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Simulation Design Bandpass Filter Microstrip Center Frequency 113 Mhz Using Hairpin Structure

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ABSTRACT

Bandpass filter is an important component in aviation equipment that functions to pass the desired frequency and to stop unwanted frequencies. In this research, the simulation design was carried out with a bandpass filter microstrip which works on the center frequency 113 MHz using hairpin structure for the receiver navigation analyzer system. This system is one of the systems installed in drone in implementation ground inspection for ILS/VOR equipment. Bandpass filter is designed using a simulation software with various dielectric materials / substrates, such as R04350, FR-4, and RT5880, for comparison purposes. The simulated parameter values obtained include return loss, insertion loss, and bandwidth.

Keyword : bandpass filter, return loss, insertion loss, bandwidth, ILS/VOR, hairpin structure.

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1. INTRODUCTION

The implementation of air traffic services activities is closely tied to the execution of maintenance and reporting activities. In KP 35 of 2019 regarding Flight Telecommunication Facility Maintenance and Reporting Procedures, it asserts that to sustain the capability, capacity, and quality of flight telecommunication facilities, service providers must carry out maintenance of flight telecommunication facilities in accordance with the provisions specified in this regulation (Direktorat Jenderal Perhubungan Udara, 2019).

Maintenance and reporting activities can be performed through ground inspection and flight inspection activities. Ground inspection is typically conducted by transporting a Portable ILS/VOR Receiver (PIR) equipment to the location of the facility. Keeping up with the advancements of time, new concepts are required, such as the use of Unmanned Aerial Vehicles (UAVs) or drones for ground inspection. This concept's utilization can enhance effectiveness and efficiency (Schrader et al., 2016).

The use of drones itself necessitates several installed systems, one of which is the receiver navigation analyzer system, which also comprises several components. One of these components is the bandpass filter (bpf). Bpf functions to filter the desired frequencies. In the design process, microstrip will be employed to achieve compact size and lightweight characteristics (Lu et al., 2017). The hairpin structure technique is also utilized for comparing different types of materials used in this context.

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Table 1. Literature Review

Reference	Parameters					
	Frequency	**Return Loss (S11)**	**Insertion Loss (S21)**	**Bandwidth**	**Filter Design**	**Dielectric Material**
(Praludi & Sulaeman, 2016)	3 GHz	≤ -20 dB	≥ -3 dB	200 MHz	Hairpin Structure	RO4350
(Khani et al., 2017)	2.4 5.7 GHz	≤ -20 dB	≥ -1 dB	≥ 70 MHz	T-Shaped Resonator	RT5880
(Fitria Nurjihan & Munir, 2020)	1.52 – 5.53 GHz	≤ -10 dB	≥ -3 dB	4.01 GHz	Defected Ground Structure	FR4
(Fubian et al., 2018)	L-Band	≤ -20 dB	≥ -1 dB	10 MHz	SIR	RT5880
(Orifansyah et al., 2020)	2.3 GHz	≤ -10 dB	≥ -3 dB	100 MHz	Hairpin Structure	FR4
(Astuti & Walesian, 2014)	1.8 GHz	≤ -15 dB	≥ -0.2 dB	60 MHz	Hairpin Structure	ROTMM10i
(Gracia Simatupang et al., 2018)	2.1 GHz	≤ -15 dB	≥ -1 dB	250 MHz	Square Open Loop Resonator	RO3210

A. ***Ground Inspection***

Ground inspection is a testing and assessment carried out on the ground for electronic and electrical aviation facilities equipment utilized in air traffic services (Fatonah, 2014). The ground inspection process is conducted periodically, typically once a month for ILS/VOR equipment (near field or far field) at various observation points.

B. ***Drone***

A drone is an unmanned aircraft that is remotely controlled using a controller or computer. Drones are manufactured in various sizes and capabilities. They are generally classified based on their flying abilities, altitude, range, and payload size (Mozaffari et al., 2019). In this context, drones are utilized to conduct ground inspection on aircraft navigation systems by measuring the radio frequency signals from the Instrument Landing System (ILS) / Very High Frequency Omni-directional Range (VOR).

C. ***Bandpass Filter***

A filter that allows signals within a specific frequency range, known as the passband, to pass through is called a bandpass filter. It is also capable of attenuating signals with lower and higher frequencies, thus, it can be stated that a bandpass filter has two stopbands (Bismoko, 2016).

D. ***Microstrip Line***

Microstrip is a transmission line consisting of a conductor strip (line) and a ground plane separated by a dielectric medium with a dielectric constant ε_r (Rohman, 2019).

E. ***Hairpin Structure***

A hairpin structure filter is a filter with an orderly arranged structure. This filter concept involves bending a microstrip path into two segments resembling the letter "U", with a bending angle of 90 degrees, and then placing them in parallel (Praludi & Sulaeman, 2016).

1. Transmission Line Width (W)

$$u = \frac{W}{h} = \frac{8e^A}{e^{2A} - 2}$$
$$A = \frac{Z_0}{60}\left[\frac{\varepsilon_r + 1}{2}\right]^{0.5} + \frac{\varepsilon_r - 1}{\varepsilon_r + 1}\left[0.23 + \frac{0.11}{\varepsilon_r}\right] \quad (1)$$

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2. Effective Dielectric Material Permittivity ($\varepsilon_{r,eff}$)

$$\varepsilon_{r,eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + \frac{12h}{W}\right)^{0.5} \quad (2)$$

3. Wavelength (λ_g)

$$\lambda_g = \frac{300}{freq\sqrt{\varepsilon_{r,eff}}} \quad (3)$$

4. Groundplane

$$L_s = 5 + Total\ Lebar\ Patch \quad (4)$$
$$W_s = 5 + W$$

F. BPF Microstrip Parameters

In determining the performance or effectiveness of a bandpass filter, it is necessary to define various parameters. These parameters are interrelated with each other (Orifansyah et al., 2020).

1. Frequency; is the number of wave vibrations per second, ranging from 30 KHz to 300 GHz, commonly referred to as radio frequency (RF). The unit of frequency is Hertz (Hz), where one Hz is defined as one cycle per second.
2. Return Loss (S11); also known as the reflection coefficient, is the amount of power reflected back towards the source from an improperly terminated point. The minimum value of return loss commonly used is < -10 dB to determine the bandwidth width.
3. Insertion Loss (S21); commonly referred to as the insertion loss, is the power sent from the source to the load, some of which is reflected back to the source and some is transmitted to the load. The commonly used minimum value is > -3 dB.
4. Bandwidth; commonly referred to as the frequency range in the middle of a bandpass filter. Bandwidth can be calculated based on the return loss characteristics.

2. RESEARCH METHOD

The method used in this research is the PPE (Planning, Production, Evaluation) model developed by Richey and Klein (Sugiyono, 2020). The focus of this method is a comprehensive analysis from the beginning to the end, covering Design, Production, and Evaluation stages.

Fig 1. PPE Model

Planning is the process of creating a product plan with specific objectives. Planning begins with needs analysis through research and literature study. Production involves the process of creating a product based on the established design. Evaluation is the testing and assessment of the quality and performance of the product against predetermined specifications. Here are the steps involved.

A. Planning

Planning is the stage of designing a microstrip bandpass filter. Literature study and analysis of the required materials, specifications, and dimensions are conducted.

Table 2. Dielectric Materials

Materials	ε_r	h
RO4350	3.77	1.44
FR-4	4.3	1.6
RT5880	2.2	1.58

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Table 3. Bandpass Filter Spesifications

Parameters	Values
Center Frequency	113 MHz
Return Loss	≤ -10 dB
Insertion Loss	≥ -3 dB
Bandwidth	± 10 MHz

B. Production

This is the design stage of the microstrip bandpass filter. Calculation of dimensions using microstrip bandpass filter formulas is performed, followed by the initial design of the bandpass filter based on these calculations.

Table 4. Bandpass Filter Dimension

Description	RO4350	FR4	RT5880
Resonator Length (W)	544.5 mm	738 mm	625.5 mm
Resonator Width (L)	10 mm	10 mm	10 mm
Groundplane Length (W_s)	549.5 mm	743 mm	630.5 mm
Groundplane Width (L_s)	410 mm	410 mm	410 mm
Feedline Length (F_i)	45 mm	45 mm	45 mm
Feedline Width (L_f)	3 mm	3 mm	3 mm

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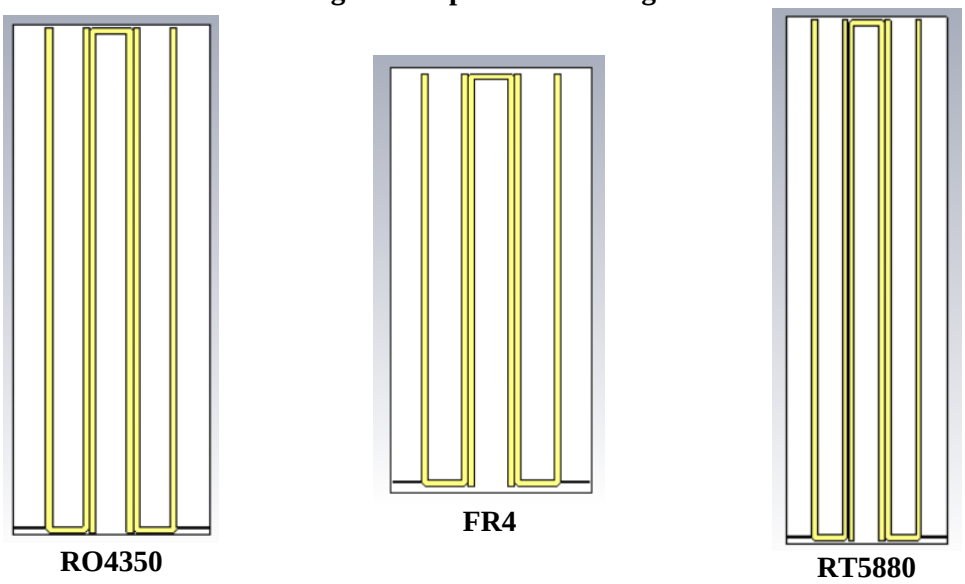
Fig 2. Bandpass Filter Design



RO4350 **FR4** **RT5880**

C. Evaluation

This is the stage of optimizing the dimensions of the microstrip bandpass filter, followed by simulating the design results of the optimization. The parameters simulated include center frequency, return loss, insertion loss, and bandwidth.

Table 5. Bandpass Filter Dimension After Optimation

Description	RO4350	FR4	RT5880
Resonator Length (W)	745.12 mm	669.55 mm	933.93 mm
Resonator Width (L)	9.38 mm	9.825 mm	9.38 mm
Groundplane Length (W_s)	751.97 mm	689.39 mm	943.73 mm
Groundplane Width (L_s)	288 mm	325.55 mm	288 mm
Feedline Length (F_i)	45 mm	45 mm	45 mm
Feedline Width (L_f)	3 mm	3 mm	3 mm

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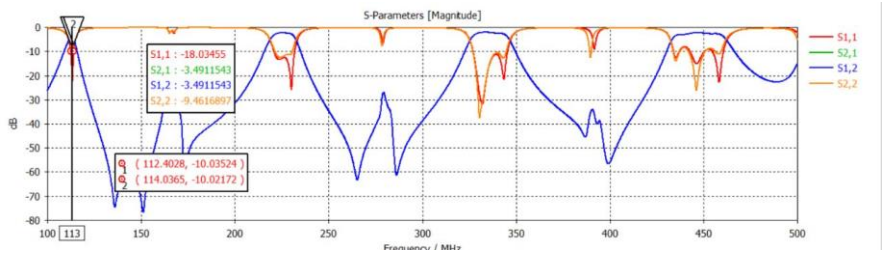
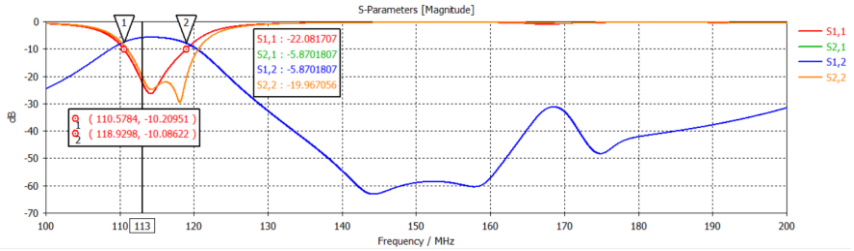
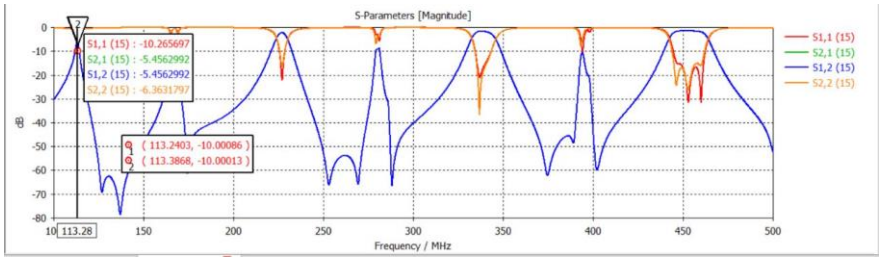
Fig 3. Simulation of Bandpass Filter



RO4350



FR4



RT5880

3. RESULTS AND DISCUSSION

After conducting the final simulation based on the optimized dimensions, differences in simulation parameters were discovered among the materials used. Subsequently, these differences were further analyzed to examine the resulting parameters and their comparisons.

A. Return Loss (S11)

Table 6. Return Loss Comparison

Materials	Spesification	Simulations	Explanations
RO4350	≤ -10 dB	-18.03 dB	V
FR4		-22.08 dB	
RT5880		-10.26 dB	

V = Satisfied
X = Unsatisfied

The table above indicates that the bandpass filter made from the three different materials has met the specified return loss requirement of being less than or equal to -10 dB. For RO4350, the value is -18.03 dB, for FR4 it is -22.08 dB, and for RT5880 it is -10.26 dB.

B. Insertion Loss (S21)

Table 7. Return Loss Comparison

Materials	Spesification	Simulations	Explanations
RO4350	≥ -3 dB	-3.49 dB	X
FR4		-5.87 dB	
RT5880		-5.45 dB	

V = Satisfied
X = Unsatisfied

The table above indicates that the bandpass filter made from the three different materials has not yet met the specified insertion loss requirement of being greater than or equal to -3 dB. For RO4350, the value is -3.49 dB, for FR4 it is -5.87 dB, and for RT5880 it is -5.45 dB.

C. Bandwidth

Table 8. Return Loss Comparison

Materials	Spesification	Simulations	Explanations
RO4350	± 10 MHz	2 MHz	X
FR4		8 MHz	
RT5880		0.1 MHz	

V = Satisfied
X = Unsatisfied

The table above indicates that the bandpass filter made from the three different materials has not yet met the specified bandwidth requirement, which is approximately -10 MHz. For RO4350, the value is 2 MHz, for FR4 it is 8 MHz, and for RT5880 it is 0.1 MHz.

4. CONCLUSION

The conclusions that can be drawn based on the results obtained from the research are as follows as can be drawn.

1. This research has been conducted regarding the simulation of a 113 MHz frequency bandpass filter using a hairpin structure with three different materials: RO4350, FR4, and RT5880.
2. There are differences in simulation results among these three materials. In terms of return loss, RO4350 has a value of -18.03 dB, FR4 has a value of -22.08 dB, and RT5880 has a value of -10.26 dB. For insertion loss, RO4350 has a value of -3.49 dB, FR4 has a value of -5.87 dB, and RT5880 has a value of -5.45 dB. Regarding bandwidth, RO4350 has a value of 2 MHz, FR4 has a value of 8 MHz, and RT5880 has a value of 0.1 MHz.
3. The factors determining the differences in the obtained parameters are the material specifications based on permittivity (ε_r) and thickness (h). For RO4350, ε_r= 3.77 and h = 1.44. For FR4, ε_r = 4.3 and h = 1.6. For RT5880, ε_r = 2.2 and h = 1.58.

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Increasing Teacher Work Productivity through Strengthening Organizational Culture, Interpersonal Communication, Tasks Interdependence, Job Satisfaction and Work Motivation

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ABSTRACT

Work productivity is the potential or power produced by individuals which is used to achieve maximum results to achieve effective and quality output. Based on preliminary research, it is known that the work productivity of teachers at PGRI Vocational Schools in Bogor Regency needs to be increased in order to achieve educational goals. Therefore, research is needed to obtain information on variables related to increasing work productivity. The aim of this research is to carry out strategies and ways to increase work productivity by conducting research on the influence of organizational culture variables, interpersonal communication, task interdependence, job satisfaction and work motivation. This research uses the path analysis method to determine the influence between the variables studied and the SITOREM method for indicator analysis in order to obtain optimal solutions in an effort to increase work productivity.

Keywords: Work Productivity, Organizational Culture, Interpersonal Communication, Task Interdependence, Job Satisfaction, Work Motivation, SITOREM Analysis

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1. INTRODUCTION

Human resources are the main asset for the Organization. Resources that have reason, feelings, desires, abilities and skills. All human resource potential greatly influences efforts to achieve an organization's goals. So that the organization and the individuals within it are talents that are not usually separated (Nengsih, 2015). Because the role of human resources is very important for an organization. So the success of an organization depends on the resources it has and how the organization can increase its productivity. Productive human resources will be able to complete their tasks correctly, quickly, and have good communication with superiors and colleagues (Hastuti, Dewi, Suhardini, 2016). Mukhyi and Hudiyanto (2016) stated that the essence of human resources in every organization or company, especially in educational institutions, is the existence of human resources as workforce. Therefore, what is meant by human resources is the workforce in an organization. From this opinion it is clear that human resources are workers who occupy a position or a group of people who have responsibility for carrying out tasks or work in a particular organization.

In the process of improving the quality of human resources, teachers in the world of education play a very important role by carrying out their professional duties. Teachers are always required to be able to improve their abilities related to their work productivity as teachers. According to Fatah (2015) states that productivity is the result of the work of a person or organization which is the appearance or performance of a person or a particular organization as a whole. And Pratiwi (2016) defines that a teacher's performance must also be accompanied by work productivity as a professional educator.

Teacher work productivity can be viewed from the teacher's duties as stated in the main duties and functions of the teacher. The main duties and functions of teachers are to assist and be responsible to the principal in teaching and learning activities, including: (a) making teaching equipment good and complete; (b) carrying out learning activities; (c) carrying out learning process assessment activities, daily tests, general tests and final exams; (d) carry out analysis of daily test results; (e) develop and implement improvement and enrichment programs; (f) fill in the student's score list; (g) carry out guiding activities (instilling knowledge) to other teachers in the learning process; (h) make learning

tools; (i) foster an attitude of appreciation for works of art; (j) participate in curriculum development and socialization activities; (k) carrying out certain tasks at school; (l) develop learning programs; (m) make notes about the progress of students' learning outcomes; (n) fill in and examine the attendance list before starting the lesson; (o) organize the cleanliness of the classroom and surrounding areas and collect and calculate credit points for promotion.

Based on a preliminary survey conducted on 17-30 January 2024 by distributing questionnaires to 30 PGRI Vocational High School (SMK) school stakeholders in Bogor Regency, data was obtained that: 1). There are 35.5% of respondents who have not met expectations in terms of work responsibilities, 2). There are 42.7% of respondents who have not met expectations in constructive actions, 3) There are 37.8% of respondents who have not met expectations in intrinsic motivation, 4). There are 41.5% of respondents who have not met expectations in terms of positive contribution, and 5). There were 45.8% of respondents who did not meet expectations in achieving work results.

