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Mathematics Learning Model for Children with Dyscalculia through Special Intervention

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MATHEMATICS LEARNING MODEL FOR CHILDREN WITH DYSCALCULIA THROUGH SPECIAL INTERVENTION

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Abstract

This research aimed to formulate a model of mathematical learning difficulties for children with dyscalculia to help children with dyscalculia overcome mathematics problems at school. This research is important to carry out considering that dyscalculia is a serious problem experienced by many students throughout the world. The SDTA model was built by analogizing the STIR model to non-communicable diseases. In this study, of 1247 students who conducted a series of tests (screening tests), there were 121 students, or 9.7% were initially identified as having dyscalculia. Furthermore, observations were carried out and confirmation was carried out with parents and teachers so that 119 students tested positive for dyscalculia. The research results showed that after intervention through treatment by the teacher, dyscalculia students experienced a very drastic decrease, especially in the material on recognizing and ordering numbers. Likewise, the results of model simulations on multiplication operation material illustrated the decline in students with dyscalculia. Specifically for division operations, the treatment process took relatively longer. Therefore, the simulation results in the SDTA model reflected students who are identified as having dyscalculia, along with planned intervention/ treatment, students could pass through the mathematics learning phase successfully.

Keywords: *Mathematical Models; Learning Difficulties; Learning Intervention; Dyscalculia.*

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A. Introduction

Dyscalculia is known as a mathematical learning disorder that affects and influences a person's ability in a child's daily life involving mathematical or number problems, such as counting money, measuring distances, or calculating time (Mahmud et al., 2020; Soares et al., 2018; Sudha & Shalini, 2014). Additionally, students with dyscalculia have difficulty with math concepts, such as fractions, decimals, and algebra (Lewis & Lynn, 2018; Reeve & Waldecker, 2017). This condition not only affects school-aged children but also adults throughout their lives (Piazza et al., 2010).

Weaknesses in mathematical abilities not only lead to problems related to school or the academic world but can also affect work, emotions, and well-being (Cohen Kadosh, Dowker, Heine, Kaufmann, & Kucian, 2013; Küçükalkan, Beyazsaçlı, & Öz, 2019; Shalev, Auerbach, & Gross-Tsur, 1995). Children with developmental dyscalculia show very diverse performance profiles (Kaufmann & Von Aster, 2012; Skagerlund & Träff, 2016; Träff et al., 2017), and this condition can affect children's ability to learn mathematics and even affect their ability to understand lessons related to mathematics and also affect children's self-confidence.

Furthermore, there are around 5-10% of school-aged children experience dyscalculia, with the prevalence rate of dyscalculia varying depending on the criteria used for diagnosis (Butterworth & Laurillard, 2010; Landerl & Moll, 2010). Although dyscalculia has been known for decades, there is still much that is not understood about this condition. So, research on dyscalculia is very important to increase understanding of this condition, especially about diagnosis and treatment, increasing awareness of the public, parents, and teachers in schools, as well as improving the daily lives of children who experience dyscalculia.

Several studies show that dyscalculia can be caused by genetic factors (Haase, 2019; Rubinsten, 2009; Szucs & Goswami, 2013), so people who have family members who suffer from this condition are more likely to experience the same condition. Research also suggests that neurological and environmental disorders may contribute to the development of dyscalculia (Shalev et al., 2000; Von Aster & Shalev, 2007). Mathematics learning disorders can occur in children and adults and can be caused by various factors, such as genetic factors, environmental factors, or brain development disorders. Although not related to general intelligence or learning deficiencies, dyscalculia can affect a person's ability to learn mathematics and pursue a career in arithmetic-related fields. Thus, the initial diagnosis carried out in identifying dyscalculic children in public schools is important for teachers and educational institutions in responding to the actions that will be taken.

In addition, early identification of children with dyscalculia is very important to provide appropriate support and intervention (Kaufmann & Von Aster, 2012; Snowling, 2013). On the other hand, identifying dyscalculia can be challenging, as there is no single diagnostic test for the condition. Currently, various assessment tools and approaches have been introduced to identify dyscalculia, such as the computer screening test developed by Butterworth (2002), DysCalculiUM (Beacham & Trott, 2005), and the Screening Test from Gliga & Gliga (2012), and there is also identification and diagnosis using paper (Chinn, 2012; Geary et al., 2009; Jordan et al., 2007). However, these standardized tests have limitations, such as a lack of sensitivity to specific areas of difficulty, especially the potential for sociocultural bias.

Some researchers have argued that the exclusive use of standardized tests can result in missing important aspects of individual strategies and difficulties, and these researchers have emphasized the importance of individual interviews and case study methods (Dowker, 2005). So, to identify dyscalculia, it is necessary to consider non-standard assessment approaches, such as dynamic assessment and cognitive profiles (Dowker, 2005). In addition to standard and non-standard assessment tools, it is important to consider multiple data sources when identifying children with dyscalculia. Teacher observations, parent reports, and other sources of information can provide valuable insight into a child's strengths and weaknesses in mathematics (Ching, 2017; Mazzocco & Myers, 2003).

