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Integrative Learning Model: Mathematics Learning Outcomes Reviewed from Mathematical Resilience

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Abstract

The integrative learning model aims to support students in developing independent learning skills by using various thinking skills, as well as helping students develop a deep understanding of systematic knowledge building, while at the same time practicing critical thinking skills. This study aims to test the effect of the integrative learning model on mathematics learning outcomes as reviewed from students' mathematical resilience. This study was conducted in the Mathematics Education study program in the 2022.1 academic year, consisting of two classes with 87 students. A simple random technique was used to determine the control class and the experimental class. The control class, consisting of 43 people, was taught with a direct learning model, and the experimental class, consisting of 44 people, was taught with an integrative learning model. The design used in this study was factorial with a 2x2 level. The results found in this study were that learning outcomes in complex analysis courses taught with an integrative learning model were higher than with direct learning. Students' mathematical resilience influences students' mathematics learning outcomes, and there is an interaction between learning models and mathematical resilience on learning outcomes in the analysis of complex courses. The learning outcomes of the high-resilience student group taught using the integrative model were higher than direct learning, but there was no difference in learning outcomes in the low-resilience student group.

Keywords: Integrative Learning; Learning Model; Learning Outcomes; Resilience

1. Introduction

Mathematics learning should be a fun process [1] and should continue to be built and developed sustainably to develop potential and improve students' abilities in applying the knowledge they gain to solve problems that are currently being and will be faced today [2] and will compete for success in the world tomorrow so they must be able to learn new concepts and skills in mathematics [3].

The problem that occurs in mathematics learning, especially in complex analysis subjects, is that the learning outcomes obtained by students in recent years are still low. These low learning outcomes are caused by factors originating from students themselves and factors originating from outside students themselves. Factors originating from outside include the learning model applied by the course supervisor. So far, the learning model applied is the direct learning model. The direct learning model is a learning model that is dominated by teacher explanations combined with exercises and feedback to help students gain real knowledge and skills [4], [5] and keeps students continuously actively involved in learning and applying lesson materials in class with steps including (1) introduction, (2) presentation, (3) guided practice, and (4) independent practice [6], [7], [8]. With this direct learning model [9], students tend to be passive in learning (Usmadi et al., 2020), so students do not have the initiative to learn independently the material to be taught and only hope for the course supervisor [10].

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To overcome the problems that occur, it is necessary to apply one of the learning models that can activate students so that they can understand the material given by the lecturer. One of the learning models that can activate students and improve learning outcomes is the integrative learning model [11], [12], [13]. The integrative learning model is a model that develops the ability to create, recognize, and disseminate relationships between different concepts, fields, or contexts [14], which aims to support students in developing independent learning skills by using various thinking skills [15], [16] as well as helping students develop a deep understanding of systematic knowledge buildings that simultaneously train critical thinking skills and see the relationship between complex topic components [17], [18].

In addition, factors originating from outside the student that influence student learning outcomes are factors originating from within the student. One factor originating from within the student is resilience. Mathematical resilience as a quality attitude in mathematics learning includes: belief in achieving success through hard work, showing persistence in the face of difficulties, and willingness to discuss, reflect, and research [19], [20], [21]. [22], students who have strong resilience, have attitudes: adaptive or can adapt to their environment; can face bad weather, problems, and challenges; solve problems logically and flexibly; find creative solutions to challenges; have curiosity and learn from experience; have the ability to control themselves; be aware of their feelings; have a strong social network and are easy to provide assistance [23]. Resilience in the context of mathematics is a positive adaptive attitude and a person's fighting spirit in learning mathematics so that the person continues to learn mathematics even though they face difficulties and challenges [24]. [25], [26]. A person with strong resilience will support the growth of a persistent and persistent attitude in facing difficulties or challenges in learning mathematics. Conversely, a person with low mathematical resilience will lose their persistent and persistent attitude or give up easily when facing difficulties [23], [27]. Mathematical resilience has four factors, namely: (1) believing that brain abilities can be developed, (2) personal understanding of mathematical values, (3) understanding how to work in mathematics, and (4) awareness of peer support, other adults, ICT, the internet, and others [28].

