Journal of General Education and Humanities
Vol. 5, No. 1, February 2026, pp. 491 – 509, https://doi.org/10.58421/gehu.v5i1.877
ISSN 2963-7147

The Effect of Using LMS Moodle on Improving Students' Understanding of Algorithms, C++ Programming, and Active Involvement in Informatics Learning at Senior High School X in Bekasi City: A Comparative Study

Mathias Marciano M.
Master of Educational Technology, Faculty of Postgraduate Education and Pelita Harapan University, Indonesia.

Article Info

Article history:

Received 2025-12-02
Revised 2025-12-22
Accepted 2025-12-23

Keywords:

Algorithm Understanding,
C++ Programming,
Comparative study,
Informatics Learning.
Moodle LMS,
Student Engagement,

ABSTRACT

This study aims to compare students' understanding of algorithms, C++ programming skills, and active engagement in Informatics learning between those who use the Moodle Learning Management System (LMS) and those who do not at SMA X Kota Bekasi. The research employs a quantitative method with a causal comparative design, involving two naturally formed groups based on their use of LMS in classroom learning. Research instruments include a learning outcome test (posttest), programming practice assessment, and a student engagement questionnaire. The results indicate that the Moodle user group demonstrated a higher understanding of algorithms, with an N-Gain score of 0.411 (medium category), compared to the non-user group, which had an N-Gain score of 0.238 (low category). In terms of C++ programming skills, the Moodle group showed more stable, higher average performance, although the Mann-Whitney U test revealed no statistically significant difference (Sig. = 0.165 > 0.05). Meanwhile, student engagement questionnaire results showed that the Moodle group had significantly higher engagement levels, as confirmed by an Independent Samples t-test (Sig. = 0.006; $p < 0.05$). Overall, the study concludes that there are positive differences in algorithmic understanding and student engagement between Moodle users and non-users, as well as a favorable, though not statistically significant, difference in C++ programming skills.

Corresponding Author:

Mathias Marciano M.
Master of Educational Technology, Faculty of Postgraduate Education and Pelita Harapan University, Indonesia.
Email: mathias.marciano@bpkpenaburjakarta.or.id

1. INTRODUCTION

The rapid advancement of information and communication technology (ICT) in education has generated various innovations that transform teaching and learning practices. One widely adopted innovation, particularly following the COVID-19 pandemic, is the Learning Management System (LMS), which functions as a digital platform to support online and hybrid learning environments [1], [2]. Among available LMS platforms, Moodle is a prominent open-source system that provides features such as discussion forums, assignment submission, online quizzes, and learning analytics, enabling teachers to design structured, interactive, and measurable learning experiences [3], [4].

In the context of informatics learning at the senior high school level, learning success is largely determined by students' conceptual understanding and their level of engagement in the learning process. Informatics requires not only mastery of theoretical concepts but also the ability to apply them in practical domains such as algorithmic thinking, programming, data processing, and system development [5], [6], [7]. Nevertheless, learning challenges frequently emerge, including limited conceptual comprehension and low student engagement, especially in classrooms that still rely predominantly on conventional, teacher-centered instructional approaches [8], [9].

The integration of Moodle LMS offers potential solutions to these challenges. Moodle allows teachers to organize learning materials systematically, deliver timely feedback, and continuously monitor students' progress. Interactive components such as quizzes, discussion forums, and structured assignments can foster active participation and support deeper conceptual understanding, particularly when combined with project-based learning strategies [10], [11].

Although prior studies have reported that LMS implementation can enhance learning outcomes and student engagement across different subjects, existing research remains fragmented in the context of high school informatics education. In particular, few comparative studies have simultaneously examined conceptual algorithm understanding, practical programming performance, and student engagement within a single instructional setting [12]. Moreover, research that distinguishes between conceptual learning outcomes and hands-on programming skills, especially in C++, at the senior high school level, remains limited. This gap indicates the need for empirical evidence that holistically evaluates the pedagogical impact of Moodle LMS on multiple dimensions of informatics learning [13], [14].

In this study, algorithm understanding is defined as students' conceptual mastery of algorithmic principles, measured through a structured pretest–posttest instrument. C++ programming skills refer to students' ability to apply programming syntax, logic, and problem-solving procedures, assessed through a practical performance rubric. Student engagement is conceptualized as a multidimensional construct encompassing behavioral, cognitive, and affective involvement in learning activities [15], [16].

Based on this context, the present study aims to analyze the effect of Moodle LMS use on students' understanding of algorithms, C++ programming skills, and learning engagement in informatics instruction at SMA X [17], [18]. Accordingly, the research addresses the following questions: (1) Is there a difference in algorithm understanding between students who use Moodle LMS and those who do not? (2) Is there a difference in C++ programming performance between Moodle and non-Moodle users? Furthermore, (3) Does the use of Moodle LMS lead to higher levels of student engagement in informatics learning? Through this approach, the study seeks to contribute more comprehensive empirical evidence to the effective integration of digital learning technologies in secondary-level informatics education.

