities more diverse and flexible. The richness of visual expression helps students increase their opportunities to receive information while attracting more attention to the tasks at hand. Additionally, the solution enables a dynamic response to various user inputs by adjusting behaviour based on student feedback.

# 2. Content

## 2.1. Related work

In the context of the information technology and artificial intelligence revolution, integrating technology into education is an inevitable trend to optimize the learning process. However, for students with mathematical difficulties, with diverse levels and forms of difficulty and slower learning ability than typically developing children, the content of the general education curriculum often does not meet their needs. Although there have been many studies in this field, information technology and assistive technology still have many research gaps that must be addressed.

Previous studies have proposed several technological solutions. Wilson et al. (2006) developed the "Number Race" game software for children aged 4 to 8 to help overcome dyscalculia [18]. This application allows children to connect spatial images with numbers, creating an engaging learning environment through interactive activities. However, "Number Race" only supports basic levels and does not meet more complex learning needs. Another tool is MentalUp, a personalized educational game application that supports cognitive development and thinking skills, while measuring indicators such as scores, levels, accuracy rates, and response times [19]. However, this application does not fully meet the urgent needs of students with dyscalculia and may confuse entertainment and learning goals for some children.

In Vietnam, the education sector is also witnessing a strong integration of information and communication technology (ICT). The "Math Flash Cards" software uses images, sounds, and games to help children practice basic calculations and track their learning progress [20]. However, the limitation of this software is that it only focuses on memorizing knowledge without paying attention to developing logical thinking and problem-solving skills, which are essential for children with learning difficulties. In addition, although popular learning systems such as OLM [21] and Violet [22] have developed strongly in supporting general students, they do not have a specialized system for students with learning difficulties. These systems often build lectures and exercise systems according to a predetermined structure, suitable for the receptive ability of typically developing students, so they are incompatible with the individual development needs of children with specific difficulties.

Despite positive steps and increasing interest in applying technology to create suitable learning environments, current solutions are still limited. Many methods only stop at attracting attention through games or improving independent skills instead of providing a comprehensive intervention strategy. For technology to truly deliver optimal benefits, specific proposals are needed to meet the diverse learning needs of students, especially those with learning difficulties.

## 2.2. Proposed method

Our proposed method supports learning for children with difficulties in mathematics, explicitly supporting three groups of users: teachers, students, and parents. Teachers are the users who play an essential role in guiding students to approach the proposed interactive system. Teachers help adjust task requirements, support levels, and appropriate rewards for each student, helping students acquire knowledge and gradually solve problems. The second user group is the primary beneficiary of the proposed method: students with difficulties in mathematics. They are the ones who manipulate the system to meet the teacher's task requirements. During this process, they can choose the appropriate response form and level of support to complete the task. Finally, the parent audience, who can monitor the entire learning process, interacts with the system to obtain information about their child's progress throughout the learning process, including their difficulties, progress, and abilities.

The core of the proposed method is illustrated through the task cycle. The task includes the requirements that the teacher assigns to the students, allowing them to practice, supplement, and improve their mathematical skills through the process of completing this task. Throughout the process, the proposed method builds the necessary support methods to help students overcome individual difficulties and limitations, enabling them to complete the task. All information about the learners' operations, including the support options used, the operation time, the number of times performed, and the choice of implementation method, is tracked to provide information about the remaining difficulties or the problems improved by the students to help the teacher adjust the following task requirements to be more suitable for the learners.