The low learning achievement in the complex analysis course is caused by the inaccuracy of the applied learning model and the low resilience of students in solving complex analysis problems. Therefore, it is necessary to conduct research by applying an integrative learning model and its relationship to resilience in improving mathematics learning achievement, with the title "Integrative learning model: Learning achievement reviewed from mathematics resilience". This study aims to determine: (1) the effect of the integrative learning model on mathematics learning achievement, (2) the effect of the interaction between the learning model and resilience on mathematics learning achievement, (3) the difference in mathematics learning achievement between students taught with the integrative and direct learning models in students who have high resilience, and (4) the difference in mathematics learning achievement between students taught with the integrative and direct learning models in students who have low resilience.

2. Material and methods

This study uses a quantitative approach with a quasi-experimental method and uses a 2x2 treatment design level. The variables in this study are students' mathematics learning outcomes in the complex analysis (LO) course as the dependent variable, while the independent variable is the Learning Model (LM) by considering resilience (R) as a moderator variable. The design of this study is explained in Table 1.

Table 1 Treatment research design with 2x2 levels

Resilience (R)	**Learning Models (LM)**	
	Integrative (LM1)	**Direct (LM2)**
High (R1)	LM1R1	LM2R1
Low (R2)	LM1R2	LM2R2

2.1. LM1R1

Group of students taught with an integrative learning model for students with high resilience; LM2R1: Group of students taught with a direct learning model for students with high resilience; LM1R2: Group of students taught with an integrative learning model for students with low resilience; and LM2R2: Group of students taught with a direct learning model for students with low resilience.

This research was conducted in the Mathematics Education study program in the 2022.1 academic year, consisting of two classes with a total of 87 students. The determination of the experimental class and the control class was carried out randomly. The odd class consisted of 43 students, as the control class was taught using the direct learning model, and the even class consisted of 44 students, as the experimental class was taught using the integrative learning model.

The instruments in this study consisted of two, namely essay tests and questionnaires. Essay tests were used to measure learning outcomes in complex analysis courses consisting of 5 items. The questionnaire was used to measure students' mathematical awareness of complex analysis subjects, with as many as 40 questions.

The research procedure was carried out in the following stages: (1) providing a resilience questionnaire to all students who participated in the complex lecture analysis, (2) determining the number of subjects in each group LM1R1, LM2R1, LM1R2, and LM2R2, each as many as 14 people, (3) applying an integrative learning model to the experimental class and a direct learning model to the control class for six meetings, (4) providing a learning outcome test, (5) analyzing data using descriptive and inferential statistics using 2-way ANOVA, and (6) drawing conclusions..

3. Results

The results of the analysis of student learning outcomes data taught with the integrative learning model (LM1) obtained an average value of 73.56 and a standard deviation of 12.58, with a minimum value of 54.23 and a maximum of 94.41. The learning outcomes of students taught with the direct learning model (LM2) obtained an average value of 66.92 and a standard deviation of 6.38, with a minimum value of 56.23 and a maximum of 79.41. The learning outcomes of students taught with the integrative learning model on students with high resilience (LM1R1) obtained an average value of 84.86 and a standard deviation of 6.03, with a minimum value of 73.53 and a maximum of 94.41. The learning outcomes of students taught with an integrative learning model for students with low resilience (LM1R2) obtained an average value of 62.26 and a standard deviation of 4.14, with a minimum value of 54.23 and a maximum of 67.65. The learning outcomes of students taught with a direct learning model for students with high resilience (LS2R1) obtained an average value of 67.41 and a standard deviation of 6.82, with a minimum value of 58.82 and a maximum of 79.41. The learning outcomes of students taught with a direct learning model for students with low resilience (LM2R2) obtained an average value of 66.42 and a standard deviation of 6.13, with a minimum value of 56.23 and a maximum of 76.47. For more details, the results of the descriptive analysis can be seen in Table 2.

Table 2 Results of descriptive statistical analysis

Variable	N	Minimum	Maximum	Mean	Std. Deviation
LM1	28	54.23	94.41	73.56	12.58
LM2	28	56.23	79.41	66.92	6.38
LM1R1	14	73.53	94.41	84.86	6.03
LM1R2	14	54.23	67.65	62.26	4.14
LM2R1	14	58.82	79.41	67.41	6.82
LM2R2	14	56.23	76.47	66.42	6.13

The results of the normality test of LM1, LM2, LM1R1, LM1R2, LM2R1, and LM2R2 data using the Kolmogorov-Smirnov test obtained a Sig. value greater than 0.05. This indicates that the LM1, LM2, LM1R1, LM1R2, LM2R1, and LM2R2 data are normally distributed. For more details, the data from the normality calculation results can be seen in Table 3.

