



# European Journal of Mathematics and Science Education

Volume 4, Issue 3, 191 - 200.

ISSN: 2694-2003

<http://www.ejmse.com/>

## Using the Aptitude Treatment Interaction Model Integrated Character Values to Improve Mathematical Story Problem Solving Skills for Fifth-Grade Students

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Received: June 21, 2023 ▪ Revised: August 10, 2023 ▪ Accepted: August 22, 2023

**Abstract:** This study aims to describe the implication of the Aptitude Treatment Interaction (ATI) model integrated with character values to increase the students' skill in solving mathematics story problems. This study applied a quasi-experimental research type using a non-equivalent control group design involving two classes with 30 students each. Data was collected using a test instrument for solving mathematics story problem. Data were analyzed using n-gain descriptive statistical analysis to see the increase in students' skill in solving mathematics story world problems. The results showed that the average score of student's aptitude in solving mathematics story problems is 91.26 which is in the category of very high. There is an increase in the students' ability with score of an n-gain of 0.77 which is in the category of high. In addition, the results of observations related to the implementation of learning model of the ATI with a percentage of 87.5% in the category of very good. Thus, the character-based ATI learning model can be used to increase the students' skill in solving mathematics story problem. In addition, it accommodates the character of students who are concerned with learning mathematics so that learning goals can be achieved both from cognitive and attitudinal aspects.

**Keywords:** *Aptitude treatment interaction, characters, mathematics story problems.*

**To cite this article:** Babo, R., & Syamsuddin, A. (2023). Using the aptitude treatment interaction model integrated character values to improve mathematical story problem solving skills for fifth-grade students. *European Journal of Mathematics and Science Education*, 4(3), 191-200. <https://doi.org/10.12973/ejmse.4.3.191>

### Introduction

To master the concept of school mathematics properly, a learning model is needed that takes into account the individual diversity of students (Azid et al., 2020; Schunk & DiBenedetto, 2020). This is in accordance with the principle of curriculum implementation at the unit level of education, namely, students have to receive quality educational services (Borba et al., 2016; Taranto, 2020) as well as have the opportunity to express themselves freely, dynamically, and happily (Badan Standar Nasional Pendidikan, 2006; Herayanti et al., 2020). In addition to understand fully of the mathematical concepts being taught by the teachers, they have to also care to the students' character development.

Education should be a space for sowing humanization, but in reality, students become a vehicle for bullying and inhumanity which destroys their character (Giacalone & Promislo, 2012; Scurba, 2020). A strong positive character is needed by having a good understanding of how to socialize in a pluralistic society which has an impact on the formation of a society that respects and respects each other as citizens (Abdullah et al., 2019; Fatimah et al., 2020).

The concept of character education is important as an effort to face challenges in education in Indonesia today. Character education is a major requirement in schools so that the next generation can be equipped with basic abilities that are not only capable of making them life-long learners, but also able to play a positive role both as individuals, school members, as members of the family, community and as citizens. For this reason, instrumental efforts must be made to increase the effectiveness of the learning process accompanied by the development of a positive culture.

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Elementary schools, which are the foundation of student character development at the level of formal education, require the creativity of educators or teachers who can internalize character education in the process of learning in the classroom given the different characteristics of students (Afandi et al., 2019; Klimecká, 2020). One of the familiar learning models that can be implemented that takes into account aspects of the diversity of students' characters and abilities is Aptitude Treatment Interaction (ATI). The Aptitude Treatment Interaction (ATI) is a learning model that includes some learning approaches by developing effectively learning situations for students who have different levels of ability (Kardoyo et al., 2020; Syamsuddin et al., 2022). Xu and Zhang (2021) revealed that this model provides chances for students to be engaged in discussion process, thinking critically, braving, and be responsible for their learning according to their abilities. This learning model describes whereabouts a reciprocal relationship (interplay) between student's achievement and learning conditions setting (Matsuda et al., 2020). This indicates that student learning outcomes are affected by the learning situations made by the teacher in the classroom (Tang & Braver, 2020). Therefore, the teacher can integrate an attitude of responsibility, honesty, and respect for the diversity of abilities possessed by one student with other students (Juhji & Nuangchalerm, 2020) so that students do not experience difficulties in getting along with friends and other people and have a high sensitivity to their environment (Paolini, 2020).

Student character development can be done indirectly through the integration process in mathematical learning by using the ATI model. It can coordinate and pay attention to the different characteristics of students as individual beings and social beings who need and support each other to face the 21st century challenges (Martin et al., 2016) namely as learners who demonstrate the ability to collaborate, group and leadership adapt in various roles and be responsible, work independently, productive with others, placing empathy in its place, and respecting different perspectives (Steyn & Van Tonder, 2017).

