Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran
Volume 11 (2) 254 – 268 December 2021
ISSN: 2088-5350 (Print) / ISSN: 2528-5173
(Online)Doi: 10.25273/pe.v11i2.10575
The article is published with Open Access at: http://e-journal.unipma.ac.id/index.php/PE

Interaction between mathematical disposition and independent learning in distance learning success: An ex post facto study

Imam Kusmaryono ✉, Universitas Islam Sultan Agung
Nuhyal Ulia, Universitas Islam Sultan Agung
M. Aminudin, Universitas Islam Sultan Agung

✉ *kusmaryono@unissula.ac.id*

Abstract: This study uses an ex post facto design with the aim of knowing the interaction between the independent variables (mathematical disposition and independent learning) as a determinant of the dependent variable (learning outcomes). The sample of this study was 32 elementary school students. The data was taken through a questionnaire method and a written test. Data analysis through two-way ANOVA test with interaction factors. The results showed that was an interaction between the independent variables (mathematical disposition and independent learning) on the dependent variable (learning outcomes) with a significance level of 0.05. Thus, it can be concluded that the interaction between mathematical disposition and independent learning is a determining factor in the mathematics learning outcomes of elementary school students in distance learning.

Keywords: Interaction, Mathematical disposition, Independent learning, Ex post facto design

Received 04 October 2021; **Accepted** 22 November 2021; **Published** 24 December 2021

Citation: Kusmaryono I., Ulia, N & Aminudin, M. (2021). Interaction between mathematical disposition and learning independence in distance learning: An ex post facto desgin. *Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran*, *11*(2), 254 – 268. Doi.org/10.25273/pe.v11i2.10575

INTRODUCTION

The COVID-19 pandemic that has hit the world has affected all sectors, including education. Due to the fast-paced COVID-19 pandemic, the paradigm of school education (learning) has changed from face-to-face learning (offline) in the classroom to distance learning in the network (online). The sudden change of the learning paradigm from offline to online is undoubtedly a problem in education for which a solution has been found (Graven, 2016; Kusmaryono et al., 2021a; Satyawan et al., 2021).

Learning mathematics for most students is a tricky thing and even causes learning anxiety (Rozgonjuk et al., 2020). Therefore it requires extra enthusiasm and motivation to learn or master it (Ulia & Kusmaryono, 2021). Especially in the current COVID-19 pandemic, learning mathematics is done through distance learning; it will increase the learning burden for elementary school students (Mata et al., 2012; Satyawan et al., 2021). Will they be successful in learning mathematics in distance learning? What is their disposition towards mathematics in distance learning? Do they have learning independence in distance learning? Many more questions arise in our minds.

The application used in distance learning (online) during this pandemic affects students' interest in learning and the tendency of students to behave, behave and act consciously to achieve goals called dispositions (Adi et al., 2019; Karlina, Intan & Astuti, 2021; Kusmaryono et al., 2021a). This disposition could be positive or negative, leading to students responding to situations (Facione, 2000). The survey results that have been carried out show that students' mathematical dispositions in distance learning affect student learning outcomes (Ulia & Kusmaryono, 2021).

Mathematical disposition is a belief or behavior in viewing and solving problems related to the context of mathematics, as well as the tendency to regard mathematics as something logical, practical, and valuable (Almerino, et al., 2019; Colita & Genuba, 2019; I. Kusmaryono et al., 2019). Mathematical disposition is an aspect that significantly supports students' success in learning mathematics remotely during this COVID-19 pandemic (Thomson & Pampaka, 2020; Ulia & Kusmaryono, 2021). The positive disposition of students towards mathematics will improve student performance in dealing with problems, fostering a sense of responsibility for learning mathematics, and developing better academic habits (Kusmaryono et al., 2021a; Russo et al., 2020).

Based on a literature review, a student's mathematical disposition is reflected in several indicators (Beyers, 2011; Feldhaus, 2014; Kusmaryono et al., 2019; National Council of Teachers of Mathematics (NCTM), 1989; Supriyanto et al., 2014) as follows: (1) Confidence in using mathematics, when completing math problems, giving arguments, and communicating ideas; (2) Flexibility in investigating mathematical ideas and looking for alternative methods to solve problems; (3) Diligent when doing math tasks; (4) Have interest and curiosity when doing math tasks; (5) Monitor and reflect on the performance that has been done while studying; (6) Assess the application of mathematics as useful in other situations and everyday experiences; and (7) Appreciating the role of mathematics in the culture and value of mathematics as a tool and language.

Learning independence is the ability of students to carry out learning activities independently with patience and lead to the achievement of the desired goals (Ghoizi et al., 2021; Mulyono, 2017). Learning independence is also a sense of responsibility that a person has in planning his learning, implementing, and evaluating his learning process (Ghoizi et al., 2021). A person's learning independence is characterized by characteristics such as creativity and initiative, responsibility, being able to restrain oneself and regulate behavior, and being able to make their own decisions (Knowles, et al., 2005 in Ghoizi et al., 2021).

Independent learning is closely related to motivation; the higher the student's motivation, the higher the possibility of carrying out his activities (Riyanti & Marwoto,

2019). Several research results found that learning independence was positively correlated with the achievement of student learning outcomes (Ghoizi et al., 2021; Mulyono, 2017). Independent learning is essential for students, especially in distance learning during the current COVID-19 pandemic. Through independent learning, students must understand the material and look for other relevant learning resources to provide excellent and maximum learning outcomes (Abidah et al., 2020; Darling-Hammond et al., 2020).