Table 3 Data Normality Test Results

	Kode	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
LO	LM1	0.112	28	0.120	0.916	28	0.128
	LM2	0.100	28	0.200(*)	0.958	28	0.321
	LM1R1	0.186	14	0.200(*)	0.954	14	0.620
	LM1R2	0.118	14	0.200(*)	0.941	14	0.431
	LM2R1	0.154	14	0.200(*)	0.916	14	0.193
	LM2R2	0.109	14	0.200(*)	0.969	14	0.860

* This is a lower bound of the true significance. a Lilliefors Significance Correction

The results of the homogeneity test of LM1 and LM2 data using Levene statistics obtained a Sig.=0.124 value. Because the Sig. value is greater than 0.05, then the LM1 and LM2 data are homogeneous. Furthermore, the results of the homogeneity test for the LM1R1, LM1R2, LM2R1, and LM2R2 data obtained a Sig.=0.262 value greater than 0.05. This means that the LM1R1, LM1R2, LM2R1, and LM2R2 data are homogeneous.

The hypotheses tested in this study are: (1) the integrative learning model has an influence on learning outcomes in the complex analysis course, (2) mathematical resilience has an influence on learning outcomes in the complex analysis course, (3) there is an interaction effect between the learning model and resilience on learning outcomes in the complex analysis course, (4) the learning outcomes of students in the complex analysis course taught using the integrative learning model are higher than the learning outcomes of students taught using direct learning for students who have high mathematical resilience, and (5) the learning outcomes of students in the complex analysis course taught using the integrative learning model are lower than the learning outcomes of students taught using direct learning for students who have low mathematical resilience.

Hypothesis testing 1, hypothesis 2, and hypothesis 3 were conducted using two-way ANOVA. The results of hypothesis testing using two-way ANOVA are presented in Table 4.

Dependent Variable: LO

Table 4 Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4202.426(a)	3	1400.809	40.733	.000
Intercept	276277.802	1	276277.802	8033.599	.000
LM	617.719	1	617.719	17.962	.000
R	1949.478	1	1949.478	56.687	.000
LM * R	1635.229	1	1635.229	47.549	.000
Error	1788.295	52	34.390		
Total	282268.523	56			
Corrected Total	5990.721	55			

a R Squared = .701 (Adjusted R Squared = .684)

Hypothesis 1 to be tested is that the integrative and direct learning model has an influence on learning outcomes in the complex analysis subject. The results in Table 4, row LM, give a value of F = 17.962 with a Sig. value = 0.00 smaller than α = 0.05. This result means that the integrative and direct learning model has a significant influence on learning outcomes in the complex analysis course. Furthermore, the results of further testing of the findings in hypothesis 1 were carried out using the t-test. The results of the t-test can be seen in Table 5 below.

Table 5 Results of the test of differences in influence between integrative and direct LM

		Levene's Test for Equality of Variances		**t-test for Equality of Means**		
		F	Sig.	t	df	Sig. (2-tailed)
		Lower	Upper	Lower	Upper	Lower
LO	Equal variances assumed	27.125	.000	2.492	54	0.016
	Equal variances not assumed			2.492	40.036	0.017

The results in Table 5 provide the meaning that student learning outcomes in the complex analysis course taught using the integrative learning model are higher than the learning outcomes of students taught using the direct learning model.

Hypothesis 2 to be tested is that mathematical resilience has an influence on the learning outcomes of complex analysis subjects. The results in Table 4 row R give an F value = 56.687 with a Sig. value = 0.00 smaller than α = 0.05. This means that students' mathematical resilience has an influence on the learning outcomes of complex analysis subjects.

Hypothesis 3 to be tested is the influence of the interaction analysis between the learning model and resilience on the learning outcomes of the complex analysis course. The results in Table 4 row LM * R give a value of F = 47.549 with a Sig. value = 0.00 smaller than α = 0.05. This result means that there is an influence of interaction between the learning model (LS) and Resilience (R) on the learning outcomes of the complex analysis course.