The survey results above show that the work productivity of teachers at PGRI Vocational High Schools (SMK) in Bogor Regency still needs to be improved and considering that work productivity is an important element related to achieving educational goals, this work productivity is interesting to research.

The aim of the research is to produce strategies and methods for increasing teacher work productivity, namely by strengthening independent variables that have a positive effect on work productivity. These variables are Organizational Culture, Interpersonal Communication, Task Interdependence, Organizational Commitment, and Motivation. The optimal solution found is then used as a recommendation to related parties, namely teachers, school principals, school supervisors, school organizing institutions and education offices

2. RESEARCH METHOD

As explained above, this research aims to find strategies and ways to increase teacher work productivity through research on the strength of influence between teacher work productivity as the dependent variable and organizational culture, interpersonal communication, task interdependence, as independent variables and job satisfaction and work motivation. as an intervening variable. The research method used is a survey method with a path analysis test approach to test statistical hypotheses and the SITOREM method for indicator analysis to determine optimal solutions for increasing teacher work productivity.

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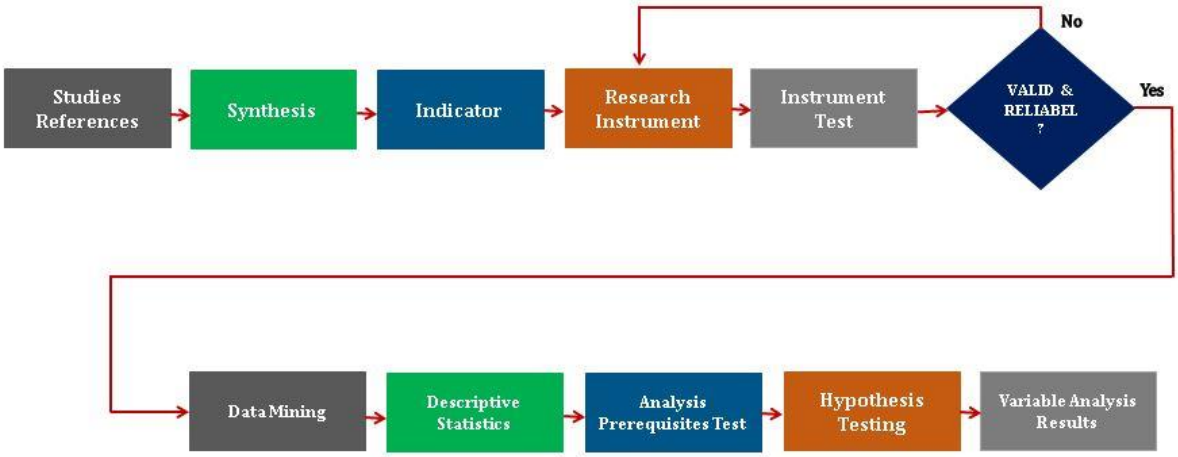

Fig 1. Quantitative Research Step

The research was carried out on foundation permanent teachers (GTY) of PGRI Vocational High Schools (SMK) in Bogor Regency with a teacher population of 289 people, with a sample of 168 teachers calculated using the Slovin formula taken from Umar.

Data collection in this research used research instruments in the form of questionnaires which were distributed to teachers as research respondents. The research instrument items are derived from the research indicators whose conditions will be explored. Before being distributed to respondents, the research instrument was first tested to determine its validity and reliability. The validity test was carried out using the Pearson Product Moment technique, while for the reliability test a calculation was used using the Cronbach's Alpha formula. After the data is collected, homogeneity tests, normality tests, linearity tests, simple correlation analysis, coefficient of determination analysis, partial correlation analysis, and statistical hypothesis testing are then carried out.

Next, indicator analysis was carried out using the SITOREM method from Hardhienata to determine the priority order for improving indicators as a recommendation to related parties as a result of this research. In determining the priority order for handling indicators, SITOREM uses three criteria, namely (1) the strength of the relationship between variables obtained from hypothesis testing, (2) the priority order for handling indicators resulting from expert assessments, and (3) the indicator value obtained from data calculations obtained from the answers of research respondents.

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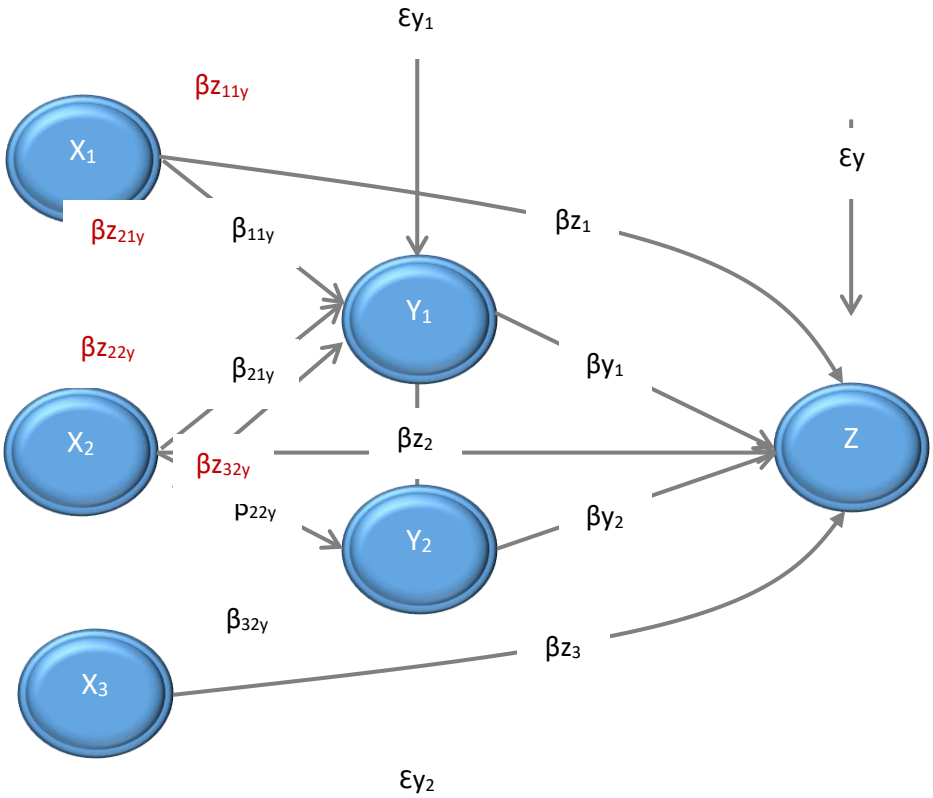

Fig. 2 Research Constellation

X1	:	Organizational Culture	Y1	:	Job Satisfaction
X2	:	Interpersonal Communication	Y2	:	Work Motivation
X3	:	Task Interdependence	Z	:	Work Productivity

βz1 : Direct influence of Organizational Culture (X1) on Work Productivity (Z).
βz2 : Direct influence of Interpersonal Communication (X2) on Work Productivity (Z).
βz3 : Direct influence of Task Interdependence (X3) on Work Productivity (Z).
βy1 : Direct effect of Job Satisfaction (Y1) on Work Productivity (Z).
βy2 : Direct influence of work motivation (Y2) on work productivity (Z).
β11y : Direct influence of organizational culture (X1) on job satisfaction (Y1)
β21y : Direct influence of Interpersonal Communication (X2) on Job Satisfaction (Y1).
β22y : Direct influence of Interpersonal Communication (X2) on Work Motivation (Y2)
β32y : Direct influence of task interdependence (X3) on work motivation (Y2)
βz11y : Indirect influence of Organizational Culture (X1) on Work Productivity (Z) through Job Satisfaction (Y1)
βz21y : Indirect influence of Interpersonal Communication (X2) on Work Productivity (Z) through Job Satisfaction (Y1)
βz22y : Indirect influence of Interpersonal Communication (X2) on Work Productivity (Z) through Work Motivation (Y2)
βz32y : Indirect influence of Task Interdependence (X3) on Work Productivity (Z) through Work Motivation (Y2)

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3. RESULTS AND DISCUSSION

Based on the results of the analysis of statistical descriptions for research variables, symptoms of central data can be revealed as listed in the following table:

Table 1. Summary of Statistical Description of Research Variables

Description	Organizational Culture (X_1)	Interpersonal Communication (X_2)	Task Interdependence (X_3)	Job Satisfaction (Y_2)	Work Motivation (Y_2)	Work Productivity (Z)
Mean	122.80	126.75	126.28	124.10	121.05	122.91
Standard Error	1.77186	1.75046	1.25326	1.37182	1.21728	1.19771
Median	130	134	130	129	124	126.5
Mode	149	150	136	149	121	130
Stand Deviation	24.2945	24.001	17.1838	21.2945	16.6906	16.4221
Sample Variance	590.223	576.049	295.284	320.223	278.575	269.687
Kurtosis	0.5498	1.64903	0.85695	0.3495	0.58266	1.64832
Skewness	-0.7772	-1.4904	-1.0468	-0.6772	-0.9844	-1.3927
Range	101	101	77	90	70	81
Minimum Score	59	52	75	69	74	64
Maximum Score	160	153	152	170	144	145

Based on the overall calculation results of the error normality test in this study, it can be seen in the summary in the following table:

Table 2. Estimated Standard Error Normality Test

Estimate Error	n	L_{count}	L_{table}		Decision
			$\alpha = 0,05$	$\alpha = 0,01$	
$z - \hat{Y}_1$	168	0.003	0.065	0.075	Normality
$z - \hat{Y}_2$	168	0.002	0.065	0.075	Normality
$z - \hat{Y}_3$	168	0.007	0.065	0.075	Normality
$z - \hat{Y}_4$	168	0.006	0.065	0.075	Normality
$z - \hat{Y}_5$	168	0.006	0.065	0.075	Normality
$Y_1 - X_1$	168	0.001	0.065	0.075	Normality
$Y_1 - X_2$	168	0.004	0.065	0.075	Normality
$Y_2 - X_2$	168	0.002	0.065	0.075	Normality
$Y_2 - X_3$	168	0.004	0.065	0.075	Normality
Normal distribution requirements : $L_{count} < L_{table}$					

Based on the overall calculation results of the error normality test in this study, it can be seen in the summary in the following table:

Table 3. Summary of Data Variance Homogeneity Test

Grouping	X^2_{count}	X^2_{table} $\alpha = 0,05$	Kesimpulan
y on the basis of X_1	3714.91	6132.59	Homogeneity
y on the basis of X_2	4563.34	5768.59	Homogeneity
y on the basis of X_3	3823.33	7288.01	Homogeneity
y on the basis of Y_1	4592.84	8451.28	Homogeneity
y on the basis of Y_2	4613.17	6192.48	Homogeneity
Y_1 on the basis of X_1	3678.36	7678.01	Homogeneity
Y_1 on the basis of X_2	3710.50	6132.59	Homogeneity
Y_2 on the basis of X_2	4469.28	6890.01	Homogeneity

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Grouping	X^2_{count}	X^2_{table} $\alpha = 0,05$	Kesimpulan
Y_2 on the basis of X_3	4912.17	7288.01	Homogeneity
Homogeneous population requirement : $\chi^2_{countg} < \chi^2_{table}$			

The overall calculation results of the regression model in this research can be seen in the summary in the following table:

Table 4. Regression Model

Relationship Model Between Variables	Regression Model	Results Significance Test
y on x_1	$\hat{y}$ = 67,122 + 0,715X	Significant
y on x_2	$\hat{y}$ = 72,423 + 0,447X	Significant
y on x_3	$\hat{y}$ = 72,122 + 0,382X	Significant
y on y_1	$\hat{y}$ = 56,152 + 0,577X	Significant
y on y_2	$\hat{y}$ = 54,165 + 0,623X	Significant
y_1 on x_1	$\hat{y}$ = 59,508 + 0,645X	Significant
Y_1 on x_2	$\hat{y}$ = 54,744 + 0,523X	Significant
y_2 on x_2	$\hat{y}$ = 58,693 + 0,533X	Significant
y_2 on x_3	$\hat{y}$ = 69,508 + 0,645X	Significant
y on x_1 through y_1	$\hat{y} = 51,45 + 0,44X_1 + 0,30X_2$	Significant
y on x_2 through y_1	$\hat{y} = 50,23 + 0,42X_1 + 0,54X_2$	Significant
y on x_2 through y_2	$\hat{y} = 56,77 + 0,40X_1 + 0,36X_2$	Significant
y on x_3 through y_2	$\hat{y} = 44,12 + 0,37X_1 + 0,43X_2$	Significant

A. Regression Model Significance Test

The overall calculation results of the linearity test of the regression model in this study can be seen in the summary in the following table:

Table 5. Summary of Regression Model Significance Test Results (F Test)

Relationship Model Between Variables	Sig	α	Results Significance Test
y on x_1	$0,000^b$	0,005	Significant
y on x_2	$0,000^b$	0,005	Significant
y on x_3	$0,000^b$	0,005	Significant
y on y_1	$0,000^b$	0,005	Significant
y on y_2	$0,000^b$	0,005	Significant
y_1 on x_1	$0,000^b$	0,005	Significant
Y_1 on x_2	$0,000^b$	0,005	Significant
y_2 on x_2	$0,000^b$	0,005	Significant
y_2 on x_3	$0,000^b$	0,005	Significant
y on x_1 through y_1	$0,000^b$	0,005	Significant
y on x_2 through y_1	$0,000^b$	0,005	Significant
y on x_2 through y_2	$0,000^b$	0,005	Significant
y on x_3 through y_2	$0,000^b$	0,005	Significant
Significant Terms : Sig < α			

The overall calculation results of the linearity test of the regression model in this study can be seen in the summary in the following table:

Table 6. Summary of Regression Model Linearity Test Results (t Test)

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Relationship Model Between Variables	Sig	α	Hasil Uji Pola Linearitas
y on x_1	0,000	0,005	Linearity
y on x_2	0,000	0,005	Linearity
y on x_3	0,000	0,005	Linearity
y on y_1	0,000	0,005	Linearity
y on y_2	0,000	0,005	Linearity
y_1 on x_1	0,000	0,005	Linearity
Y_1 on x_2	0,000	0,005	Linearity
y_2 on x_2	0,000	0,005	Linearity
y_2 on x_3	0,000	0,005	Linearity
y on x_1 through y_1	0,000	0,005	Linearity
y on x_2 through y_1	0,000	0,005	Linearity
y on x_2 through y_2	0,000	0,005	Linearity
y on x_3 through y_2	0,000	0,005	Linearity
Linear Terms : Sig < α			

Multicollinearity testing aims to determine whether the regression model found any correlation between independent variables or independent variables. Testing uses the Spearman Test. The effect of this multicollinearity is that it causes high variability in the sample. This means that the standard error is large, as a result, when the coefficient is tested, tcount will be a smaller value than ttable. The overall calculation results of the multicollinearity test are as follows:

Table 7. Summary of Multicollinearity Test

Independent Variable	Tolerance	VIF	Precondition	Decision
Organizational Culture (X1)	0.211	4.645	H_0 : VIF < 10, there is no multicollinearity H_1 : VIF > 10, there is multicollinearity	Ho accepted There is no multicollinearity
Interpersonal Communication (X2)	0.212	4.771	H_0 : VIF < 10, there is no multicollinearity H_1 : VIF > 10, there is multicollinearity	Ho accepted There is no multicollinearity
Task Interdependence (X3)	0.212	4.408	H_0 : VIF < 10, there is no multicollinearity H_1 : VIF > 10, there is multicollinearity	Ho accepted There is no multicollinearity
Job Satisfaction (Y1)	0.237	4.356	H_0 : VIF < 10, there is no multicollinearity H_1 : VIF > 10, there is multicollinearity	Ho accepted There is no multicollinearity
Work Motivation (Y2)	0.243	4.122	H_0 : VIF < 10, there is no multicollinearity H_1 : VIF > 10, there is multicollinearity	Ho accepted There is no multicollinearity

In this research, to test whether there is heteroscedasticity using the Glejser Test where if the significant value is <0.05 then heteroscedasticity occurs, if on the contrary the significance value is ≥ 0.05 then homoscedasticity occurs. The overall calculation results of the heteroscedasticity test in this study can be seen in the summary in the following table:

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Table 8. Summary of Heteroscedacity Test

Independent Variable	Sig.	α	Precondition	Decision
Organizational Culture (X1)	0,000	0,05	H_0 : Sig < 0,05 then there is no heteroscedasticity. H_1 : Sig ≥ 0,05 then there is heteroscedasticity.	Ho accepted There is no heteroscedasticity
Interpersonal Communication (X2)	0,000	0,05	H_0 : Sig < 0,05 then there is no heteroscedasticity. H_1 : Sig ≥ 0,05 then there is heteroscedasticity.	Ho accepted There is no heteroscedasticity
Task Interdependence (X3)	0,000	0,05	H_0 : Sig < 0,05 then there is no heteroscedasticity. H_1 : Sig ≥ 0,05 then there is heteroscedasticity.	Ho accepted There is no heteroscedasticity
Job Satisfaction (Y1)	0,000	0,05	H_0 : Sig < 0,05 then there is no heteroscedasticity. H_1 : Sig ≥ 0,05 then there is heteroscedasticity.	Ho accepted There is no heteroscedasticity
Work Motivation (Y2)	0,000	0,05	H_0 : Sig < 0,05 then there is no heteroscedasticity. H_1 : Sig ≥ 0,05 then there is heteroscedasticity.	Ho accepted There is no heteroscedasticity

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Path Analysis

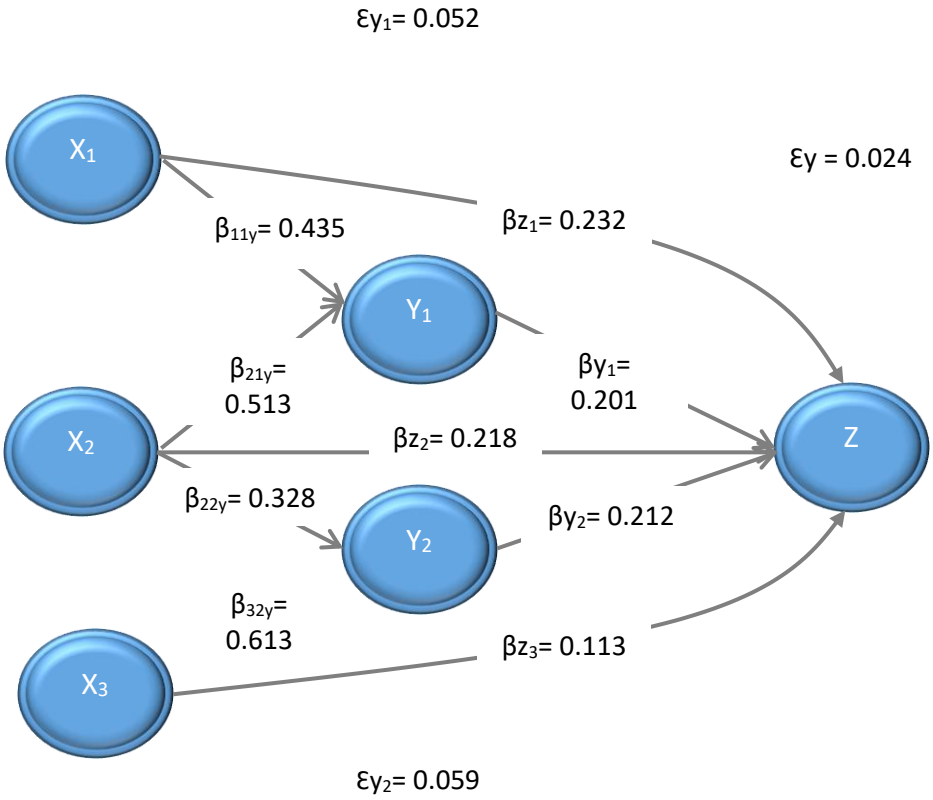

Fig. 3 Path Analysis Results

X1	:	Organizational Culture	Y1	:	Job Satisfaction
X2	:	Interpersonal Communication	Y2	:	Work Motivation
X3	:	Task Interdependence	Z	:	Work Productivity

