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Student's Self-Efficacy in the Implementation of Virtual Reality Media in Mathematics Learning

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ABSTRACT

The implementation of Merdeka curriculum aims to provide the flexibility for both teachers and students in conducting the learning process. Preliminary research at one of the public secondary high schools in Pangkalpinang showed that students had a strong interest in learning, when the information, communication and technology are involved; however, teachers are likely to use the technology-based media in the classroom. This study was conducted to increase students' self-efficacy after being given treatment using virtual reality. This study used a quantitative approach with a quasi-experimental design. A total of 60 students participated in this study, consisting of 30 students in the experimental group and 30 students in the control group. The data collection technique used is a questionnaire. This study was conducted in one of junior high schools in Pangkalpinang. The research results were analysed using n-gain, Kolmogorov-Smirnov normality test, Levene's homogeneity test, and Mann-Whitney U test. The Kolmogorov-Smirnov test showed the significance value of the control group is 0.008 and the significance value of the control group is 0.002. The results indicate that the data were not normally distributed. Therefore, the Mann-Whitney U test was used, resulting a significance value of 0.000. The value obtained is less than 0.05 (< 0.05), so that the alternative hypothesis was accepted. The study proves that VR based learning media can effectively enhance students' self-efficacy.

Keywords: Virtual Reality, Selft-Efficacy, Merdeka Curriculum

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Introduction

Indonesia, as of now, is still implementing the Merdeka curriculum in primary and secondary school levels. The Merdeka curriculum provides significant benefits for both students' soft skill and hard skill, therefore the implementation must be carried out optimally and effectively (Ramadhan & Warneri, 2023; Syaripudin et al., 2023). Learning using the Merdeka curriculum benefits students for allowing students to choose the learning methods based on their own potentials and interests (Amelia Rizky Idhartono, 2022; Cholilah et al., 2023; Devi et al., 2024; Jannah & Rasyid, 2023; Jannati et al., 2023; Pratycia et al., 2023). Therefore, teachers must be able to accommodate and adapt to students' potentials and interests in every learning process including mathematics learning.

Knowledge is developed, among other ways, through mathematics learning (Atho, 2025). Mathematics learning is perceived as challenging for students because of its abstract and complex nature. The difficulty can negatively impact students' confidence in working on mathematic tasks, a concept known as self-efficacy. Sell-efficacy (SE) is important because it affects students' competencies (Zhang & Zhang, 2024), their skill in completing their tasks (Etherton et al., 2024), and it affects significantly on the learning process (Baumanns & Rott, 2024; Quintero et al., 2024). Self-efficacy is considered important as a form of students self confidence in achieving their goals (Ito et al., 2024; Kan & Xie, 2024; Li et al., 2024; Sun et al., 2024; Wang et al., 2023). The higher a person's self-efficacy the greater their perseverance tend to be (Achmad et al., 2023; Galiana et al., 2024) and their learning achievement (Mou, 2024). In the context of mathematics education; high self-efficacy is correlated positively to learning motivation, perseverance, and students' academic achievement.

The fact on the field, after a direct observation in one of secondary high schools in Pangkalpinang, reveals an issue in mathematics learning on the implementation of Merdeka curriculum. The self-efficacy of secondary high school students is still low, with 75% is on the low category, 12 % in the very low category and 13% is on the moderate category. The students' interest in learning using Information Technology (IT) is not accommodated effectively by teacher's ability to implement learning through IT. Even tought teacher is the key role in mathematics learning (X. Yang & Kaiser, 2022). This condition should be addressed by giving solution on how to balance between student's interest and teacher's competencies so that it can impact student's self-efficacy positively. Teachers should be capable in utilizing significant media in implementing mathematics learning (Michael et al., 2023). One of the media that teacher can use is the IT based media, for its impact on self-efficacy (Paetsch et al., 2023). One of IT based media is Virtual Reality (VR).

A deep and realistic experience (Cimino et al., 2024) can be offered through VR media (el Mathari et al., 2024). The students' anxiety in learning mathematics can be alleviated for the object being studied can be observed directly by students (Ribé-Viñes et al., 2024). By exploring objects virtually through VR visualization, students are provided with a complete and interactive experience (Skidmore et al., 2024; Y. Yang et al., 2023), so much like in a real environment (Lorentz et al., 2023). Mathematics learning that applies VR provides positive perspective for students and their abilities can be enhanced (Bodur et al., 2024).