Proper identification and diagnosis of dyscalculic children will provide an idea of how intervention should be carried out, especially by teachers at school. So it is very important to carry out continuous research related to dyscalculia learning difficulties (Nelson et al., 2022; Powell et al., 2021), especially to increase our understanding of dyscalculia, improve diagnosis and treatment, and also increase public awareness (Haberstroh & Schulte-Körne, 2019).

In Indonesia, since 2009, we have started to show good commitment regarding the problem of learning disorders for children at school. This is proven by the existence of regulations and policies to seriously deal with the problem of learning disorders for students in schools (Jap et al., 2017). However, government policies for dealing with student learning disorders in schools do not necessarily work as expected (Little et al., 2020; Mulyadi, 2017). Commitment in the form of regulations is an important intervention for dyscalculic children, in addition to teacher and parent factors that contribute to the learning success of dyscalculic children.

Several studies have been conducted, and teacher intervention in the learning process has a positive impact on the continuity of the learning process (Ciullo & Dimino, 2017; Rouse & Kiuhara, 2017; Hock et al., 2017). However, the teacher's inability to understand children with dyscalculia is hampering the implementation of this process in addition to the intensity of teacher support for dyscalculia. This success is not solely due to the availability of complete regulations and adequate teacher capabilities for children with dyscalculia (Grizzle-Martin, 2014). On the other hand, the participation of parents' support in providing intervention to their children is very much needed and highly anticipated by educators in helping children's study success (Bradshaw et al., 2008; Landerl & Moll, 2010; Muscott et al., 2008). Parental support can be provided with various positive activities that lead to the formation of learning success for children with dyscalculia. This is to help children develop the social and cognitive skills needed for success in school, and it can have a positive effect on children's academic achievement

(Chouinard & Roy, 2008; Elliot & McGregor, 2001; Epstein & Van Voorhis, 2010; Fan & Chen, 2001; Hill & Tyson, 2009).

Although intervention efforts by parents and teachers for children with dyscalculia can help improve their mathematical abilities. However, this is not enough, and there needs to be appropriate, structured, and coordinated intervention early and continuously to help children with dyscalculia achieve learning success in overcoming mathematics learning disorders. Several studies also show that early identification and appropriate and coordinated intervention between parents, teachers, educational psychologists, and stakeholders are very important to help children with dyscalculia achieve success in learning mathematics (Geary, 2004; Mazzocco & Thompson, 2005; Parsons & Hallam, 2014; Räsänen et al., 2009; Von Aster & Shalev, 2007); therefore, there needs to be a more systematic, structured, and coordinated effort in helping children with dyscalculia to achieve success in learning mathematics through treatment programs.

Currently, to maximize the improvement in the mathematical abilities of children with dyscalculia, many efforts have been made. For example, a study by Mazzocco & Thompson (2005) showed that teachers who use new technology can help improve the math skills of children with dyscalculia. In addition, some parents also consult with educational psychologists to provide additional support in developing effective learning strategies for their children who experience difficulties in mathematics (Živković et al., 2022). Furthermore, based on recent studies, the success of interventions or the effectiveness of interventions carried out by teachers, parents, and educational institutions is greatly influenced by several factors, one of which is the lack of availability of timely and affordable intervention services for children with dyscalculia (Maclean & Law, 2022; Sapiets et al., 2021). This is also largely determined by the awareness of teachers and parents about dyscalculic children as well as resource support from educational institutions and the government in providing appropriate intervention services for dyscalculic children (Svalina & Ivic, 2020).

Another success is supported by the challenges in estimating and determining the most effective type of intervention for each child with dyscalculia because each child has different profiles and needs (Geary et al., 2009). Therefore, there is a need for coordinated cooperation in providing effective, appropriate, and coordinated intervention services to help children with dyscalculia learning difficulties achieve success in learning together with their friends at school.

In this study, the researcher tried to find a solution to maximizing interventions in schools carried out by teachers to help children with dyscalculia by formulating a mathematical model, which it is hoped can become one of the considerations and foundations for teachers and educational institutions in strengthening interventions and efforts to help children with learning difficulties with dyscalculia. The mathematical model that is built and analyzed will formulate standards or guidelines for maximizing positive efforts in helping children with dyscalculia learning difficulties, such as the accuracy of the time required and the use of appropriate interventions.