Hypothesis 4 and hypothesis 5 testing were conducted using Tukey's advanced test. The results of hypothesis testing using Tukey are presented in Table 6.

Table 6 Multiple Comparisons Dependent Variable: LO

	(I) Kode	**(J) Kode**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
			Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound
Tukey HSD	LM1R1	LM1R2	22.608	2.216	0.000	16.725	28.491
		LM2R1	17.45	2.217	0.000	11.567	23.333
	LM1R2	LM1R1	-22.608	2.217	0.000	-28.490	-16.725
		LM2R2	-4.165	2.217	0.250	-10.048	1.718

Hypothesis 4 to be tested is that the learning outcomes of students in complex analysis courses taught with an integrative learning model are higher than the learning outcomes of students taught with direct learning in students who have high mathematical resilience. The results in Table 6 rows LM1R1 vs LM2R1 give a Sig.=0.00 value smaller than α=0.05. This result means that hypothesis 4 is accepted.

Hypothesis 5 to be tested is that student learning outcomes in complex analysis courses taught with an integrative learning model are lower than student learning outcomes taught with direct learning for students who have low mathematical resilience. The results in Table 5 row LM1R2 vs LM2R2 give a Sig.=0.25 value greater than α=0.05. This result means that hypothesis 5 is rejected, which means there is no difference in student learning outcomes in complex analysis courses taught with an integrative learning model and those taught with direct learning for students who have low mathematical resilience.

4. Discussion

Based on the research results that have been explained, it was obtained that the integrative learning model has a direct effect on the learning outcomes of the complex analysis course. The average learning outcomes taught with the integrative learning model were 73.56 higher than the learning outcomes of students taught with the direct learning model, 66.92. These results are supported by the results of the t-test, that the learning outcomes of the complex analysis course taught with the integrative learning model were higher than those with direct learning. This is because the integrative learning model can develop the ability to create, recognize, and transmit relationships between different concepts, fields, or contexts [14], which aims to support students in trying to develop independent learning skills by using various thinking skills [15], [16], as well as helping students develop a deep understanding of systematic knowledge buildings that simultaneously train critical thinking skills [8], [29], [30] and see the relationship between complex topic components [17], [31], [32]. Integrative learning is said to be a learning process that involves sharing and exchanging information, creating new relationships based on that information, and formulating it into new structures.

The second finding obtained from this study is that mathematical resilience influences learning outcomes in complex analysis courses. This is because mathematical resilience can trigger self-confidence through hard work, perseverance in facing difficulties, and wanting to discuss, reflect, and research to improve their learning outcomes [23], [33], [34]. Students who have high resilience have a high fighting spirit to improve their learning outcomes, on the other hand, students who have low resilience do not care about their learning outcomes. Student resilience can overcome obstacles in learning mathematics due to a lack of self-confidence and anxiety in learning mathematics, and it has an impact on students' intellectual abilities [35]. In other words, resilience is the ability of individuals to face and respond positively to unpleasant situations and decisions to take advantage of unpleasant conditions as opportunities for students to develop [36]. From the description above, mathematical resilience is also commonly called mathematical resilience.

The third hypothesis provides information that there is an interaction effect between learning models and resilience on learning outcomes in complex analysis subjects. This information is reinforced by the plot results presented in Figure 1 below.