Distance learning (online) can be carried out at any time, not limited by space and time, learning resources are available very much, and we can get unlimited learning experiences. However, in its implementation for successful online learning, besides mathematical disposition (Almerino, et al., 2019; Ulia & Kusmaryono, 2021), it also requires high independent learning from each student (Lin et al., 2017).

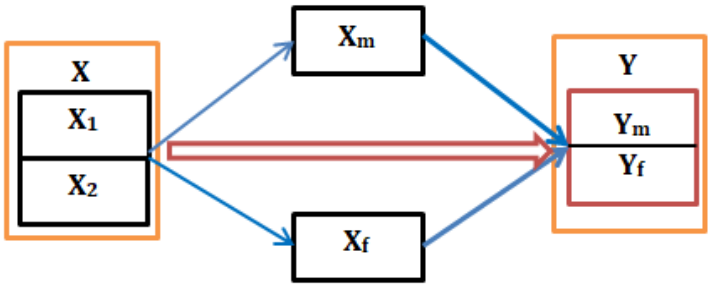
This research is designed to answer the following questions: (1) How big is elementary school students' level of mathematical disposition in participating in distance learning? (2) How big is elementary school students' level of learning independence in participating in distance learning? (3) How big is the mathematics learning achievement of elementary school students in distance learning? Furthermore, (4) Is there an interaction between mathematical disposition and learning independence in determining the mathematics learning outcomes of elementary school students in distance learning?

The results of this study provide a significant contribution to the importance of affective aspects in supporting student learning success. Teachers can use the results of this study to improve distance learning outcomes in mathematics now and in the future. The mathematical disposition and independent learning are the basic capital determining student success.

METHODS

Research Design

This study uses the Ex Post Facto Design, a quasi-experimental study that examines the independent variables and their impact on the dependent variable. Ex post facto research is carried out to examine an event and then look back to find out the factors that can cause the incident (Sehic, 2017; Sharma, 2019). In this quasi-experimental study, the samples were not taken at random (Sharma, 2019). Ex Post Facto research design is presented in the following scheme.



X = Affective; X_1 = Mathematical Disposition; X_2 = Learning Independence
X_m = Affective_Male ; X_f = Affective_Female
Y = Learning Outcomes (LO); Y_1 = LO Male; Y_2 = LO Female

FIGURE 1. Ex Post Facto Research Design

Participants

The participants in this study were a teacher, an observer, and 2 study groups in an elementary school, namely class VI-A = 32 students and class VI-B = 30 students. The students (participants) were aged between 10 to 11 years. The students who became the research respondents were not taken randomly but based on purposive sampling so that 32 students were obtained as respondents. Respondents consisted of 16 male students and 16 female students. The 32 selected respondents will receive treatment in mathematics learning with a problem-based learning approach.

Research Variable

The independent variable in this study consisted of 2 affective aspects, namely mathematical disposition (X1) and learning independence (X2). In contrast, the dependent variable of this study is the cognitive aspect, namely the results of mathematics learning outcomes (Y). Four combinations of independent variables were made to investigate the interaction between affective and cognitive aspects in the success of student learning outcomes in terms of gender, namely (1) Variable_1.00 = Disposition Math – Male; (2) Variable_2.00 = Disposition Math – Female; (3) Variable_3.00 = Independence – Male; and (4) Variable_4.00 = Independence – Female.

TABLE 1. *Mathematical disposition questionnaire instrument*

Indicators	Descriptions	Questionnaire numbers
Confidence	*Confidence in solving math problems, communicating ideas, and giving reasons*	1,2,3
Flexibility	*Flexibility in exploring mathematical ideas and trying out alternative methods of solving problems*	4,5,6
Usefulness	*Tendency to believe or believe about the usefulness of mathematics in other fields to meet current or future needs.*	7,8,9
Perseverance	*Tendency to persevere and try hard when necessary when involved in mathematical activities.*	10,11,12
Curiosity	*Interest, curiosity, and ability to find in doing math*	13, 14, 15
Appreciation	*Appreciation of the role of mathematics in culture and its value, both mathematics as a tool, and mathematics as a language*	16, 17, 18
Metacognition	*Tendency to monitor and reflect on thinking processes and performance of oneself as learners.*	19, 20

Source: (NCTM, 1989 in Ulia & Kusmaryono, 2021).

Material

Collecting research data was done through questionnaires and written tests. According to the mathematical disposition indicators, the mathematical disposition questionnaire consists of 20 statement items (**Table 1**). The learning independence questionnaire consists of 20 statement items according to the indicators of learning independence (**Table 2**). The questionnaire in this study was used to measure the level of mathematical disposition and students' independent learning in distance learning.

The type of questionnaire is a closed questionnaire, where respondents put a checkmark in the column according to the Likert scale 1-5. The written test consists of five

descriptive questions related to fractional operations. The maximum score for the written test is 100.

Mathematical disposition questionnaires (Ulia & Kusmaryono, 2021) and independent learning (Knowles, et al., 2005 in Ghoizi et al., 2021) have been developed by previous researchers. The quality of these instruments was tested for the level of validity and reliability. Test the validity of the instrument through the person product-moment formula and the instrument reliability test was carried out using the Cronbach's Alpha (Isaac & Chikweru, 2018).