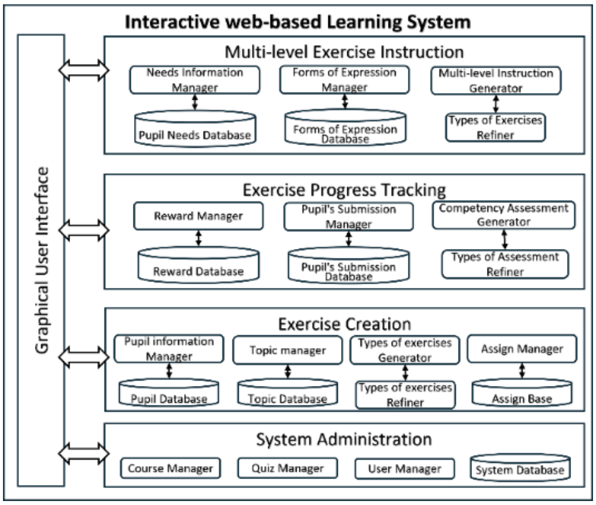



***Figure 1. The architecture of the proposed system***

For these reasons, our proposed approach develops an interactive system (Ez-math) whose architecture includes the main components described in Figure 1. These are Graphical User Interface, System Administration, Exercise Creation, Step-by-Step Support, and Progress Tracking.

### 2.2.1. Multi-level-exercise instrucstion

Children with math difficulties often have problems with vision, attention, memory, language comprehension, or generalization. This makes it more difficult to see documents and to read than usual. Even when observing, children will need help focusing on the necessary content, hindering the absorption and memorization of knowledge. Accordingly, the proposed method designs a multi-sensory support form that incorporates both vision and hearing to create a flexible, interactive environment suitable for various subject types. Additionally, the method provides multiple levels of support in each exercise type to help students gradually solve problems and complete the task.

First, this module supports expression in many different forms by visualizing all possible content to help learners receive information in the easiest way. In addition to the visual representation, the operations are also presented in voice form so that the meaning of the command buttons can be read to the listener in pure Vietnamese.

Second, this module provides students with a variety of ways to answer (Figure 3). Depending on the learner's wishes, an answer can be received by typing text, adjusting the increase and decrease buttons to display the number of choices, dragging and dropping suggested answers, or even the reader answering by speaking through the audio recording function from the device the learner is using. This both provides flexibility and ensures that the data collected is useful for monitoring progress and adjusting the learning path.

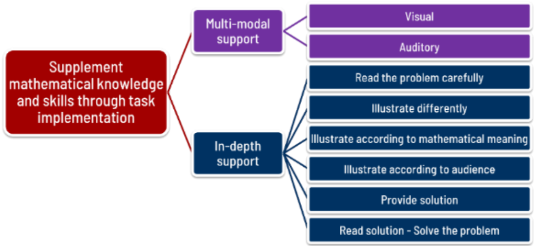



***Figure 2. Implement task***

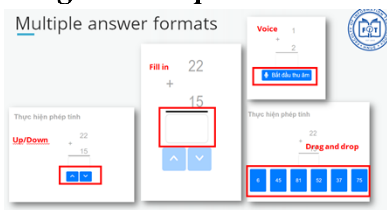



***Figure 3. Multiple answer formats***

Third, during the exercise, the module provides students with levels of support, from fewer to more suggestions, to help students solve the requirements of the exercise as well as overcome difficulties (Figure 2). These levels of support start from the most superficial level, which is reading the exercise correctly to provide information to students in the best way. The following levels of support are visual representations ranging from static to dynamic methods that help illustrate requirements or procedures to help students gradually carry out the requirements given by the problem. It can be in the form of a number line or a number table that visually describes and helps students understand the principle of change in mathematics, or in illustrations through simple, familiar objects on which students can count directly. *Building levels of support helps learners improve step by step in solving problems to create a comfortable mentality, increase motivation, and prolong the persistence of the learning process. However, this does not cause a false assessment of the learner's performance because each corresponding support will be assessed according to the actual ability the learner has applied in performing the task.* Illustrations of the support levels for each type of problem are described at the link: https://math1.learning2ne1.com/.