The influence between the independent variable and the dependent variable when viewed from path analysis, the influence on the Work Productivity variable (Z) is formed as a result of the functioning of Organizational Culture (X1), Interpersonal Communication (X2), Task Interdependence (X3) Job Satisfaction (Y1) and Work Motivation (Y2). Discussion of research results can be described as follows:

Table 9. Research Hypothesis

Hypothesis	Path Analysis	Uji Statistik	Decision	Conclusion
Organizational Culture (X1) on Work Productivity (Z)	0.232	$H_0 : \beta_{z1} \leq 0$ $H_1 : \beta_{z1} > 0$	H_0 rejected H_1 accepted	Direct Positive Influence
Interpersonal Communication (X2) on Organizational Culture (Z)	0.218	$H_0 : \beta_{z2} \leq 0$ $H_1 : \beta_{z2} > 0$	H_0 rejected H_1 accepted	Direct Positive Influence
Task Interdependence (X3) on Work Productivity (Z)	0.113	$H_0 : \beta_{z3} \leq 0$ $H_1 : \beta_{z3} > 0$	H_0 rejected H_1 accepted	Direct Positive Influence
Job Satisfaction (Y1) on Work Productivity (Z)	0.201	$H_0 : \beta_{Y1} \leq 0$ $H_1 : \beta_{Y1} > 0$	H_0 rejected H_1 accepted	Direct Positive Influence
Work Motivation (Y2) on Work Productivity (Z)	0.212	$H_0 : \beta_{Y2} \leq 0$ $H_1 : \beta_{Y2} > 0$	H_0 rejected H_1 accepted	Direct Positive Influence

Hypothesis	Path Analysis	Uji Statistik	Decision	Conclusion
Organizational Culture (X1) on Job Satisfaction (Y1)	0.435	$H_0 : \beta_{11y} \leq 0$ $H_1 : \beta_{11y} > 0$	H_0 rejected H_1 accepted	Direct Positive Influence
Interpersonal Communication (X2) on Job Satisfaction (Y1)	0.513	$H_0 : \beta_{12y} \leq 0$ $H_1 : \beta_{12y} > 0$	H_0 rejected H_1 accepted	Direct Positive Influence
Interpersonal Communication (X2) on Work Motivation (Y2)	0.328	$H_0 : \beta_{22y} \leq 0$ $H_1 : \beta_{22y} > 0$	H_0 rejected H_1 accepted	Direct Positive Influence
Task Interdependence (X3) on Work Motivation (Y2)	0.613	$H_0 : \beta_{32Y} \leq 0$ $H_1 : \beta_{32Y} > 0$	H_0 rejected H_1 accepted	Direct Positive Influence
Organizational Culture (X1) on Work Productivity (Z) through Job Satisfaction (Y1)	0.049	$H_0 : \beta_{z11} \leq 0$ $H_1 : \beta_{z11} > 0$	H_0 rejected H_1 accepted	Indirect Positive Influence
Interpersonal Communication (X2) on Work Productivity (Z) through Job Satisfaction (Y1)	0.119	$H_0 : \beta z_{12} \leq 0$ $H_1 : \beta z_{12} > 0$	H_0 rejected H_1 accepted	Indirect Positive Influence
Interpersonal Communication (X2) on Work Productivity (Z) through Work Motivation (Y2)	0.076	$H_0 : \beta z_{22} \leq 0$ $H_1 : \beta z_{22} > 0$	H_0 rejected H_1 accepted	Indirect Positive Influence
Task Interdependence (X3) on Work Productivity (Z) through Work Motivation (Y2)	0.133	$H_0 : \beta z_{32} \leq 0$ $H_1 : \beta z_{32} > 0$	H_0 rejected H_1 accepted	Indirect Positive Influence

The indirect effect test is used to test the effectiveness of the intervening variable which mediates the independent variable and the dependent variable. The results of the indirect influence test are as follows**:**

Table 10. Research Hypothesis

Indirect Influence	Z_{Count}	Z_{table}	Decision	Conclusion
Organizational Culture (X1) on Work Productivity (Z) through Job Satisfaction (Y1)	4,238	1,966	H_0 rejected H_1 accepted	proven to mediate
Interpersonal Communication (X2) on Work Productivity (Z) through Job Satisfaction (Y1)	4,114	1,966	H_0 rejected H_1 accepted	proven to mediate
Interpersonal Communication (X2) on Work Productivity (Z) through Work Motivation (Y2)	4.654	1,966	H_0 rejected H_1 accepted	proven to mediate
Task Interdependence (X3) on Work Productivity (Z) through Work Motivation (Y2)	4.478	1,966	H_0 rejected H_1 accepted	proven to mediate

B. Optimal Solution to Increase Work Productivity

Based on the results of statistical hypothesis testing, determining indicator priorities, and calculating indicator values as described above, a recapitulation of research results can be made which is the optimal solution for increasing work productivity as follows:

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Table 11. SITOREM Analysis

	Organization Culture (βz1 = 0,232) (rangk.I)			
	Indicator in Initial State		**Indicator after Weighting by Expert**	**Indicator Value**
1	Innovation at work	1st	Oriented to work results (18.17)	4.12
2	Oriented to work results	2nd	Team oriented (18.13)	4.14
3	Team oriented	3rd	Innovation in work (17.16)	4.10
4	Empowerment of human resources in organizations	4th	Empowerment of human resources in organizations (17.12)	3.86
5	Consistent with the rules that have been set	5th	Adaptation to change (15.21)	3.76
6	Adaptation to changes	6th	Consistent with established rules (14.21)	3.98
	Interpersonal Communication (βz2 = 0,218) (rangk.II)			
	Indicator in Initial State		**Indicator after Weighting by Expert**	**Indicator Value**
1	Self-disclosure	1st	Interpreting ability (21.38)	3.57
2	The ability to understand other people	2nd	Provide input for progress (21.13)	4.02
3	Provide support to others	3rd	Be positive (20.16)	3.68
4	Be positive	4th	Providing support to others (19.12)	4.04
5	Provide input for progress	5th	Self-disclosure (18.21)	3.74
6	Ability to interpret	6th	Ability to understand others (17.10)	4.00
	Task Interdependence (βz3 = 0,113) (rangk.V)			
	Indicator in Initial State		**Indicator after Weighting by Expert**	**Indicator Value**
1	Individual dependence on others within a unit	1st	Dependence of other employees on other employees (20.38)	3.82
2	Individual dependence on others outside the unit	2nd	Individual dependence on others within a unit (20.16)	3.84
3	Dependence of other employees on other employees	3rd	Individual dependence on others outside the unit (20.13)	4.12
4	Interdependent reciprocal relationships	4th	Reciprocal interdependent relationships (20.12)	4.14
	Job Satisfaction (βy1 = 0,201) (rank.IV)			
	Indicator in Initial State		**Indicator after Weighting by Expert**	**Indicator Value**
1	Earned income	1st	Earned income (14.07)	3.85
2	Career advancement opportunities at work	2nd	Work relationships with friends and leaders (14.03)	4.11
3	Work relationships with friends and leaders	3rd	Control of the quality of work by the management (13.06)	3.65
4	Control of the quality of work by the leadership	4th	Have the opportunity to be creative at work. (13.02)	4.03
5	Security in carrying out tasks	5th	Security in the performance of duties (12.21)	3.78
6	Have the opportunity to be creative at work.	6th	Career advancement opportunities at work (12.19)	3.76
	Work Motivation (βy2 = 0,212) (rank.III)			
	Indicator in Initial State		**Indicator after Weighting by Expert**	**Indicator Value**
1	Attachment to work	1st	Adequate rewards (18.12)	3.89
2	Desire for power	2nd	Job Guarantee (18.08)	3.90
3	The desire to gain appreciation and recognition	3rd	Desire for appreciation and recognition (17.06)	3.98
4	Adequate rewards	4th	Good supervision (17.02)	4.12
5	Job Guarantee	5th	Will to power (15.22)	4.12

6	Good supervision	6th	Attachment to work (14.50)	4.14

Work Productivity

	Indicator in Initial State		Indicator after Weighting by Expert	Indicator Value
1	Job responsibilities	1st	Job responsibilities (21.38)	3.98
2	Constructive action	2nd	Building action (21.13)	3.75
3	Intrinsic motivation	3rd	Intrinsic motivation (20.16)	3.89
4	Positive contribution	4th	Positive contribution (19.12)	3.98
5	Achievement of work results.	5th	Achievement of work results. (18.21)	3.92

SITOREM ANALYSIS RESULT

	Priority order of indicator to be Strengthened		Indicator remain to be maintained
1st	Empowerment of human resources in organizations	1.	Oriented to work results
2nd	Adaptation to changes	2.	Team oriented
3rd	Consistent with the rules that have been set	3.	Innovation at work
4th	Ability to interpret	4.	Provide input for progress
5th	Be positive	5.	Provide support to other people
6th	Self-disclosure	6.	Ability to understand other people
7th	Adequate rewards	7.	Good supervision
8th	Job Guarantee	8.	The will to power
9th	The desire to gain appreciation and recognition	9.	Attachment to work
10th	Earned income	10.	Work relationships with friends and leaders
11th	Control of the quality of work by the leadership	11.	Have the opportunity to be creative at work
12th	Security in carrying out tasks	12.	Individual dependence on other people outside the unit
13th	Career advancement opportunities at work	13.	Reciprocal interdependent relationships
14th	Dependence of other employees on other employees		
15th	Individual dependence on others within a unit		
16th	Job responsibilities		
17th	Constructive action		
18th	Intrinsic motivation		
19th	Positive contribution		
20th	Achievement of work results.		

4. CONCLUSION

Based on the results of the analysis, discussion of research results and hypotheses that have been tested, it can be concluded as follows:

a) Strengthening Teacher Work Productivity can be done by using strategies to strengthen variables that have a positive effect on Work Productivity.
b) Variables that have a positive influence on work productivity are organizational culture, interpersonal communication, task interdependence, job satisfaction and work motivation. This was proven from the results of variable analysis using the Path Analysis method.
c) The way to strengthen work productivity is to improve indicators that are still weak and maintain good indicators for each research variable.

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Planning of Transformational Teachers in Differentiated Learning at SMK Negeri 1 Muara Batu, Aceh Utara Regency

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ABSTRACT

Planning is a process to determine goals and objectives to be achieved by taking a strategic method to achieve goals. Transformational teachers are learning leaders who are able to move the education ecosystem in order to realize education that in the learning process is student-centered. Transformational teachers must have free and independent thinking in designing existing learning according to the needs of students, one of which is differentiated learning, because differentiated learning can meet the learning needs of different students so that it can arouse students' activeness, curiosity, learning optimism, and creativity. However, in implementing differentiated learning, transformational teachers face difficulties in understanding the concept and strategies of differentiated learning due to a lack of understanding in the technicalities of managing classrooms with varying levels of student abilities and learning styles in terms of content, processes or products both in preparation and in implementation. This study aims to describe: (1) Planning of Transformational teachers in improving differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency. (2) Supporting and inhibiting factors for the implementation of Teacher Mobilizers in improving differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency. This research is phenomenological using a qualitative approach carried out at SMK Negeri 1 Muara Batu, North Aceh Regency. Data collection techniques through observation, interviews, and documentation. Data analysis techniques are carried out through data reduction, data presentation and data verification. The results of the study show that: (1) The Planning of Transformational teachers in improving differentiated learning at SMK Negeri 1 Muara Batu North Aceh Regency is going well such as: (a) has designed learning in the form of learning outcomes, diagnostic test questionnaires, becoming learning facilitators, and motivating student learning. (b) Designing schedules, learning objectives and flow of learning objectives as well as differentiated learning modules, (c) supervising, conducting diagnostic assessments, analyzing the results of previous report cards to determine the level of student ability, (d) reflecting, preparing learning media in accordance with students' learning styles, developing learning materials and models based on student needs. (e) guided by module 2.1 of the Transformational teachers Education Program. (2) Supporting factors for transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, namely: (1) library, and (2) Provision of learning tools. The inhibiting factors faced by teachers driving differentiated learning at SMK Negeri 1 Muara Batu North Aceh Regency include: (1) Factors related to students, (2) Factors related to educators which include problems with teachers' mastery of the material, problems with teachers' mastery in classroom management, and (3) Factors related to learning evaluation

Keywords: Transformational teachers Planning, Differentiated Learning

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1. INTRODUCTION

In Law No. 20 of 2003 concerning the national education system, it is explained that education is a conscious effort to realize an active learning process so that it can develop students' self-potential to have religious strength, self-control, personality, intelligence, noble morals and skills for themselves, the community and the nation and also the State.

The Minister of Education and Culture of the Republic of Indonesia, Nadiem Makarim, about "Freedom of Learning" delivered on National Teacher's Day in November 2019, has surprised many parties. This idea is a strategic and innovative step as well as a big challenge in the world of education in Indonesia.

In addition to Freedom of Learning, the Minister of Education and Culture also touched on Transformational teachers. This program aims to boost teacher potential and increase student independence in learning. Transformational teachers are part of the educational reform process towards better change, and have a fundamental role in the implementation of independent learning.

Based on the results of initial observations, it was found that in implementing differentiated learning, teachers face difficulties in understanding the concepts and strategies of differentiated learning due to a lack of understanding in the technique of managing classrooms with various levels of students'

abilities and learning styles in terms of content, process or products, both in preparation and in their implementation. There is still a lack of teachers in utilizing learning media related to active technology such as interactive multimedia, digital video and animation, podcasts and so on in the learning process. Limited resources such as time, textbooks, or learning equipment. It is difficult to measure the effectiveness of differentiated learning and monitor the progress of each student individually. Not all fellow teachers are open to changes in learning approaches, they have not implemented differentiated learning, namely with aspects of content, process or product.

From the above research, the author sees how teacher planning in implementing differentiated learning in the classroom because planning is one of the management functions that cannot be eliminated to achieve effective and efficient goals. From the results of the search related to these studies, there are similarities and differences between the research that has been carried out previously and the research that will be carried out by the researcher. Therefore, this research is feasible to carry out because it is not plagiarism from previous research. Therefore, the researcher intends to conduct research to describe and study more deeply about the planning of the transformational teachers program in improving differentiated learning. With this, the researcher intends to conduct a research entitled "**Planning of Transformational teachers in Differentiated Learning at SMK Negeri 1 Muara Batu, North Aceh Regency**"

2. RESEARCH METHODS

The approach in this research is a qualitative descriptive approach, namely a research procedure for producing descriptive data sources in the form of written words or words from people and observed behavior. The use of a qualitative descriptive approach is because this research has complex, dynamic and meaningful problems, and requires an in-depth understanding of social situations (Sutrisno Hadi, 2004: 34).

David William in Meleong, (2012: 17) states that qualitative research is collecting data in a natural setting, using natural methods, and carried out by people or researchers who are naturally interested. Descriptive research methods are research strategies and techniques that attempt to describe, record, analyze and interpret conditions or events that already exist and are encountered in the field in the form of society, problems or symptoms in society, by collecting in-depth facts, then data is presented in verbal form, not in numerical form

In this case, the researcher tried to analyze the transformational teachers in the learning process at one of the Vocational Secondary Schools in Bireuen Regency. In this case, the researcher used informants consisting of the Principal, Deputy Principal Bid. curriculum, four transformational teachers, school committee, and three students at SMK Negeri 1 Muara Batu, North Aceh Regency with a total of 10 subjects.

3. RESULTS AND DISCUSSION

Research Results

Planning for Transformational teachers in Differentiated Learning at SMK Negeri 1 Muara Batu, North Aceh Regency

To determine the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, it is measured by 5 (five) question indicators, namely: (a) determining the technical implementation, (b) limiting the goals and determining the implementation, (c) collecting and analyzing information, (d) developing alternatives, (e) preparing and communicating plans and decisions

a. Establish technical implementation

To find out how to determine the implementation techniques in the planning of transformational teachers in differentiated learning, the following are the results of the researcher's interview with Mr. Eko Faisal, S.Pd, M.Pd, as the Principal of SMK Negeri 1 Muara Batu North Aceh Regency, stated that:

> In determining what to do, when and how to do Teacher Driving Planning on differentiated learning, I asked the teacher to prepare a differentiated lesson plan at the beginning of the semester, then I asked what was needed to support the learning process

The results of the researcher's observation in the field on the technical determination of implementation in the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, it can be seen that the technical determination of implementation

in the planning of transformational teachers in differentiated learning has gone well, this can be seen by the availability of learning outcomes, diagnostic test questionnaires.

Based on the results of the above interviews and observations, in general, it can be concluded that, the technical determination of the implementation in the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency has been going well, including the school has designed learning, become a learning facilitator, and motivate student learning.

b. Limiting goals and setting implementation

To find out how to limit targets and set work implementations to achieve maximum effectiveness through the process of determining targets in planning transformational teachers in differentiated learning, the following are the results of the researcher's interview with Mr. Eko Faisal, S.Pd, M.Pd, as the Principal of SMK Negeri 1 Muara Batu, North Aceh Regency, stating that:

> In limiting the goals and setting the implementation of work to achieve maximum effectiveness in the planning of the transformational teachers in differentiated learning, I ask teachers to carry out differentiated learning on content, processes or products where possible. If not, then at least among the three there are those that are done by differentiating

The results of the researcher's observation in the field on the limitation of targets and determining the implementation of work to achieve maximum effectiveness through the process of determining targets in the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, it can be seen that it has gone well, this can be seen with the learning schedule, the content of the differentiated learning module which includes differentiation, content, processes, and products.

Based on the results of the above interviews and observations, in general, it can be concluded that the restriction of targets and the determination of work implementations to achieve maximum effectiveness through the process of determining targets in the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu North Aceh Regency has been running well, including the school has designed schedules, learning objectives and the flow of learning objectives as well as differentiated learning modules

c. Collecting and analyzing information

To collect and analyze information in the planning of transformational teachers in differentiated learning, the following are the results of the researcher's interview with Mr. Eko Faisal, S.Pd, M.Pd, as the Principal of SMK Negeri 1 Muara Batu, North Aceh Regency, stating that:

> I collect information through the curriculum waka and directly from teachers based on the results of supervision carried out twice in one semester

Observations by researchers in the field about techniques for collecting and analyzing information in teacher planning in differentiated learning, it can be seen that schools conduct periodic supervision in one semester twice, conduct diagnostic assessments, and analyze the results of previous report cards to determine the level of student ability

Based on the results of the above interviews and observations about the technique of collecting and analyzing information in planning teacher driving in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, in general, it can be concluded that: (1) conducting supervision, (2) conducting a diagnostic assessment, (3) analyzing the results of previous report cards to determine the level of student ability

d. Developing alternatives

To develop alternatives from the results of information analysis in planning teacher driving in differentiated learning, the following are the results of the researcher's interview with Mr. Eko Faisal, S.Pd, M.Pd, as the Principal of SMK Negeri 1 Muara Batu, North Aceh Regency, stating that:

> After supervising the class, I invite teachers to reflect on the learning process in the classroom, if there are obstacles faced then I will try to find solutions in order to support teachers' planning to carry out differentiated learning

Observations of researchers in the field about the development of alternatives from the results of information analysis in teacher planning in differentiated learning, it can be seen that after supervising the classroom, the school reflects on the learning process in the classroom, prepares learning media and content according to the student's learning style, develops materials and learning models based on student needs.