In this study, researchers tried to find a model to understand and help children with dyscalculia learning disorders through a mathematical modeling approach. Researchers consider mathematical models for non-communicable diseases, such as diabetes or cancer, namely the SITR (Susceptible, Infections, Treatment and Recovery) mathematical model. This SITR model can help predict the development of a disease by taking into account the main factors of treatment given and the time required for a person to recover (Asamoah et al., 2018; Bowman et al., 2005; Castillo-Chavez et al., 2003). Although the mathematical models used for diabetes and cancer with the learning disorder dyscalculia have different characteristics, the basic concepts of using mathematical models to develop effective solutions can be applied to both. Mathematical models for children with dyscalculia learning disorders tend to focus more on the intervention provided by teachers, whether in the form of approaches/ strategies, teaching materials, or the effective duration of time used to help the successful learning of children with dyscalculia learning difficulties. However, both have similarities in using the data and information collected to take advantage of advances in the field of mathematics and their solutions to help solve complex problems.

Mathematical models themselves have often been used to help find solutions to problems in the world of education; for example, Mutiawati, Johar, Ramli, & Mailizar (2022) use mathematical models to predict student learning behavior in mathematics learning situations by paying attention to the effects of student motivation and social interactions. Nathan & Jackob (2020), in their research, created a mathematical model that is used to analyze and predict students' mathematics anxiety and performance. Furthermore, mathematical models are also created and utilized for broader educational policy purposes (Medetova et al., 2021; Obukhov et al., 2020). Next, the mathematical model that has been formulated is then continued with model simulation.

This simulation is intended to provide a geometric picture related to the results that have been analyzed. Simulation is the application of a model to obtain strategies that help solve problems or answer questions related to the system (Velten at al., 2024). Thus, mathematical models and simulations will also be used to evaluate intervention programs implemented by teachers in schools, both based on the intervention provided (be it strategy, approach, treatment, or materials) and also the accuracy of the duration of the time needed to help children with learning difficulties. Through this mathematical model of learning difficulties for children with dyscalculia, it is hoped that we can find a structured solution to understand and overcome the problem of learning difficulties for children with dyscalculia with appropriate strategies and by the characteristics of the problem children are experiencing.

B. Method

Data collection was carried out through basic mathematics ability tests, dyscalculia tests, interviews, and observations. The basic mathematics ability test was carried out using a test sheet. The basic mathematics ability test used is a standard test according to the applicable national curriculum

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and by the child's education level. Test questions include understanding numbers, the ability to calculate operations, measurement, using number facts, understanding shapes, recognizing units, and handling data. Then students who have low abilities will continue to take the dyscalculia learning disorder test by being given a Dyscalculia Test Sheet (DTS).

Interviews in the research were conducted after a basic mathematics ability test and a dyscalculia test was carried out. This interview was intended to identify students' difficulties in depth after the test and classify students' mathematical difficulties. This is based on the fact that dyscalculic children have various characteristics in their learning difficulties (Kaufmann & Von Aster, 2012; Skagerlund & Träff, 2016; Träff et al., 2017). Furthermore, to strengthen the written test results for students, observations were carried out. The observations in this research followed the observation guidelines from the Guidelines for Classroom Observations from Zerafa (2020). Observation is a data collection technique by conducting direct observations of research objects to obtain factual data to compare with data obtained from sources.

The population in this study were all elementary school students (SDN) in Banda Aceh City, totaling 72 public elementary schools. Meanwhile, the sample in this research was students from Grade II and Grade III at 27 public elementary schools, totaling 1247 students. The selection of students in classrooms of Grade II and III took into consideration that Grade II and III students had studied basic mathematics (Grade I), which could be an initial problem for children with dyscalculia. Grade II and III students, totaling 1247, took the Mathematics Skills Test (MST).

In MST, 585 Grade II students were tested with MST Type A, and 662 Grade III students were tested with MST Type B. The MST results found 171 students with very low abilities (students prone to dyscalculia). Based on the basic ability test, it was found that 171 students had very low abilities (students vulnerable to dyscalculia). Furthermore, vulnerable students were given the Dyscalculia Test Sheet (DTS) and it was found that 121 students were initially identified as having dyscalculia problems. Observations and confirmation with parents and teachers were carried out to ensure that students were identified as positive for dyscalculia, namely 119 students who were positive for dyscalculia. Taking into account the focus on number recognition, number ordering, and arithmetic operations, 59 students received special intervention or treatment from the teacher.

C. Result and Discussion

1. Result

In this study, the population was divided into 4 groups: Group S (susceptible), which is the class of individuals who have not been detected with dyscalculia and have low grades in mathematics; groups; Group I (infections), which in the case of this research states the class of individuals who have been positive/ confirmed with dyscalculia learning difficulties, which is then notated D (dyscalculia); Group T (treatment), which states the class of individuals who are positive for experiencing dyscalculia learning difficulties and then receives intervention or treatment; and Group A (achievement), which states the class of individuals who have been able to overcome their mathematics learning difficulties.