2. METHOD

Research Design

This study employs a quantitative, causal-comparative research design, comparing two pre-existing groups to determine differences in a dependent variable that may be related to a particular treatment or condition. Unlike true experiments or quasi-experiments that involve direct researcher intervention and random assignment of subjects, causal-comparative research does not use randomization or manipulation of the independent variable. Instead, it compares naturally formed groups based on specific experiences or characteristics [19], [20].[21], [22].

In this study, two groups of students are compared: the Moodle LMS user group and the non-user group. Both groups participated in Informatics learning with the topic *Algorithms and C++ Programming* during the same period. The Moodle user group received learning materials through various LMS features, including interactive modules, online quizzes, discussion forums, and digital assignments. Conversely, the non-user group used conventional learning methods without LMS involvement in delivering the material.

This design was chosen because it allows the researcher to assess differences in learning outcomes and student engagement across different learning conditions without directly manipulating the independent variable. By comparing the learning outcome scores and engagement levels of the two groups, the researcher can determine whether there are significant differences potentially associated with the use of the Moodle LMS [23], [24].

Research Time, Place, and Subjects

This study will be conducted in the even semester of the 2024–2025 academic year, specifically from March to April 2025.

Population and Sampling

The population in this study consists of all 10th-grade students at SMA X in Bekasi City during the 2024/2025 academic year. The school has several parallel 10th-grade classes. This population shares common characteristics, as previously described: a homogeneous student background (adolescents aged 15–16, familiar with technology, and following the same curriculum).

The sample was selected using cluster sampling based on existing classes. Cluster sampling offers advantages in cost and time efficiency because sampling is conducted at the group or cluster level. This method is also practical when a complete list of individuals in the population is unavailable, whereas a list of clusters is available. However, this method has disadvantages, such as increased sampling variance due to similarities within clusters (*intra-cluster homogeneity*) and potential bias if the selected clusters do not adequately represent the entire population [25], [26].

From the 10th-grade population, two classes were purposively selected based on balanced average academic ability (as determined by previous scores) and the willingness of the homeroom teachers to participate in the study. These two classes were designated as the Moodle user class and the non-user class. The total sample consists of 60 students, with each class comprising 30 students. Class X-1 serves as the Moodle user group using the LMS in learning, while Class X-5, with 30 students, serves as the non-user group without LMS use. This division ensures that both groups have relatively equal numbers and characteristics, thereby increasing the validity of the comparison results.

3. RESULTS AND DISCUSSION

Normality Test

Algorithm Understanding

The normality test for algorithm understanding displays the SPSS test results. The following displays the results of the normality test for student understanding based on the pretest and posttest scores for the Moodle user class.

Table 1. Results of the normality test for understanding the material, pretest, and posttest, for the Moodle user class.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.126	29	.200*	.962	29	.367
Posttest	.151	29	.090	.949	29	.168

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results of the normality test using the Kolmogorov-Smirnov and Shapiro-Wilk methods on the pretest and posttest data for the Moodle user class shown in the table above, the significance value (Sig.) for the pretest data was 0.200 in the Kolmogorov-Smirnov test and 0.367 in the Shapiro-Wilk test, while for the Moodle user class (posttest) data, the significance values were 0.090 and 0.168. Since all significance values were greater than 0.05, it can be concluded that both data sets are normally distributed. Therefore, the pretest and posttest data for the Moodle user class meet the assumption of normality and can be further analyzed using a parametric test, namely the Paired Sample t-Test.

Table 2. Results of the normality test for understanding the material in the pretest and posttest for the non-Moodle user class

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.191	30	.007	.907	30	.012
Posttest	.126	30	.200*	.966	30	.433

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results of the normality test for the pretest and posttest data for the non-Moodle user class shown in the table above, the pretest significance values (Sig.) were 0.007 (Kolmogorov-Smirnov) and 0.012 (Shapiro-Wilk), both less than 0.05, indicating that the pretest data were not normally distributed. Meanwhile, the posttest significance values were 0.200 (Kolmogorov-Smirnov) and 0.433 (Shapiro-Wilk), both greater than 0.05, indicating that the posttest data were normally distributed. Therefore, because one of the two data groups (the pretest) was not normally distributed, the difference in pretest and posttest scores for the non-Moodle user class must be tested using a nonparametric test, such as the Wilcoxon Signed-Rank Test [27], [28].

Understanding the C++ Programming Language

Table 3. Results of the Normality Test for Understanding the Practical Test Material

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Eksperimen	.232	30	.000	.800	30	.000
Kontrol	.228	30	.000	.784	30	.000

a. Lilliefors Significance Correction

Based on the results of the normality test shown in the table above, the significance value (Sig.) for the practical test results for both Moodle-using and non-Moodle-using classes was 0.000 for the Kolmogorov-Smirnov test and 0.000 for the Shapiro-Wilk test, respectively. Because the significance values for both tests were less than 0.05, it can be concluded that the distributions of the practical test results for both classes were not normal. Therefore, the analysis of differences in practical test results between Moodle-using and non-Moodle-using classes cannot use parametric tests (such as the Independent T-Test) but must use a nonparametric test, namely the Mann-Whitney Test [29], [30].