TABLE 2. *Learning independence questionnaire instrument*

Indicators	Descriptions	Item Number
Have initiative	*Able to come up with own ideas*	1, 2
	Dare to act and make decisions	3
Formulate learning objectives	*Have a learning orientation to the future*	4, 5
	Have the ability to learn independently	6
Diagnosing learning goals	*Determining learning speed*	7
	Able to set learning goals	8, 9
Identify learning resources	*Trying to find reference sources for learning*	10
	Able to determine the material to be studied	11, 12
Choosing the right learning strategy	*Able to develop learning steps*	13, 14
	Understand how to study effectively	15, 16
Evaluating learning outcomes	*Play a role in evaluating learning*	17
	Able to reflect on their learning activities	18, 19
	Be aware of the increase and decrease in learning outcomes	20

Source:(Knowles, et al., 2005 in Ghoizi et al., 2021)

TABLE 3. *Validity of the mathematical disposition questionnaire instrument*

No. Item	r_{xy}	r_{table}	Decision	No. Item	r_{xy}	r_{table}	Decision
1	0.577	0.4683	Valid	11	0.660	0.4683	Valid
2	0.631	0.4683	Valid	12	0.651	0.4683	Valid
3	0.666	0.4683	Valid	13	0.479	0.4683	Valid
4	0.493	0.4683	Valid	14	0.714	0.4683	Valid
5	0.542	0.4683	Valid	15	0.698	0.4683	Valid
6	0.474	0.4683	Valid	16	0.704	0.4683	Valid
7	0.612	0.4683	Valid	17	0.502	0.4683	Valid
8	0.698	0.4683	Valid	18	0.497	0.4683	Valid
9	0.545	0.4683	Valid	19	0.612	0.4683	Valid
10	0.630	0.4683	Valid	20	0.543	0.4683	Valid

Testing the validity of the questionnaire instrument was carried out through the person product-moment formula (Isaac & Chikweru, 2018). The test results (**Tables 3** and **4**) show the r_{xy} values ranging from 0.474 to 0.714 (**Table 3**. *Validity of the mathematical disposition questionnaire instrument*) and from 0.479 to 0.893 (**Table 4**. *Validity of the learning independence questionnaire instrument*). Because all questionnaire items have an r_{xy} value greater than the r table value of 0.4683 Person product-moment at a significance level of 0.05, then all questionnaire items are said to be valid. Thus, the mathematical disposition questionnaire and learning independence questionnaire can be used as research instruments.

TABLE 4. *Validity of the learning independence questionnaire instrument*

No. Item	r_{xy}	r_{table}	Decision	No. Item	r_{xy}	r_{table}	Decision
1	0.748	0.4683	Valid	11	0.609	0.4683	Valid
2	0.625	0.4683	Valid	12	0.682	0.4683	Valid
3	0.774	0.4683	Valid	13	0.597	0.4683	Valid
4	0.529	0.4683	Valid	14	0.866	0.4683	Valid
5	0.479	0.4683	Valid	15	0.893	0.4683	Valid
6	0.606	0.4683	Valid	16	0.777	0.4683	Valid
7	0.593	0.4683	Valid	17	0.531	0.4683	Valid
8	0.542	0.4683	Valid	18	0.544	0.4683	Valid
9	0.674	0.4683	Valid	19	0.593	0.4683	Valid
10	0.486	0.4683	Valid	20	0.587	0.4683	Valid

TABLE 5. *Questionnaire instrument reliability test*

Reliability Statistics *Mathematical disposition instrument*		**Reliability Statistics** *Learning independence instrument*	
Cronbach's Alpha	N of Items	Cronbach's Alpha	N of Items
.761	**20**	**.872**	**20**

In **Table 5** each reliability test obtained Cronbach's Alpha values of 0.761 (instrument of mathematical disposition) and 0.872 (instrument of independent learning). The r table value for N = 20 with a significance of 0.4683 (Isaac & Chikweru, 2018). With these results, the results of r count **>** r table so that the questionnaire instrument developed is declared reliable and can be used as a research instrument.

TABLE 6. *Validity of instrument test*

No. Item	r_{xy}	r_{table}	Decision
1	0.892	0.632	Valid
2	0.698	0.632	Valid
3	0.738	0.632	Valid
4	0.738	0.632	Valid
5	0.697	0.632	Valid

Testing the validity of the written test instrument is carried out through the person product-moment formula (Isaac & Chikweru, 2018). The test results (Table 6) show the rxy values ranging from 0.697 to 0.892. Because all written test items have r_{xy} value greater than the r table value of 0.632 Person product-moment at a significance level of 0.05, then all written test items are said to be valid so that they can be used as research instruments.

TABLE 6. *Instrument test*

Reliability Statistics	
Cronbach's Alpha	N of Items
.645	**5**

In **Table 6** reliability test obtained Cronbach's Alpha values of 0.645. The r table value for N = 5 with a significance of 0.632 (Isaac & Chikweru, 2018). With these results,

the results of ***r*** count > ***r*** table so that can be used as a research instrument.

Procedure

In the first week before learning begins, the researcher gives a mathematical disposition questionnaire to students. Students fill out a mathematical disposition questionnaire by placing a checkmark in the appropriate score column. In the second and third weeks, the teacher carries out mathematics learning in four meetings (4 x 2 x 35 minutes) virtually using the Google Meeting application. Mathematics learning is designed with a problem-based learning approach. In the fourth week of learning, students complete a written test. One day after learning and completing the test students fill out a independent learning questionnaire.

Data analysis

The level of mathematical disposition and independent learning was measured using criteria that had been developed by previous researchers (Cheng, 2012; Ulia & Kusmaryono, 2021) as shown in **Table 7**.