Based on the results of the above interviews and observations on the development of alternatives from the results of information analysis in the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu North Aceh Regency, in general, it can be concluded that: (1) reflecting, (2) preparing learning media according to the student's learning style, (3) developing learning materials and models based on student needs.

e. Prepare and communicate plans and decisions.

To prepare and communicate plans and decisions, the following are the results of the researcher's interview with Mr. Eko Faisal, S.Pd, M.Pd, as the Head of SMK Negeri 1 Muara Batu North Aceh Regency, stating that:

> In carrying out differentiated learning, they are guided by Module 2.1 provided in the LMS and the independent learning results they get in the training of the Transformational teachers Education Program.

Based on the interviews that have been conducted by the author, in carrying out the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, it has been guided by Module 2.1 provided in LMS in the training of the Transformational teachers Education Program.

The results of the researcher's observations in the field about the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, it can be seen that the school has prepared module 2.1 of the transformational teachers education program , which is about differentiated learning.

Therefore, from the results of the above research, teacher planning is a learning that is provided by schools to provide student learning by paying attention to learning interests, learning readiness and learning styles. The planning of differentiated learning activities at SMK Negeri 1 Muara Batu, North Aceh Regency, involves all elements of the school, especially the curriculum waka, teachers, committees and students.

The above explanation can be concluded that the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency is a learning provided by schools to provide student learning by paying attention to their learning interests, learning readiness and learning styles. Therefore, it is very important to create a good atmosphere, of course, it must be good in planning so that at the implementation stage everything can run as planned, this is so that students can develop themselves optimally.

Supporting and inhibiting factors for the implementation of Teacher Mobilizers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency.

Looking at the results of the interview, how the efforts of the transformational teachers in implementing differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency. This is evident from the results of interviews and observations in the field conducted during research at SMK Negeri 1 Muara Batu, North Aceh Regency, proving that there are supporting and inhibiting factors faced by transformational teachers in implementing differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency.

The supporting factors for the implementation of Teacher Mobilizers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency are explained as follows:

a) Library

A school library is a place that is an integral part of a school educational institution as a place to store, collect library materials that are managed and arranged systematically in a certain way to be used by students and teachers as a source of information, in order to support teaching and learning programs in schools. The library gives each child the possibility to learn individually. In the independent study program or enrichment program activities for fast children, the library is an important place and facility. Without an adequate library, it is very difficult to be able to carry out the independent study or enrichment program. Ideally, a good library is one that has a number of books with a ratio of 10 books per person.

To find out the library facilities in supporting differentiated learning at SMK Negeri 1 Muara Batu North Aceh Regency which is addressed to the principal, School Supervisor, Vice President for Curriculum, transformational teachers and students.

"Mr. Eko Faisal, S.Pd, M.Pd as the principal of the school replied: We already have an adequate library. Books are also available."

Agreeing with what was conveyed by the principal, Mrs. Nurhayati, S.Pd as the school supervisor also expressed the following:

"The school library is good, subject books are widely available."

Then the researcher asked the question, whether the transformational teachers uses the library as a learning resource for Asyifa students who are grade XII RPL students revealed as follows:

"Yes, we use books that are in the library and some are from douwnload results."

The results of the researcher's observations in the field related to library facilities in supporting differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, it can be seen that the library of SMK Negeri 1 Muara Batu, North Aceh Regency has met the criteria of a good library that has a number of books with a ratio of 10 books per person, but to support differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, the transformational teachers also prepare digital book links for downloaded by students.

b) Provision of Learning Tools .

To find out the provision of differentiated learning tools at SMK Negeri 1 Muara Batu North Aceh Regency which is addressed to school principals, School Supervisors, Vice President for Curriculum, transformational teachers and students.

"Mr. Eko Faisal, S.Pd, M.Pd as the principal of the school replied: Learning tools are already supportive, we have provided wifi, laptops and other teaching aids."

In line with the above expression, Mrs. Zuraida, S.Pi, M.Si as the Vice President for Curriculum said that"

"For learning tools, we provide wifi in schools so that teachers and students can access a variety of learning materials."

Slightly different from what was conveyed by the principal, Mrs. Nurhayati, S.Pd as the school supervisor revealed the following:

"Not completely, because there are still classes that do not reach the internet network, then the number of infocus is also still lacking."

Then the researcher asked the question, whether the transformational teachers uses learning tools that support the learning process to Fitrah Syawali who is a grade XII RPL student revealed as follows:

"Yes, usually teachers bring laptops, props such as cardboard, scissors, drawings and others according to the material presented."

The results of the researchers' observations in the field related to the provision of learning tools in supporting differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, it can be seen that SMK Negeri 1 Muara Batu, North Aceh Regency has provided wifi, laptops and other teaching aids, but there are still classes that do not reach the internet network, then the number of infocus is also still lacking. This is not a significant obstacle because in addition to using these learning tools, the transformational teachers also brings personal laptops, other teaching aids in accordance with the material presented.

Meanwhile, the factors that hinder the implementation of Teacher Mobilization in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency were directed to questions to the principal, School Supervisor, Vice President for Curriculum, teacher and students.

"Mr. Eko Faisal, S.Pd, M.Pd as the principal of the school replied: The learning results obtained by students in the learning process in the classroom are good and students are more enthusiastic and creative."

Agreeing with what was conveyed by the principal, Mrs. Nurhayati, S.Pd as the school supervisor also expressed the following:

"For learning outcomes in general, it is good, although there are still some things that are lacking. It is usually held remedial again by teachers in their field of study."

Mrs. Faizah, S.Pd as a transformational teachers said that"

"The challenges faced by students when implementing differentiated learning are (1) Adjustment of student learning needs, (2) Testing and evaluation, (3) Classroom management skills. The solution is to make a mapping of student needs and make good classroom management.

The challenges faced as educators when implementing the Transformational teachers Program are changes in curriculum, policies, technology and community demands that affect the world of education. The solution is that I have to adjust according to the existing situation. and what is the solution.

The challenge I face is related to learning evaluation when implementing differentiated learning, namely that this learning can have a positive impact on students. This positive impact is very useful for triggering *students' critical thinking* . In terms of this positive side, this is what makes teachers interested in implementing differentiated learning. However, the reality in the field is certainly not smooth, there are various challenges that hinder the implementation of this learning, one of which is in terms of time. The solution is good time management in the learning process."

Furthermore, Mr. Venus Sulthony, S.Kom as the transformational teachers also revealed the following:

"The challenges faced by students when implementing differentiated learning sometimes there are students who do not like the group that we have determined according to their learning style. The solution is usually to give understanding to the student so that he can collaborate with all colleagues in the class

The challenges I face as an educator sometimes need colleagues to collaborate, but my colleagues are in the way, or our hours are clashing so that we cannot be together.

The challenge I face is related to learning evaluation when implementing differentiated learning, which is when we have to continuously monitor students who are working in groups to conduct formative assessments. The solution is to keep monitoring how each student participates in group work."

The results of the researchers' observations in the field related to the factors inhibiting the implementation of Teacher Mobilizers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency are influenced by three factors, namely:

1. Factors related to students,
   The challenge faced by teachers driving differentiated learning when implementing differentiated learning is that sometimes there are students who do not like the group that we have determined according to their learning style because group members are not confused, always the same colleagues, if there are group members who are not present, other group members will be overwhelmed to complete the project.
2. Factors related to educators,
   As a teacher, the driving force in differentiated learning must adjust the material to be taught and developed according to the learning needs of students. In their role as a learning manager or learning manager, teachers must be able to manage the classroom because the classroom is a learning environment and one of the aspects of an organized school environment. Teachers must have expertise so that they are able to carry out their duties and functions
3. Factors related to learning evaluation.
   Learning evaluation when implementing differentiated learning is when teachers have to continuously monitor students who are working in groups to conduct formative assessments with a limited time.

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Discussion

Based on the results of interviews, observations, and document studies that have been carried out, several data have been obtained on the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency where schools provide educational services for students as much as possible. A number of data obtained by researchers need to be interpreted so that the data found can be accounted for for its truth. From the findings, the author then attempts to conduct an analysis of the results of research related to the use of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency.

This research was carried out by looking at the facts and field findings as described in the previous chapter, and comparing them with the concepts or theories in the Interpretation of Transformational teachers in Differentiated Learning. After that, the author will also focus on the discussion in accordance with the next problem of this research, namely the use of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency and the supporting and inhibiting factors of differentiated learning. The results of the discussion about SMK Negeri 1 Muara Batu in North Aceh Regency were carried out through several stages. The stages are:

Planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency

Udin (2011:3) defines that planning is a series of activities to prepare decisions regarding what is expected to happen (events, circumstances, atmosphere, and so on) and what will be done (intensification, existentialization, revision, renovation, substitution, creation, and so on). Manap (2014:13) also explained that good planning is the most likely planning to be implemented. Through planning, the goals to be achieved, the scope of the work to be carried out, the people involved in the work, the various resources needed, as well as the steps and work methods selected based on their urgency and priorities, can be explained.

Based on the above statement, it can be concluded that the process of extracurricular management in schools should begin with careful planning by teachers, and principals as those who play a role in making decisions on differentiated learning. At the stage of planning differentiated learning in schools, there are several steps that need to be taken before organizing differentiated learning.

According to (Mohammad Mustar, 2014:7) the steps in planning consist of five things, namely:

1) Establish what to do, when and how to do it
2) Limiting targets and setting work implementations to achieve maximum effectiveness through the process of setting targets.
3) Collecting and analyzing information
4) Developing alternatives.
5) Preparing and communicating plans and decisions

According to Eca, et al. (2020: 138) With careful planning, it can facilitate every activity that has been agreed upon by the principal, teachers, extracurricular coaches, in carrying out differentiated learning where there is careful planning, students can easily carry out differentiated learning effectively and efficiently.

The planning of teachers driving differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency begins with planning that has been designed as well as possible, first making the learning plan as good as possible in differentiated learning planning, which involves all elements of the school. Technical determination of implementation in teacher planning in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, the school has designed learning in the form of learning outcomes, diagnostic test questionnaires, becoming learning facilitators, and motivating student learning

Limiting targets and determining work implementations to achieve maximum effectiveness is carried out through the process of determining targets in the planning of transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency has designed schedules, learning objectives and flow of learning objectives as well as differentiated learning modules.

The technique of collecting and analyzing information in the training of transformational teachers in differentiated learning is carried out through (1) supervision, (2) diagnostic assessment, (3) analysis of the results of previous report cards todetermine the level of student ability.

Techniques for developing alternatives from the results of information analysis in the Teacher Awareness of Differentiated Learning are carried out by the principal along with other elements (1) reflecting, (2) preparing learning media according to the student's learning style, (3) developing materials and learning models based on student needs

Government regulatory guidelines in carrying out teacher driving planning in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency are guided by Module 2.1 provided in LMS in the training of the Transformational teachers Education Program.

Supporting and inhibiting factors of Transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency

With supporting factors, all learning activities will run smoothly according to the desired expectations. With the existence of inhibiting factors for transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, it can improve quality and smoothness if handled and managed properly and correctly.

The supporting factors for transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, are: (1) library, and (2) provision of learning tools.

In addition to supporting factors, there are also inhibiting factors faced by teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, including: (1) Factors related to students, (2) Factors related to educators which include problems with teachers' mastery of materials, problems with teachers' mastery in classroom management, and (3) Factors related to learning evaluation.

The way to overcome these obstacles is to do various things, namely (1) mapping student needs and making good classroom management, (2) good time management in the learning process, (3) giving students an understanding to collaborate with all colleagues in the class, and (4) actively monitoring how each student participates in group work.

4. CONCLUSION

Based on the results of the research and discussion that the researcher has explained, it can be seen that the planning of Teacher Mobilizers in improving differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency has been going well. The following is an explanation of the conclusion of the Transformational teachers planning in improving differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency:

1. The Planning of Transformational teachers in improving differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency is going well such as: (1) has designed learning in the form of learning outcomes, diagnostic test questionnaires, becoming learning facilitators, and motivating student learning. (2) Designing schedules, learning objectives and flow of learning objectives as well as differentiated learning modules, (3) supervising, conducting diagnostic assessments, analyzing the results of previous report cards to determine the level of students' abilities, (4) conducting reflections, preparing learning media in accordance with students' learning styles, developing learning materials and models based on student needs. (5) guided by module 2.1 of the Transformational teachers Education Program.
2. The supporting factors for transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, are: (1) library, and (2) provision of learning tools.
3. The inhibiting factors faced by transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency include: (1) Factors related to students, (2) Factors related to educators which include problems with teachers' mastery of materials, problems with teachers' mastery in classroom management, and (3) Factors related to learning evaluation.

Implication

The implementation of this research has implications for related parties, including:

1. The planning steps of transformational teachers in improving differentiated learning at SMK Negeri 1 Muara Batu North Aceh Regency are carried out by (1) determining what to do, when and how to do it, (2) limiting goals and setting work implementations to achieve maximum effectiveness through the process of setting targets, (3) collecting and analyzing information, (3) developing alternatives, (4) preparing and communicate plans and decisions

2. The supporting factors for transformational teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, are: (1) library, and (2) provision of learning tools. In addition to supporting factors, there are also inhibiting factors faced by teachers in differentiated learning at SMK Negeri 1 Muara Batu, North Aceh Regency, namely: (1) Factors related to students, (2) Factors related to educators which include problems with teachers' mastery of the material, problems with teachers' mastery in classroom management, and (3) Factors related to learning evaluation

Suggestion

The implementation of differentiated learning, which is provisionally a new thing in the world of Indonesian education, makes teachers should learn a lot about this. The application of differentiated learning needs to be pursued by all teachers in Indonesia because this learning accommodates the different learning needs of students, which of course is very meaningful for students. Differentiated learning is child-friendly learning and this is in line with Indonesia's commitment to supporting learning for all. Another positive impact of the implementation of differentiated learning is the increase in students' ability to understand learning. This happens because of the increased enthusiasm and interest in learning of students as a result of teaching that is tailored to students' interests and learning styles.

Teachers need to maximize the application of differentiated learning to be in accordance with its essence. Due to the lack of experience of teachers in implementing this differentiated learning model, differentiation has not been fully carried out. Teachers still often apply the old undifferentiated learning model. Learning content is still not differentiated, and neither are processes and products. Therefore, socialization and training on the application of differentiated learning for teachers need to be followed until the provision of knowledge is sufficient. The principal as the leader and supervisor of the performance of educators in schools needs to continue to support the implementation of this differentiated learning. The facilities and infrastructure needed in differentiated learning need to be met. Likewise, in order to achieve good human resources in implementing differentiated learning, school principals need to increase opportunities for teachers to participate in workshops, training, and socialization of the implementation of differentiated learning.

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The Effectiveness of Using Assemblr Edu Application Media Based on AR (Augmented Reality) on Understanding the Concept of Elementary School Geomatry 3D

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ABSTRACT

The purpose of the following research is to understand the effectiveness of the use of AR-based assemblr edu (augmented reality) applications applied to students in elementary school geometry 3D. To understand the weight that students get before and after the assemblr edu application media is applied to learning. The following research uses an experimental quantitative approach method through the One Group Pretest Posttest Design design. The results of research using the assemblr edu application have an effective impact on understanding the concept of geomatry elementary school. The average score of students increased from 49 to 72. Statistical analysis with the SPSS version 25 application obtained the average value of the N-Gain score reached 0.74 which indicates a high category. While the significance data shows 0.000 (2-tailed) (0.000), the t-count value is 43.214 while the t-tabel is 21.788. The increase in the weight of the pretest and posttest understanding of the concept of geometry 3D is 0.88211 and is included in the high improvement category. The ES weight is 2.110 which is categorized as "high". Based on the existing requirements, the ES weight shows that the use of AR-based assemblr edu application media (Augmented Reality) is effective.

Keywords: Assemblr Edu; Augmented Reality; Concept Understanding

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1. INTRODUCTION

Education plays a crucial role in the 21st century generation of learners, especially when supported by technological advancements in education. These advancements will facilitate the learning process. Education enables a change in the purpose of learning from a one-way delivery of knowledge and information, to a guiding process that supports the development of knowledge and information of learners as the center (student-centered). Learning is the process of organizing learners in their environment, which in turn can optimize their motivation to learn (Binmuslim, 2019). According to Muntoha in (Sutriyani & Widyatmoko, 2020) Education is one of the main aspects as a determinant of a nation's intelligence. Therefore, it is necessary to have educational institutions and teachers who are able to organize professional learning in the classroom. However, professional learning with creativity and innovation has not been fully implemented by educational institutions in Jepara. It appears that student learning outcomes have not increased and tend to show a decreasing graph, this also implies that the use of teaching models used by teachers is still traditionalistic and needs development. Learning is a stage undertaken by students to achieve certain goals. A conducive learning environment can make the learning stage more efficient, effective and enjoyable. Learners will not be limited to existing learning procedures, but will be faced with problems that require them to understand the concepts behind them and get a variety of procedures or strategies to solve these problems.

Concept understanding skills are closely related to problem solving. Based on Uno and Perkins in (Diana et al., 2020) explained that understanding is the ability of an individual to use the information learned. The parameters of student understanding are shown when students are able to explain concepts in their own words, apply the information appropriately to new contexts, form new analogies, and generalize. Memorization and recitation do not indicate understanding. another opinion from (Mayasari & Habeahan, 2021) Concept understanding is a crucial aspect for students. This understanding is achieved through the process of examining the skills that students have. Without a good understanding, students will have difficulty remembering the information that has been conveyed by the teacher. Based on researchers' views in various learning environments, the main cause of students' low scores is a lack

of understanding of concepts. This makes them unable to work on a number of problems given by the teacher. Many students' math scores, especially on the material of geometry 3D, are still below the KKM. Students will understand the concept better if a comprehensive review of the material is carried out, besides that there has been no development of suitable learning media in optimizing student learning outcomes so that the use of this teaching material will help students maximize knowledge.

This is in accordance with the statement (منار على محمد, 2022) teaching materials (learning media) are tools for teachers at the teaching and learning stage. This media is used as a solution for teachers to facilitate and increase the effectiveness of material delivery. The use of teaching materials is a crucial aspect of the success of the teaching and learning stage, the expression was stated by Supriyono in (Rahmannisa et al., 2023). The use of media increases student learning motivation and minimizes boredom. Technological advances have a major impact on the teaching and learning stages and can be used as a learning resource for students. This software allows the media presented to be more diverse and creative, if desired. Based on research (منار على محمد, 2022), digital-based teaching materials can optimize student learning motivation through various formats, animation and audio. The more innovative and creative the teaching materials used by teachers, the more motivated students will be to learn. One of the solutions to solve students' low understanding of the concept of geomatry material is the use of AR (augmented reality) based teaching materials tailored to the needs of modern students in the 21st century.