The previous study has focused on developing VR based mathematics learning media to help students in understanding the difficult geometry concepts. The result of the study indicates that the use of VR media in mathematics education significantly improves students' conceptual understanding (Anisa et al., 2024). Aside from improving students' conceptual understanding, the use of VR media in

learning can positively impact students' self-efficacy. A study obtained that using a VR based learning environment helped improve students' self-efficacy and enable them to be more innovative and creative (Nissim & Weissblueth, 2017). The previous research has studied the influence of self-efficacy and self-regulation on learning motivation in VR based laptop assembly simulation. The analysis result showed that self-efficacy has a positive and significant effect on students' learning motivation (Sindu & Kertiasih, 2024). Even though many studies have explored the benefits of VR media in mathematics education, there are still limited studies that specifically examine the impact of VR media on students' self-efficacy in the context of mathematics education. Integrating VR media into mathematics education has the potential not only to improve the conceptual understanding but also to strengthen students' confidence in their ability to solve mathematical problems.

Therefore, this study aims to increase self-efficacy on the implementation of VR media in mathematics learning process. The result of this study is expected to contribute to the development of effective learning strategy to enhance students' self-confidence and academic achievement..

Methods

This study was conducted using a quantitative approach with an experimental method. The research design used is a quasi-experimental design of the non-equivalent control group design type. This study population consists of all students of VIII grade/ The study involved a sample of The sampling technique used is purposive sampling. The sample consisted of 30 students from class VIII A and 30 students from class VIII B in one of public high school in Pangkalpinang. Students in class VIII B served as the experimental group which received treatment using VR based learning media, while class A served as the control group which received learning without VR media. The research design can be seen in Figure 1

Group	Pretest Measure	Treatment	Posttest Measure
Experiment (VIII B)	O_1	X_1	O_2
Control (VIII A)	O_1	X_2	O_2

Explanation:
O_1 : Pretest (Self efficacy)
O_2 : Posttest (Self efficacy)
X_1 : learning process using VR media
X_2 : learning process without using VR media

Figure 1. *Research Design*

The data collection technique used was a questionnaire which was designed to measure students' self-efficacy. The questionnaire used to measure students' self-efficacy was previously validated by experts (Dr. Winda Ramadanti, M.Pd from Universitas Muhamamdiyah Bengkulu and Dr. Indah Widiati, M.Pd. From Univeristas Islam Riau) by involving self-efficacy indicators. The collected data

were processed and analysed using the N-gain test, Kolmogorov-Smirnov normality test, Levene's homogeneity test, and the Mann-Whitney U hypothesis test (as the normality test indicated a non-normal distribution and the homogeneity test showed that the data were not homogenous, the results of the normality test can be seen in Table 3). All the data analysis was performed using IBM SPSS 26. The formulated hypothesis in this study is as follow:

Ho : There is no significant increase in students' self-efficacy following the implementation of VR based learning media

Ha: : There is a significant increase in students' self-efficacy following the implementation of VR based learning media

The research steps can be seen in Figure 2 below:

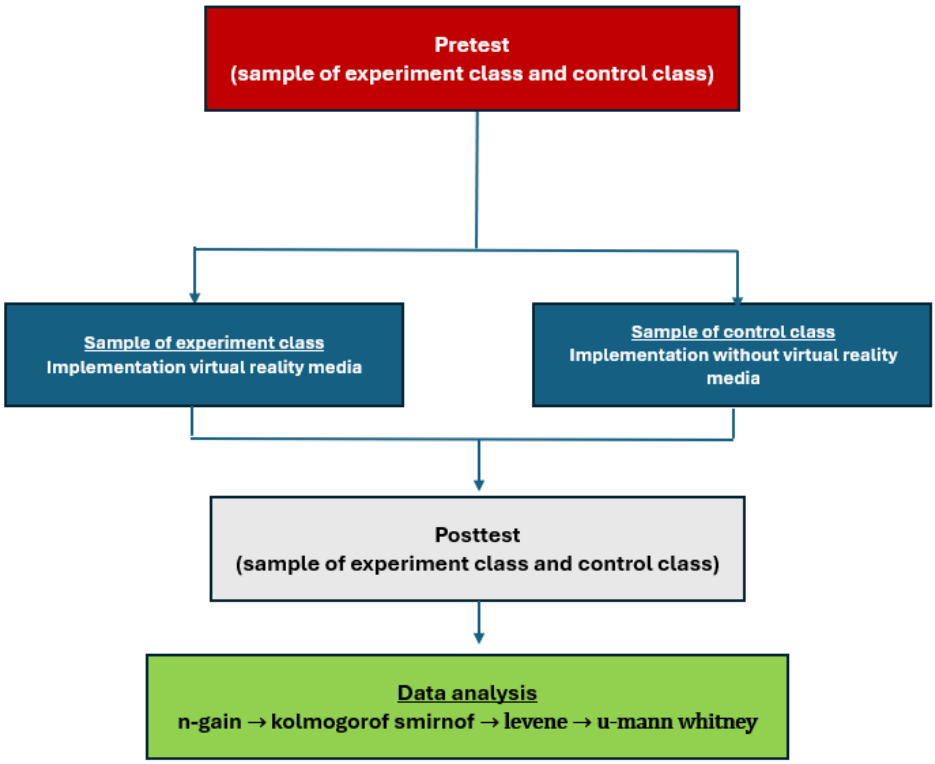

Figure 2. *Research steps*

Results and Discussion

According to the research steps, this study began by administering a pre-test to all the samples (both the experimental and control groups). After obtaining the self-efficacy data from both groups. The treatment then was applied. The treatment given to the experimental group involved the use of VR based learning media, while the control group were given instruction without the use of VR media. The learning processes of the experimental and control groups are showed in Figure 3 and Figure 4 as follow:

Figure 3. *The mathematics learning process of the experimental group using VR media*

Figure 4. *The control group without using VR media*

After the learning treatment was administered, both experimental and control groups were given post-test to allow further data analysis. The results of the pre-test and post-test on students' self-efficacy, along with the N-gain scores for each group can be seen in Table 1 (for experimental group) and Table 2 (for control group).

Table 1. *Self-efficacy of sample experiment class*

NO	Name Initials	Pretest Value	Posttest Value	N-gain Value	NO	Name Initials	Pretest Value	Posttest Value	N-gain Value
1	AA	90	75	-1,50	16	RN	71	78	0,24
2	KA	68	75	0,22	17	SM	60	71	0,28
3	RK	80	85	0,25	18	PI	58	55	-0,07
4	SR	69	83	0,45	19	RA	63	65	0,05
5	EJ	83	80	-0,18	20	CR	71	68	-0,10
6	MA	81	83	0,11	21	CI	70	75	0,17
7	KTA	80	79	-0,05	22	NJ	68	*70*	0,06
8	MF	56	75	0,43	23	DA	64	66	0,06
9	MK	71	80	0,31	24	SJ	71	61	-0,34
10	DA	84	83	-0,06	25	AQA	58	74	0,38

NO	Name Initials	Pretest Value	Posttest Value	N-gain Value	NO	Name Initials	Pretest Value	Posttest Value	N-gain Value
11	JIR	76	83	0,29	26	ZAK	73	72	-0,04
12	FP	70	71	0,03	27	AT	93	96	0,43
13	AC	71	71	0,00	28	RL	81	74	-0,37
14	AD	60	60	0,00	29	FRP	73	75	0,07
15	FI	73	76	0,11	30	DS	74	71	-0,12

Table 2. *Self-efficacy of sample control class*

NO	Name Initials	Pretest Value	Posttest Value	N-gain Value	NO	Name Initials	Pretest Value	Posttest Value	N-gain Value
1	JC	34	46	0,18	16	MZ	79	75	-0,19
2	AH	68	73	0,16	17	ZA	61	61	0,00
3	SI	71	64	-0,24	18	AA	56	68	0,27
4	RR	69	64	-0,16	19	AH	74	64	-0,38
5	ZV	69	56	-0,42	20	RAD	74	60	-0,54
6	RA	59	34	-0,61	21	GI	71	55	-0,55
7	RAP	71	44	-0,93	22	ZDP	61	61	0,00
8	KAU	41	53	0,20	23	ZZ	33	41	0,12
9	NA	93	75	-2,57	24	SAM	41	41	0,00
10	BF	83	85	0,12	25	RAU	51	33	-0,37
11	AAS	26	26	0,00	26	RAK	61	41	-0,51
12	ARA	74	64	-0,38	27	RRA	41	41	0,00
13	RI	74	70	-0,15	28	SA	41	64	0,39
14	DB	51	33	-0,37	29	AN	79	51	-1,33
15	ME	71	71	0,00	30	GO	51	34	-0,35

The results presented in Table 1 and Table 2 has included the N-gain scores for both groups, then followed by testing the normality of each data set using the Kolmogorov-Smirnov test with the help of IBM SPSS 26. The criteria for drawing the conclusions in the test as follow: if the significance value is less than 0.05 (< 0.05), the data distribution is not normal; however, if the significance value is greater than 0.05 (> 0.05), the data distribution is considered normal. The results of the Kolmogorov-Smirnov test for both groups using IBM SPSS are presented in Table 3.