By integrating character education into the ATI learning model, teachers can build a learning process that creates generations of noble character by instilling character in elementary school students in the process of learning mathematics. Substantively and theoretically, this model can be understood as a concept or prospective having some treatments that are potently used for particular individuals according to each other's abilities. The ATI model technique is one of the implications of mastery lessons in the curriculum at the unit level of education. This curriculum which has a competency-based approach highly upholds and places the role of students as learners. Learning completeness in the curriculum at the unit level of education is determined by assessing benchmark references for each basic competency. The main feature of the ATI learning model is to pay special attention to the differences in each student, wherein each group of students there are students with high ability, medium and low.

According to Satianingsih et al. (2020), the character is a person's personality that is formed from the results of internalization of various kindness that are assured and utilized as principles for perspective, thinking, behaving, and acting. Kindness consists of some values, ethics, morals, and norms such as being trustworthy, honest, and respecting others. One person's interaction with others grows the community character and national character. Therefore, the development of the character of the nation can be developed by individual character (Steinweg et al., 2018). However, peoples live in a socio-cultural environment that has norms and rules that have to be obeyed. That is, the development socio-cultural and character can only be carried out in a process of educational system that cannot be separated students from the national socio-cultural (Pradana et al., 2020). Begum et al. (2022) argues that in the learning process, education of integrated character is the familiarization of values, facilitating the acquisition of awareness of the importance of values, and the internalization of values into students' everyday behavior through the process of learning both taking place inside and outside the classroom in all subject matters.

According to Dewia and Alam (2020), education of character is everything which the teachers carry out that can impress the student's character. Teachers always help establish the students' character. This includes examples of teacher's behavior and style in presenting the subject matter, tolerance, and various other related matters. Character is a person's behavior, morals, temperament or personality which is formed from the process of internalizing virtue which is the basis for the perspective of behaving, thinking and acting (Kim et al., 2018). Virtue consists of several norms, ethics, moral values such as honesty, courage to act, trustworthiness, and mutual respect for one another.

Thus, it is very important to teach a concept or teaching material while still paying attention to developing character of student (Voogt & McKenney, 2017). An intellectually advanced individual, understanding and upholding the teachings of his religion, and practicing all religious orders is the ultimate goal of the education he seeks. The final result wanted from education is the formation of a society that is prosperous, peaceful, and free from all constraints by practicing character education as an effort to improve morals which is the main foundation of character education (Abdullah & ZA, 2018). This is done as an effective way to improve the morals and behavior of every human being, even the evilest human being, which can be corrected by giving them religious education, as well as education about good behavior. This strategy is carried out after the teacher makes a plan for the values that will be integrated into learning.

Included in learning mathematics, introducing and providing understanding of material concepts, the teacher pays attention to aspects of student character, so that there is a balance between knowledge and character development. Learning by paying attention to student character can provide space for students so that students can interact with other students so that students are comfortable with each other in discussions to solve the problems presented to them.

Likewise in learning mathematics, students can discuss solving story problems where it is not an element of feeling alone that is only able to solve a problem but by sharing information and experiences, students can increase the confidence of friends in solving problems or story problems related to daily life of student. By applying a model of learning or strategy that keeps to aspects of the difference of individual student skill by way of the model of ATI learning. Thus, learning mathematics by implementing a model of learning that accommodates students' varied abilities by paying attention to aspects of students' attitudes or characters is expected to improve students' capability in solving mathematical story word problems. The students' capability is the goal of learning mathematics which is adjusted on the curriculum implemented in Indonesia and is also the principle of learning mathematics by NCTM (2000). Therefore, by applying a model of learning that notice aspects of the students' character and abilities who are different from one another, it can increase students' skill in solving mathematical story word problems which has an impact on increasing conceptual understanding and students' mathematics learning achievement.

## Methodology

### Research Design

The research design in this paper is quasi-experimental research where the implementation implicates two classes, namely the experimental class and the comparison class. In the experimental class, the ATI learning model was applied, in which character values were integrated into its implementation, while the comparison class applied the model of conventional learning. It is carried out to obtain the description of the application of the model of ATI integrated with values of character in mathematical learning to instill character values in elementary school students. In this paper, the design of research used is a design of non-equivalent control group that began with pretest math story problems in both the experimental class and the comparison class before being given a model of ATI learning. After learning was done by applying the model of ATI learning in the class of experimental and the model of conventional learning in the comparison or control class, then posttest was carried out to get a picture of the abilities to solve mathematics story problems.