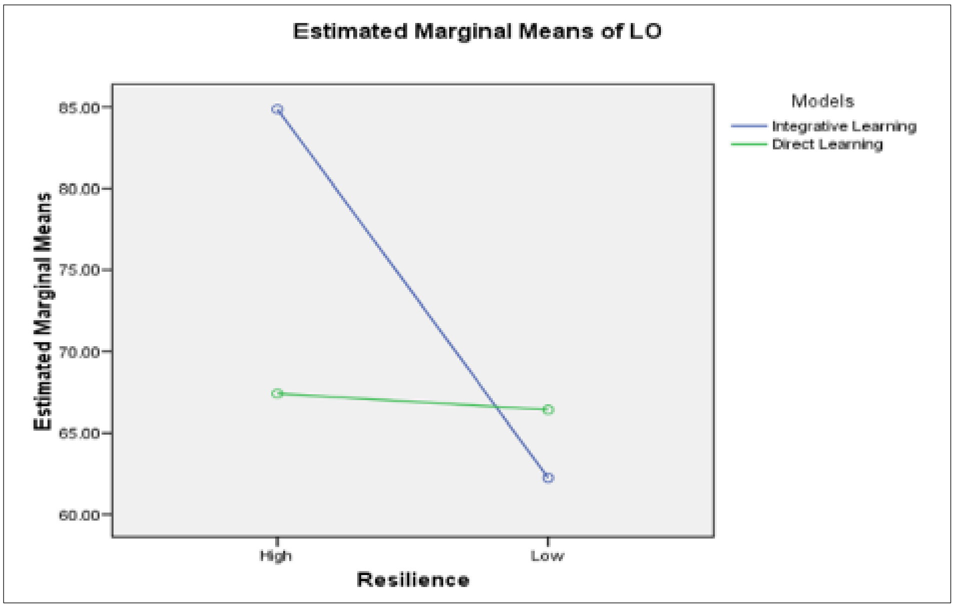

Figure 1 Interaction between learning models and resilience

This means that students who receive high-quality learning show higher success than students who receive low-quality learning based on learning outcomes measured using standardized basic skills tests. The application of effective learning models will result in higher student scores; therefore, educators must consider relevant learning models when designing learning. However, the selection of the right learning model must accommodate the different characteristics of students. Students who have resilience are students who believe that they will achieve their success through hard work, show perseverance in the face of difficulties, and are willing to discuss, reflect, and research [19], [20], [21]. Students who have high resilience have an adaptive attitude or can adapt to their environment; can face bad weather, problems, and challenges; solve problems logically and flexibly; find creative solutions to challenges; are curious and learn from experience; have the ability to control themselves; aware of their feelings; have strong social networks and are easy to help [20].

The fourth finding provides information that student learning outcomes in complex analysis courses taught with an integrative learning model are higher than student learning outcomes taught with direct learning in students who have high mathematical resilience. This is because students who have high resilience will support the growth of a persistent and persistent attitude in facing difficulties or obstacles to learning mathematics [23], [27], students who have high resilience have an adaptive attitude or can adapt to their environment; can face bad weather, problems, and challenges;

solve problems logistically and flexibly; find creative solutions to challenges; are curious and learn from experience; have the ability to control themselves; are aware of their feelings; have a strong social network and are easy to provide assistance [20]. Students who have high resilience and are given an integrative learning model can be persistent and persistent in facing difficult mathematics material and can find creative solutions to solve problems so that learning outcomes in complex courses increase. Students who are taught with an integrative learning model in the form of collaboration will easily communicate the knowledge they have so that students' understanding of mathematics lessons will be deeper and as a result, student learning outcomes can increase [37]. Integrative learning encourages students to actively build their mathematical knowledge by connecting various facts, rules, and concepts, which they already have with new information they get and then continue by building hypotheses and making conclusions through scientific procedures.

The fifth finding provides information that there is no difference in student learning outcomes in complex analysis subjects taught with an integrative learning model and those taught with direct learning in students who have low mathematical resilience. Students who have low mathematical resilience will lose their perseverance and persistence or give up easily when faced with difficulties [23], [27]. Students who have low resilience do not care about their learning outcomes because they tend to give up when faced with difficult questions [33], [38], and will lose their perseverance and persistence [23], [27]. This finding is interesting because it indicates that the application of the learning model does not substantially affect learning outcomes in this group of students. Integrative learning and direct learning are two different learning models in teaching complex analysis courses. However, in testing students with low mathematics resilience, no differences in learning outcomes were detected between the two.

5. Conclusion

Based on the results and discussion, it can be concluded that:

- The learning outcomes of the complex analysis course taught using an integrative learning model are higher than those taught using direct learning,
- Students' mathematical resilience has an influence on students' mathematics learning outcomes,
- There is an interaction between the learning model and mathematical resilience on the learning outcomes of the complex analysis course,
- The learning outcomes of the group of students with high resilience who are taught using an integrative learning model are higher than those taught using direct learning, and
- There is no difference in learning outcomes in the group of students with low resilience who are taught using an integrative learning model or direct learning.

Compliance with ethical standards

Disclosure of conflict of interest

The authors have declared no conflict of interest in relation to this article.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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