Meanwhile, the assumptions for forming the mathematical model used in this research are:

a. The population is constant (closed), meaning N = (S(t)) + (D(t)) + (T(t)) + (A(t)). The population size at time *t* is equal to the number of vulnerable individuals, active dyscalculia, treatment interventions, and the number of successful difficulties/ achievements.
b. The population can be included in group S (Suspectable) if they experience difficulties learning mathematics at school.
c. The population can be included in the active dyscalculia group D (Dyscalculia) if they experience identification and diagnosis β falls into the category of children with dyscalculia learning difficulties.
d. Natural learning failure can occur in all subpopulations, with a failure rate μ, with the probability that the entire population can drop out.
e. Individuals with active dyscalculia subpopulation D (Dyscalculia) may receive γ intervention.

f. Individuals with subpopulation T (treatment) can return to subpopulation D (dyscalculia) with a return rate ρ because the intervention provided does not match the characteristics of the difficulties experienced by the individual.
g. Treatment is carried out through learning interventions with dyscalculia learning tools.
h. On average, the number of individuals who have been able to overcome the problem of learning difficulties in mathematics at T with a rate of ε will fall into subpopulation A (achievement).

Based on the assumptions above, an SDTA model scheme is obtained for the population of children with dyscalculia learning difficulties in the form of the following compartment diagram.

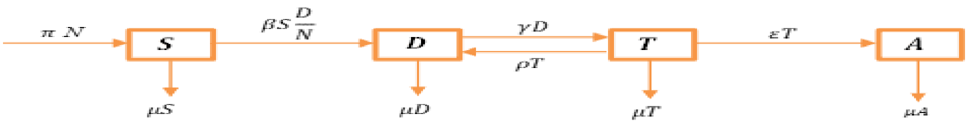

Figure 1. Diagram illustrating the dynamics of the spread of student dyscalculia

Based on this description, the interpretation of the 4-D nonlinear ordinary differential equation model (Atangana & Araz, 2021) is obtained as follows:

$$\begin{aligned}\frac{dS(t)}{dt} &= \pi N - \beta_0 S(t)\frac{D(t)}{N} - \mu_0 S(t)\\ \frac{dD(t)}{dt} &= \beta_0 S(t)\frac{D(t)}{N} + \rho_0 T(t) - \gamma_0 D(t) - \mu_0 D(t)\\ \frac{dT(t)}{dt} &= \gamma_0 D(t) - \rho_0 T(t) - \varepsilon_0 T(t) - \mu_0 T(t)\\ \frac{dA(t)}{dt} &= \varepsilon_0 T(t) - \mu A(t)\end{aligned} \quad (1)$$

The system of equations (1) can be transformed into a non-dimensional model. This simplification considers that the proportion of students in each compartment can be expressed in the following equation:

$$X = \frac{S(t)}{N}, Y = \frac{D(t)}{N}, Z = \frac{T(t)}{N}, W = \frac{A(t)}{N}, \text{dan } \tau = \mu_0 t \quad (2)$$

Furthermore, from equation (10) we obtain:

$$X + Y + Z + N = \frac{S(t)}{N} + \frac{D(t)}{N} + \frac{T(t)}{N} + \frac{A(t)}{N} = 1$$

From equation (2), the system of equations (1) can be formed in a non-dimensional model as follows:

$$\begin{aligned} \frac{dX}{d\tau} &= 1 - \beta\, X\, Y - X \\ \frac{dY}{d\tau} &= \beta X\, Y + \rho Z - \gamma Y - Y \\ \frac{dZ}{d\tau} &= \gamma Y - \rho Z - \varepsilon Z - Z \\ \frac{dW}{d\tau} &= \varepsilon Z - W, \end{aligned} \qquad (3)$$

With $\beta = \frac{\beta_0}{\mu_0}, \rho = \frac{\rho_0}{\mu_0}, \gamma = \frac{\gamma_0}{\mu_0},$ and $\varepsilon = \frac{\varepsilon_0}{\mu_0}$

Furthermore, if you look at the system of equations formed in (3), it is known that the variable W does not appear in the other equations. Therefore, it can be seen that the number of students in compartment W does not affect the rate of change in the number of students in other compartments. That means the W equation can temporarily be ignored by the system. So that equation (4) can be translated into:

$$\begin{aligned} \frac{dX}{d\tau} &= 1 - \beta\, X\, Y - X \\ \frac{dY}{d\tau} &= \beta X\, Y + \rho Z - \gamma Y - Y \\ \frac{dZ}{d\tau} &= \gamma Y - \rho Z - \varepsilon Z - Z \end{aligned} \qquad (4)$$

With $\beta = \frac{\beta_0}{\mu_0}, \rho = \frac{\rho_0}{\mu_0}, \gamma = \frac{\gamma_0}{\mu_0},$ and $\varepsilon = \frac{\varepsilon_0}{\mu_0}$ are dimensionless parameters. The variables used in the mathematical model of learning difficulties for children with dyscalculia are presented in Table 1 below:

Table 1. List of variables for the distribution model of the influence of learning difficulties in children with dyscalculia

No.	Variable	Definition	Condition	Unit
1.	N(t)	The total student population at the time *t*	N (t) ≥ 0	Individual
2.	S(t)	The number of individuals who are vulnerable to experiencing learning difficulties	S (t) ≥ 0	Individual