Augmented reality (AR) is a 3-dimensional learning media used for interesting teaching and learning stages and is believed to optimize passion or motivation for learning in students. Based on (Mursyidah & Saputra, 2022) AR is a technology that absorb virtual 2D and 3D objects into real 3D environments, allowing people to have a more natural relationship with computers by projecting virtual objects into the real world. Similarly expressed by (Dobrovská & Vaněček, 2021) in the field of education, augmented reality is very suitable, and many applications are successfully used to improve the learning process. With the advancement of the times and the development of gadget technology owned by 21st century students today, this facilitates the learning process between teachers and students. One of the applications of technology in education is through the use of AR (augmented reality) through the assemblr edu application.

The use of AR has strong implications in strengthening students' competence and material understanding. Findings by (Nugraha et al., 2021) indicates that pupils can have an engaging, stimulating, and interactive learning experience with AR media, which improves their comprehension of the material covered in class. In addition, in research (Setyawan et al., 2020) AR can be used as a tool to visualize the structure of abstract concepts and models and to understand objects. Because the use of AR is very interesting and informative.

Observations conducted on Thursday, March 27, 2023 yielded data on 13 pupils' daily math exam scores; on average, only 45% of them received scores higher than the KKM. In addition, the diversity of traits and characters and the different levels of learning understanding among students make it difficult for teachers at the learning stage. Students' difficulties in understanding concepts are caused by their ignorance of the material, so teachers need to provide a real picture so that learning material is easier to understand. Unconducive classroom conditions and less enjoyable teaching and learning stages make students less active and uninterested in learning. This happens because the teacher only focuses on the material in the LKS (Student Worksheet) handbook. Based on the description above and the support of relevant theories, researchers conducted this study to analyze the effectiveness of using AR teaching materials through the assemblr edu application on understanding the concept of geometry 3D in elementary school students.

2. RESEARCH METHOD

This study employs an experimental quantitative approach method, a Purposive Random Sampling sample selection strategy, and a One Group Pretest-Posttest design. According to Nurdyansyah (2020), this technique involves random sample selection where the sample group is targeted to have certain attributes in a study. In the following study, the purposive random sampling technique was applied with the data collection subjects being 5th grade students of State Elementary School 03 Sekuro, totaling 13 students. Research data collection was carried out through tests that were tested on students. The pretest and posttest test instruments used were descriptive questions totaling 10 questions. The data analysis technique used is N-gain score testing and one-sample t-test testing using the IBM SPSS 25 application.

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3. RESULTS AND DISCUSSION

The results of research at SDN 3 Sekuro grade 5 in mathematics subjects regarding the material of geometry 3D show that the use of assemblr edu teaching materials has proven effective in optimizing the understanding of the concept of geometry 3D in elementary schools. In order to create a positive learning environment where students actively engage with one another and teachers, educators must be able to maximise the learning resources already in use while also keeping up with the ever-accelerating pace of technological advancement. This view is also stated by Rully Charitas Indra Prahmana & Hartono in (Al Mawaddah et al., 2021) "Through the use of computers, smartphones, and the web, individuals have been able to progress innovation, instruction, and media, which has motivated individuals to get to be more profitable and proficient in their every day lives." which means through the use of computers, smartphones, and the internet, people can advance technology, education, and media, which has inspired people to become more efficient and productive in their daily lives. In fact, teachers must develop appropriate learning strategies to ensure expertise and potential development in students. According to (Hayati, 2021) in her research argues that they enjoy games that involve hands-on activities and learning by doing. Thus, teachers must be able to manage and create learning content that integrates elements of play. The above ideas are evidence that advances in educational technology and learning media have encouraged people to use electronic devices more effectively and efficiently in carrying out their daily activities. Teachers must also create effective learning strategies to ensure that learners acquire developed skills.

Based on research conducted in class 5 State Elementary School 03 Sekuro 03 Sekuro with 13 students on Thursday, March 27, 2024 and in the implementation given twice treatment (treatment) by using assemblr edu application media based on augmented reality, obtained the results of the pretest and posttest test equipment done by students. The value data can be examined in Table 1:

Table 1. *Pretest* and *Posttest* scores

Test	Lowest Score	Highest Score	Total Score	Average	Number of Students
Pretest	42	58	640	49	13
Posttest	58	80	931	72	13

Source: Research Data, 2024

The pretest and posttest values in table 1. were tested using prerequisite testing, namely normality testing. According to (Usmadi, 2020) normality testing is used as a statistical test to understand whether research variables or data have a normal data distribution or not. To test the normality of pretest and posttest data in the following study, Shapiro-Wilk testing was used. This test aims to ensure that the data is normally distributed with the condition that the significance level is > 0.05. The test was run using IBM SPSS for Windows version 25 software, and the results can be examined in table 1.

Table 2. Normality Test Results Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.184	13	.200*	.937	13	.414
Posttest	.153	13	.200*	.950	13	.592

a lower bound of the true significance.

a. Lilliefors Significance Correction

The outcomes of the normality test are shown in Table 2, which demonstrates that the data is normally distributed with a significance level of 0.200 > 0.05 for the student pretest. The data's normal distribution was further explained by the posttest's significance level of 0.200 > 0.05. The following results are supported by research conducted (Yulianto et al., 2022) that the values are normally

distributed, where the significance level is 0.200 which exceeds 0.05, so the data can be used. In the following study, the hypothesis was tested using N-Gain score testing, which was used to evaluate the increase in understanding of the concept of geometry 3D in grade 5 students before and after being treated using AR-based assemblr edu application media (Augmented Reality). The N-Gain score hypothesis test was conducted with the IBM SPSS for Windows version 25 application, and the results are presented in table 5 below.

Table 3. N-Gain Test Results

Descriptive Statistics

N		Minimum	Maximum	Mean	Std. Deviation
Ngain_Score	13	.28	.55	.7463	.88211
Ngain_Percent	13	27.59	55.10	74.6263	8.21063
Valid N (listwise)	13				

According to Table 3, the N-Gain score's mean or average score is 0.74, falling into the high category. The 0.88211 improvement in pretest and posttest scores for comprehending the idea of geometry 3D is likewise categorised as high. According to (Zulfa et al., 2023) The normality test, also known as the N-Gain test, is used to measure how effective a treatment is. This is supported by previous research which explained that the understanding of the concept of geometry 3D increased significantly, indicated by the posttest value that exceeded the pretest. According to the N-Gain produced by (Alqadri et al., 2021), the acquisition of a high N-Gain value, which is at a score of 0.76, from the limited trial results. The elementary school level's utilisation of 3D augmented reality-based learning resources demonstrates great satisfaction and the method's viability. In fact, based on (Anggraeni et al., 2023), AR media has a positive impact on learning to build space. This shows that previous research is in line with the results of current research regarding the effectiveness of augmented reality-based assemblr edu application media in improving understanding of the concept of geometry 3D in grade 5 elementary school students.

The results of the N-Gain Score test analysis showed a value of 0.88211, which is categorized as "high". Sourced from research (Herman et al., 2023) revealed the feasibility and satisfaction with the use of 3D Augmented Reality-based teaching materials aimed at elementary school education levels in the learning process. In research (Kuzgun, 2019) that AR technology attracts children's attention, helps them interact, and gives them a sense of reality. This shows that the use of these media can significantly optimize the understanding of the concept of geometry 3D in grade 5 students. Hypothesis testing using the one sample t-test test in the following study was carried out with the help of IBM SPSS for Windows version 25 software, and the results can be examined in table 4.

Table 4. *One Sample* Test Results

One-Sample Test

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
pretest	35.824	12	.000	49.154	46.16	52.14
posttest	43.214	12	.000	71.308	67.71	74.90

Research data in table 4. The results of the One Sample Test above, can be observed that the utilization of the assemblr edu application media shows the score of significance (2- tailed) obtained 0.000. That way, the score is below the predetermined significance level of 0.05. The results of this study indicate that the significance level (2-tailed) is 0.000 < 0.05, which means that Ha has been

approved and Ho is denied. It is possible to draw the conclusion that there is a difference between the pretest and posttest average values—that is, between the values obtained before and after treatment. In addition, in the results of this analysis there is a t-count value which was originally a pretest of 35.824 an increase in the posttest with a value of 43.214. As for the t-tabel set in the 12 differentiation is 21.788 . The score obtained indicates evidence that the use of assemblr edu application media based on augmented reality (AR) is very effective for the learning activity process. This is supported by the results of research conducted (Car et al., 2023) entitled "Uses of Augmented Reality in Preschool Education" shows AR (Augmented Reality) users have the ability to relate to events, study objects around them and receive data. In line with other research conducted (Lino Padang et al., 2022) which suggests that because the representation is realistic, interactive and can be observed in various angles, assemblr edu teaching materials can help motivate students in learning.

Assemblr edu as a media means of learning resources in the results of this study indicate that the media assistance process of teaching and learning activities is able to influence students in understanding a concept, especially in geometry 3D material in elementary school delivered by educators. In line with (Iskandar et al., 2023) that the use of assemblr edu has a fairly strong influence on student interest and motivation to learn. However, the use of assemblr edu can be one of the innovations of educators as a diverse learning media and create meaningful learning experiences. Other research conducted (Ermawati & Zuliana, 2020) also reinforces the use of learning media affects grade 5 students' ability to understand math concepts, which has a positive impact on activities and interactions between students when mastering the subject matter. This helps learners to achieve the best level of achievement. It also provides the value obtained by students before getting treatment (pretest) and the value after getting treatment (posttest) of 5th grade students in using assemblr edu application media based on augmented reality (AR) on understanding the concept of geometry 3D at State Elementary School 03 Sekuro there is a significant difference in understanding the material in the classroom, especially in mathematics subjects. Learning resources in the learning process, one of which is assemblr edu application media can help educators and students. Then the research conducted (Sugiarto, 2022) stated that assemblr edu helps students understand the concept of material, and student responses regarding feasibility as media are 99.11%.

This can show that with this value obtained from the calculation stage entered in the ES (effect size) equation to determine the value of the effectiveness of its use and after calculation obtained an ES weight of 2.110 which is categorized as "high". Based on the existing requirements, the ES weight shows that the use of AR-based assemblr edu application media (Augmented Reality) is effective in optimizing understanding of the concept of geometry 3D in grade 5 Elementary School.

4. CONCLUSION

According to the study's findings, students at the 03 Sekuro State Elementary School have a considerably better grasp of the idea of creating space now that they have used the AR-based assembly edu application media (Augmented Reality). The results of the analysis using the N-Gain score test show an increase in the score of understanding the concept of geometry 3D from pretest to posttest of 0.88211, which indicates a significant increase. In addition, the results of the one sample t-test test display the significance weight (Sig.) worth 0.000 < 0.05, which rejects the null hypothesis (Ho) and accepts the alternative hypothesis (Ha). In addition, there is a t-count value which was originally a pretest of 35.824 an increase in the posttest with a value of 43.214. As for the t- table set in the differentiation of 12 is 21.788 which explains that there is a difference in the average value before (pretest) and after (posttest) the application of the media. The learning media of assemblr edu application based on augmented reality (AR) is proven to be effective than learning that does not use teaching materials in optimizing student learning understanding in the mathematics subject of elementary school geometry 3D material. This is evident from the average value of the results after the test (posttest) after the use of learning media in class 5 which is higher with a score of 49 than before the test (pretest) whose average score is 72. Furthermore, the effect size (ES) value calculated from the calculation process reached 2.110, categorized as "high" according to existing criteria. This explains that the use of AR-based assemblr edu application media is effective in optimizing the understanding of the concept of geometry 3D by students.

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The Effectiveness of Group Guidance Services through Modeling Techniques by Applying the Tabligh Nature Of Rasulullah SAW. to Increase the Self-Confidence of Class VII Students at MTSn 2 Medan

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ABSTRACT

Research that has been conducted with the title"The Effectiveness of Group Guidance Services through Modeling Techniques withApplying the Tabligh Nature of the Prophet Muhammad Saw. to Increase Self-Confidence Class VII students at MTsN 2 Medan" which is motivated by the phenomenon of field findingsshows that there are students who experience low self-confidencelow self-confidence such as an attitude that is not brave and anxious students when presenting the results of a discussion in front of the class and not daring to appeardiscussion in front of the class and not daring to perform murojo'ah activities. The purpose ofThe objectives of this study are (1) to determine the description of students' self-confidence in class VII at MTsN 2 Medan.class VII students at MTsN 2 Medan. (2) to find out the effectiveness of group guidance services through modeling techniques by applying the tabligh nature of Rasulullah Saw. to increase the confidence of seventh grade students at MTsN 2 Medan. This research using a quantitative approach with a pretest - posttest control group design. group design. The results showed that: (1) Increased self-confidence of students in class VII H MTsN 2 Medan. Before the intervention, 70% of students were in the medium category and 30% in the low category. After the intervention, 50% of students were in the medium category and 50% in the high category. (2) There is an effectiveness of group guidance services modeling techniques by applying the tabligh nature of Rasulullah Saw. in increasing student confidence. A significant difference can be seen between the pre-test and post-test results with a sig value. (2 tailed) of 0.005 <0.05, which means that there is a significant effect before the intervention (pre-test) and after the intervention (post-test) on students' self-confidence.

Keywords: **Group Guidance Services; Modeling Techniques; Self-Confidence**

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1. INTRODUCTION

Education is one of the main pillars in individual and societal development. Law No. 20 of 2003 concerning the National Education System emphasizes that education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, as well as the skills needed by society, nation and state.

Self-confidence is part of an individual's character which plays a role in actualizing one's potential (Asrori, 2020). According to Akrim Ridha (Jannah, 2021), self-confidence (*al tsiqah bi al nafs*) is the main foundation of a person's potential in living his life. If this self-confidence is weak, such as doubts about one's ideals and life decisions, as well as doubts about one's potential (*al iman bi al dzathi*), then all your potential will be lost.

According to Lindenfield (2019), self-confidence is an individual's belief in their own abilities and self-assessment that can be shown to the public. In this way, the public can clearly understand the opinions and ideas of the individual. Self-confidence is divided into two, namely external self-confidence and inner self-confidence. Self-confidence requires the development of communication skills, assertiveness, self-presentation, and emotional control. Meanwhile, inner self-confidence involves self-love, self-understanding, positive thinking, and having clear goals.

In education, self-confidence influences success in studying, working, and family and social relationships (Solina et al., 2020). Someone who believes in themselves tries to develop their potential

to the maximum. Students who have high self-confidence tend not to give up easily and are able to express themselves well. On the other hand, students with low self-confidence will face various difficulties in the learning process, such as difficulty developing talents and interests, and tend to be passive in interactions (Mega Agustien & Indah Pratiwi, 2022).

During adolescence, especially at junior high school (SMP) level, individuals experience significant changes both physically and psychologically (Hurlock, 2015). These changes often affect students' self-confidence. Adolescents who experience social pressure, shifts in identity, and high expectations from their environment can experience significant fluctuations in self-confidence (Hurlock, 2015).

Academic and social pressure in middle school is often a major factor influencing students' self-confidence. Competition in class, assessment from peers, and demands from parents and teachers can have a negative impact on students (Yogyakarta State University Public Relations, 2021). Field findings still found students who had a low level of self-confidence, characterized by students who were afraid to present the results of discussions in front of the class and did not dare to perform murojaah activities when suddenly asked. Therefore, it is important to identify and implement strategies that can help students overcome self-confidence issues.

One approach that can be applied to increase student self-confidence is through group guidance services. Group guidance plays an important role in supporting students' social and emotional development, as well as helping them overcome various challenges faced during adolescence (Nurihsan & Juntika, 2005).

In the context of group guidance, modeling techniques are one method that has been proven to be effective. Research conducted by (Patriana, 2019) shows that the results of the research reveal that the application of the group guidance model with modeling techniques has proven to be effective in increasing students' self-confidence, as revealed through non-parametric statistical tests *Wilcoxon*. The test results on the self-confidence scale show a probability value below 0.05 (0.006<0.05), which indicates a significant increase in students' self-confidence scores after following group guidance with the technique *modeling*.

The modeling technique was introduced by Albert Bandura. Several experiments by Bandura (1969, 1977, 1986) show that most learning is carried out not only through direct experience, but can also be obtained by observing the behavior of other people. In Bandura's view, one of the fundamental processes in which clients learn new behavior is by imitating the social models provided by the therapist (Corey, 2012). Bandura (2021) developed four stages of learning through modeling, namely: attention, retention, reproduction and motivational stages.

Bandura's social learning theory reveals that learning does not only occur through direct experience but also through observation (Corey, 2012). In this context, students can observe model behavior that shows self-confidence. Modeling techniques in group guidance involve several steps, including selecting relevant models (Komalasari & Wahyuni, 2011). The model used must have credibility and skills that are considered positive by students.

Rasulullah saw. is a person who has high self-confidence. He was able to convey Islamic teachings with full confidence and courage. The exemplary nature of the tabligh of the Prophet Muhammad. can provide motivation and inspiration to group guidance participants who can learn from the Prophet Muhammad. how to build strong self-confidence so they can achieve their desired goals. Emulate the attitude of the Prophet Muhammad. in all cases it is a must for all people, including educators and students (Setyowati, 2019).

Tabligh, which means to convey, is a characteristic given to the Prophet Muhammad. as the last Apostle. He was given the task by Allah to convey to his people all the commands given by Allah without reducing any of these commands (Musyirifin, 2020). Tabligh is the act of conveying or inviting others while providing examples of correct behavior in life. This includes argumentative and communicative aspects, which require individuals to have the ability to convey opinions well and communicate effectively in conveying useful messages (Amalia & Herianingrum, 2015).

The method used to support individuals in a group where each member has the opportunity to actively improve the understanding, attitudes, or skills needed to overcome problems or improve personal development is called group guidance (Syarqawi et al., 2022).

Therefore, this research aims to explore the effectiveness of modeling techniques by applying the tabligh characteristics of the Prophet Muhammad. in group guidance as a strategy to increase student self-confidence.

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2. RESEARCH METHOD

This research uses a quantitative approach with Pre-Experimental methods, especially design *One-Group Pretest-Posttest*. In this design, the pretest is carried out before the intervention and the posttest is carried out after the intervention to measure the changes that occur (Sugiyono, 2024). This research involves treatment in the form of group guidance with modeling techniques that adopt the tabligh characteristics of the Prophet Muhammad. to increase the self-confidence of class VII MTsN 2 Medan students who have medium and low self-confidence.

The variables in this research consist of the independent variable, namely group guidance with modeling techniques (X), and the dependent variable, namely student self-confidence (Y). The instruments used include unstructured interviews to obtain initial information from guidance and counseling teachers as well as scale questionnaires to measure student self-confidence.

Research objects are selected using techniques *purposive sampling*, with a sample consisting of 10 class VII-H students who have medium and low levels of self-confidence, from a population of 384 class VII students at MTsN 2 Medan. This research was carried out at MTsN 2 Medan for four months, from April to August 2024. Data analysis was carried out using the Wilcoxon test to measure differences before and after treatment in ordinal scale data (Muhid, 2019).