Homogeneity Test

Understanding of Material Algorithms

The homogeneity test for understanding of the material was performed using SPSS. The homogeneity test was presented in two groups: Moodle-using and non-Moodle-using classes.

Table 4. Results of the Homogeneity Test for Pretest Understanding of Material

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Pretest	Based on Mean	.098	1	57	.756
	Based on Median	.289	1	57	.593
	Based on Median and with adjusted df	.289	1	55.550	.593
	Based on trimmed mean	.116	1	57	.734

Based on the results of Levene's Test, the significance value was 0.756 ($p > 0.05$) using the mean approach. Therefore, it can be concluded that the pretest data on understanding the material between the Moodle user class and the non-Moodle user class had homogeneous variance. This indicates that the homogeneity assumption is met and that the data meet the requirements for further testing of score differences [31], [32], [33].

Table 5. Results of the Homogeneity Test for Posttest Understanding of Algorithm Material

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Posttest	Based on Mean	1.339	1	57	.252
	Based on Median	1.281	1	57	.262
	Based on Median and with adjusted df	1.281	1	48.110	.263
	Based on trimmed mean	1.344	1	57	.251

Based on the results of the homogeneity of variance test (Levene's Test) on the post-test data on material comprehension between the Moodle user and non-user classes, a significance value of 0.252 was obtained for the mean approach, 0.262 for the median, and 0.251 for the trimmed mean. All significance values were above the critical limit of 0.05, indicating no significant difference in variance between the two groups. Therefore, it can be concluded that the post-test data had homogeneous variance and met the assumption of homogeneity for further difference testing, such as a t-test or a nonparametric test, based onhe data distribution [34].

C++ Language Understanding

Table 6. Results of the Homogeneity Test: Practical Material Understanding Test

Test of Homogeneity of Variances		Levene Statistic	df1	df2	Sig.
RataRata_Skor	Based on Mean	.001	1	58	.975
	Based on Median	.046	1	58	.831
	Based on Median and with adjusted df	.046	1	57.862	.831
	Based on trimmed mean	.000	1	58	.997

A homogeneity test was conducted to determine whether the variance of practical test scores between Moodle-using and non-Moodle-using classes was equal (homogeneous). The practical test assessment instrument consisted of six assessment aspects, each scored on a 1–4 scale by two teachers, and the average combined score of both teachers was used to analyze each student. Analysis of the homogeneity of variance test using Levene's Test for Equality of Variances showed that the Levene Statistic value based on the mean was 0.001 with a significance (Sig.) of 0.975, based on the median was 0.046 with a Sig. of 0.831, and based on the Trimmed Mean was 0.000 with a Sig. of 0.997. All significance values were above the 0.05 threshold; therefore, it can be concluded that there was no significant difference in variance between the Moodle-using and non-Moodle-using classes. Thus, the variances of the practical test scores from both groups can be considered homogeneous, and the data meet the requirements for further analysis using a two-group difference statistical test.

Student Engagement

Homogeneity Test for the Student Engagement Variable:

Table 7. Results of the Homogeneity Test for the Student Engagement Questionnaire

Test of Homogeneity of Variances		Levene Statistic	df1	df2	Sig.
Keterlibatan (6 soal)	Based on Mean	.311	1	58	.579
	Based on Median	.380	1	58	.540
	Based on Median and with adjusted df	.380	1	56.410	.540
	Based on trimmed mean	.318	1	58	.575

Based on the results of the homogeneity of variance test (Levene's Test) for the student engagement variable, measured by six questions, the significance value (Sig.) was 0.579 for the mean-based test. Because this significance value is greater than 0.05 (0.579 > 0.05), it can be concluded that the data from the Moodle and non-Moodle user classes have homogeneous variance. Similar results were also seen in the median (Sig. = 0.540), adjusted df (Sig. = 0.540), and trimmed mean (Sig. = 0.575) tests, all of which showed values above 0.05. Thus, the assumption of homogeneity is met, and the intergroup comparison can proceed using the parametric Independent-Samples t-test.

 https://doi.org/10.58421/gehu.v5i1.877

After completing the analysis requirements test based on normality (Kolmogorov-Smirnov and Shapiro-Wilk approaches) and homogeneity (Levene's approach), the following table can be used to summarize the results:

Table 8. Summary of Analysis Requirements Test Results

Variable	Normality Test	Distribution	Homogeneity Test	Type of Follow-Up Test
Algorithm Understanding (Moodle Users)	Kolmogorov–Smirnov & Shapiro–Wilk	Normal	Homogeneous	Paired Sample t-Test
Algorithm Understanding (Non-Moodle)	Kolmogorov–Smirnov & Shapiro–Wilk	Not Normal (Pretest)	Homogeneous	Wilcoxon Signed-Rank Test
Practical Test (Moodle Users & Non-Moodle)	Kolmogorov–Smirnov & Shapiro–Wilk	Not Normal	Homogene ous	Mann–Whitney U Test
Student Engagement	Kolmogorov–Smirnov & Shapiro–Wilk	Normal	Homogeneous	Independent Sample t-Test

Based on the results of the analysis requirements test, which included normality and homogeneity tests, the pretest and posttest data on algorithm understanding in the Moodle user class were normally distributed. The pretest data were not normally distributed among non-Moodle users, but the posttest data were. For the practical test data, neither the Moodle user nor the non-Moodle user class was normally distributed. The homogeneity test showed that all data had homogeneous variance. Therefore, parametric tests such as the t-test can be used for normally distributed and homogeneous data, while nonparametric tests such as the Wilcoxon Signed-Rank Test and the Mann-Whitney Test are used for data that does not meet the assumption of normality.