TABLE 7. *Criteria of Mathematical Disposition and Learning Independence*

Level	Interval score	Category
V	$4.00 < \text{score} \leq 5.00$	Very High
IV	$3.00 < \text{score} \leq 4.00$	High
III	$2.00 < \text{score} \leq 3.00$	Moderate
II	$1.00 < \text{score} \leq 2.00$	Low
I	$\text{score} \leq 1.00$	Very Low

Sources: (Cheng, 2012; Ulia & Kusmaryono, 2021).

Questionnaire data and test results were processed with descriptive statistics. To test the interaction between independent variables on the dependent variable, a two-way ANOVA test with interaction factors was used. The criteria for measuring student learning outcomes from written test data are grouped into five intervals based on the mean and standard deviation of the normal distribution of data (Berengolts & Lindenbaum, 2008; Driscoll & Lecky, 2001). The achievement of student learning outcomes will be compared with the minimum criteria for learning outcomes of 70.00. The following are the criteria for measuring learning outcomes in **Table 8**.

TABLE 8. *Criteria of learning outcomes (LO)*

Level	Interval score	Category
V	$(\bar{x} + 2\sigma < \text{LO})$	Very High
IV	$(\bar{x} + 1\sigma < \text{LO} \leq \bar{x} + 2\sigma)$,	High
III	$(\bar{x} - 1\sigma < \text{LO} \leq \bar{x} + 1\sigma)$	Moderate
II	$(\bar{x} - 2\sigma < \text{LO} \leq \bar{x} - 1\sigma)$	Low
I	$(\text{LO} \leq \bar{x} - 2\sigma)$	Very Low

Sources: (Berengolts & Lindenbaum, 2008; Driscoll & Lecky, 2001).

RESULTS

The results of this study consist of three data, namely data on mathematical disposition, data on independent learning, and data on learning outcomes of mathematics. Data on

mathematical disposition and independent learning were obtained from the results of processing the questionnaire scores. Learning outcomes data were obtained from test results after students took part in mathematics learning.

Mathematical disposition

To answer the first research question, how big is the level of mathematical disposition of elementary school students in participating in distance learning? We have tested the mathematical disposition data to significantly prove that the data follow a normal distribution. The statistical description of the research data on students' mathematical dispositions is presented in **Table 9**.

TABLE 9. *Statistic descriptive of mathematical disposition*

Indicators	Students Male (N=16)		Students Female (N=16)	
	Mean	STDEV	Mean	STDEV
Confidence	3.61	0.77	3.12	0.87
Flexibility	3.73	0.64	2.90	0.73
Usefulness	3.59	0.44	3.20	0.82
Perseverance	3.45	0.76	2.86	0.50
Curiosity	3.35	0.78	2.60	0.75
Appreciation	3.77	0.48	3.17	0.66
Metacognition	3.85	0.61	2.90	0.89
Overall	**3.62**	**0.68**	**2.96**	**0.74**
Percentage	**65.6%**	**---**	**59.2%**	**---**
Category	High		Moderate	

TABLE 10. *Statistic descriptive of learning independence*

Indicators	Students Male (N=16)		Students Female (N=16)	
	Mean	STDEV	Mean	STDEV
Confidence	3.60	0.47	3.60	0.67
Dicipline	3.50	0.52	3.75	0.54
Initiative	2.80	0.42	2.95	0.38
Responsibility	3.00	0.46	3.74	0.40
Motivation	3.40	0.45	3.85	0.59
Overall	**3.26**	**0.46**	**3.58**	**0.52**
Percentage	**65.2%**	**---**	**71.6%**	**---**
Category	High		High	

Referring to **Table 9**, it can be seen that the level of mathematical disposition of male students is 3.62 (65.6%) in the high category and female students 2.96 (59.2%) in the medium category. If the average score of all students (32 students) is calculated, a score of 3.29 (62.4%) is obtained from the ideal score. In general, the level of mathematical disposition of elementary school students in distance learning is in the high category.

Learning Independence

To answer the second research question, how big is the level of independent learning of elementary school students in participating in distance learning? We have tested the independent learning data significantly proving that the data follow a normal distribution. The statistical description of the data from the research results of student independent

learning is presented in **Table 10**.

Referring to **Table 10,** it appears that the level of independent learning for male students is 3.26 (65.2%) in the high category and female students 3.58 (71.6%) in the high category. If the average score of all students (32 students) is taken, a score of 3.42 (68.4%) is obtained from the ideal score. In general, the level of independent learning of elementary school students in distance learning is in the high category (Fadiana et al., 2021).

Learning Outcomes

The third research question is how big is the mathematics learning outcomes of elementary school students in distance learning? We have tested the learning outcomes data to significantly prove that the data follow a normal distribution. Next determine the minimum, maximum, mean, and standard deviation scores. The data on the mathematics learning outcomes test has been analyzed statistically descriptively as shown in **Table 11** below.

TABLE 11. *Statistic descriptive of learning outcomes*

Respondent	N	Learning Achievement				
		Minimum	Maximum	Mean	STDEV	Category
Male	16	50	90	72.16	10.36	Moderate
Female	16	50	98	76.62	11.43	Moderate
Total	32	---	---	74.39	11.06	

The descriptive statistics of learning outcomes in **Table 11** show that the total average score is 74.39 with a standard deviation of 11.06. The score of classical learning outcomes has reached the target of the minimum criteria set (74.39 > 70.00). The average score of male students' learning outcomes (72.16) is in the medium category and female students (76.62) are in the medium category.