No.	Variable	Definition	Condition	Unit
3.	D(t)	Number of individuals who have been diagnosed with dyscalculia at time *t*	D(t) ≥ 0	Individual
4.	T(t)	A number of dyscalculic children who were given treatment in the form of dyscalculia learning intervention at time *t*	T(t) ≥ 0	Individual
5.	A(t)	A number of children who have been able to overcome the problem of mathematics learning difficulties/ dyscalculia at time *t*.	A(t) ≥ 0	Individu al

The parameters used to form a mathematical model of learning difficulties for dyscalculic children are presented in Table 2 below:

Table 2. List of model parameters for the distribution of learning difficulties in children with dyscalculia

No.	Parameter	Definition	Condition	Unit
1.	μ	The rate at which the number of students in a population increases or decreases	$\mu \geq 0$	$\frac{1}{Time}$
2.	π	Number of individuals entering/ recruiting at age >7 years in the population.	$0 \leq \pi \leq 1$	
3.	γ	The average number of individuals experiencing dyscalculia who will be treated per unit time	$\gamma \geq 0$	$\frac{1}{Individual - Day}$
4.	β	An average number of individuals identified and diagnosed with dyscalculia at time *t*.	$\beta \geq 0$	$\frac{Individual}{Day}$
5.	ε	The average number of individuals who were successful/ able to overcome mathematics learning difficulties after intervention.	$\varepsilon \geq 0$	$\frac{Individual}{Day}$
6.	ρ	The average number of individuals who have been treated but return to dyscalculia per unit of time	$\rho \geq 0$	$\frac{1}{Time}$

a. Equilibrium points and basic reproductive numbers

The system of equations (4) has two equilibrium points, namely the equilibrium point free from dyscalculia learning difficulties and the endemic equilibrium point (dyscalculia learning difficulties consistently exist, but are limited to a certain scope). The equilibrium point (balance point) is a point that does not change with time. This means that when *t=1,2,…,n* the point value will be fixed and will not change. The point $x * = (x_1 *, x_2 *, \dots, x_n *)$ is called the equilibrium point of the system *x=f(x)* if it satisfies $f(x_1 *, x_2 *, \dots, x_n *) = 0$ (Penny, 2000). Therefore, the system of equations (4) can be written as:

$$1 - \beta\, X\, Y - X \quad = 0 \tag{5}$$
$$\beta X\, Y + \rho Z - \gamma Y - Y \quad = 0 \tag{6}$$
$$\gamma Y - \rho Z - \varepsilon Z - Z \quad = 0 \tag{7}$$

b. Endemic Equilibrium Point in a Specific Scope

The equilibrium point free from the influence of dyscalculia learning difficulties is the equilibrium point when there are no dyscalculia learning difficulties in the student population, so Y=0. Next, substituting Y=0 into equation (5), we get:

$$\Leftrightarrow 1 - \beta\, X\, Y - X \;= 0$$
$$\Leftrightarrow 1 - \beta\, X\, (0) - X \;= 0$$
$$\Leftrightarrow 1 - X \;= 0$$
$$\Leftrightarrow X \;= 1 \tag{8}$$

Next, substituting Y=0 into equation (6), we get the equation:

$$\Leftrightarrow \beta X\, Y + \rho Z - \gamma Y - Y \quad = 0$$
$$\Leftrightarrow \beta X\, (0) + \rho Z - \gamma(0) - (0) \;= 0$$
$$\Leftrightarrow \rho Z \;= 0$$
$$\Leftrightarrow Z \;= 0 \tag{9}$$

So we get the equilibrium point free from dyscalculia learning difficulties, the system of equations (4), namely:

$$T_1 = (X_0, Y_0, Z_0) = (1{,}0{,}0) \tag{10}$$

c. Parameter Value

The mathematical model for the difficulties of dyscalculic children in this study is generally formed in four non-linear ordinary differential equations as shown in equations (1). Then the initial values and parameters are given in

Table 3. The parameter values used in this research were obtained in the following way:

1) The total population is 1247 students. The sample taken in the research from each school was 171 students based on a basic mathematics ability test and an initial test for dyscalculia. The average age of elementary school students is 8.5 years. So, the rate of population change is $\mu = \frac{171}{(8,5)(90)} = \frac{171}{765} = 0.2235 \frac{1}{day}$.
2) Students who are susceptible to dyscalculia can suffer from dyscalculia with the rate of movement of students susceptible to dyscalculia to dyscalculia is β=0.032.
3) Students who suffer from dyscalculia will be treated with the transfer rate of students from dyscalculia to treatment is γ=1/7.
4) Students who have been treated will recover and move to the Achievement group at a rate of 1/7 meaning it takes seven days to recover from dyscalculia.