The use of parametric tests (such as the t-test) and nonparametric tests (such as the Wilcoxon or Mann-Whitney) in the same analysis can yield different interpretations due to differences in their underlying assumptions and sensitivities. Parametric tests that require normality and homogeneity tend to be more robust when the data meet these assumptions, while nonparametric tests are more robust against violations of these assumptions but less sensitive. If the data are approximately normal, both tests may yield consistent results; however, when the data are clearly non-normal or contain outliers, the results may differ significantly. In these cases, nonparametric tests are preferred. Therefore, the choice of test should be based on a prior examination of statistical assumptions. If results differ between the two approaches, researchers should report these differences transparently and provide critical explanations in the discussion to ensure the validity of the research findings.

Questionnaire Results (Student Engagement)

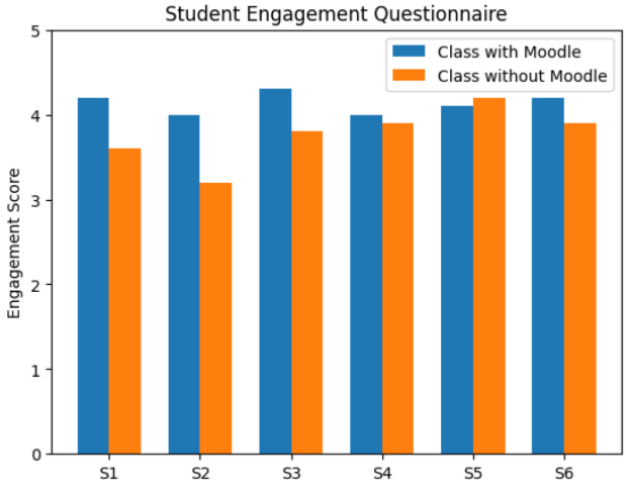

Figure 1. Student Engagement Questionnaire

Based on the graph of the student engagement questionnaire results, which consisted of six items, students in the Moodle-using class showed higher average scores than students in the non-Moodle-using class on almost all items [35], [36]. For the first item (s1), which relates to active participation in learning activities in the Moodle LMS, the Moodle-using class scored above 4, while the non-Moodle class scored below. For the second item (s2), which concerns efforts to understand the material through the LMS module independently, the difference between the classes was striking, with Moodle users significantly outperforming the others. A similar trend was observed in the third item (s3), regarding comfort with the LMS, where Moodle-using students reported a significantly higher level of comfort. For the fourth item (s4), which concerns taking the initiative to complete exercises and quizzes, and the fifth item (s5), which concerns discussion activities with the teacher or peers, the two classes showed similar scores, although the non-Moodle-using class scored slightly higher on s5. Finally, for the sixth item (s6), which concerns attention to teacher explanations via the LMS, the Moodle-using class still scored higher [37], [38].

Overall, this graph shows that students in Moodle-using classes are more actively, independently, and emotionally engaged in the LMS-based learning process compared to students in non-Moodle-using classes.

Furthermore, N-Gain and T-Test tests were conducted using Excel, followed by Mann-Whitney and Wilcoxon tests using SPSS, as shown below:

N-Gain

The pretest-posttest N-Gain calculation is shown in the following table.

Table 9. Pretest-posttest N-Gain Table for Non-Moodle User Classes

	pretest	posttest
Mean	54,43	65,27
N-Gain	0,238 Moderate	

Based on the table above, the average pretest score for students in the non-Moodle user class was 54.43, which increased to 65.27 during the posttest. The difference in scores yields an N-Gain of 0.238, which, according to Hake's criteria, is considered low (not moderate as stated in the table). This indicates that the improvement in students' understanding of algorithms in the non-Moodle user class was relatively ineffective. Although scores increased, the level of change was relatively small compared to the maximum potential improvement that could be achieved.

Table 10. N-Gain table for pretest-posttest Moodle user class

	pretest	posttest
Mean	50,246	70,690
N-Gain	0,411 Moderate	

Based on the table above, the average pretest score for the Moodle user class was 50.246, while the average posttest score increased to 70.690. The difference between the pretest and posttest scores yields an N-Gain of 0.411, which falls into the moderate category according to Hake's (1999) criteria.

This means that the learning implemented in the Moodle user class effectively increased students' understanding of algorithms and C++ programming, although there is still room for further improvement. These results indicate significant progress in students' conceptual mastery after the learning process.