Interaction between Mathematical Disposition and Learning Independence

The fourth research question is whether there is an interaction between mathematical disposition and learning independence in determining the mathematics learning outcomes of elementary school students in distance learning? Questions were answered by analysis through the two-way ANOVA test with interactions (Tusell, 1990) in **Table 12** and **Figure 2**.

TABLE 12. *Tests of between-subjects effects*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	899.672[a]	3	299.891	3.131	.032
Intercept	375615.766	1	375615.766	3921.131	.000
Affective	293.266	1	293.266	3.061	.085
Gender	.016	1	.016	.000	.990
Affective * Gender	**606.391**	**1**	**606.391**	**6.330**	**.015**
Error	5747.563	60	95.793		
Total	382263.000	64			
Corrected Total	6647.234	63			

a. R Squared = .135 (Adjusted R Squared = .092)

Table 12 in the "Affective*Gender" row shows the significance value (Sig. 0.015 < 0.05) and the F value (F = 6.330; p < 0.05) resulting in Ho being rejected. So it can be concluded that there is a meaningful interaction between the affective aspects, namely mathematical disposition and learning independence with gender in determining learning outcomes. There is a relationship interaction between mathematical dispositions and learning independence in determining the level mathematics learning outcomes are also strengthened with that shown in **Figure 2.**

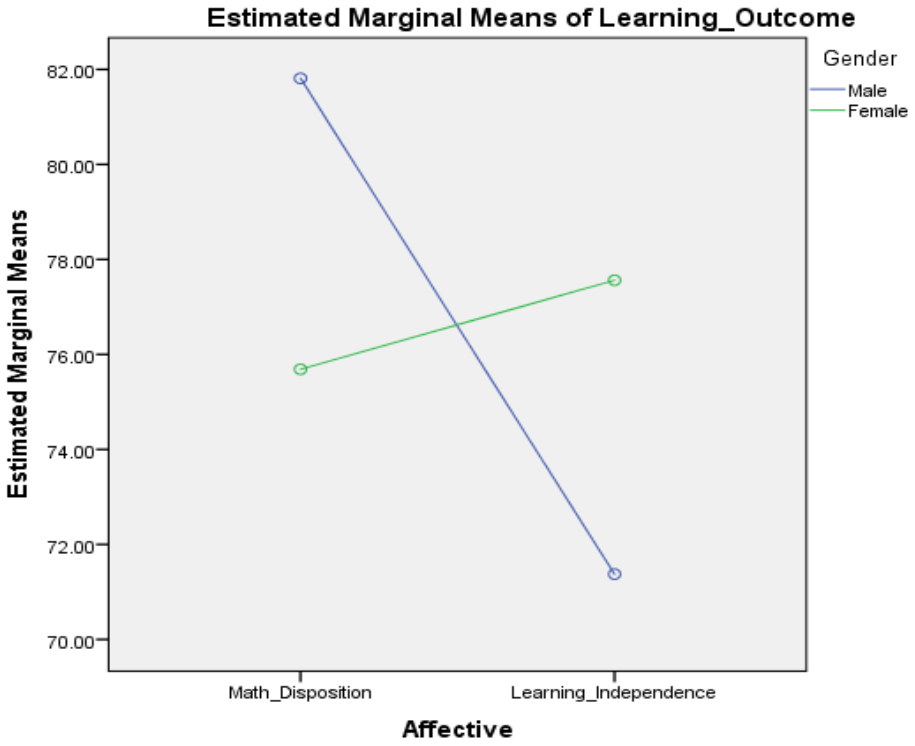


FIGURE 2. *Interaction of mathematical disposition and learning independence*

The graph in **Figure 2** shows the intersection of the lines. The intersection of these lines indicates an interaction in the affective aspect, namely between mathematical disposition and independent learning in terms of student gender. Where these two aspects affect student learning outcomes in male and female students significantly. Because it is significant, we continue to look at the post hoc multiple comparisons test (Aslam & Albassam, 2020; Lee & Lee, 2018). Based on the results of the Tukey HSD further test (Lee & Lee, 2018) it is known that there are differences in learning outcomes in terms of 4 combinations of affective aspects and gender. The effectiveness of the affective aspect in influencing student learning outcomes based on gender is illustrated in **Figure 3** below.

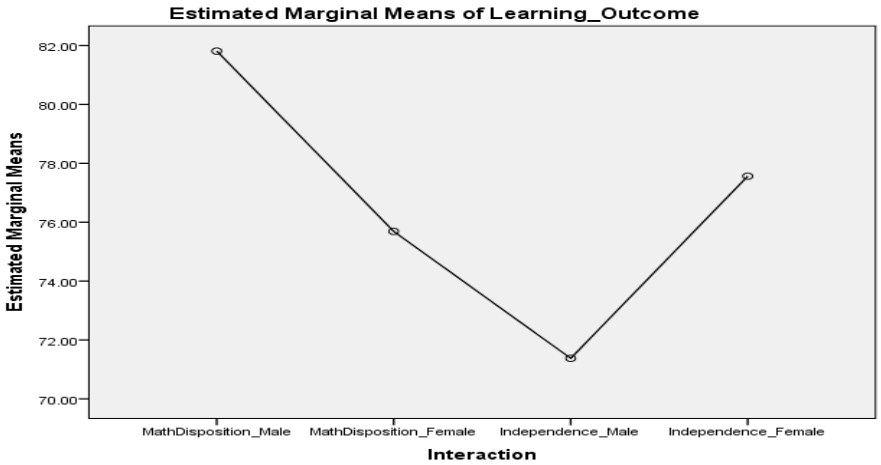


FIGURE 3. *Estimated marginal means of learning outcomes*

DISCUSSION

Looking back at the research data (**Table 9**), it appears that male students' level of mathematical disposition is better than female students. This difference is because female students have low scores on indicators: flexibility, perseverance, curiosity, and metacognition. In contrast, male students can achieve high categories on all indicators of mathematical disposition. However, in general, elementary school student's level of mathematical disposition in distance learning mathematics is in the high category.