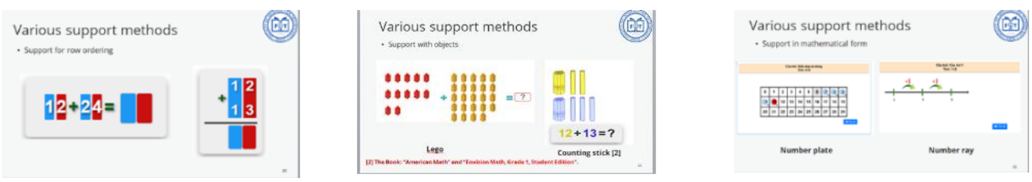



***Figure 4. Some type of support methods***

This support is generally designed according to the principles presented in the study "Working memory and language: Skill-specific or domain-general relations to mathematics?". The first level is solving problems without physical support, meaning that students can complete the task without any external assistance. The second level involves making connections between objects and words, which enhances memorisation by linking visual representations with reading aloud and their meanings. At the third level, support is more advanced when converting the meaning of quantities into the number of objects, which can be animals or illustrative objects. This is the support level: “Comparing small objects and counting series of numbers”.

Finally, this module supports students according to their interests. Instead of the objects displayed in the problem being any objects, the module allows teachers to choose to display objects that each student likes and select the type of expected reward according to their wishes. This helps to create motivation and prolong the interest of learners in using the tool as a means of training to improve perseverance and reduce the inherent stress of these students in the learning process.

### 2.2.2. Exercise progress tracking

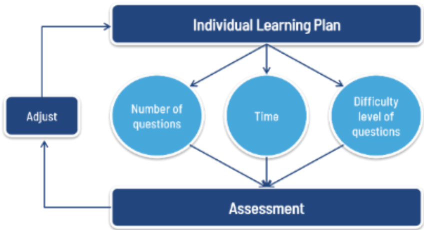



*Figure 5. Task Assessment*

To support each step of the implementation of the student's request and to have information about the ability and difficulties that students encounter while solving the problem, this module is built to track the entire process in which students perform operations with each required exercise. Tracking practice progress is the basis for individualizing learning based on the cognitive level and existing difficulties of each student with mathematics. This process is illustrated in Figure 5.

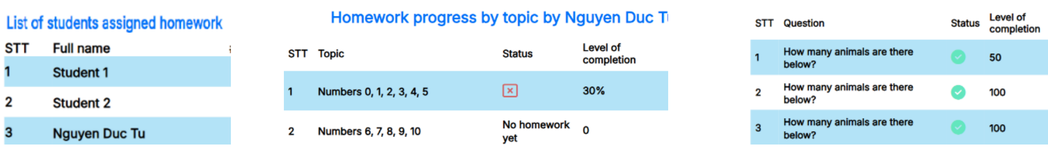



*Figure 6. Track pupil progress*

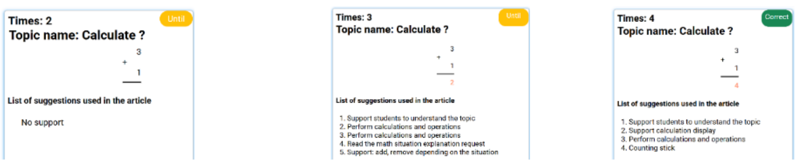



*Figure 7. Illustration of student progress*

Each exercise is considered completed when the student gives an answer that meets the requirements of the exercise, regardless of whether support is used or not, what level of support is used, and the order in which the student uses the support levels. The module tracks the entire process of students interacting with the assigned exercise. This function is set up for all three subjects: teachers, parents, and students; however, the display of this information differs for the user groups. Instead of just showing whether it is completed or not in the role of students, in the role of teachers and parents, this result shows details about quantitative information on the level of completion and performance of students. This is information about how often the student has answered and the support used each time, as shown in Figures 6 and 7. In addition to showing that the student has completed the exercise, this module evaluates the student's level of completion through many criteria: the number of times the student has answered, the number of help sessions used, and the time to complete. It is expressed in percentage form, showing the student's ability and capacity to solve the problem. This information forms the basis for classifying the student's problem-solving ability and is also an indicator of the issues that still need to be overcome in the student. This is essential information to help teachers adjust teaching strategies for students, as well as the necessary support from the family.