T-Test

Table 11. Paired T-Test Pretest-Posttest Calculation Results for the Moodle User Group

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Pretest - Posttest	-20.4433498	20.17815495	3.746989307	-28.1187094	-12.7679901	-5.456	28	.000

Based on the results of the Paired Sample t-Test on the pretest and posttest scores of students' understanding of the material in one class, an average difference of -20.44 was obtained with a standard deviation of 20.78 and a standard error of 3.75. The calculated t-value was -5.456 with a degree of freedom (df) of 28 and a significance value (Sig. 2-tailed) of 0.000. Since the significance value is <0.05, it can be concluded that there is a statistically significant difference between the pretest and posttest scores. In other words, the learning in this class increases students' understanding of the material, even though the difference value is negative due to the subtraction order (pretest - posttest), which indicates that the posttest score is higher than the pretest score.

Wilcoxon Signed-Rank Test

For the pretest-posttest results of the non-Moodle user class, the statistical test used was the Wilcoxon Signed-Rank Test. This is because the pretest results were not normally distributed. Therefore, the results of the Wilcoxon Signed-Rank Test using SPSS are as follows:

Table 12. Wilcoxon Signed-Rank Test Results for Pretest-Posttest

Test Statistics[a]

	Posttest - Pretest
Z	-3.118[b]
Asymp. Sig. (2-tailed)	.002

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Based on the results of the Wilcoxon Signed-Rank Test on the pretest and posttest scores of students' understanding of the material in non-Moodle user classes, the Z value was -3.118, and the Asymp. Sig. (2-tailed) value was 0.002. Because the significance value is less than 0.05, it can be concluded that there is a significant difference between the pretest and posttest scores. This shows that, although the data is not normally distributed, there is a significant increase in understanding of the material after learning, even without using special interventions such as the Moodle LMS. The posttest-pretest sequence and negative Z value indicate that most students experienced an increase in scores after learning.

Mann-Whitney U Test

The Mann-Whitney U Test was used to test posttest differences between classes. This test examined the practical understanding of C++ programming material between Moodle and non-Moodle users. The results of the normality and homogeneity tests did not meet the criteria. Therefore, the Mann-Whitney U Test for posttests between classes was calculated using SPSS, with the following results:

Table 13. Mann-Whitney U Test Results for Moodle User Class Practice Test

Test Statistics[a]

	Skor_Akhir
Mann-Whitney U	413.000
Wilcoxon W	878.000
Z	-.549
Asymp. Sig. (2-tailed)	.583

a. Grouping Variable: Kelas_Kode

Based on the results of the Mann-Whitney U test on the material understanding value between the Moodle user class and the non-Moodle user class, the Mann-Whitney U value was 344.500 with an Asymp. Sig. (2-tailed) value of 0.165. Because the significance value is greater than 0.05, it can be concluded that there is no statistically significant difference between the Moodle user class and the non-Moodle user class in terms of material understanding. This means that although there is a difference in the average values between groups, it is not statistically significant at the 95% confidence level.

Table 14. Mann-Whitney U Test Results for Non-Moodle User Classes

Test Statistics[a]	Nilai
Mann-Whitney U	344.500
Wilcoxon W	809.500
Z	-1.388
Asymp. Sig. (2-tailed)	.165

a. Grouping Variable: Kelas

Based on the Mann-Whitney U test results for the final scores of the practical test on understanding algorithm material between the Moodle-using and non-Moodle-using classes, the Mann-Whitney U value was 413.000 and a significance value (Asymp. Sig., 2-tailed) of 0.583. Since the significance value is greater than 0.05, it can be concluded that there is no significant difference between the practical scores of students in the Moodle-using and non-Moodle-using classes. Therefore, the use of the Moodle LMS in learning in Moodle-using classes did not significantly affect practical test results on understanding algorithm material compared with non-Moodle-using classes in this context.

Based on the results of the Independent Sample t-Test on student engagement scores between the Moodle-using and non-Moodle-using classes, the Levene's Test for Equality of Variances significance value was 0.310, which is greater than 0.05. This indicates that the variances across the groups are homogeneous (equal variances assumed). Therefore, the t-test results are interpreted using the "Equal variances assumed" line.

Table 15. Independent Sample Test of the Student Engagement Questionnaire

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Skor_Keterlibatan	Equal variances assumed	1.052	.310	2.879	49	.006	.3904761905	.1356056469	.1179664405	.6629859404
	Equal variances not assumed			2.808	39.187	.008	.3904761905	.1390538546	.1092560574	.6716963236

In this row, the t-value is 2.879 with 49 degrees of freedom (df) and a significance level (2-tailed) of 0.006, which is less than 0.05. This indicates a significant difference in student engagement scores between Moodle-using and non-Moodle-using classes. The mean difference between the two groups is 0.390, with a 95% confidence interval ranging from 0.118 to 0.663. This means that the learning implemented in Moodle-using classes, in this case, the use of the Moodle LMS, has a positive effect on student engagement compared to non-Moodle-using classes that do not use the LMS.

Based on the results of Levene's Test for Equality of Variances, the p-value of 0.851 (>0.05) indicates that the variances between the groups are homogeneous. Therefore, the interpretation of the t-test results uses the line "Equal variances assumed."