Based on the research data analysis (**Table 10**), it appears that the level of learning independence of male and female students is in the high category. There is a slight difference in the achievement of the initiative indicator scores; female students have higher initiative scores. Often male students lose concentration and initiative when the teacher works hard for the growth of better critical thinking skills (Bahri & Corebima, 2015; Coman et al., 2020; Darling-Hammond et al., 2020), at the same time, they need the teacher's help to complete academic tasks (Darling-Hammond et al., 2020). Although the independence scores of female students were higher than male students, they were in the same class interval, namely the high category.

The achievement of a high level of mathematical disposition and student learning independence cannot be separated from the role of the teacher in creating effective learning (communication) interactions (Almerino, et al., 2019; Ulia & Kusmaryono, 2021). Learning interactions occur not only during mathematics learning but also outside of learning time. The teacher provides learning modules and fraction operation materials through videos. Learning modules and videos can be downloaded and studied repeatedly at any time by students. The teacher also provides a question and answer room with students through WhatsApp Groups.

Student responses to the implementation of problem-based learning-based distance learning, among others; (1) train logical thinking, reasoning, and construct knowledge (Kusmaryono et al., 2021b), (2) honed understanding skills (Bada & Olusegun, 2015; Cresswell & Speelman, 2020), (3) learning mathematics is fun, (4) they are more enthusiastic about learning mathematics, and (5) self-confidence increases to learn mathematics. So that the implementation of distance learning (online) can improve mathematical disposition, train independence, and increase student learning motivation (Almerino, et al., 2019; Kusmaryono et al., 2021a; Ulia & Kusmaryono, 2021).

The high level of mathematical disposition and learning independence impacts the achievement of learning outcomes. The statistical description of learning outcomes in Table 5 shows that both classically and in groups (gender) have succeeded in exceeding the minimum completeness criteria target of 70.00. The range and standard deviation of the learning outcomes of male and female students are not much different.

The results of the two-way ANOVA analysis with interactions (Kim, 2014; Tusell, 1990) (see **Table 12**) (see **Table 12**) significantly indicate the interaction between the independent variables (mathematical disposition and learning independence) on the dependent variable (learning outcomes). In other words, the interaction between mathematical disposition and learning independence is a determining factor for distance learning mathematics outcomes for elementary school students (see **Figure 2**). More in-depth interaction analysis regarding student gender (see **Figure 3**: Estimated Marginal Means of Learning Achievement) shows that student learning outcomes depend on gender and affective aspects, namely mathematical disposition and learning independence. The results of the analysis (**Figure 3**) confirm that the mathematical disposition of male students is more effective in supporting learning outcomes (Almerino, et al., 2019; Graven, 2016; Kusmaryono et al., 2019; Merz, 2009). In comparison, the independence of female students is more effective in supporting learning outcomes (Mulyono, 2017; Riyanti & Marwoto, 2019).

CONCLUSION

This study concludes that elementary school student's level of mathematical disposition in distance learning is in the high category. Also, the level of independent learning of elementary school students in distance learning is in the high category; the mathematics learning outcomes of elementary school students in distance learning are in the medium category (good enough), but both classically and as a group (gender) have succeeded in exceeding the minimum completeness criteria target. There is an interaction between the independent variables (mathematical disposition and learning independence) on the dependent variable (learning outcomes) with a significance level of 0.05. In other words, the interaction between mathematical disposition and learning independence is a determining factor in the mathematics learning outcomes of elementary school students in distance learning.

The limitation of this study is that due to the absence of control over the independent variables, it is challenging to obtain certainty that relevant causal factors have been included under investigation. Two factors that are related do not necessarily imply a causal relationship. All factors may be related to an additional unknown or unobserved factor.

In distance learning during the COVID-19 pandemic, they (students) need more how teachers teach effectively and help their learning difficulties towards learning independence. Therefore, the interaction between these variables requires the teacher to be responsible for paying attention to and maintaining the mathematical disposition of students to remain productive (positive) dispositions. Teachers need also to encourage and direct students' learning methods to increase students' independent learning

ACKNOWLEDGEMENT

Special thanks are given to the Sultan Agung Islamic University, Semarang, which provided research funds and elementary school students for their participation in the research.

REFERENCES

1. Abidah, A., Hidaayatullaah, H. N., Simamora, R. M., Fehabutar, D., & Mutakinati, L. (2020). The Impact of covid-19 to indonesian education and its relation to the philosophy of "Merdeka Belajar." *Studies in Philosophy of Science and Education*, *1*(1), 38–49. https://doi.org/10.46627/sipose.v1i1.9
2. Adi, M., Siregar, P., & Lisma, E. (2019). The effect of disposition student mathematics learning achievement in medan state 28 junior high school. *Journal of Community Service and Research*, *3*(1), 22–27.