### 2.2.3. Exercise creation

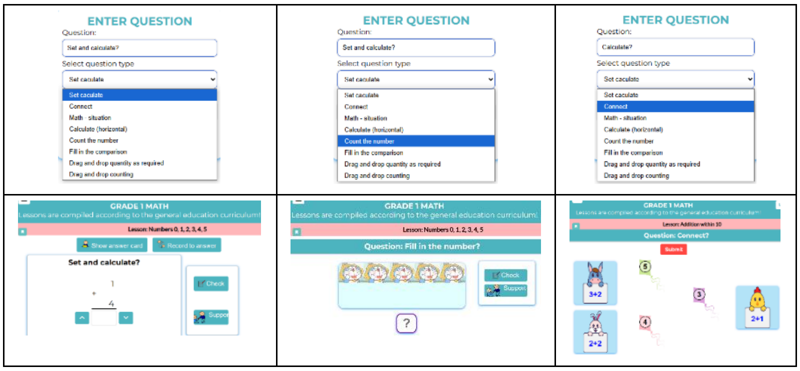


***Figure 8. Some types of exercises***

Differences in learners' difficulties and learning abilities lead to the need to carry out personalization for each student. Our proposed method allows teachers to design exercises suitable for students' abilities and attract attention based on rich illustrations in the form of expression. The exercise design module is used to create different exercise systems for each group of students to suit their abilities and desires. This module includes the following components: Student Information Manager to manage basic information and learning history of students; Difficulty or Disability Manager to manage disability categories and information about different difficulty levels of students; Exercise Generator to create exercises according to the system of topics based on the history and difficulties encountered by students and to help teachers choose the main keywords that students need to remember in each lesson topic; Exercise Generator to create basic exercises automatically, suitable for students' receptive ability; and finally Exercise Refinement to refine integrated exercises. This module also requires information about the reference rules of lesson topics, the types of exercises by topic, and the difficulty level of exercises according to history and students' difficulties. The module also allows teachers to change the graphical representations according to students' preferences. Teachers can select these graphic representations from the library provided by the system or an image uploaded by the teacher themself to the system. These are objects illustrated in the assignment requirements or rewards students receive when learning actively. This makes the illustrations interesting, increasing students' attention when observing and enhancing students' motivation to learn, and improving students' retention in the learning process.

## 2.3. Experiment

### 2.3.1. Experimental objectives

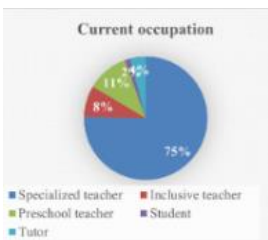
The experiment was conducted to achieve two primary objectives. Firstly, to evaluate the feasibility of the proposed method based on a survey of the main subjects using the proposed method to support children with difficulty learning mathematics, which includes teachers and experts in teaching mathematics who understand the difficulties that this group of children often encounter. Their quality contributions help the study evaluate the ability to support this group of children and thereby adjust it more appropriately for the main beneficiaries of the proposed method. Secondly, to evaluate the effectiveness of the proposed learning method in improving the mathematical skills of first-grade students through guided practice.

### 2.3.2. Experimental procedure

To perform the two-objective evaluation of the proposed method, the necessary work is deployed, including the following steps. First, to develop a support solution suitable for children with difficulty learning mathematics, the study analysed the needs and desires of the primary target audience of the proposed method, which were teachers supporting children with learning difficulties in mathematics. The website was then designed and developed based on the proposed solution. The first test was conducted on teachers who had experience teaching children with difficulty learning mathematics. Through the actual use of the product developed by the proposed method, a qualitative survey was conducted again with the participating teachers to evaluate the ability to provide practical support for children with difficulty learning mathematics. This allowed the study to adjust and improve the website to better meet the wishes and actual requirements. The improved version of the website was then put into practical use to support children with difficulty with calculations. From there, the effectiveness of the proposed method was evaluated through a quantitative test assessing the improvement in the mathematical skills of participants, as well as a qualitative survey from the interventionist's perspective on the improvement of children during the process of interacting with the proposed method's system.

### 2.3.3. Survey to evaluate the feasibility of the proposed method

* ***Participants:*** Participants include 73 teachers, researchers, trainees, and students in special education, math pedagogy, disabilities, etc., at schools across the country.