3. RESULTS AND DISCUSSION

A. Description of Class VII Students' Self-Confidence at MTsN 2 Medan

1. Description of Class VII Students' Confidence at MTsN 2 Medan before Receiving Group Tutoring Services.

Researchers carried out initial identification of the level of self-confidence of class VII students at MTsN 2 Medan, and from these results selected 10 students who fell into the medium and low categories as research samples. This sample was selected based on the results of previous questionnaires, which reflect the distribution of scores and percentages of students' self-confidence. This data is summarized in the following table:

Table 1
Recapitulation of Students' Self-Confidence Before Giving Treatment

Nu	Respondent's name	Score	Percentage (%)	Category
1	FA	90	58	Currently
2	ROB	79	51	Low
3	AK	88	57	Currently
4	NI	74	48	Low
5	NUNH	92	59	Currently
6	SRH	88	57	Currently
7	MRH	90	58	Currently
8	MAH	90	58	Currently
9	RAR	89	57	Currently
10	MA	78	50	Low
Average score		**85.8**	**55**	**Currently**

From the table above, it can be seen that there are 7 students who are in the medium category (FA, AK, NUNH, SRH, MRH, MAH, RAR) with scores between 88-92 and a percentage of 57%-59%, while 3 other students are included in the low category (ROB, NI, MA) with a score of 74-79 and a percentage of 48%-51%. The overall average score is 85.8 with an average percentage of 55%, which falls into the medium category. These students were selected because they were in a category that required intervention to increase self-confidence.

2. Description of Class VII Students' Confidence at MTsN 2 Medan After Receiving Group Tutoring Services.

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After class VII students at MTsN 2 Medan received group guidance services using modeling techniques that applied the tabligh characteristics of the Prophet Muhammad, an evaluation was carried out to see changes in their level of self-confidence. The evaluation results are summarized in the following table:

Table 2
Recapitulation of Students' Self-Confidence After Being Given Treatment

Nu	Respondent's name	Score	Percentage (%)	Category
1	FA	108	70	High
2	ROB	108	70	High
3	AK	90	58	Currently
4	NI	91	59	Currently
5	NUNH	109	70	High
6	SRH	107	69	High
7	MRH	99	64	Currently
8	MAH	111	72	High
9	RAR	94	61	Currently
10	MA	99	64	Currently
	Average score	**101.6**	**66**	Currently

Based on the table, of the 10 students selected, there are 5 students in the "Medium" category (AK, NI, MRH, RAR, MA) and 5 students in the "High" category (FA, ROB, NUNH, SRH, MAH) . As many as 50% of respondents were in the "High" category with a score between 107-111 and a percentage of 69%-72%, while the other 50% were in the "Medium" category with a score of 90-99 and a percentage of 58%-64%. The overall average score was 101.6 with an average percentage of 66%, both in the "Moderate" category.

After the group guidance intervention using modeling techniques that applied the tabligh characteristics of the Prophet Muhammad, there was an increase in the students' self-confidence category. Before this service was provided, 70% of students were in the medium category and 30% were in the low category. However, after the service was implemented, there was a change in distribution where 50% of students were in the medium category and the other 50% were in the high category. The average score increased from 85.8 to 101.6, with the average percentage also increasing from 55% to 66%.

Data analysis shows that there is a significant difference in the level of students' self-confidence before and after they receive group guidance services using modeling techniques that adopt tabligh characteristics. This research indicates an increase in the average self-confidence score of class VII students at MTsN 2 Medan. These differences reflect that students' self-confidence can vary, is not always stable, and can change depending on specific situations. As expressed by Angelis (2005), self-confidence is not always the same in every activity, but can change depending on the context and situation faced.

B. Effectiveness of Group Tutoring Services Through Techniques *Modeling* by Applying the Tabligh Characteristics of the Prophet Muhammad. to increase the self-confidence of class students at MTsN 2 Medan.

In this research, researchers conducted tests *wilcoxon* to compare the pre-test and post-test scores of 10 participants. Following are the test results *wilcoxon* in table form:

Table 3
Wilcoxon Test Results

Statistical test	Mark
N	10

Total positive rank	55
Number of negative ratings	0
The value of z	-2.807[b]
Asymp. Sig. (2-tailed)	0.005

Based on the results of the Wilcoxon test, the Asymp. Sig. (2-tailed) of 0.005 indicates that the results are significant, because this value is smaller than 0.05. This means there is a significant change after students are given treatment, which shows that the alternative hypothesis is accepted. Thus, this hypothesis test shows that group guidance services through modeling techniques apply the tabligh characteristics of the Prophet Muhammad. effective in increasing the self-confidence of class VII students at MTsN 2 Medan.

The effectiveness of this service is also seen during the implementation of group guidance, where the group dynamics that are formed help students develop their self-confidence. This is in line with the view of Harahap (2021), who states that group guidance can utilize group dynamics to discuss topics that are relevant and useful for students' personal development, especially in the context of increasing self-confidence.

4. CONCLUSION

This research aims to increase students' self-confidence through group guidance by applying modeling techniques based on the tabligh characteristics of the Prophet Muhammad. The research results showed that this intervention was effective in increasing the self-confidence of class VII students at MTsN 2 Medan. The following are some conclusions that can be drawn from this research:

1. Increased Self-Confidence: Before the intervention, 70% of students were in the medium self-confidence category, while the other 30% were in the low category. After the intervention, significant changes occurred, with 50% of students now in the medium category and the other 50% in the high category. The average self-confidence score increased from 85.8 to 101.6, and the average percentage also increased from 55% to 66%.
2. Effectiveness of Modeling Techniques: The results of data analysis show that the Asymp. Sig. (2-tailed) of 0.005 which is smaller than 0.05, indicating that the implementation of group guidance uses modeling techniques based on the tabligh characteristics of the Prophet Muhammad. significantly effective in increasing the self-confidence of class VII students at MTsN 2 Medan. Additionally, there was a significant increase in the mean, median, and mode of self-confidence scores after the intervention, further confirming the effectiveness of this approach.

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The Use of Audio Visual Media on Learning Outcomes in the Independent Curriculum

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ABSTRACT

Rapid advances in science and technology have had a major impact on education, especially with the introduction of the Merdeka Curriculum which integrates literacy, skills and technology. One of the proposed solution is the use of audiovisual learning media that uses sight and sound to present material more interestingly and effectively. The purpose of the study is to destermine the impact of using audiovisual media on learning outcomes in the context of the Merdeka Curriculum. The method use is a literature review that collects data from various sources such as books,journal articles,and the internet. The data is analyzed descriptively to destermine the effectivitas of audiovisual media in improving mathematics learning. The research shows that audiovisual media can improve student understanding and retention by presenting material visually and audibly, so that learning becomes more interactive and interesting.

Keywords: Learning Media, Audio Visual, Independent Curriculum

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1. INTRODUCTION

The development of technology is increasingly rapid today, along with the advancement of science and the use of technology. So that technology increases in various fields, not except in the field of Education (Effendi, D., & Wahidy, A. 2019). The development of information technology has great potential in how to learn, obtain and manage data and information (Taufiq, M., A. V. Amalia, 2017). The development of information technology-based learning media can manage data in the form of audio, audio visual, including multimedia so that it is one of the alternatives to overcome problems in learning (Darmawan, 2016).

Audiovisual media is one of the good learning media for the world of education. This media is a media that presents material by utilizing both human senses. The two senses are the sense of hearing and the sense of sight. Audio-visual media that displays images with voices will make it easier for students to understand a lesson better. It is time for this audio-visual media to be used in the world of Education. Audio visual media combined with books as open media can create good learning outcomes for students. (Teguh P., et al., 2024).

In the Independent Curriculum, in order for a learning process to run well and the quality of students' competencies increases, educators today are required to better understand the content of learning materials into an innovative interactive learning medium (Fitra, J., & Maksum, 2021). Learning media is a teaching aid in the form of a vehicle that contains learning materials and distributes them in a more effective and efficient way, so that it is able to stimulate students to absorb it better (Teguh P., et al., 2024).

The reality in the field shows that there are still many obstacles experienced by educators in the implementation of the Independent curriculum. The lack of literacy or reference for community access, and the competence of educators cause the implementation of the curriculum to not be achieved. There are still many educators who only rely on book packages to be used as learning resources, while at this time there are many references to learning resources that can be easily accessed through the web. Activities regarding the material that will be delivered to students. Lack of Literacy sometimes also goes hand in hand with the lack of references obtained. There are still books for students and for

educators published by book centers that are considered to be of poor quality as expected (Laila, AKN, et al. 2022).

Based on the above description, the researcher is encouraged to research "The Use of Audio Visual Learning Media on Learning Outcomes in the Independent Curriculum".

2. RESEARCH METHODS

The writing of this article using the literature review method or the literature approach will be used in the writing of this article. The research method is carried out by collecting data from various sources such as books, scientific journal articles, and the internet. These sources are considered to be able to obtain data suitable for research. The researcher then recorded and collected the resulting data to be used in the development of this article. This research is included in the type of qualitative descriptive research using literature research. Literature relevant to the question and research objectives will be used. A literature review itself is a written summary of several sources such as articles, journals, books, and other documents that describe the information and its arrangement based on topic, issue, or purpose (Creswell, 2016).

The type of information used by the author in this study was obtained from literature researchers through various sites and applications such as Google Researcher, Distribute Or Die, and Mandeley. Information that explains the identified facts to provide understanding and explanation (All Habsy, 2017). The analysis uses Miles and Huberman's theory (Sugiyono, 2014). Keywords are words that are used as keys in a code or words that highlight and describe the content of a document (Students, 2013).

3. RESULTS AND DISCUSSION

A. Audio Visual Learning

Ramli's Audiovisual Learning revealed that there are at least five types of learning media (Ibrahim M.A, et al., 2022: 108):

1. Two-dimensional projection media (only has length and width) such as: charts, images, graphs, posters, base maps and so on.
2. Media without 3D projection (Length, width/height, e.g. real objects, models, dolls, and so on.
3. Audio media (hearing media): such as radios and tape recorders.
4. Media with projection (projection media) such as film, slides, film strips, and overhead projectors.
5. television (TV) and video recorder (VTR) are tools for viewing images and listening to audio remotely. A VTR is a tool that simultaneously records, stores, and displays the audio and images of an object

Rudy Berta in (Ramli, M.2012) compares eight classifications of learning media, namely:
(1) mobile audiovisual media
(2) statistical audiovisual media,
(3) semi-mobile audio media,
(4) visual moving,
(5) still image media,
(6) semi-moving media,
(7) audio and print media;

There are various classifications of learning media that have been proposed by experts, but there are some basic similarities.
Below are the types of learning media.

1. Viewable media. For example, objects such as images and posters can only be enjoyed visually without moving or making sounds (Mumlahanah Ibrahim, visual media 2022: 108).
2. Audio media is a medium that can only be used by listening, such as voice notes, radio, and music (Al-Yadillah and Fitrianshah in Ibrahim, 2022: 108).
3. Audiovisual media is media that can only be used through sight and sound, such as videos, short films, and slideshows (Ibrahim, 2022: 108).

These media can be used to help the learning process in the classroom. This media helps educators make learning more interesting, effective and efficient. Learning media can make it easier for educators to carry out the teaching and learning process. The media selected and used must be adjusted

to the ability of the educator, because it affects the teaching and learning process. In addition, the selection of learning media must also be adjusted to the learning needs of students (Ibrahim 2022: 108).

B. Learning Outcomes

Student learning outcomes are achievements achieved by students academically through exams and assignments, the activeness of asking and answering questions can increase the acquisition of these learning outcomes. In academic circles, there is often the idea that the success of educators is not determined by the student's grades listed on the report card or diploma, but for the measure of success in the cognitive field can be known through the learning outcomes of a student. To find out the indicators of learning success, it can be seen from "student absorption and behavior seen in students. The learning outcomes achieved are the achievement of learning achievements achieved by students with criteria, or predetermined values" (Syaiful Bahri Djamarah and Aswan Zain in Supardi, 2013). Meanwhile, according to Nana Sudjana, the cognitive realm is compatible with intellectual learning outcomes which consists of six aspects, namely knowledge or memory, understanding, application, analysis, synthesis, and evaluation. This realm emphasizes more on the ability to think logically and rationally. Learning outcomes are patterns of action, values, understandings, attitudes, awards and skills (Suprijono in Thobroni, 2016: 20). The learning outcomes of students obtained through Education will be able to compete in various community life activities.

Learning outcomes competencies abilities achieved by students after going through learning activities designed and implemented by educators in a school in a certain class. Meanwhile, according to Gagne and Briggs, learning outcomes are a person's ability after following a certain learning process. Based on the Taksonomo Blossom theory, learning outcomes are achieved through categories of domains, namely. The cognitive domain consists of six aspects, namely the realm of consciousness (C1), the realm of understanding (C2), the realm of application (C3), the realm of analysis (C4), the synthesis (C5), and the realm of assessment (C6). So that the learning outcome is the ability that students have after participating in which includes cognitive, affective, and psychomotor abilities. From the above understanding, it can be concluded that learning outcomes are the results given to students in the form of assessments after going through a learning process with assessments in the form of knowledge values, attitudes, skills in students and changes in behavior Nana Sudjana, 2011).

Through a learning process, an achievement called a learning outcome will be obtained. Learning outcomes can be used to see students' ability to understand learning outcomes in a sense that includes more cognitive, affective, and psychomotor fields (Sudjana.2011:3)

C. Independent Curriculum Differentiated Learning

The Independent Curriculum is a new name from the predecessor of the curriculum which was officially launched by the Minister of Education and Culture. Nadiem Anawar Makarim. So far, educational institutions still have the freedom to choose the curriculum they want to apply in their schools. The choice of curriculum is available between other 2013 Curriculum or the Independent Curriculum (Faradila Intan Sari et al., 2022). The Independent Curriculum the goal of providing more relevant, meaningful and empowering learning for students. By giving schools and educators the flexibility to adapt, the curriculum aims to adapt to the needs and possibilities of students and their environment, thus producing a generation that is ready to face future challenges.

Independent Curriculum, educators are driving forces who must have the ability to manage classroom activities effectively. Educators must be able to create effective relationships with students in schools. The Independent Curriculum is an innovation that creates a pleasant and ideal learning environment. Nadiem hopes that proving high scores and KKM will not make learning difficult for educators and students. This curriculum also emphasizes character education, so as to produce a generation with superior character and superior human resources (HR). In addition, this curriculum brings together iteration skills, knowledge, and skills regarding the utilization of technology. Students have the freedom to think critically and learn from a variety of sources, allowing them to find information and solve real-world problems. In the view of Mr. Nadiem Makarim, Minister of Education, Culture, Research and Technology of the Republic of Indonesia (Zabrina, N.et al., 2023).

In the context of the Independent, educators pay great attention to learning and understanding knowledge in schools. Based on the theory above, the application of media in the independent

curriculum requires a container or purpose in its implementation, one of which is to improve listening skills. Listening is listening to symbols and words attentively, understanding, appreciating, and interpreting them in order to obtain information, and understanding the meaning of communication that is not conveyed by the speaker or the words spoken.

D. Audio Visual Media Innovation on Mathematics Learning Outcomes in the Independent Curriculum.

The importance of a learning update in the to ensure that responsive to the development of the times and the needs of students in an ever-changing era. The Merdeka curriculum is a flexible educational approach that gives schools and educators the freedom to design learning to suit the local context, student needs, and skill development. Learning innovations include audiovisual media, power Point, video, and the Canva application. The selection of learning media plays a very important role in students' creativity (Tri Wahyuni, et al., 2023).

InnovationThe role of educators plays a very important role, educators can encourage the creativity your students by choosing learning methods that are tailored to them. Educators' learning innovations, which used to only use the lecture method, now demand the use of technology in the delivery of learning materials (Tri Wahyuni, et al., 2023). The use of audiovisual media in the educational environment has become an integral part and modern learning process of mathematics. Application media can improve student learning outcomes. This media can make learning more fun and on target. It also improves memory and comprehension, making it easier for students to answer practice questions. One of the main advantages of audiovisual media is that it provides an introduction to concepts that are taught visually and are easy to understand. Drawings, diagrams, and graphs help learners understand the topic more specifically. This is especially useful for abstract concepts that are difficult to understand with words. (Saputra, 2022: 25).

One of the learning media that can improve student learning outcomes is audiovisual media. This media is a tool used in learning to help written and spoken words in conveying knowledge, attitudes, and ideas in learning. Audio-visual media is a media that involves the senses of hearing and vision at the same time in a (Yudhi Munadi, 2008:55). The nature of the message that can be based on both verbal and nonverbal messages is like audio media (Munadi, Y., 2013).

The combination of visual and audio elements in audio-visual media allows students to better remember information. Through images and animated explanations, you can create information that sticks more deeply in the learners' memories. The more you memorize, the better you can apply that knowledge in exams and in everyday conditions. Audio-visual media improves educators to make learning more interactive and interesting. When learners watch videos, follow visual presentations, and participate in simulations, they become more active in the learning process. Participation actively increases understanding and retention of course content (Saputra, 2022: 27).

Audiovisual media is a medium that involves seeing and hearing simultaneously in a process (Maryam et al. 2020). Examples of learning media vary media are viseo and movies that contain learning content. PAI learning media innovation by using various media means to create materials in the form of videos and movies that are easily accessible on online sites such as YouTube. Another study found that varied media helped students absorb material faster because students were more receptive to material than educators who only provided material in written form (Suparyanto and Rosad, 2020).

"Learning using mixed media is proven to be more effective and efficient and can improve student learning outcomes" (Musfiqon, 2012: 187). Audio-visual media is included in mixed media, which is a type of media that in addition to containing sound elements, it also contains image elements that can be seen in the form of video recordings, films of various sizes, sound slides and so on. In using students in understanding the relationship between living things during learning (Gabriela, NDP, 2021:843).

In the opinion of the researcher, the use of a variety of learning media to provide clearer information about mathematics learning materials. This is in line with the statement of Kuswanto and Romelah who argue that the impact of using video media for educators spurs educators to be more creative, and makes it easier for educators to save their energy in presenting the material and then be

able to learn more about the material in the video (Kuswanto and Romelah, 2020). Therefore, the use of a learning medium with various variations is useful for learning.

4. CONCLUSION

Technological developments, especially audio-visual-based learning media, have a significant impact on the world of education, especially in the Independent Curriculum. The use of audio-visual media can improve students' understanding through stimulation of the senses of vision and hearing at the same time. Although there are challenges in the implementation of the curriculum, such as lack of digital access and educator competence, innovation in the use of learning media can improve students' learning literacy.

The Independent Curriculum offers flexibility for educators to design learning that is relevant to the needs of students. By choosing innovative methods and utilizing technology, educators can create interactive and interesting learning styles, thereby increasing student motivation and absorption. Therefore, it is important for educators to continue to develop digital literacy and utilize various learning resources to achieve better educational goals. The use of interactive learning media, especially audio-visual media, has proven to be effective in facilitating students' understanding of learning.