### Sample and Data Collection

This research was carried out on fifth-grade elementary school students located in Pangkep Regency involving 60 students as the sample of research. The research sample was selected by implementing a technique of random sampling. Data was collected using a story problem ability test instrument consisting of 5 questions related to the material for adding and subtracting various forms of fractions. Before being used, this instrument was first tested for validity by testing it on students. To find out the level of validity, an item validity test is carried out by looking for correlation or support for the total item. The calculation is done by correlating the item score with the total item score. In determining whether or not an item is appropriate for this instrument, a correlation coefficient significance test is carried out at a significance level of 0.05. Furthermore, if  $r_{count} \geq r_{table}$  (2-tailed test with sig. 0.05) then the instrument or question items have a significant correlation with the total score (declared valid). In the following, the data on the results of the instrument validity test are presented.

Table 1. Instrument Validity Test Results

	Item-Total Statistics			
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
item_1	63.50	52.603	.407	.631
Item_2	61.33	57.540	.678	.562
Item_3	67.83	48.006	.574	.547
Item_4	59.60	60.248	.585	.593
Item_5	60.93	53.857	.504	.772

By comparing the r-table and r-count values where the r-table value is at a significant 0.05 of 0.361, it can be explained that all question items are suitable for use in data collection.

Descriptions related to learning activities by integrating character values are described based on the observation results identified through the sheet of observation. The observation sheet was developed by taking into account learning indicators that integrate character values in mathematical learning process.

### Analyzing of Data

Data related to students' story problem solving skills obtained through learning with the application of the ATI model which integrates character values, namely the values of honesty and tolerance. Where the value of honesty is integrated during student activities in completing practice questions and assignments given by the teacher. Meanwhile, the value of tolerance is integrated when learning activities take place, there are question and answer activities, group discussions. These two aspects were observed in the observation sheet to measure their implementation.

The data collected was then analyzed using descriptive statistical analysis which aims to see the increase in students' skill in solving the problem of the story and describing the implementation of the learning process by taking into account the descriptive statistical analysis technique used as the n-gain standard. In finding out a category of improving the students' skill to solve story problems after giving treatment both in the class of experimental and in the class of control, the standard gain interpretation is described in the following table.

Table 2. Standard Gain Interpretation

Nilai (g)	Level
$g \geq 0,7$	Great
$0,7 > g \geq 0,3$	Moderate
$g < 0,3$	Poor

Meanwhile, for the analysis of the implementation of learning, it can be reviewed from the application of a plan of the lesson by looking for the percentage of Inter Judge Agreement (IJA) using the following formula:

$$IJA = \frac{A_y}{A_y + A_N} \times 100\%$$

Information:

$A_y$  = Activities that are carried out

$A_N$  = Activities that are not carried out

The category for implementing learning is categorized as feasible if the implementation is more than 75%. Thus, the implementation of learning by paying attention to aspects of integrating character values from the applied learning model is carried out well if it meets this percentage. Meanwhile, to pay attention to each observed aspect related to the implementation category, it is categorized using the following guidelines.

Table 3. Categorization of Aspects of Observing the Implementation of Learning

Range Score	Points	Category
86-100%	4	Very Good
76-85%	3	Good
60-75%	2	Enough
50-59%	1	Not Enough
$\leq 54\%$	0	Very Less

## Findings/Results

### Description of the Implementation of the ATI Learning Model Integrated with Character Values

The application of the model of ATI learning integrated with character values in learning mathematics is described as follows.

#### Early Treatment

At this stage, an initial identification was carried out regarding students' abilities where the researcher determined and classified groups of the students based on students' initial mathematical ability level. This determination is based on semester exam results in the field of mathematics.

#### Grouping of Students

Students are categorized into three ability groups, namely high, moderate, and low ability levels. The determination of categories is based on the following classification (Ratumanan & Laurens, 2011). (1) Students with high mathematical ability if  $80 \leq \text{score obtained} \leq 100$ ; (2) Students with moderate mathematical ability if  $60 \leq \text{score obtained} < 80$ . (3) Students with low mathematical ability if  $0 \leq \text{score obtained} < 60$ .

#### Providing Treatment

Each group was given a treatment that was considered according to its characteristics. In this approach, students who have "high" aptitude are given independent learning strategies where students learn by using handouts, namely a collection of material that has been prepared by the teacher. Students who have "moderate" abilities are given regular teaching lessons. Meanwhile, groups of students with "moderate" and "low" abilities were given learning strategies with a general learning approach and individual assistance. This assistance is provided in the form of enrichment to master the material by students who need additional time to study the concepts that will be discussed in class. In addition, the

researcher also asked high-ability students to help their friends understand the content being studied. It is at this stage, that the teacher can integrate character education values such as the nature of responsibility, honesty and being able to work together, and respecting the differences in abilities between one friend and another in the tolerance form.

The application of the ATI learning model where in its implementation it integrates character education in the learning process by equipping students with the introduction of values, facilitating their acquisition, awareness of the importance of values, and internalizing values into student behavior that takes place in class. This strategy is carried out by integrating character values in learning with a focus on 3 (three) main characters, namely responsibility, honesty, and tolerance. Specifically described as follows.