Thus, the following parameter values are obtained:

Table 3. Distribution of parameter values for learning difficulties in children with dyscalculia

Parameter	Value	Note
μ	0,2235	The rate at which the number of students in a population increases or decreases
γ	1/7	Transfer rate of students from dyscalculia to treatment
β	0.032	The rate of movement of students prone to dyscalculia to dyscalculia
ε	1/7	The recovery rate from dyscalculia
ρ	0	The rate of movement of students who have been treated then returns to dyscalculia
$S(0)$	171	The number of susceptible individuals on day 0
$D(0)$	0	The number of individuals with dyscalculia on day 0
$T(0)$	0	The number of individuals treated on day 0
$A(0)$	0	The number of individuals who recovered from dyscalculia on day 0

Based on the variables, initial values, and parameter values in Tables 1, 2, and Table 3, the SDTA model simulation is then carried out in equations (1). The simulation results at the dyscalculia-free and non-dyscalculia-free equilibrium points were simulated using the MATLAB program to provide a geometric picture related to the variables and parameters analyzed.

d. Dyscalculia-Free Equilibrium Point

Based on the next generation matrix method in the system of equations (4), the basic reproduction number is obtained R_0=0.032143<1, the independent equilibrium point of dyscalculia is $T_1 = (X_0, Y_0, Z_0) = (0.1211; 0; 0)$. Because R_0<1, dyscalculia will not spread. Simulation of the equilibrium point free from learning difficulties for children with dyscalculia with initial values $S(0) = 777, D(0) = 163, T(0) = 1 \; and \; A(0) = 0$. In this study, the simulation model was based on the results of a series of tests on 171 students, and intervention or treatment was carried out specifically by the teacher on students who experienced problems with the skills of recognizing and ordering numbers, addition and subtraction operations, and multiplication operations totaling 59 students. Below is a graph of the simulation results of learning difficulties for children with dyscalculia.