3. Almerino, Jr., P. M., Etcuban, J. O., De Jose, C. G., & Almerino, J. G. F. (2019). Students' affective belief as the component in mathematical disposition. *International Electronic Journal of Mathematics Education*, *14*(3), 475–487. https://doi.org/10.29333/iejme/5750
4. Aslam, M., & Albassam, M. (2020). Presenting post hoc multiple comparison tests under neutrosophic statistics. *Journal of King Saud University - Science*, *32*(6), 2728–2732. https://doi.org/10.1016/j.jksus.2020.06.008
5. Bada, & Olusegun, S. (2015). Constructivism Learning Theory: A Paradigm for Teaching and Learning. *IOSR Journal of Research & Method in Education Ver. I*, *5*(6), 66–70. https://doi.org/10.9790/7388-05616670
6. Bahri, A., & Corebima, A. D. (2015). The contribution of learning motivation and metacognitive skill on cognitive learning outcome of students within different learning strategies. *Journal of Baltic Science Education*, *14*(4), 487–500.
7. Berengolts, A., & Lindenbaum, M. (2008). On the distribution of z score. *Iranian Journal of Science & Technology*, *32*(1), 1–9. https://doi.org/10.1109/cvpr.2004.1315211
8. Beyers, J. (2011). Development and evaluation of an instrument to assess prospective teachers ' dispositions with respect to mathematics. *International Journal of Business and Social Science*, *2*(16), 20–33.
9. Cheng, Y. S. (2012). A measure of second language writing anxiety: Scale development and preliminary validation. *Journal of Second Language Writing*, *13*(4), 313–335. https://doi.org/10.1016/j.jslw.2004.07.001
10. Colita, M. S., & Genuba, R. L. (2019). School climate and mathematical disposition of grade 10 students. *International Journal of Trends in Mathematics Education Research*, *2*(4), 173–178.
11. Coman, C., Ţîru, L. G., Meseşan-Schmitz, L., Stanciu, C., & Bularca, M. C. (2020). Online teaching and learning in higher education during the coronavirus pandemic: Students' perspective. *Sustainability (Switzerland)*, *12*(24), 1–22. https://doi.org/10.3390/su122410367
12. Cresswell, C., & Speelman, C. P. (2020). Does mathematics training lead to better logical thinking and reasoning? A cross-sectional assessment from students to professors. *PLoS ONE*, *15*(7), 1–21. https://doi.org/10.1371/journal.pone.0236153
13. Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, *24*(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791
14. Driscoll, P., & Lecky, F. (2001). An introduction to estimation - 2: From z to t. *Emergency Medicine Journal*, *18*(1), 65–70. https://doi.org/10.1136/emj.18.1.65
15. Facione, P. A. (2000). The Disposition Toward Critical Thinking: Its Character, Measurement, and Relationship to Critical Thinking Skill. *Informal Logic*, *20*(1), 61–84. https://doi.org/10.22329/il.v20i1.2254
16. Fadiana, M., Yulaikah, Y., & Kusumawati, D. (2021). The development of semiotic based contextual mathematics learning videos to support learning from home. *AL-ISHLAH: Jurnal Pendidikan*, *13*(1), 21–30. https://doi.org/10.35445/alishlah.v13i1.372
17. Feldhaus, C. A. (2014). How Pre Service Elementary School Teachers' Mathematical Dispositions are Influenced by School Mathematics. *American International Journal of Contemporary Research*, *4*(6), 91–97.
18. Ghoizi, E., M.V., R., Soedjarwo, S., & Ivan, K. (2021). The effect of learning motivation on learning independence and learning outcomes of students in the package C equivalence program. *IJORER : International Journal of Recent Educational Research*, *2*(4), 455–467. https://doi.org/10.46245/ijorer.v2i4.122
19. Graven, M. (2016). Strengthening maths learning dispositions through 'math clubs.' *South African Journal of Childhood Education*, *5*(3), 1–7.