Table 4. Character Values and Integration Target Activities

Integrated Character Values	Integration Target
Responsibility	Integrated during the picket duty of class cleaning and in completing the assignments given by the teacher
Honesty	Integrated when the activity is completing practice questions and assignments given by the teacher
Tolerance	Integrated during activities that use the question-and-answer method, group discussions

#### Achievement-Test

Both in the initial activities and final activities in the application of learning by implementing the ATI learning model with the integration of character education, an assessment of mathematics learning outcomes is carried out which measures ability of students in solving problem of mathematical story. Descriptively, the results of implementing learning through the implication of the ATI learning model with the integration of character education and conventional learning model are described as follows.

Table 5. Results of Observations on the Implementation of the ATI Learning and Conventional Learning Model

No	Aspects observed	Aptitude Treatment Interaction (ATI)				Conventional			
		1	2	3	4	1	2	3	4
1.	Open the learning through apperception and motivational activities	3	3	3	4	3	3	3	3
2.	Asking problems or cases related to students' daily lives to increase students' interest and curiosity	3	4	4	3	3	3	3	3
3.	Responding to student answers openly from the questions raised	4	4	4	4	3	3	3	3
4.	Presenting learning objectives at the meeting	3	3	3	3	3	3	3	3
5.	Form student groups and distribute worksheets for activities to find problems, discuss problems, and solve problems	4	4	4	3	3	3	2	4
6.	Accompanying students who have difficulties in solving mathematics story problems in groups	4	4	4	4	2	2	3	4
7.	Directing the process of the course of the discussion in order to conclude the resolution of the problems discussed	3	4	3	3	3	3	3	3
8.	Provide space for students to conduct an assessment of their own abilities by solving the math story problems given	4	4	4	4	3	3	3	2
9.	Assessing student activities	4	3	3	3	3	2	2	2
10.	Guiding students to conclude problems discussed on a class scale at the end of learning as material for learning reflection	3	3	3	3	3	3	3	3
Average		3.5	3.6	3.5	3.4	2.9	2.8	2.8	3

Table 5 above shows the average observation results related to the implementation of model of ATI learning with a percentage of 87.5%. While for conventional learning the average implementation is 2.87 with a percentage of implementation of 71.87. Thus it can be described that the learning activities with the implication of the model of ATI learning fulfill the aspects of the application of model of learning in the very good category while learning that applies conventional learning models is in the good category. By paying attention to the implementation of learning through the percentage of Inter Judge Agreement (IJA) it can be described that the implementation of model of ATI learning can be categorized as feasible where this learning model pays attention to aspects of character integration in its implementation reaching 87.5%. Meanwhile, conventional learning with an implementation percentage of 71.87% cannot be categorized as feasible in its implementation. Thus, the ATI learning model has been implemented well to pay attention to aspects of

character values as an integration process that combines the diversity of student abilities and student characters in the process of mathematics learning.

*Description of Ability to Solve Students' Mathematics Story Problems in Implementation of ATI Learning and Conventional Learning Model*

Before the lesson with the model of ATI is applied, a test of the skill in solving mathematical story word problems is carried out. It is processed to obtain a description of students' initial abilities in solving math story problems. Likewise with conventional learning, before it is implemented, a test of students' ability to solve mathematics story word problem is carried out. After applying the lesson by using the model of ATI learning in the class of experimental and learning of conventional in the class of control, then given a test of the ability to solve math story problems in both classes. The results of activities of the pretest and posttest related to the ability to solve students' mathematics story problems are described as follows.

*Table 6. Description of Students' Ability to Solve Mathematics Story Problems*

ATI				Classification and Qualification	Conventional			
Pre-test		Post-test			Pre-test		Post-test	
F	%	F	%		F	%	F	%
2	6,67	22	73,33	90 < x ≤ 100 = Very Good	0	0	1	3,33
9	30	7	23,34	80 < x ≤ 89 = Good	0	0	13	43,34
18	60	1	3,33	65 < x ≤ 79 = Enough	16	53,33	15	50
1	3,33	0	0	55 < x ≤ 64 = Not Enough	9	30	1	3,33
0	0	0	0	0 < x ≤ 54 = Very Less	5	16,67	0	0
30	100	30	100	Total	30	100	30	100