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The Development of Interactive Multimedia on Ethnoscience Integrated Acid and Base Material Oriented to Scientific Literacy Capabilities

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ABSTRACT

Education is a conscious and planned effort to create an environment and learning process where students actively develop religious spiritual strength, self-control, personality and intelligence. The independent learning curriculum proposes changes to the education system for educational progress that is relevant to modern times. The independent learning goal is to create fun education for teachers and students. . Because chemistry subjects require an understanding of abstract concepts, students often have difficulty understanding them. Ethnoscience integrated learning is a new innovation in the world of education that combines culture and science. The 2022 PISA results show that Indonesian students' reading literacy has decreased by 12 points from the 2018 PISA results. These results also explain that Indonesian students are lower than the global literacy average of 117 points. Sadly, only 25.46% of Indonesian students reach the PISA minimum competency standards for reading. Learning media, or even multimedia, is not only a tool to help teachers, but also increases the literacy and character values of each student. This study aims to determine the effectiveness of using interactive multimedia in integrated acid-base material in ethnoscience which is oriented towards scientific literacy abilities. The method used in this study is to compare data from several relevant journals. This research uses a narrative review approach. This research relies on secondary data such as journals and previous research on the relationship between interactive multimedia, ethnoscience, and scientific literacy. The research results show that interactive multimedia integrated with ethnoscience in acid-base material can influence scientific literacy abilities. This is proven from previous research sources that have been studied. Interactive multimedia with chemistry learning on interesting acid-base material integrated with ethnoscience has the benefit of influencing students' thinking abilities through interactive behavior. Chemistry material presented with an integrated ethnoscience culture can increase students' scientific literacy in learning.

Keywords: Interactive Multimedia, Ethnoscience, Scientific Literacy

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1. INTRODUCTION

According to SISDIKNAS Law no. 20 of 2003, Education is a conscious and planned effort to create an environment and learning process where students actively develop religious spiritual strength, self-control, personality and intelligence. Decree of the Minister of Education, Culture, Research and Technology of the Republic of Indonesia number 262/M/2022 concerning guidelines for implementing the curriculum in the context of learning recovery number 56/M/2022. The independent learning curriculum proposes changes to the education system for educational progress that is relevant to modern times. The independent learning goal is to create fun education for teachers and students.

Chemistry is part of a subject taught comprehensively in senior secondary schools (SMA) in the independent curriculum. Because chemistry subjects require an understanding of abstract concepts, students often have difficulty understanding them (Arofah and Rinaningsih, 2021). One of the chemical materials is acids and bases, this acid-base material is considered difficult by most students because it is considered complex which includes the ability to analyze, calculate and make connections in the acid-base material which can hinder students' understanding ability in studying the acid-base material (Rahmadani & Guspatni, 2023).

Ethnoscience learning is an approach to creating a learning environment that integrates culture in the learning process (Iqlima Maytrea & Namirah, 2020). Ethnoscience integrated learning is a new innovation in the world of education that combines culture and science. This will influence how students use technology and science to solve problems and protect the environment (Putri et al., 2022). As a

result of rapid globalization, Indonesia's local cultural values are being eroded. To prevent this from happening, an ethnoscience approach in the learning process must be applied (Puspasari et al., 2019).

One of the increasingly popular learning media is interactive multimedia technology, which can be accessed via various devices, consisting of text, images, audio, animation and video. Learning media, or even multimedia, is not only a tool to help teachers, but also increases the literacy and character values of each student. With interactive multimedia, students can understand lessons and improve their scientific literacy skills through the content contained in interactive multimedia.

The 2022 PISA results show that Indonesian students' reading literacy has decreased by 12 points from the 2018 PISA results. These results also explain that Indonesian students are lower than the global literacy average of 117 points. Sadly, only 25.46% of Indonesian students reach the PISA minimum competency standards for reading (OECD, 2023). Scientific literacy is very important because it can improve inquiry skills, increase oral and written vocabulary to understand and communicate science, and improve relations between science, technology and society (Pertiwi et al., 2018).

This research is important because it examines the development of interactive multimedia that is integrated with ethnoscience which is oriented towards scientific literacy skills which is a preventive step in overcoming students' learning difficulties in chemistry, especially acids and bases, as well as addressing students' scientific literacy skills considering this. Indonesian students' reading literacy is decreasing. With the aim of finding out the effectiveness of using interactive multimedia in integrated acid-base material in ethnoscience which is oriented towards scientific literacy abilities. It is hoped that this can support students' problems in learning chemistry, especially acids and bases, and can overcome students' scientific literacy abilities, especially in Indonesia itself.

2. RESEARCH METHOD

By comparing data from several relevant journals, this research uses a narrative review approach. This research relies on secondary data such as journals and previous research on the relationship between interactive multimedia, ethnoscience, and scientific literacy. In this preparation, descriptive analysis is used. Several electronic databases, such as Goegle Scholar, PubMed, and Semantic Scholar, performed the searches. Articles included in this research must meet the following criteria: have an ISSN, be freely accessible, be full of text, and have relevance between the title and content of the article with one of the dependent variables (scientific literacy ability); independent variable (interactive multimedia development); and published between 2020 and 2024.

3. RESULTS AND DISCUSSION

Research Result

Based on the criteria testing carried out, five articles were selected to be used as references in this literature study, as shown in the following table.

Table 1.
List of Reference Journals Used

Author and Year	Journal Name	Research Title	Summary of Research Results
(Hutama & Hidayah, 2022	UNESA Journal of Chemical Education	Pengembangan Multimedia Interaktiff Berbasis Flash Pada Materi Titrasi Asam Basa	The research results showed that the average percentage of validation results was 88.96% with very valid criteria. Based on practicality, the average percentage result was 89.165%, which is included in the very practical criteria. The effectiveness of getting classical completion results is 100% with an average score of 88.34%.
Iqlima Maytrea & Namirah, 2020	Journal of Chemistry Education Research	*Development Of Ethnoscience-Based Learning Module In Acid*	The research results show that the module developed according to BSNP is valid with Aiken's calculations for content and media aspects of 0.99 and 0.97. Student responses in

		And Base Themes For The 11th Graders Of Senior High School	the high, medium and low groups had percentages of 92%, 93% and 92% which were included in the very good category.
Ramadhoni & Muchtar, 2024	Jurnal Teknologi Pendidikan: Jurnal Penelitian dan Pengembangan Pembelajaran	*Development of Integrated Smart Apps Creator Media with Guided Inquiry Learning Model on Reaction Rate Material*	This research produces Smart Apps Creator media learning that is integrated with the guided inquiry learning model on reaction rate material. The results of validation by media assessment experts obtained an average of 89.6% (very valid). The results of the teacher response assessment obtained an average of 89.5% (very practical) and the results of the student response assessment obtained an average of 82.2% (very practical).
Azkia et al., 2023	JCAE (Journal of Chemistry And Education)	Pengembangan Media Pembelajaran Interaktif Terintegrasi Etnosains Untuk Meningkatkan Kemampuan Literasi Sains dan Motivasi Belajar Peserta Didik Pada Materi Hidrolisis Garam	The research results show that the development of learning media is based on the criteria: (1) Validity; viewed from the aspects of content, presentation, language and media, the average score was 95.32 (very valid). (2) Practicality, viewed from the results of the readability of learning media in the individual test of 4.08 (good) and the small group test of 4.32 (very good), the results of the student response questionnaire were 3.9 (good), and the results of observations implementation of learning is 4.51 (very good), (3) Effectiveness, in terms of increasing scientific literacy skills with an N-gain score of 0.49 (medium) and learning motivation with an N-gain score of 0.61 (medium).
Robbia & Fuadi, 2024	Jurnal Ilmiah Profesi Pendidikan	Pengembangan Keterampilan Multimedia Interaktif Pembelajaran Ipa Untuk Meningkatkan Literasi Sains Peserta Didik di Abad 21	With scientific literacy in learning, it is hoped that students will have the ability to knowledge and understand scientific concepts, the ability to search for or determine answers to questions originating from curiosity from everyday experience, have the ability to explain existing phenomena, be able to identify scientific problems and information technology.

Based on the table above, most research states that the development of interactive multimedia integrated with ethnoscience is effective and good to use in overcoming scientific literacy abilities. This makes the material presented easier for students to understand, improves their thinking abilities, and enables active learning (Putri et al., 2024).

Discussion

Interactive multimedia is media that consists of two or more components consisting of text, graphics, images, audio, video and animation. By combining images, animation, and even interesting sound, interactive media can display concepts with an attractive appearance. Students may not get bored with monotonous learning with a display like that. This will make them more interested in understanding what they are learning. This is in accordance with "cognitive theory of multimedia learning, multimedia representations may produce deeper learning and understanding than

presentations presented in only one format" (Mayer, 2009: 100). With environmental-based technology, teachers are trained to change teacher-centered learning approaches to student-centered learning approaches. This technology encourages students to actively participate and interact during the learning process. It is hoped that interactive multimedia, especially those related to certain subjects, can help the learning process in the classroom (Robbia & Fuadi, 2024), especially in acid-base chemistry subjects.

Ethnoscience learning is an approach to creating a learning environment that integrates culture in the learning process (Iqlima Maytrea & Namirah, 2020). Because chemistry lessons are related to everyday life, ethnoscience learning helps students understand chemistry material (Arfianawati et al., 2016). The ethnoscience approach can improve student learning outcomes and produce a generation that is scientifically literate, innovative and scientifically minded (Setiawan, 2013). Therefore, in cultural ethnoscience integrated chemistry learning helps students transform what they see into creative principles and forms about nature. They not only imitate or accept what is taught, but they also create meaning, understanding and significance from what they learn (Sumarni, 2018).

Scientific literacy means understanding science, communicating it (orally or in writing), and applying science to solve problems. This also means having a strong attitude and sensitivity towards oneself and one's environment when making decisions. In its development, PISA in 2015 determined that scientific literacy consists of four major dimensions (aspects) that are interconnected, namely competence (science process), science knowledge or content, science context, and attitudes. According to PISA, scientific literacy skills are measured through three indicators: finding scientific problems or questions, explaining phenomena scientifically, and using scientific evidence. This aims to foster students' scientific literacy skills which are based on logic, reasoning, and critical and creative analysis (Jufri, 2017). Scientific literacy is very important because it can improve inquiry skills, increase oral and written vocabulary to understand and communicate science, and improve relations between science, technology and society (Pertiwi et al., 2018).

According to (Hutama & Hidayah, 2022) Based on research conducted on the Development of Flash-Based Interactive Multimedia on Acid-Base Titration Material, it was found that interactive multimedia is suitable for use as a learning medium to improve student learning outcomes. When compared with conventional learning media, interactive multimedia learning such as the Adobe Flash CS6 Professional program increases students' understanding of chemistry, especially acid-base titration material. Flash-based interactive multimedia is presented in relevant lessons and also has video demonstrations that help students understand the concepts being studied. There are several other studies such as research conducted by (Iqlima Maytrea & Namirah, 2020). Based on the description of the research results regarding the development of an ethnoscience-based chemistry learning module on the theme of acids and bases for class XI high school, it can be concluded that learning using an ethnoscience integrated module allows students to participate actively and directly in scientific activities and increase their awareness and pride in their own culture. By incorporating culture into teaching materials, this learning makes students more aware and proud of their own culture. Other research regarding the development of integrated Smart Apps Creator media with guided inquiry learning models on reaction rate material carried out by (Ramadhoni & Muchtar, 2024) showed that the results of applying reaction rates using Smart Apps Creator software are very feasible and practical to use in learning because they can be accessed at any time and anywhere and used to help the learning process.

This is also continuous in the research of Robbia & Fuadi, (2024) where the use of interactive multimedia has a great influence on students' scientific literacy abilities. Current developments require the use of technology in various fields, including education, so interactive media becomes important. With scientific literacy in learning, it is hoped that students can understand and comprehend scientific concepts, search for or determine answers to questions that originate from everyday curiosity, explain existing phenomena, and identify scientific problems and technological information. An educator increases the scientific literacy of his students to increase: 1) scientific knowledge and explanations; 2) spoken and written vocabulary necessary to understand and communicate science; and 3) the relationship between science, technology and society.

The use of interactive multimedia integrated with ethnoscience is very important for students' scientific literacy abilities. This is in line with previous research, namely research by Azkia et al., (2023) which shows that after using interactive learning media that combines ethnoscience, the posttest score

is between the medium and high categories. This shows that students have better scientific literacy after learning. These results are in line with research conducted by Yunita et al., (2018), who found that adding the surrounding environment to chemistry learning helped students gain an understanding of knowledge concepts and make them related to real world situations, which resulted in a more meaningful learning experience. . Learning local culture improves students' critical thinking, understanding of concepts, and abilities in the science process (Syahmani et al., 2022). In chemistry learning, the surrounding environmental context increases students' scientific literacy (Kusasi et al., 2021).

So, the most effective solution to overcome difficulties in students' scientific literacy skills in acid-base lessons is to use interactive multimedia that can be accessed by students. Interactive multimedia with chemistry learning on interesting, ethnoscience-integrated acid-base material has the benefit of influencing students' thinking abilities through interactive behavior. Chemical material presented with an integrated culture of ethnoscience can increase students' scientific literacy in learning (Azkia et al., 2023), one of which is acid-base material. The public's view of chemistry is not only about abstract material, difficult to understand, and discussing dangerous chemicals. But it is found in everyday life, for example, ethnoscientific culture related to acid-base substances in Jambi province, including the tradition of making batik, betel nut, and the use of local Jambi plants as acid-base indicators. Therefore, by studying ethnoscience, the concept of acid-base material which is related to everyday life, it can help students to understand local culture and discover that there is a relationship between ethnoscience and acid-base material.

According to Bloom et al. (1956), learning outcomes can be broken down into three domains: cognitive, affective, and psychomotor. Each domain has several levels of ability, from simple to complex, from easy to difficult, and from concrete to abstract. The following is a table explanation of the relationship between the evaluation aspects of Bloom's taxonomy and students' scientific literacy abilities:

1. Scientific Literacy in the Cognitive Realm.

Table 2.
Scientific Literacy in the Cognitive Realm

Cognitive	Scientific Literacy
Understand	Explains natural phenomena and changes made to nature through human activities.
	Identify questions and problem issues.
	Explain phenomena scientifically.
Apply	Using scientific evidence.
Analyze	Linking relationships with the application of science in everyday life.

2. Scientific Literacy in the Affective Domain

Table 3.
Scientific Literacy in the Affective Domain

Affective	Scientific Literacy
Respond	Compromising the answer to a question or solving a scientific problem.
Organize	Classify the fields of science application in personal, social and global forms.
	Combines content knowledge, procedural knowledge, and epistemic knowledge.

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3. Scientific Literacy in the Psychomotor Realm

Table 4.
Scientific Literacy in the Psychomotor Realm

Psychomotor	Scientific Literacy
Articulation	Integrating the application of science in everyday life
Naturalization	Creating scientific literacy abilities in students that are based on logic, reasoning, and critical and creative analysis.

Below is also a schematic of the relationship between interactive multimedia, ethnoscience characteristics, aspects of scientific literacy, and evaluation aspects of Bloom's taxonomy.

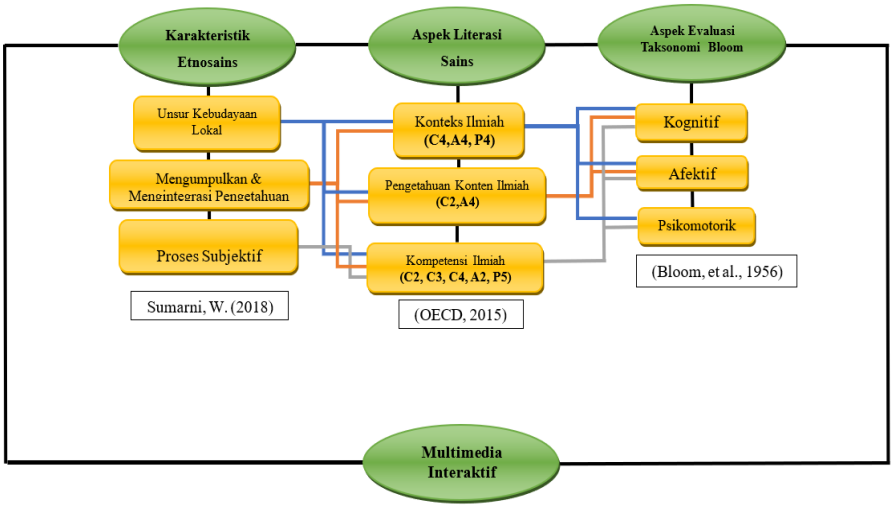

Fig 1. Scheme of the Relationship Between Ethnoscientific Characteristics, Aspects of Scientific Literacy, and Evaluation Aspects of Bloom's Taxonomy

4. CONCLUSION

In improving the quality of education itself, one way is to use technology, especially what is currently popular, namely interactive multimedia. Interactive multimedia integrated with ethnoscience in acid-base material can influence scientific literacy skills. This is proven from previous research sources that have been studied. Interactive multimedia with chemistry learning on interesting acid base material integrated with ethnoscience has the benefit of influencing students' thinking abilities through interactive behavior. Chemistry material presented with an integrated ethnoscience culture can increase students' scientific literacy in learning.

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Mathematics Operation Card (MOC): Mathematics Operating Number Educational Game Cards for Elementary School Students

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ABSTRACT

Mathematics is a subject with very abstract material, so the existence of learning media is very necessary. The purpose of this research is to develop an educative game card learning media "Mathematics Operation Card (MOC)" aimed at low-grade elementary school students. The development stage was carried out using the ADDIE model which consisted of five stages, namely Analysis, Design, Development, Implementation, and Evaluation. The instruments used in this study were interview guides, observation sheets, student response questionnaires, and learning achievement tests. Based on the results of expert validation and materials as well as limited trials, MOC received a good category that was suitable for use and received positive responses from students. So that MOC can be applied in the process of learning mathematics in class.

Keywords: learning media, ADDIE, development, game cards

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1. INTRODUCTION

Education plays a very important role in the development of the nation and state. Educational reform through curriculum revitalization is needed and must be carried out continuously to create better and quality education (Samsidar, 2018). Changes in the educational paradigm imply the need for repositioning of educators and students in the education and learning process (Baharuddin, 2018). Education must be able to produce human resources who have complete competence, this competence is known as 21st-century competence (Etistika Yuni Wijaya et al., 2016). 21st-century competence provides students with provisions so that they can develop and compete globally and play a role in the real world. Thus, skills in creative thinking, critical thinking, communication, and collaboration are very much needed by teachers and students today (Septikasari & Frasandy, 2018). With these skills, teachers can present learning creatively and can increase student competence to the maximum. Mathematics learning for the majority of students is still considered a scary and difficult subject to learn.

Mathematics is also studied to develop several aspects of ability, including conceptual understanding, problem-solving, reasoning, and mathematical communication (Isnaini Handayani & Afifah Fitria Ramadhani, 2020). The implementation of mathematics learning does not always go well and there are many obstacles faced by educators (Prayitno & Faizah, 2019). Many factors cause mathematics to be considered a difficult subject to learn, namely, the characteristics of mathematics which are abstract, systematic, logical, symbolic, and full of various formulas that confuse students (Faizah et al., 2022). One of the goals of learning mathematics is to learn to communicate (mathematical communication) (Hafifah & Bharata, 2018). Mathematical communication skills are students' abilities to convey mathematical ideas both orally and in writing. In the process of learning and solving mathematical problems, students need to understand the problem, express it in mathematical models, and connect between concepts, so mathematical communication skills are very important for students to have (Utami & Cahyono, 2020). Students' mathematical communication skills can be developed through the learning process at school, one of which is the mathematics learning process (Hidayat et al., 2020; Ikhtiar et al., 2021). Thus, mathematics has an important role in the development of mathematical communication skills. Thus, innovation is needed in mathematics learning in schools to be able to increase student motivation while improving student learning outcomes.