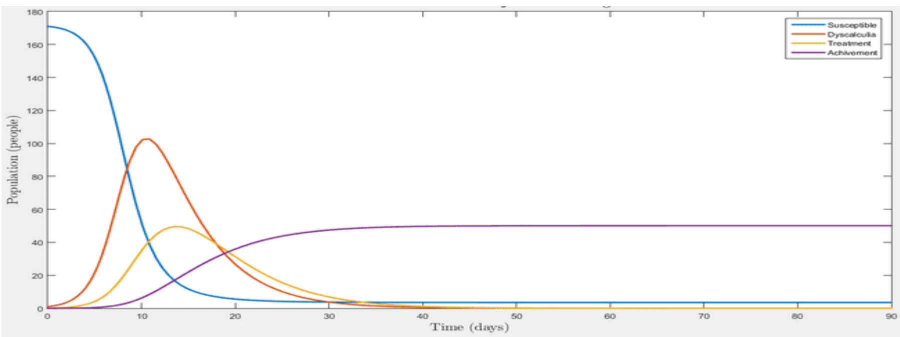

Figure 2. Simulation results in the skill of recognizing numbers

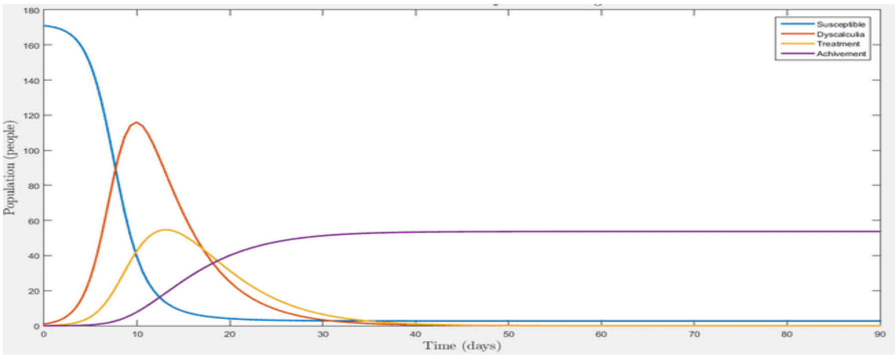

Figure 3. Simulation results in the skill for ordering numbers

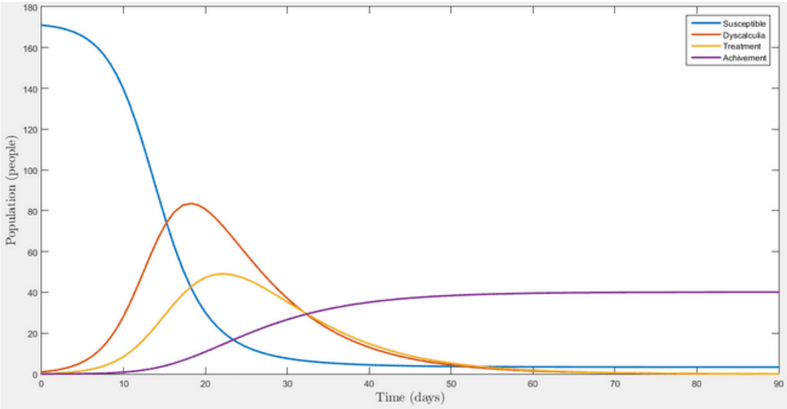

Figure 4. Simulation results on skill in addition operations

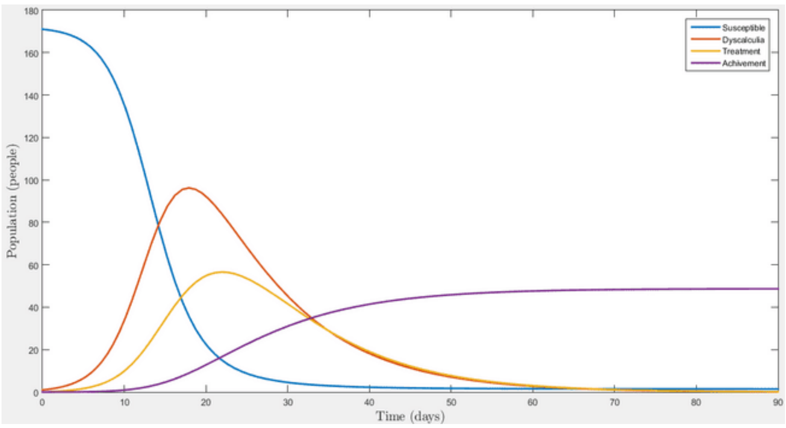

Figure 5. Simulation results in skill in reduction operations

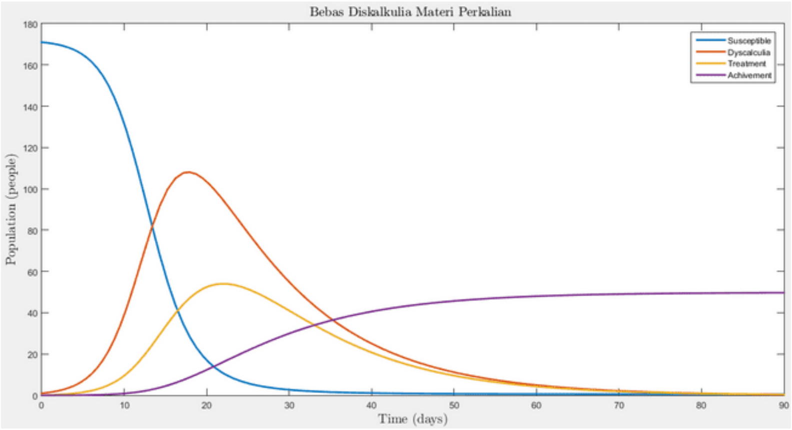

Figure 6. Simulation results in skill in multiplications

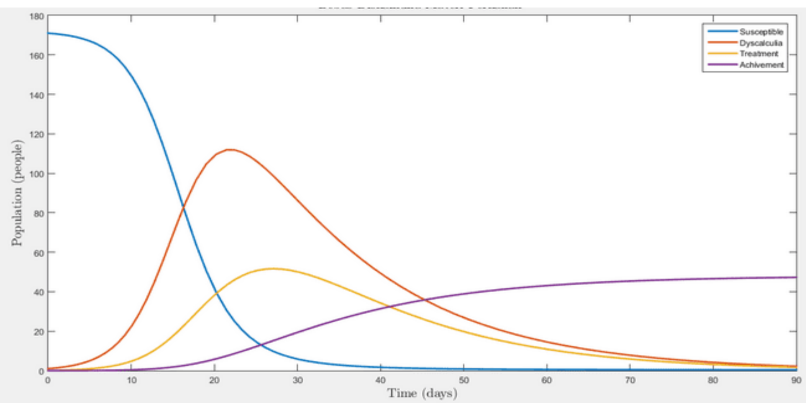

Figure 7. Simulation results in skill in divisions

The graphic simulation in Figure 2 and Figure 3 shows 171 susceptible students at the start of the simulation (day 0), then there was a dramatic decline after the basic mathematics ability test and dyscalculia test were carried out. The research findings show that starting from day 20, almost 121 students with dyscalculia were identified. In the introduction and ordering numbers material, 59 students took part in the treatment program. After the intervention, it experienced a very drastic decline starting on day 60 and on day 70 it was at zero. Furthermore, based on the simulation results seen in Figure 4 and Figure 5, the number of children with dyscalculia also decreased after treatment was carried out by the teacher.

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Likewise, the graphic simulation in Figure 6 on the multiplication test, is a little different in Figure 7, there the simulation results on the division material show that the treatment process is relatively long, although there was a decrease in the number of students with dyscalculia starting from day 40, but on day 70 there were still students who experienced problems with the multiplication material and on day 80 there was a decrease that was close to 0 and until day 90 there were still students who had not been able to solve simple multiplication problems for them.