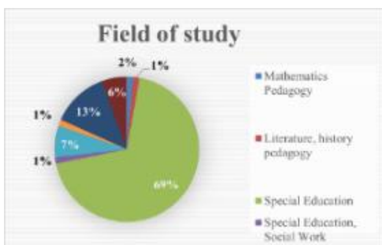




***Figure 9. Statistics on the field and years of work of the participants***

* ***Results:*** Based on user feedback, an evaluation of the system was conducted, focusing on the user interface and support capabilities for children with learning disabilities in Math. The user interface was assessed on its ability to provide information and facilitate interaction, with criteria including ease of use, clarity, visual appeal, and suitability for the target demographic. In this category, the system received high ratings,

with scores for visual criteria ranging from 4.1 to 4.9 on a 5-point scale. The system's support capabilities were evaluated based on its capacity to offer diverse and engaging learning aids, such as appropriately representing student characteristics, capturing attention, aligning with children's interests, and encouraging active exploration. User satisfaction with the system-generated support features was notably high, with scores between 4.6 and 4.8. Overall, the system's suitability for children with learning disabilities achieved an average score of 4.42. This result places the system within the 'Suitable' to 'Very suitable' range (defined as scores from 4.1 to 5.0) and affirms its pedagogical significance for the target user group.

### 2.3.4. Evaluation of the effectiveness of the proposed method

**** Participants:*** A special education teacher used the proposed application to conduct an individual intervention for a student with difficulty with mathematics in grade 1. The device used to run the proposed application for intervention was a computer.

**** Results and discussions***

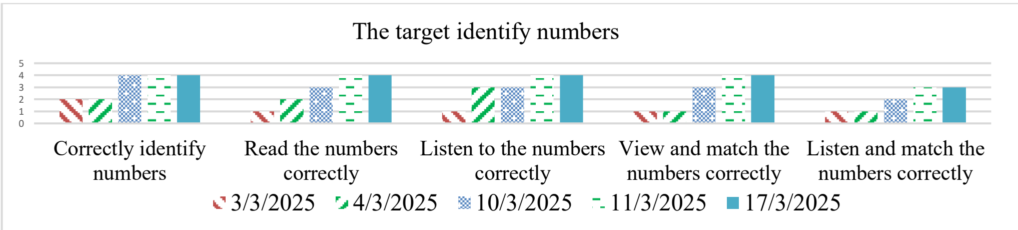



***Figure 10. The target identification numbers***

The individualized intervention program, which focuses uniquely on the needs, characteristics, and interests of each student, is meticulously constructed. This individualized approach ensures that students participate in the intervention regularly (2 sessions/week), each lasting from 30 to 60 minutes. Our study was conducted in two weekly sessions spanning the entire semester. We evaluated the effectiveness of the proposed method using the following process: assessing improvement in students' basic mathematical skills. Before each intervention hour, the teacher will design the lesson and create specific requirements for each student in our system. This design is tailored to the individual challenges of each student and their ability to meet the lesson's requirements.

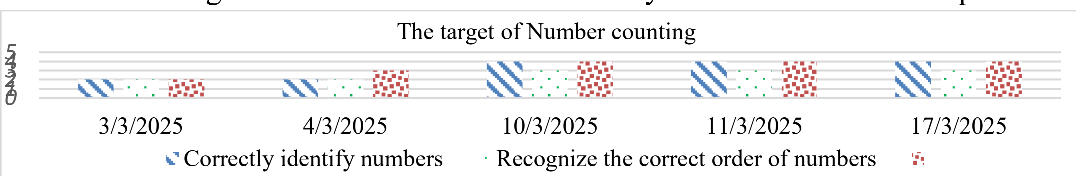



***Figure 11. The target of Number counting***

Additionally, the completion history and details of the support provided by the system, including the type of support, level of support, time to complete, and the number of times completed, indicate the student's ability to solve problems. When implementing direct intervention, the teacher or intervention specialist guides and supports the student directly throughout the learning process. The student's learning progress is regularly assessed to adjust the intervention program accordingly.