Table 6 above shows that the average score of student's aptitude in solving mathematics story problems before the ATI learning model was applied was 78.30 which was in the medium category. Meanwhile, the average score of the aptitude in solving students' mathematics story problems in classes with conventional learning was 63.23 which was in the low category. After being given a pre-test, learning is continued by implementing the model of ATI learning to the class of experimental and learning of conventional to the class of control. The results of the application of learning with the model of ATI learning at each meeting tend to meet the same aspects. All phases of the initial activities were carried out optimally. While in the core learning activities, several activities are not optimal, namely: (1) the teacher guides students to identify problems where the teacher guides students who get difficulty in accomplishing in their groups to accomplish problems but only some students can be guided. (2) the teacher guides students in guiding the discussions of class to resume problems but this activity is limited to only some groups or students. (3) the teacher guides and facilitates students to measure their own abilities by solving word problems. However, only a portion can be guided in general. (4) the teacher guides students to analyze data in general. (5) the teacher guides students to resume the problem on the scale of class. At the stage of giving the test, the teacher gives practice questions to students by confirming that group questions or assignments are completed in groups. Meanwhile, independent assignments have to be completed independently. At the end of learning activities, all activities are carried out. Thus, the teacher has carried out all stages of learning well when teaching students in class by using ATI learning models.

After applying the model of ATI learning in the class of experimental and conventional learning in the class of control, a final exam then given, namely the post-test to get an overview of students' abilities in solving mathematical word problems. From Table 4. It is obtained that the score of average about students' abilities in solving math story problems after the model of ATI learning was applied is 91.26 which is in the very high category. Meanwhile, the average score of the students' ability to solve mathematics word problems in the class with conventional learning was 80.87 which was in the high category.

*Description of the Effect of Applying the Model of ATI Learning on Students' Ability to Solve Mathematics Story Problem*

To find out the impact of applying the model of ATI learning on students' mathematics story problem-solving skills, a comparison was made of the value of average of students' mathematics story problem-solving skill using N gain acquired from both the class of experimental and control by taking into account the scores from the pre-test and post-test of both classes. The results of the N gain statistical analysis can be established in Table 5. below

*Table 5. Descriptive Statistical Analysis of N Gain Data.*

Class	n	Average		Maximum		Minimum		n-gain
		Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	
Experiment	30	78,30	91,27	100	100	55	76	0,77

Table 5 above shows that with the implication of the model of ATI learning, the students' ability to solve mathematics story problems increased before and after the ATI learning model was applied by 0.77 which is in the great category. This indicates that the implication of the model of ATI learning by integrating students' character values can increase students' skill in solving mathematics story problem.

### Discussion

The findings of this study provide an explanation that character is an aspect that needs attention in the mathematical learning process. This can be integrated with cultural values in the process of learning where teachers teach students always to be close to concrete situations in everyday life. Thus, schools can shape the character of their students according to the characteristics that have been inherited by the existing local culture.

Character education that is integrated into learning mathematics is carried out through instilling character through the introduction and internalization of values in behavior during the learning process. The teacher helps shape the character of students when the explanation of mathematics teaching material takes place, the way the teacher tolerates students. Thus, the character or personality of students is formed from the results of internalizing attitude values which have an impact on the formation of attitudes of honesty, responsibility, courage to act, trustworthiness, and respect for others as a form of student tolerance.

In addition, in the process of learning mathematics by paying attention to aspects of character that can be identified in a social context so that values relevant to learning mathematics such as cooperation, honesty, and empathy for fellow students are very possibly be developed through social interaction that can occur through learning (Askhamov et al., 2016). Thus, interaction design in the form of pedagogical relationships is important in learning mathematics (Horn & Kane, 2015). This can foster student character education that is aimed at strengthening certain values such as mutual respect, full responsibility, high honesty, concern for others, and overall justice and helps students understand, examine, and implement them in their own lives (Baehr, 2017; Kaur, 2015).

Although character education has limitations in its integration process, using the Aptitude Treatment Interaction (ATI) learning model can accommodate the character values to be built. This is done considering the characteristics of this learning model can provide opportunities for students to develop themselves based on their abilities and provide space for students to interact with one another. If possible, the teacher can provide an understanding or the moral principles needed in the learning process.

These characters can be formed in learning mathematics by applying a model of mathematics learning that carries out to these aspects. The model of ATI learning is a model that has a function not only in providing students with educational values that are intellectual but also in providing education that helps shape student character (Van Schoors et al., 2021). This can be seen through learning in the classroom by instilling habits and consistent character traits (Tetzlaff et al., 2021). For example, students are allowed to help each other in understanding the concepts discussed in the learning process. In addition, respect each other in the case of mastery of the concept of mathematics where students' ability to receive and respond to mathematics learning material has different speeds. This is the main characteristic of the ATI learning model which carries out toward students' aptitude to find out various mathematical concepts in order to the treatment given is adjusted to the student's abilities (Hanum et al., 2021; Septiana et al., 2021).