2. Discussion

In this study, The SDTA model was formulated by analogizing the SITR model to non-communicable diseases in 90 days. Researchers began by conducting identification tests on elementary school children in Banda Aceh City. Of the 1247 students who underwent a series of tests (screening tests), there were 121 students, or 9.7% who were initially identified as having dyscalculia problems. This confirms previous research which states that around 5-10% of school-age children experience dyscalculia, with the prevalence rate of dyscalculia varying depending on the criteria used for diagnosis (Butterworth & Laurillard, 2010; Landerl & Moll, 2010). Elementary school students who were tested and identified as having dyscalculia were then given special treatment in a series of studies carried out for 90 days.

The treatment in this research is a teacher intervention during the research to help students with dyscalculia learning difficulties overcome the mathematics problems they face. One way of intervention that can be done is by providing clear and structured instructions. Children with dyscalculia often have difficulty processing mathematical information presented orally or in written form (Amland et al., 2021; Wadlington & Wadlington, 2008). By providing clear and structured instructions, children will more easily understand the mathematical concepts being taught. So, in this research, before teachers carry out learning to help children with dyscalculia, a workshop was carried out to align perceptions and learning strategies according to the dyscalculia problems faced by each student. So teachers use different strategies and approaches in helping children who experience dyscalculia, this is important because each child has different learning needs (Luit, 2019). This is also based on several studies showing that intervention through learning for children with dyscalculia can make significant progress when children are given appropriate intervention and according to the problems they face, this can support children in overcoming their mathematical difficulties (Holmes & Dowker, 2013; Kaufmann et al., 2003).

Children with dyscalculia often have difficulty processing mathematical information conveyed orally or in written form, so interventions are needed that can provide clear and structured instructions (Amland et al., 2021; Wadlington & Wadlington, 2008). By providing clear and structured instructions, children will more easily understand the mathematical concepts being taught. Apart from that, teachers can also utilize visualization in providing instructions, such as by using pictures or diagrams, so that children can more easily understand the mathematical concepts being conveyed. Apart from providing clear and structured instructions, teachers also need to provide support and motivation to children who experience dyscalculia. Children with dyscalculia often feel insecure and frustrated in learning mathematics because of the difficulties they experience (Chinn, 2004; Fu & Chin, 2017; Jabaliah et al., 2021). By providing support and motivation, teachers can help children stay motivated in learning mathematics and feel more confident in facing the difficulties they experience.

The results of the tests for identification and treatment carried out in this research for the next 90 days were simulated using the MATLAB program to provide a geometric picture related to the results that had been analyzed by giving a value to each parameter studied. Simulation is the application of a model to obtain strategies that help solve problems or answer questions related to the system (Velten et al., 2024; Luna et al., 2022). This simulation activity also aims to provide an overview and draw conclusions regarding the behavior of a system or model being formulated.

Thus, based on the simulation graphs from the model of learning difficulties for dyscalculic children, it shows an effective process from

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identification of dyscalculia to achievement in overcoming problems faced by dyscalculic students, with transitions from one stage to the next and minimal failure in intervention, which reflected in an increase in the number of achieving students and a decrease in the population in other categories over time.

In the case of this research, through mathematical model simulations, it is shown that dyscalculic students who have participated in a special mentoring program through treatment carried out by teachers can be helped in overcoming the mathematical problems that students are facing. Special assistance and treatment are an effort in the process of helping students to understand basic mathematical concepts that are obstacles. This requires a set of systematic learning procedures. So teachers need to give special treatment to students according to the problems students face in the process of learning school mathematics, who are treated differently from other children in class (Gersten et al., 2005; Mahmud et al., 2020; Mohd Syah et al., 2016).

This research tries to contribute to the development of science and technology, especially in educational applications. It is hoped that this research can be used as a measuring tool to review the implementation of interventions carried out by teachers to help children with dyscalculia learning difficulties. Apart from that, this research also provides an overview of intervention/ treatment standards and a measure of the duration of time that can be carried out by teachers to help children with dyscalculia overcome students' learning difficulties.

D. Conclusion

This research provides an understanding of the journey of students identified as dyscalculia in elementary school children. Through the SDTA model, we can describe the transition experienced by students from the vulnerable stage to reaching the recovery stage. The simulation that has been carried out provides a quantitative illustration of the effectiveness of intervention or treatment in helping children with dyscalculia. From the start of the simulation, we witnessed a significant reduction in the population of students susceptible to dyscalculia, which is consistent with the assumption that rapid and effective early intervention can reduce the number of students identified with dyscalculia. The graph shows a decrease in the vulnerable population from 171 students with very low abilities (students vulnerable to dyscalculia). By observing and confirming with parents and teachers, 119 students were found to be positive for dyscalculia. For 90 days, 59 students had problems with the material on recognizing and ordering numbers, addition and subtraction operations, and division and multiplication operations, indicating that the intervention implemented was effective in reaching students who needed learning assistance from a teacher or a companion. This shows that students can pass through the problem phase faced by dyscalculia students successfully or achieve recovery in a relatively short time with appropriate and planned intervention.

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