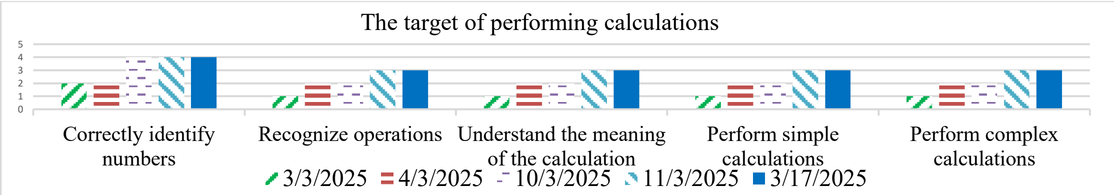



***Figure 12. The target of performing calculations***

In the test, before using the application to learn mathematics, students chose most of the support levels, especially the reading support, which was used 100% in all requests. To perform the addition request, students mostly used the support to associate numbers with the number of objects; the result of the calculation was obtained by counting the number of objects in both terms. This suggests that many of the difficulties in learning mathematics also impact children's reading ability, and children's difficulty in calculating is related to their ability to recall the association between numbers and quantities. Students correctly performed the calculation request after using the support illustrated by objects, and they showed a positive attitude towards this function.


***Figure 13. Interest goals***

In general, compared to traditional methods where exercises are displayed on paper with fixed, difficult-to-customize settings, solving on a web platform makes children more enthusiastic, interested in the lesson, and focused on the lesson (based on the results of the target of interest and concentration, attention is mainly achieved with little or no support). Children can perform the requirements and tasks requested by the interventionist. The target of number recognition and counting is achieved with little or no support. The target of performing calculations gradually improves through each intervention session, and, mainly, students recognize and read calculations and perform complex calculations with the support of the interventionist.

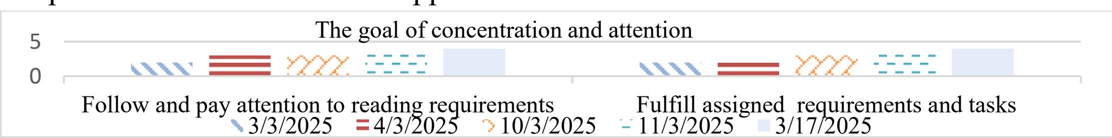



***Figure 14. The goal of concentration and attention***

With the addition of the application's meaning illustration feature, students performed better. They calculated more correctly when the support was displayed in the form of an animation illustrating the increase in addition (Objective: Correctly Recognising and Correctly Performing Addition). Additionally, when answering questions, an audio response form helps students provide answers easily rather than having to use the keyboard. The application must inevitably be modified and upgraded to suit the continuous needs of users. To see the meaning and effectiveness of the application adjustment, compare the assessment results on the objectives before and after the adjustment. Some application adjustments made during the testing and monitoring of student behavior and needs are presented in Table 1.

***Table 1. Application editing process***

| Old design | Design after modification | Result |
|---|---|---|
| In the forms for learners to answer, there is only a response operation by typing from the keyboard or by dragging and dropping the mouse. | Add audio feedback. | Students complete more requirements, making it more convenient for learners. |
| In the form of supporting children in performing calculations, the illustration only stops at static images, so it does not help children clearly visualize the meaning of the calculation in terms of increasing or decreasing. | Add illustrations of increasing motion for addition and decreasing motion for subtraction, specifically increasing to the right of the number line or decreasing to the left of the number line. Or illustrate with a table showing the jumps on the number line. | The goal of performing calculations is to complete more with support. |

## 3. Conclusions

In this paper, we have proposed a method to support children with difficulty learning mathematics. By developing an interactive digital application, we have built an interactive learning system according to the curriculum of the Ministry of Education. We have tested and evaluated the effectiveness of the proposed process. The experimental results show that this method can potentially become a supporting tool in teaching and learning mathematics in grade 1 for children with difficulty in mathematics.

**REFERENCES**

[1] Frey BB, (2018). *The SAGE Encyclopedia of educational research, measurement, and evaluation*. SAGE Publications Inc.