https://doi.org/10.4102/sajce.v5i3.342
20. Isaac, O. E., & Chikweru, A. E. (2018). Test for significance of Pearson's correlation coefficient (r). *International Journal of Innovative Mathematics, Statistics & Energy Policies*, *1*(1), 11–23.
21. Karlina, Intan, S., & Astuti, S. (2021). Efektivitas pembelajaran luring dan daring terhadap hasil belajar tematik siswa di sekolah dasar. *Jurnal Ilmu Pendidikan*, *3*(4), 1717–1723. https://doi.org/10.31004/edukatif.v3i4.642
22. Kim, H. Y. (2014). Statistical notes for clinical researchers: Two-way analysis of variance (ANOVA)-exploring possible interaction between factors. *Restorative Dentistry & Endodontics*, *39*(2), 143. https://doi.org/10.5395/rde.2014.39.2.143
23. Kusmaryono, I., Suyitno, H., Dwijanto, D., & Dwidayati, N. (2019). The effect of mathematical disposition on mathematical power formation: Review of dispositional mental functions. *International Journal of Instruction*, *12*(1). https://doi.org/10.29333/iji.2019.12123a
24. Kusmaryono, I., Jupriyanto, J., & Kusumaningsih, W. (2021a). A systematic literature review on the effectiveness of distance learning: Problems, opportunities, challenges, and predictions. *International Journal of Education*, *14*(1), 62–69. https://doi.org/10.17509/ije.v14i1.29191
25. Kusmaryono, I., Jupriyanto, J., & Kusumaningsih, W. (2021b). Construction of students' mathematical knowledge in the zone of proximal development and zone of potential construction. *European Journal of Educational Research*, *10*(1), 341–351. https://doi.org/10.12973/eu-jer.10.1.341
26. Kusmaryono, I., Suyitno, H., Dwijanto, D., & Dwidayati, N. (2019). The effect of mathematical disposition on mathematical power formation: Review of dispositional mental functions. *International Journal of Instruction*, *12*(1), 343–356. https://doi.org/https://doi.org/10.29333/iji.2019.12123a
27. Lee, S., & Lee, D. K. (2018). What is the proper way to apply the multiple comparison test? *Korean Journal of Anesthesiology*, *71*(5), 353–360. https://doi.org/10.4097/kja.d.18.00242
28. Lin, Y. W., Tseng, C. L., & Chiang, P. J. (2017). The effect of blended learning in mathematics course. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(3), 741–770. https://doi.org/10.12973/eurasia.2017.00641a
29. Mata, M. de L., Monteiro, V., & Peixoto, F. (2012). Attitudes towards Mathematics: Effects of Individual, Motivational, and Social Support Factors. *Child Development Research*, *2012*(8), 1–10. https://doi.org/10.1155/2012/876028
30. Merz, A. (2009). Teaching for mathematical dispositions as well as for understanding: The difference between reacting to and advocating for dispositional Learning. *The Journal of Educational Thought*, *43*(1), 65–79. https://www.jstor.org/stable/23765513?seq=1
31. Mulyono, D. (2017). The influence of learning model and learning independence on mathematics learning outcomes by controlling students ' early ability. *International Electronic Journal of Mathematics Education*, *12*(3), 689–708.
32. National Council of Teachers of Mathematics (NCTM). (1989). *NCTM: Evaluation Standard 10: Mathematical Disposition*. NCTM. http://webapp1.dlib.indiana.edu/virtual_disk_library/index.cgi/4273355/FID3542/DOCS/ENC2280/28023310.HTM
33. Riyanti, G. A., & Marwoto, P. (2019). Enhancing independence and learning motivation by using youtube. *Physics Communication*, *1*(1), 86–93. https://doi.org/10.15294/physcomm.v0i0.20629
34. Rozgonjuk, D., Kraav, T., Mikkor, K., Orav-Puurand, K., & Täht, K. (2020). Mathematics anxiety among STEM and social sciences students: the roles of mathematics self-efficacy, and deep and surface approach to learning. *International Journal of STEM Education*, *7*(1), 1–11. https://doi.org/10.1186/s40594-020-00246-z
35. Russo, J., Bobis, J., Sullivan, P., Downton, A., Livy, S., McCormick, M., & Hughes, S.

(2020). Exploring the relationship between teacher enjoyment of mathematics, their attitudes towards student struggle and instructional time amongst early years primary teachers. *Teaching and Teacher Education*, *88*(102983), 1–9. https://doi.org/10.1016/j.tate.2019.102983

36. Satyawan, I. M., Wahjoedi, W., & Swadesi, I. K. I. (2021). The effectiveness of online learning through Undiksha e-learning during the covid-19 pandemic. *Journal of Education Technology*, *5*(2), 191. https://doi.org/10.23887/jet.v5i2.32364
37. Sehic, S. (2017). College-level second language courses and creative thinking skills : An ex post facto study. *The Journal of Language Teaching and Learning*, *7*(1), 119–142.
38. Sharma, S. (2019). Experimental and Ex Post Facto Designs. In *Horizon University: Vol. May* (pp. 1–17). Horizon University.
39. Supriyanto, A., Mardiyana, & Subanti, S. (2014). Karakteristik Berpikir Matematis Siswa SMP Majelis Tafsir Al- Qur ' an (MTA) Gemolong dalam Memecahkan Masalah Matematika pada Materi Sistem Persamaan Linear Dua Variabel (Spldv) Ditinjau dari Kemampuan Penalaran Siswa dan Gender. *Jurnal Elektronik Pembelajaran Matematika*, *2*(10), 1056–1068.
40. Thomson, S., & Pampaka, M. (2020). Exploring associations with mathematics dispositions: a novel perspective combining measurement and set-theoretic analytical approaches. *International Journal of Research and Method in Education*, *44*(5), 474–492. https://doi.org/10.1080/1743727X.2020.1856066
41. Tusell, F. (1990). Testing for interaction in two-way ANOVA tables with no replication. *Computational Statistics & Data Analysis*, *10*(1), 29–45.
42. Ulia, N., & Kusmaryono, I. (2021). Mathematical disposition of students', teachers, and aarents in distance learning: A survey. *Premiere Educandum : Jurnal Pendidikan Dasar Dan Pembelajaran*, *11*(1), 147–159. https://doi.org/10.25273/pe.v11i1.8869

PROFILE

Dr. Imam Kusmaryono is a senior lecturer at the faculty of teacher training and education, Universitas Islam Sultan Agung , Semarang. His area of expertise is mathematics education. Some of his scientific articles have been published in reputable international journals (Scopus ID: 57189000884).

Nuhlya Ulia, M.Pd. is the head of the primary school teacher education study program at Universitas Islam Sultan Agung, Semarang. Currently pursuing a doctoral program at a Semarang State University. [Sinta **ID**: 6041530]

M. Aminudin, M.Pd. is a lecturer in the mathematics education study program at the Sultan Agung Islamic University, Semarang. Currently pursuing a doctoral program at the State University of Malang.