In this row, a t-value of -0.505 was obtained with a significance (2-tailed) of 0.616, which is greater than 0.05. This indicates that there is no significant difference in perceptions of learning effectiveness between students in Moodle-using and non-Moodle-using classes. Thus, the use of the Moodle LMS in Moodle-using classes does not have a significant impact on perceptions of learning effectiveness compared to non-Moodle-using classes, based on the questionnaire data.

Discussion

The Effect of the Moodle LMS on Algorithm Comprehension at SMA X Bekasi City

Based on the data analysis, the implementation of the Moodle LMS appears to have a positive effect on students' understanding of algorithmic concepts at SMA X in Bekasi City. This is indicated by the increase in average scores in the Moodle user class from 50.25 (pretest) to 70.69 (posttest), with an N-Gain of 0.411, which falls in the medium range. The Paired Sample t-Test further confirms a statistically significant difference between pretest and posttest scores (Sig. 0.000 < 0.05), indicating that Moodle-supported learning effectively enhances algorithm comprehension.

In contrast, the non-Moodle class also experienced improvement, with average scores rising from 54.43 to 65.27; however, the resulting N-Gain value of 0.238 falls into the low category. Although the Wilcoxon Signed-Rank Test indicates a statistically significant increase in comprehension (Sig. 0.002), the magnitude of improvement is noticeably lower than that observed in the Moodle user class. This suggests that while conventional learning can improve understanding of algorithms, Moodle provides additional instructional value.

Overall, these findings indicate a meaningful difference in algorithm comprehension and learning structure between students who used Moodle and those who did not. Moodle use appears to support more independent, organized, and resource-accessible learning, which is particularly relevant for algorithmic material that requires step-by-step reasoning and repeated practice.

These results are consistent with studies reporting that Moodle-based learning environments support conceptual understanding in STEM subjects at the secondary education level, particularly through structured modules, self-paced activities, and formative quizzes (Gamage et al., 2022; Wiguna & Indrayani, 2022). Similar patterns reported in higher education contexts, such as improvements in programming-related understanding through Moodle-based tutorials (Sukardi & Rozi, 2019), further suggest that Moodle's pedagogical benefits are transferable, though contextual adaptation remains necessary for high school learners.

 https://doi.org/10.58421/gehu.v5i1.877

The Effect of the Moodle LMS on C++ Programming Comprehension at SMA X Bekasi City

Based on the analysis, the implementation of the Moodle LMS has a positive effect on students' comprehension of C++ programming at SMA X in Bekasi City. This is shown by the practical test results from both Moodle and non-Moodle classes, where the average teacher assessment scores in the Moodle class were higher and more stable than those in the non-Moodle class. The Moodle user class consistently scored around 85, while the non-Moodle class showed greater score variations and generally lower results, particularly in the second teacher's assessment.

Although the Mann-Whitney U test results indicate no statistically significant difference between the two classes (Sig. 0.165 > 0.05), the data trend shows that the Moodle LMS helps students improve their C++ programming skills in a more structured and consistent manner. Moodle provides easy access to learning materials, opportunities for independent practice, and support for understanding basic programming concepts, which, overall, positively influences students' mastery of programming skills, even though the statistical improvement is not yet significant. The analysis of C++ programming comprehension shows a more nuanced pattern. Descriptively, students in the Moodle user class demonstrated more stable and slightly higher practical test scores compared to those in the non-Moodle class. The Moodle class consistently achieved average scores around 85, while the non-Moodle class exhibited greater variability and generally lower performance, particularly in one of the teacher assessments.

However, the Mann-Whitney U test indicates that this difference is not statistically significant (Sig. 0.165 > 0.05). Therefore, in this sample, the use of the Moodle LMS cannot be concluded to have a statistically significant effect on students' C++ programming performance. Instead, the findings suggest a positive tendency toward more consistent performance among Moodle users, rather than a definitive improvement in practical programming outcomes.

Several factors may explain this result. First, the duration of the LMS implementation may not have been sufficient to yield measurable gains in practical programming skills, which typically require prolonged, iterative practice. Second, the assessment rubric, while reliable, may be less sensitive to incremental improvements in syntax mastery and logical structuring. Third, variations in teacher feedback patterns and limited guided coding practice within the LMS could have reduced the observable impact of Moodle on hands-on programming performance.

Comparable findings have been reported in blended learning studies, where Moodle-supported classes demonstrated performance levels equivalent to conventional instruction rather than significantly superior outcomes, particularly when instructional design and practice intensity varied across subjects. This alignment suggests that Moodle's effectiveness in programming instruction is highly dependent on how deeply practical activities and feedback mechanisms are embedded into the LMS design.

The Effect of the Moodle LMS on Student Engagement at SMA X Bekasi City

In contrast to the mixed results for practical programming, Moodle use shows a strong, statistically significant effect on student engagement. Questionnaire results indicate that students in the Moodle user class scored higher across behavioral, cognitive, and affective engagement indicators than those in the non-Moodle class. The Independent-Samples t-Test confirms this difference as statistically significant (Sig. = 0.006 < 0.05).