This is done to provide equal opportunities to students in mastering teaching materials, including in completing assignments given by the teacher (Hawkins et al., 2017). One of the competencies expected by the implication on the model of ATI learning is the ability to solve math story problems. Implementation of this model can increase students' aptitude in solving story problem. Where the students take advantage of their mastering in concept of mathematics that has been instilled in the process of learning and then used in on the problem-solving process of mathematics stories. Students solve math story problems by utilizing different contexts and situations based on the experiences of each student. Thus, the model of ATI learning can be utilized as a model of learning which impresses in facilitating students in improving their ability to solve story problems which are closely related to students' daily lives.

### Conclusion

The description of the results of this research illustrates that one important aspect of learning mathematics is character education. In the process of mathematical learning, a strategy for delivering mathematics teaching materials is needed by integrating consistent character values so that students have good character according to local cultural values. One of the ways to grow character of student in mathematical learning is to instill the habit of building student character through the material being taught by incorporating religious values or social values. One learning model that can integrate student character values is the ATI learning model because it delivered different student abilities so that different treatments are needed including different abilities in solving story problem presented by the teacher to students. Thus, it is hoped that students will respect one another regarding the differences in the abilities of student's ability to solve math story problems that they have. With these differences, students help each other in mastering teaching materials and understanding mathematical concepts in the mathematical learning process through mentoring from the teachers where

the learning process integrates character values with the ATI learning model. Therefore, integrating character values in the implication of the ATI learning model, it can increase students' aptitude in problem solving of mathematical story.

### Recommendations

This study examines the application of the model of Aptitude Treatment Interaction (ATI) learning by integrating character values to improve students' problem-solving skills in solving story problems. By applying this model, it is hoped that it can accommodate students' varying abilities in learning and mastering a mathematical concept so that there is no difference in the services performed by the teacher in the process of learning in the classroom. In addition, for integrating the character into the process of learning by applying the model of ATI learning, an illustration is obtained that the students respect each other in terms of differences in abilities so that students help each other in mastering the material discussed in class. However, in this study, it has not been explored regarding the way students understand the material and how students solve mathematics story problems. Therefore, other researchers can develop this research by paying attention to aspects of students' style of learning or cognitive styles in accomplishing problem of the mathematical story. In addition, other researchers can also identify the implementation of the model of ATI learning to improve students' communication of mathematics ability so that various skills related to students' cognition can be improved in learning mathematics by mastering concepts and teaching materials.

### Limitations

The aspects measured in this study were still limited to problem-solving skills related to students' mathematics story problems. However, the instruments used in data collection did not pay attention to various aspects of students' abilities so that there was a possibility that the instruments used were not appropriate for students who had low initial mathematical abilities. In addition, it still needs to be explored further related to categories in classifying students' abilities in solving mathematics story problems so that a development process is needed to determine levels or categories related to students' proficiency to complete standard problems of mathematical stories. During the process of learning, giving special treatment to students who have low mathematical abilities is quite time-consuming and makes students with high abilities feel bored because they are waiting for instructions from the teacher to complete practice questions or understand the material that they tend to already understand. As a consequence, it raises the view or idea that students with low abilities get more attention than students who have high mathematical abilities.

### Acknowledgements

We would like to thank profusely to all parties who have given us the opportunity to complete this paper. Special thanks are conveyed to Rector of Universitas Muhammadiyah Makassar and Research Management Centre (LP3M) Universitas Muhammadiyah Makassar who had funded this study in the scheme "Penelitian Unggulan Perguruan Tinggi (PUPT)" for Academic Year 2021/2022.

### Conflict of Interest

The authors declare that there is no conflict of interest.

### Authorship Contribution Statement

Babo: Reviewing, supervision, collecting data, analyzing data. Syamsuddin: Conceptualization, design, collecting data, analyzing data, statistical analysis, editing/reviewing and writing.

### References

- Abdullah, A., & ZA, T. (2018). Orientation of education in shaping the intellectual intelligence of children. *Advanced Science Letters*, 24(11), 8200-8204. <https://doi.org/10.1166/asl.2018.12523>
- Abdullah, I., Hidayana, B., Setiadi, Kutanegara, P. M., & Indiyanto, A. (2019). Beyond school reach: Character education in three schools in Yogyakarta, Indonesia. *Journal of Educational and Social Research*, 9(3), 145-159. <https://doi.org/10.2478/jesr-2019-0032>
- Afandi, Sajidan, Akhyar, M., & Suryani, N. (2019). Development frameworks of the Indonesian partnership 21st-century skills standards for prospective science teachers: A Delphi Study. *Indonesian Journal of Science Education/Jurnal Pendidikan IPA Indonesia*, 8(1), 89-100. <https://doi.org/10.15294/jpii.v8i1.11647>
- Askhamov, A. A., Konyshva, A. V., & Gapsalamov, A. R. (2016). Use of E-resources of the learning environment in teaching mathematics to future engineers. *International Journal of Environmental and Science Education*, 11(5), 673-684. <https://bit.ly/3KZpNFU>
- Azid, N., Hasan, R., Nazarudin, N. F. M., & Md-Ali, R. (2020). Embracing industrial revolution 4.0: The effect of using web 2.0 tools on primary schools students' mathematics achievement (fraction). *International Journal of Instruction*, 13(3), 711-728. <https://doi.org/10.29333/iji.2020.13348a>