The higher the student's learning motivation, the higher the mathematics learning outcomes obtained by the students. Various methods and strategies can be used by teachers to make learning more interesting and meaningful. Learning motivation makes a major contribution to student success in learning, especially in integer material (Budiyani et al., 2021). Many methods can be used to increase student motivation, including through videos, image media, games, and others (Febrita & Ulfah, 2019). New variations of methods are needed to teach mathematical concepts, especially to elementary school children, so that they can understand the material provided by educators and make mathematics a fun learning material. One way that can be done is to design learning by inviting students to learn and play at the same time (Setiawan et al., 2020). Play activities can help children improve their aspects in an integrated and comprehensive manner(Hayati & Putro, 2017). Through games, they will be able to devote attention, feelings, and thoughts in the playing process and be able to stimulate aspects of development in children(Salminen et al., 2021). One example is implementing mathematics learning using cards which can be an alternative and very effective for elementary school students (Wulandari et al., 2020).

The learning that has been carried out so far tends to only use picture media in teaching and learning activities carried out by educators. This is considered by students to be a boring activity. Understanding of mathematical concepts can be improved through various relevant educational game media. Srintin et al., (2019) conducted a study on the development of UMINO card game media in Mathematics Learning for Integer Operations which showed that the UMINO game was able to sharpen the brain in calculating and could improve students' learning outcomes. Adawiyah & Kowiyah (2021) also developed Domino game media in Mathematics Learning for Multiplication Operations for Elementary School Students which showed that there was an increase in student motivation in memorizing multiplication operations. Based on research that has been conducted by other researchers, it has been shown that the use of educational game cards is indeed very effective in improving students' abilities to identify and solve mathematical problems (Sari & Juwita, 2021). However, the majority of the development of game card media on number material still has almost the same game concept which is monotonous as in general card games that already exist. So, in this study, the development of an educational game card was carried out which is called the Math Operation Card (MOC).

Math Operation Card (MOC) is a mathematical number operation card consisting of character cards as symbols for each player, operation cards, and number cards. Implementing MOC in learning, especially mathematical number operation material, is expected to increase student motivation through game media and create collaboration between students. Thus, the MOC innovation can make it easier for students to learn and increase motivation in learning mathematical number operation material and can create an active learning environment.

2. RESEARCH METHOD

This research aims to develop a math educational game card "*Math Operation Card* (MOC)" for elementary school students. MOC is expected to help students in understanding the concept of number operations through games. In addition, using MOC game cards is expected to increase students' learning motivation.

The development of this MOC educational game card uses the ADDIE development model which consists of 5 stages, namely, Analysis; Design; Development; Implementation; and Evaluation. Each step of the MOC Educational Game Card development can be explained as follows.

a. Analysis

The analysis stage was carried out using two methods, namely observation and interviews. The analysis stage is carried out to obtain data and information related to learning media needs in the school field, especially at the elementary school level. Where elementary school students are still in the concrete operational cognitive domain.

b. Design

Based on the data obtained at the analysis stage, the appropriate teaching aids were designed. At this design stage, the design of props in the form of MOC cards, the design of playing card techniques, and the packaging design of MOC props were obtained. The researcher also adjusted the props to the basic concepts of number operation material in elementary school.

c. Development

At the Development stage, researchers develop MOC educational game card products in accordance with the design that has been made in the design stage. At this stage also developed validation instruments for material experts and learning media experts, as well as tool trial instruments which include response questionnaires, learning outcomes tests and student activity observation sheets.

d. Implementation

After the MOC educational game card product is produced, then at the implementation stage, expert validation and limited trials are carried out on 20 grade 3 elementary school students. Expert validation is carried out to test the validity of MOC math game cards according to the material and media feasibility according to experts. Expert validation was given to media experts and mathematics material experts. Furthermore, from the validation results, the average of all validators was calculated and then the percentage was calculated using the following formula.

$$p = \frac{R}{n} \times 100\%$$

From the percentage results obtained, they were converted according to the criteria presented in Table 1 below.

Table 1.
Conversion of Textbook Quality Based on Expert Validation Results

Percentage (%)	Qualification	Interpretation
90 - 100	Very good	Very feasible and does not need to be revised
75 - 89	Good	Feasible, but needs minor revisions
65 - 74	Simply	Feasible, but needs major revisions
55 - 64	Less	Not Feasible, but can be used with major revisions
0 - 54	Very Less	Not worth using

While from the limited trial, data on student responses and learning outcomes tests were obtained. Both data will be analyzed quantitatively descriptively to conclude the feasibility of MOC educational game cards.

e. Evaluation

Based on the data that has been obtained from the implementation stage, further evaluation and revision of MOC educational game cards are carried out in accordance with the results of validation and limited trials, so that MOC educational game cards are ready to be implemented in the classroom.

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3. RESULTS AND DISCUSSION

a. Research Results

The MOC Educational Game Card development steps can be explained as follows.

a Analysis

In this phase, observations and interviews with teachers in elementary schools were conducted to explore information related to learning media needs. Based on the information obtained, the availability of learning media in schools is still very minimal, both conventional learning media and ICT-based learning media. In low-grade students, learning media is still needed to strengthen the concept of number operations in students. Based on the results of observations and interviews in the field, researchers analyzed teaching materials, and it was found that mathematics materials in the lower grades prioritized the cultivation of number concepts and number operations. So it was decided to make a math learning media that is useful for planting the concept of numbers and number operations. To attract students' attention, the learning media to be developed will focus on the concept of games, namely number operation cards named "*Mathematics operation Card* (MOC)".

b Design

At the design stage, researchers designed the MOC Educational Game Card. The design in question is planning the content contained in the card and designing the shape of the card to be developed. During the design process, researchers always ask for input from teachers at school and appropriate media experts. The MOC Educational Game Card design is as follows.

Card Back Layout Design

Fig 1. One of the Card Front Layout Designs

c Development

At the development stage, the realization of printing cards that have been designed previously is carried out. At this stage, the rules of the card game are also compiled, so that anyone can use it by reading the rules of the game made. The shape of the developed cards is as follows.

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Fig 2. Shape of MOC Educational Game Card

d Implementation

After the cards have been printed and are ready to use, the researchers then conduct product validation and trials. Product validation was carried out by 2 experts, namely media experts and material experts. The media assessment was obtained from the day of validation results. The product trial was carried out in 2 stages, namely the first stage of testing using game cards for 10 students, then a test was carried out with the completion using the product that had been developed and given a student response questionnaire. To find out student interest when using MOC educational game cards. The number of results obtained from the validation of media and material experts is 156, which can be converted into a percentage of 78 and can be categorized in the qualification "Good" so that the media is feasible to use with minor revisions. The revisions made are based on the input provided by the two experts. Material experts provide input on aspects of material relevance and evaluation, while media experts provide input on aspects of design, size, and type of material used. The researcher then adjusted the media design and added card components so that it could be used in the limited trial stage.

Based on the results of the limited trial, it is known that students gave a positive response to the use of learning media, and from the results of student tests it was known that 9 students could answer the questions correctly, while 1 student still made 2 mistakes out of 10 questions given.

e Evaluation

Based on the data that has been obtained at the implementation stage, researchers conduct data processing and conclude the development of educational game card media "MOC". At this stage, it can be concluded that the educational game card learning media "MOC" is feasible to use, and can be used by teachers in the learning process in the classroom on number operation material.

3.2. Discussion

This study aims to develop an educational game card learning media named "*Mathematics Operation Card* (MOC)". This game card was developed based on a needs analysis conducted at MI Hasanuddin Tebel Sidoarjo Elementary School. Observations and interviews were conducted which revealed the need for media that can help teachers teach number operation material in low grades. Based on the development process, it is known that the MOC educational game card learning media is feasible to use and can be implemented in the classroom during the learning process. The need for learning media is very high because mathematics is an abstract subject. (Andi Rustandi & Rismayanti, 2021). The effectiveness of media on learning is very high in helping to achieve the learning objectives set by the teacher in the classroom. (Nababan, 2020). Learning media can improve learning outcomes, and student activeness, and can provide a positive student response to the material being taught.

4. CONCLUSION

Educational game card learning media named "Mathematics Operation Card (MOC)" has been successfully developed in this study. The learning media was developed using the ADDIE development model which consists of 5 stages, namely Analysis, Design, Development, Implementation, and Evaluation. As for the Analysis stage, a needs analysis and teaching materials were carried out at the school, and information was obtained that there was still a great need for learning media for planting concepts about number material and number operations in low grades. The second stage is Design, at this stage, the layout of the MOC is designed and continued at the Development stage, namely, the learning media that has been designed is made a prototype that is ready to be tested at the Implementation stage. At the implementation stage, validation was carried out by two experts, namely media experts and material experts to validate the developed media, and the results showed that the media was in a good category and was suitable for use with minor revisions. Revisions made based on material experts are on the addition of card components on odd numbers and division operations, while from media experts it is recommended to change the color of the media to be more attractive and the addition of designs that are more suitable for low-grade students so that the appearance of the media becomes more attractive and by the target age of learning media users. From the results of the media revision, a limited trial was conducted and obtained positive responses from students and good test results. Based on the results of validation and trials, it can be concluded that the MOC educational game card learning media is suitable for use in the classroom during the learning process.

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Analysis of the Increase in Efficacy and Motivation to Learn Mathematics towards the Use of Interactive Learning Model in Elementary School

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ABSTRACT

Learning mathematics is very important as a guide in problem solving, logical reasoning in everyday life. In increasing the desire of students in the field of mathematics, which in most students' views is learning that is difficult to understand and scary. so that an innovation is needed along with the times of science and technology in the form of using interactive learning models with the help of media according to the existing material. the use of interactive learning models can foster self-efficacy and motivation in students so that they are able to implement mathematics in solving problems in everyday life.

Keywords: Mathematics, Self-efficacy, Learning Motivation, Interactive Learning Model

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1. INTRODUCTION

Learning is a process that involves many affective elements, including attitudes, values, interests, appreciation, and social emotional adjustment (Dimyati et al., 2002: 18). Mathematics is considered a boring and daunting subject due to a lack of understanding of the importance of the subject (Lasut et al., 2022; Masril et al., 2020; Zagoto, 2018). As a result, math becomes a very subjective component and is no longer systematic and objective. This causes students to not have a high desire to learn mathematics and have a negative attitude towards automatic math lessons. Learning mathematics is essential to teach students the skills of quantitative analysis, logical reasoning, and problem solving. This is very important in today's era of globalization.

According to Arifin and Mahmud (2022), students get the greatest benefit from learning mathematics when they can implement the knowledge they have gained in their personal and professional contexts. During the learning process, early exposure to mathematics promotes children's self-efficacy and motivation, especially in the process of learning mathematics. This can improve attitudes and abilities in everyday life and in the classroom.

Most students see math as a scary and difficult subject to understand. They experience tension during the learning process in the classroom, which inhibits many learners from asking questions, expressing opinions, or actively participating in the learning process. Learners dislike math lessons due to high anxiety. As a result, their understanding of math decreases. According to Jbeili (2003), mistakes in understanding math can lead to missed opportunities or even being unable to complete other daily tasks. Learning seems boring, which causes learners to choose to remain silent while taking notes and listening. Not only the low efficiency of the learning process, but also students' low desire to learn shows the impact of the above learning process. To achieve this, the learning environment should provide a sense of comfort for students. Students may be more motivated to learn in this comfortable environment. This may improve their learning outcomes and improve their attitude towards mathematics (Anomeisa & Ernaningsih, 2020; Dakhi, 2022; Sarumaha et al., 2018; Zulhelmi & Mahidin, 2017).

To achieve educational goals and achieve desired learning outcomes, the development of self-efficacy and learning motivation is essential. In the book Self-Efficacy, Bandura (1994) and Friedman & Schustack (2008) define self-efficacy as the ability each student has to solve problems and achieve set learning goals.

Self-efficacy is a basic belief in learning as it affects what will be learned in the future. Primary school is the place where learning begins to enable students to continue to the next level hence the admission of new students in schools and education is an important part of human history always needed in every stage of civilization (Ramadhini & Kowiyah, 2022).

Motivation to learn can be defined as an internal drive that encourages a person to actively participate in learning activities (Ormrod, 2009). There are two types of motivation to learn: intrinsic motivation and extrinsic motivation. Intrinsic motivation is motivation that comes from within a person, such as curiosity. While extrinsic motivation comes from outside, such as praise, appreciation, or gifts from others. (2018) Motivation is one of several important components that help achieve learning goals. To improve learning effectiveness and increase student motivation, teachers must be able to develop the latest innovations.

To improve the learning process, teachers can use various types of media to help the learning process to be more optimal. Learning media can also help reduce boredom in learning. Technology-based media is commonly used in mathematics learning. Educators can do many things by creating interactive learning models in the learning process. Both the model and the learning media used can be adjusted to the needs and teaching materials, especially in the process of learning mathematics.

Self-efficacy and self-motivation are two concepts that are interrelated and very important in determining a person's behavior and achievements, especially in the context of education and self-development. Self-efficacy** refers to a person's belief in their ability to succeed at a task or achieve a goal. These beliefs influence how hard a person will try, how they face challenges, and how they persevere in the face of adversity. The higher a person's self-efficacy, the more likely they are to succeed because they are more motivated to act and have more confidence in their abilities. Self-motivation** is an internal drive that encourages a person to act and achieve goals. This motivation can be intrinsic, where a person is motivated by personal satisfaction or interest, or extrinsic, where the drive comes from external rewards such as praise, awards, or grades.These two concepts are very important in the learning process. Individuals with high self-efficacy and strong self-motivation tend to be more persistent in pursuing their goals, more resistant to failure, and better prepared to learn from their experiences. Therefore, developing positive self-efficacy and strong self-motivation is very important to achieve success in various areas of life.

2. RESEARCH METHOD

The researcher used a descriptive-analytical qualitative approach in the research to be conducted. Sandelowski (2000) asserts that this method allows researchers to maintain fidelity to the data while facilitating more nuanced interpretation and analysis. In descriptive qualitative research, the researcher can focus on the description of events while emphasizing data analysis to reveal the meaning that lies beneath the surface. Therefore, the researcher plans to go directly to the field to collect factual data through interviews and observations, with the aim of developing hypotheses or conclusions based on the evidence obtained.The population of this study consisted of 48 children from class IV A and IV B at SD N 1 Bumi Waras representing class IV.Data collection techniques and instrusmen;data collection technique this research carries out data collection techniques through interviews, direct observation in the field, and photo and video recordings. The interviewees were the guardians of class IV A and IV B and the students of class IV of SDN 1 Bumi Waras.

Data collection instruments the data collection instruments used in this study used qualitative methods, where the researcher acts as the main instrument. The researcher's responsibilities include determining the research focus, identifying sources of information, collecting data, evaluating data quality, analyzing data, interpreting findings, and drawing conclusions from the overall research process.

3. RESULTS AND DISCUSSION

In the process of collecting research data, the researcher conducted several stages as follows;planning and determining a problem that will be studied by researchers;preparing the focus of research problems and methods that will be used in research;making instrusment data for the data collection process to the object to be studied;the researcher then conducted field observations to see the problem directly in the field, after previously requesting permission from the object of research, namely SD N 1 Bumi Waras;collecting research data in the field.

Based on the results of field observations conducted by researchers by taking sample data through the interview process using analytical descriptive qualitative methods, the data on mathematics learning

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outcomes on efficacy and motivation in students towards the use of interactive learning models are as follows.

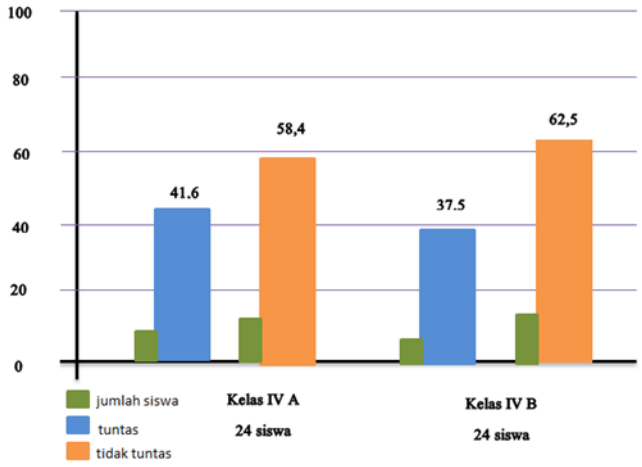

Fig 1.
Grade IV Mathematics Learning Exam Score

Table 1.
Grade IV Mathematics Learning Exam Score

Class	Total Participants Learners	Completeness			
		Completed ≥ 70		not complete ≤ 70	
		figures	presentation	figures	presentation
IV A	24	10	41,6%	14	58,4%
IV B	24	9	37,5%	15	62,5%
Amount	**48**	**19**	**39,5%**	**29**	**60,5%**

Source: documentation of initial observations of class IV SD Negeri 1 Bumi Waras school year 2024/2025

Based on the table above, it can be observed that a less innovative learning model has an impact on the efficacy and motivation of students to learn mathematics so that low and unachieved learning outcomes in accordance with learning objectives. Based on data obtained from the source of the data population, namely educators in learning mathematics, students have difficulty in basic mathematics so that if students have not been able to master the basis of mathematics, for a more in-depth learning process it will be more difficult for students to understand, so with this it is important to increase efficacy and motivation in students,According to educators, there are several things that can be done in increasing efficacy and motivation such as, according to class IV A educators by making fun learning such as models, games, interesting media so that students are motivated and interested in learning materials and according to class IV B educators with interesting learning and providing motivation by telling stories that can foster students' interest in learning so that learning outcomes will increase.Efforts made by educators in this case such as several ways made by educators so that students are active, modified learning models and innovations using media that are in accordance with learning materials. Meanwhile, according to data statements from students in learning mathematics, students are happy with basic arithmetic operations and are less interested in other mathematics material in fostering motivation and solving problems in learning mathematics they can study with friends, ask the teacher and at least study alone in solving them, students like game-based learning and video quizzes, while the statements of students vidoe stories and explanations and explanations on the blackboard seem boring. So the importance of using interactive learning methods in fostering efficacy and motivation in students, especially in learning mathematics.

Based on the observations of the researchers, it can be said that through the activities of learning model innovations in line with the development of science and technology carried out by educators in the form of using interactive learning models in accordance with the independent curriculum, it has a stimulating impact on increasing the self-efficacy and learning motivation of students in the learning process, especially in learning mathematics, which in general is a difficult and stressful learning.

This can be proven by the increasing enthusiasm of students in learning mathematics based on interactive learning models assisted by game media, in this case indirectly fostering, familiarizing self-efficacy and motivation in each student.

4. CONCLUSION

The results and discussion show that self-efficacy and motivation greatly influence the learning process. Students who have higher levels of self-efficacy and motivation can obtain better learning outcomes, especially in mathematics, which is generally a difficult and stressful subject.

One of the steps that can be taken to foster efficiency and motivation is fun learning, fun learning is created from interactive learning models with the help of media, so it takes awareness in educators to be able to create a fun and exciting class, especially in learning math.

Based on the above, the researcher can conclude that the use of interactive learning models in mathematics learning can increase stimulate the ability of self- efficacy and motivation in students.

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