Students using Moodle demonstrated higher levels of active participation, greater independence in understanding learning materials, increased comfort during learning activities, and stronger initiative in completing tasks and engaging in discussions [39], [40]. These findings indicate that Moodle effectively fosters an engaging learning environment that encourages sustained student involvement. This pattern is consistent with previous research showing that Moodle features such as online quizzes, modular content, and assignment tracking promote active participation and learner autonomy at the senior high school level [41], [42]. Although forum participation may vary, high engagement in quizzes and assignments suggests that Moodle supports consistent learning behaviors that are essential for academic development.

Synthesis of Findings

Taken together, the results indicate that Moodle LMS implementation at SMA X Bekasi City is more effective in enhancing conceptual understanding and student engagement than in producing statistically significant gains in practical C++ programming performance. Algorithm comprehension benefits directly from Moodle's structured content delivery and formative assessment features, while engagement is strengthened through interactive and self-regulated learning opportunities. In contrast, practical programming skills appear to require longer exposure, more intensive guided practice, and refined assessment strategies to yield significant differences [43], [44], [45], [46].

This synthesis highlights that Moodle functions most effectively as a pedagogical support system for conceptual learning and engagement, while its impact on applied programming skills depends on the quality of instructional design, practice intensity, and feedback integration.

4. CONCLUSION

Based on the results of data analysis and the discussion in Chapter IV, it can be concluded that the use of the Moodle LMS has a positive effect on the learning process and outcomes in Informatics, particularly in algorithm material and C++ programming. The conclusions of this study are outlined as follows:

1. Using the Moodle LMS positively affects students' understanding of algorithmic concepts.

   This is evident from the increase in average scores and higher N-Gain values in the Moodle user class (N-Gain = 0.411, medium category) compared to the non-Moodle class (N-Gain = 0.238, low category). Statistical tests, such as the paired t-test and the Wilcoxon test, show significant differences, indicating that the Moodle LMS helps students understand algorithmic concepts more effectively.

2. The Moodle LMS also contributes to improving students' understanding of the C++ programming language.
   Structured materials and activities within the LMS help students understand syntax, logic, and basic programming structures. This is reflected in the practical test results, which show that students' C++ programming skills in the Moodle user class are more stable and higher, even though the Mann-Whitney U test did not show a statistically significant difference (Sig. 0.165 > 0.05). Moodle enables students to learn independently and revisit programming materials flexibly, supporting gradual conceptual understanding.
3. Students in the Moodle user class show higher levels of engagement compared to the non-Moodle class,
   both in behavioral, cognitive, and affective aspects. This is demonstrated through higher questionnaire scores and statistically significant test results. Moodle provides interactive features such as discussion forums, online quizzes, and progress tracking, which encourage students to be more active in learning. However, the effectiveness of the LMS is also influenced by external factors such as teacher readiness, available time, and the quality of instructional design.

ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to all individuals and institutions that supported the completion of this study. Special appreciation is extended to the teachers and school administrators of Senior High School X in Bekasi City for granting access, providing necessary facilities, and offering continuous collaboration during the research process. The authors also thank the participating students for their active involvement and willingness to engage with the LMS Moodle platform throughout the study. Deep gratitude is conveyed to the academic supervisors for their constructive feedback and guidance, which significantly enhanced the quality of this research. Finally, the authors acknowledge the support of their families, colleagues, and friends, whose encouragement played an important role in the successful completion of this work.

LIMITATIONS

This study has several limitations that should be considered when interpreting the findings. First, the selection of classes was non-random, as the research employed cluster sampling based on existing class groupings. Although efforts were made to balance academic ability across classes, this design limits the ability to control for pre-existing differences among students fully.

Second, the study was conducted in a single senior high school with a relatively small sample size (N = 60). Consequently, the generalizability of the findings to other schools, regions, or educational contexts should be approached with caution.

Third, a potential teacher effect cannot be ruled out entirely. Differences in instructional style, familiarity with Moodle features, and classroom management strategies may have influenced learning outcomes and student engagement, independent of LMS use. Finally, student engagement was measured using a six-item questionnaire. While the instrument captured key behavioral, cognitive, and affective aspects, a broader, more detailed engagement scale, or triangulation with log data (e.g., login frequency, forum participation, quiz attempts), could provide a more comprehensive picture of student engagement.

Practical Implications and Recommendations

Based on the findings and identified limitations, several actionable recommendations can be proposed to enhance the effectiveness of Moodle LMS implementation in Informatics learning. First, schools should provide systematic training for teachers on Moodle pedagogy, focusing not only on technical operations but also on instructional design, formative assessment, and feedback strategies within the LMS.

Second, the quality and structure of Moodle learning modules should be standardized across classes. Clear learning objectives, consistent module organization, and alignment between materials, quizzes, and practical assignments are necessary to ensure uniform learning experiences.

Third, structured feedback cycles should be implemented, with students receiving timely, specific feedback on quizzes, programming exercises, and discussion contributions. This feedback mechanism is essential for supporting conceptual understanding, particularly in algorithmic thinking and programming logic. Fourth, minimum weekly practice requirements should be established, such as mandatory coding exercises or quizzes, to encourage regular engagement and reduce passive LMS usage.