- Badan Standar Nasional Pendidikan. (2006). Permendiknas RI No. 22 Tahun 2006 tentang standar isi untuk satuan pendidikan dasar dan menengah [RI Minister of national education no. 22 of 2006 concerning content standards for elementary and middle education units]. BSNP.
- Baehr, J. (2017). The varieties of character and some implications for character education. *Journal of youth and adolescence*, 46, 1153-1161. <https://doi.org/10.1007/s10964-017-0654-z>
- Begum, A., Liu, J., Qayum, H., & Mamdouh, A. (2022). Environmental and moral education for effective environmentalism: An ideological and philosophical approach. *International Journal of Environmental Research and Public Health*, 19(23), Article 15549. <https://doi.org/10.3390/ijerph192315549>
- Borba, M. C., Askar, P., Engelbrecht, J., Gadanidis, G., Llinares, S., & Aguilar, M. S. (2016). Blended learning, e-learning and mobile learning in mathematics education. *ZDM*, 48, 589-610. <https://doi.org/10.1007/s11858-016-0798-4>
- Dewia, E. R., & Alam, A. A. (2020). Transformation model for character education of students. *Cypriot Journal of Educational Sciences*, 15(5), 1228-1237. <https://doi.org/10.18844/cjes.v15i5.5155>
- Fatimah, M., Sutama, & Aly, A. (2020). Religious culture development in community school: A case study of Boyolali middle school, central Java, Indonesia. *Humanities & Social Sciences Reviews*, 8(2), 381-388. <https://doi.org/10.18510/hssr.2020.8243>
- Giacalone, R. A., & Promislo, M. D. (2012). Broken when entering: The stigmatization of goodness and business ethics education. *Academy of Management Learning & Education*, 12(1), 86-101. <https://doi.org/10.5465/amle.2011.0005a>
- Hanum, O., Johar, R., & Yusrizal. (2021). Students' thinking process in solving higher-order thinking (HOT) problems through aptitude treatment interaction (ATI) learning model. *Journal of Physics: Conference Series*, 1882, Article 012086. <https://doi.org/10.1088/1742-6596/1882/1/012086>
- Hawkins, R. O., Collins, T., Hernan, C., & Flowers, E. (2017). Using computer-assisted instruction to build math fact fluency: An implementation guide. *Intervention in School and Clinic*, 52(3), 141-147. <https://doi.org/10.1177/1053451216644827>
- Herayanti, L., Widodo, W., Susantini, E., & Gunawan, G. (2020). The effectiveness of the blended learning model based on inquiry collaborative tutorial toward students' problem-solving skills in physics. *Journal for the Education of Gifted Young Scientists*, 8(3), 959-972. <https://doi.org/10.17478/jegys.675819>
- Horn, I. S., & Kane, B. D. (2015). Opportunities for professional learning in mathematics teacher workgroup conversations: Relationships to instructional expertise. *Journal of the Learning Sciences*, 24(3), 373-418. <https://doi.org/10.1080/10508406.2015.1034865>
- Juhji, J., & Nuangchalerm, P. (2020). Interaction between science process skills and scientific attitudes of students towards technological pedagogical content knowledge. *Journal for the Education of Gifted Young Scientists*, 8(1), 1-16. <https://doi.org/10.17478/jegys.600979>
- Kardoyo, Nurkhin, A., Muhsin, & Pramusinto, H. (2020). Problem-based learning strategy: Its impact on students' critical and creative thinking skills. *European Journal of Educational Research*, 9(3), 1141-1150. <https://doi.org/10.12973/eu-jer.9.3.1141>
- Kaur, S. (2015). Moral values in education. *IOSR Journal of Humanities and Social Science*, 20(3), 21-26. <https://bit.ly/3QZe9Ph>
- Kim, K., Harris, C. J., & Pham, L. (2018). How Character Education Impacts Teachers. *International Journal of Multidisciplinary Perspectives in Higher Education*, 3(1), 45-67. <https://doi.org/10.32674/ijmphe.v3i1.632>
- Klimecká, E. (2020). Labelling of gifted children in the family from the perspective of teachers and its manifestations at school. *Journal of Contemporary Educational Studies/Sodobna Pedagogika*, 71(137), 196-212. <https://bit.ly/3OX9YR7>
- Martin, C. K., Nacu, D., & Pinkard, N. (2016). Revealing opportunities for 21st century learning: An approach to interpreting user trace log data. *Journal of Learning Analytics*, 3(2), 37-87. <https://doi.org/10.18608/jla.2016.32.4>
- Matsuda, N., Weng, W., & Wall, N. (2020). The effect of metacognitive scaffolding for learning by teaching a teachable agent. *International Journal of Artificial Intelligence in Education*, 30, 1-37. <https://doi.org/10.1007/s40593-019-00190-2>
- National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. <https://bit.ly/3loOudv>
- Paolini, A. C. (2020). Social emotional learning: Key to career readiness. *Anatolian Journal of Education*, 5(1), 125-134. <https://doi.org/10.29333/aje.2020.5112a>