Table 3. *Test of Normality data self-efficacy experiment class and control class*

Tests of Normality							
		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kode	Statistic	df	Sig.	Statistic	df	Sig.
Nilai	Self Efficacy Experimen	.209	30	.002	.637	30	.000
	Self Efficacy Kontrol	.188	30	.008	.772	30	.000
a. Lilliefors Significance Correction							

Table 3 shows the results of the normality test for the self-efficacy data of the experimental and control samples. As shown in Table 3, the significance value of the experimental group's self-efficacy data is 0.0002 while the control group's significance value is 0.0008. From the result and the criteria for conclusions drawing, since both values are less than 0.05, it can be concluded that the self-efficacy data distributions for both the control and experimental groups are not normal. The analysis continued by testing the homogeneity of the N-gain data from both groups using Levene's test with the assistance of IBM SPSS 26. The criteria of this test are, if the significance value is less than 0.05 (<0.05), the data are considered to come from a non-homogenous population, if the significance value is greater than 0.05 (<0.05), the data are considered come from a homogenous population. The results are presented in Table 4 below.

Table 4. *Test of homogeneity data self-efficacy experiment class and control class*

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Nilai	Based on Mean	5.349	1	58	.024
	Based on Median	4.618	1	58	.036
	Based on Median and with adjusted df	4.618	1	44.280	.037
	Based on trimmed mean	4.927	1	58	.030

Table 4 shows the results of the homogeneity test using Levene's test with the assistance of SPSS. The significance value obtained is 0.024. Since 0.024 is less than 0.05, it can be concluded tat the data came from a non-homogenous population. Because the normality test shows that the data are not normally distributed and the homogeneity test shows that the data come from a non-homogenous population, the hypothesis testing was conducted using the non-parametric Mann-Whitney U test as follow: if the significance value is less than 0.05 (< 0.05), H_0 is rejected and H_a is accepted; if the significance value is greater than 0.05 (> 0.05), H_0 is accepted and H_a is rejected. The results of the Mann-Whitney U hypothesis test using SPSS are presented in Table 5 below.

Table 5. *Test of hypothesis self-efficacy of experiment class and control class*

Test Statistics[a]	
	Nilai
Mann-Whitney U	129.500
Wilcoxon W	594.500
Z	-4.745
Asymp. Sig. (2-tailed)	.000
a. Grouping Variable: Kode	

Table 5 shows the results of the hypothesis test using the Mann-Whitney U test in SPSS. From Table 5, it can be seen that the significance value obtained is 0.00000. Since the value is less than 0.05,

it can be concluded that H_0 is rejected and H_a is accepted; therefore, it can be concluded that after the implementation of VR based learning media in mathematics education, the students; self-efficacy significantly improved.

This study was conducted on the basis that the implementation of mathematics learning did not run smoothly in accordance with the objectives of implementing the independent curriculum in Indonesia. The use of technology is still very minimally applied by teachers, even though students have a high interest in technology-based learning. Therefore, this also affects students' self-efficacy. The solution offered is to implement technology-based learning. In line with previous studies that implemented AR-based learning media can influence students' reflective abstraction (Wafiqoh et al., 2023). Virtual reality media provides the right solution. Based on the results above, VR media has a positive influence and makes a difference. Students' self-efficacy has increased with the implementation of VR media in the mathematics learning process. There are several obstacles in implementing VR media. These obstacles are 1. implementing VR media takes a long time, because not all students understand how to use it. 2. Teachers must understand how to use VR media. 3. 3D videos prepared for use on VR media must be in accordance with the material being taught. 4. VR media used must be at least 6 pieces

Conclusion

Based on the pre-test and post-test results of students' self-efficacy administered to both the experimental and control groups through a questionnaire, and the analysis using N-gain, Kolmogorov-Smirnov, Levene, and Mann-Whitney U tests, it can be concluded that the implementation of the VR based learning media in mathematics education led to an increase on students' self-efficacy. This improvement can be a recommendation for teachers to implement VR based learning media in the classroom, as it provides the opportunities for students to engage with learning media during learning process and taking students' interest in IT based learning into consideration.

Following the completion of this study, the research team recommends the future research to conduct a qualitative descriptive analysis of the limitations of the VR based learning media and following the results, further development of VR media can be done, ensuring the previously identified shortcomings are minimized.

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