[2] Winkel K & Zipperle I, (2023). Children with mathematical learning difficulties do their working memory skills differ from typically developing first graders?. *Journal für Mathematik-Didaktik,* 44(2), 417-440, DOI: 10.1007/s13138-023-00222-4.

[3] Butterworth B, Varma S & Laurillard D, (2011). Dyscalculia: From brain to education. *Science,* 332(6033), 1049-1053, DOI: 10.1126/science.1201536.

[4] Butterworth B, (2010). Foundational numerical capacities and the origins of dyscalculia. *Trends in Cognitive Sciences,* 14(12), 534-541, DOI: 10.1016/j.tics.2010.09.007.

[5] Le VP, (2024). *Learning disabilities: Correct perception to have remedial measures*, https://giaoducthoidai.vn/khuyet-tat-hoc-tap-nhin-nhan-dung-de-co-bien-phap-khac-phuc-post249762.html.

[6] Nguyen TB, (2013). Barriers to quality education for children with disabilities in Vietnam. *VNU Journal of Science: Education Research,* 29(2). [Online], Available: https://js.vnu.edu.vn/ER/article/view/501 (in Vietnamese).

[7] Roschelle JM, Pea RD, Hoadley CM, Gordin DN & Means BM, (2000). Changing how and what children learn in school with computer-based technologies. *The Future of Children,* 10(2), 76, DOI: 10.2307/1602690.

[8] Janssen J, Erkens G, Kirschner PA, Kanselaar G, (2010). Task-related and social regulation during online collaborative learning. *Metacognition, and Learning,* 7(1), 25-43, DOI: 10.1007/s11409-010-9061-5.

[9] Ke F, Pachman M, Dai Z, (2020). Investigating educational affordances of virtual reality for simulation-based teaching training with graduate teaching assistants, *Journal of Computing in Higher Education,* 32(3), 607-627, DOI: 10.1007/s12528-020-09249-9.

[10] Wu C, Tzeng Y & Huang Y, (2020). Measuring performance in the learning process of digital game-based learning and static E-learning. *Educational Technology Research and Development,* 68(5), 2215-2237, DOI: 10.1007/s11423-020-09765-6.

[11] Firat M, (2023). Integrating AI Applications into learning management systems to enhance e-Learning, *Öğretim Teknolojisi ve Hayat Boyu Öğrenme Dergisi - Instructional Technology and Lifelong Learning*, 1-14, DOI: 10.52911/itall.1244453.

[12] Lopez CE & Tucker CS, (2019). The effects of player type on performance: A gamification case study. *Computers in Human Behavior,* 91, 333-345, DOI: 10.1016/j.chb.2018.10.005.

[13] Fischer F, Kollar I, Stegmann K & Wecker C, (2013). Toward a script theory of guidance in computer-supported collaborative learning. *Educational Psychologist,* 48(1), 56-66, DOI: 10.1080/00461520.2012.748005.

[14] Ministry of Education and Training, (2018). *General Education Program 2018*.

[15] Ha HK, Le AV, Nguyen A & Vu VD, (2018). *Math 1.* Connecting knowledge & life

[16] Do DT, Do TD, Nguyen HA, Tran TN & Nguyen TTS, (2018). *Math 1*, Kite.

[17] Tran ND, Khuc TC, Dinh TXD, Nguyen KD, Dinh TKL & Huynh TKT, (2018). *Math 1.* Creative Horizon.

[18] Athanasios SD, Marios AP & Miltiadis L, (2016). Emerging Technologies for ICT based education for dyscalculia: Implications for computer engineering education. *International Journal of Engineering Education,* 32(4), 1604-1610.

[19] Dogan R & Demirköz E, (2019). Investigating MentalUP Educational games application's measurement and improvement capacity of attention and relevant cognitive skills.

[20] Toy theater, 2024. *Math Flashcards: Educational Games for Kids*, https://toytheater.com/math-flash-cards.

[21] OLM, 2024. *OLM online education platform: Smart online learning,* https://olm.vn.

[22] Violet, 2024. *Online Library*, https://violet.vn/.