- Pradana, D. A., Mahfud, M., Hermawan, C., & Susanti, H. D. (2020). Nationalism: Character education orientation in learning development. *Budapest International Research and Critics Institute-Journal*, 3(4), 4026-4034. <https://doi.org/10.33258/birci.v3i4.1501>
- Ratumanan, T. G., & Laurens, T. (2011). *Penilaian hasil belajar pada tingkat satuan pendidikan [Assessment of learning outcomes at the level of educational units]*. Unesa University Press.
- Satianingsih, R., Budiyo, S. C., & Subandowo, M. (2020). Character education in multicultural society: Case in Indonesia. *International Journal of Multicultural and Multireligious Understanding*, 7(4), 337-344. <https://bit.ly/47UcKiY>
- Schunk, D. H., & DiBenedetto, M. K. (2020). Motivation and social cognitive theory. *Contemporary Educational Psychology*, 60, Article 101832. <https://doi.org/10.1016/j.cedpsych.2019.101832>
- Sciurba, K. (2020). Depicting Hate: Picture books and the realities of white supremacist crime and violence. *Teachers College Record*, 122(8), 1-44. <https://doi.org/10.1177/016146812012200813>
- Septiana, E., Zubainur, C. M., & Ramli, M. (2021, May). The enhancement of student's mathematical understanding ability through the Aptitude Treatment Interaction (ATI) learning model. *Journal of Physics: Conference Series*, 1882, Article 012072. <https://doi.org/10.1088/1742-6596/1882/1/012072>
- Steinweg, A. S., Akinwunmi, K., & Lenz, D. (2018). Making implicit algebraic thinking explicit: Exploiting national characteristics of German approaches. In C. Kieran (Ed.), *Teaching and learning algebraic thinking with 5-to 12-year-olds: The global evolution of an emerging field of research and practice* (pp. 283-307). Springer. [https://doi.org/10.1007/978-3-319-68351-5\\_12](https://doi.org/10.1007/978-3-319-68351-5_12)
- Steyn, G. M., & Van Tonder, S. (2017). Exploring learning experiences of female adults in higher education using a hybrid study approach: A case study. *Gender and Behaviour*, 15(1), 8135-8159. <https://hdl.handle.net/10520/EJC-88008dc08>
- Syamsuddin, A., Babo, R., Sulfasyah, Bakri, H., & Jainuddin (2022). An investigation of students' mathematical concept understanding and motivation through the implementation of aptitude treatment interaction learning model. *Kasetsart Journal of Social Sciences*, 43(4), 891-902. <https://bit.ly/45ryHUI>
- Tang, R., & Braver, T. S. (2020). Towards an individual differences perspective in mindfulness training research: Theoretical and empirical considerations. *Frontiers in Psychology*, 11, Article 0818. <https://doi.org/10.3389/fpsyg.2020.00818>
- Taranto, E. (2020). MOOCs for mathematics teacher education: New environments for professional development. In *Teaching and learning mathematics online* (pp. 359-384). Chapman and Hall/CRC. <https://doi.org/10.1201/9781351245586-22>
- Tetzlaff, L., Schmiedek, F., & Brod, G. (2021). Developing personalized education: A dynamic framework. *Educational Psychology Review*, 33, 863-882. <https://doi.org/10.1007/s10648-020-09570-w>
- Van Schoors, R., Elen, J., Raes, A., & Depaepe, F. (2021). An overview of 25 years of research on digital personalised learning in primary and secondary education: A systematic review of conceptual and methodological trends. *British Journal of Educational Technology*, 52(5), 1798-1822. <https://doi.org/10.1111/bjet.13148>
- Voogt, J., & McKenney, S. (2017). TPACK in teacher education: Are we preparing teachers to use technology for early literacy? *Technology, pedagogy and education*, 26(1), 69-83. <https://doi.org/10.1080/1475939X.2016.1174730>
- Xu, T., & Zhang, B. (2021). Improving thinking skills in early childhood using effective teaching strategies. *Aggression and Violent Behavior*, Article 101704. <https://doi.org/10.1016/j.avb.2021.101704>