Finally, active monitoring of student participation, especially in discussion forums, should be conducted. Teachers can use Moodle analytics to identify students with low engagement and provide targeted academic support or motivational interventions.

By addressing these aspects, Moodle LMS implementation can move beyond content delivery toward a more pedagogically effective learning ecosystem that maximizes student understanding, skill development, and engagement in Informatics learning.

REFERENCES

[1] C. A. A. P. Abar and U. Carnevale de Moraes, "Flipped Classrooms and Moodle: Digital Technologies to Support Teaching and Learning Mathematics," *Acta Didactica Napocensia*, vol. 12, no. 2, pp. 209–216, Dec. 2019, doi: 10.24193/adn.12.2.16.

[2] S. H. P. W. Gamage, J. R. Ayres, and M. B. Behrend, "A systematic review on trends in using Moodle for teaching and learning," *Int J STEM Educ*, vol. 9, no. 1, p. 9, Dec. 2022, doi: 10.1186/s40594-021-00323-x.

[3] M. Viaren and T. Taali, "Efektivitas Pembelajaran menggunakan Learning Management System Berbasis Moodle," *Jurnal Pendidikan Teknik Elektro*, vol. 3, no. 2, pp. 279–286, Dec. 2022, doi: 10.24036/jpte.v3i2.196.

[4] Y. Wulandari, A. Halim, N. Nasrullah, M. Syukri, and E. Elisa, "Implementasi Model Pembelajaran Blended Learning Tipe Flipped Classroom Untuk Meningkatkan Minat Belajar Peserta Didik," *Tatar Pasundan: Jurnal Diklat Keagamaan*, vol. 17, no. 2, pp. 155–169, Oct. 2023, doi: 10.38075/tp.v17i2.332.

[5] M. Foan Tapatab, "Upaya Meningkatkan Keaktifan Belajar Siswa Melalui Penggunaan Learning Management System (LMS) Berbasis Moodle Pada Materi Hukum Hooke," *Jurnal Syntax Admiration*, vol. 3, no. 5, pp. 693–710, May 2022, doi: 10.46799/jsa.v3i5.433.

[6] G. Skedsmo and S. G. Huber, "Exploring the complexities of assessment, evaluation, and accountability in education," *Educ Assess Eval Account*, vol. 37, no. 1, pp. 1–4, Feb. 2025, doi: 10.1007/s11092-025-09452-1.

[7] Erlianda Cibro and Yahfizham Yahfizham, “Mengidentifikasi Dasar Algoritma Pemrograman,” *Jurnal ilmiah Sistem Informasi dan Ilmu Komputer*, vol. 4, no. 1, pp. 194–206, Jan. 2024, doi: 10.55606/juisik.v4i1.763.

[8] R. K. Shah and L. A. Barkas, “Analysing the impact of e-learning technology on students’ engagement, attendance and performance,” *Research in Learning Technology*, vol. 26, no. 0, Dec. 2018, doi: 10.25304/rlt.v26.2070.

[9] A. Cockett and C. Jackson, “The use of assessment rubrics to enhance feedback in higher education: An integrative literature review,” *Nurse Educ Today*, vol. 69, pp. 8–13, Oct. 2018, doi: 10.1016/j.nedt.2018.06.022.

[10] P. Sindiani, R. S. Dewi, and F. A. Bahrudin, “Pengaruh Penggunaan Media Pembelajaran Moodle terhadap Hasil Belajar Peserta Didik pada Mata Pelajaran PPKn,” *Equilibrium: Jurnal Pendidikan*, vol. 11, no. 2, pp. 203–214, May 2023, doi: 10.26618/equilibrium.v11i2.10584.

[11] A. Kovari and J. Katona, “Effect of software development course on programming self-efficacy,” *Educ Inf Technol (Dordr)*, Feb. 2023, doi: 10.1007/s10639-023-11617-8.

[12] D. Apriadi and A. Afiarini, “Pelatihan Pemanfaatan E-Learning sebagai Media Pembelajaran untuk Meningkatkan Kompetensi Dosen pada Fakultas Ilmu Sosial dan Politik Universitas Musi Rawas,” *Jurnal Abdi Masyarakat Indonesia*, vol. 3, no. 4, pp. 1219–1224, Jul. 2023, doi: 10.54082/jamsi.834.

[13] R. Akmalul Ahsan, “Implementasi E-Learning Berbasis Moodle Pada Mata Pelajaran Informatika,” *Indonesian Journal of Computer Science*, vol. 13, no. 1, Feb. 2024, doi: 10.33022/ijcs.v13i1.3728.

[14] A. H. Duin and J. Tham, “The Current State of Analytics: Implications for Learning Management System (LMS) Use in Writing Pedagogy,” *Comput Compos*, vol. 55, p. 102544, Mar. 2020, doi: 10.1016/j.compcom.2020.102544.

[15] Adawiyah Ritonga and Yahfizham Yahfizham, “Studi Literatur Perbandingan Bahasa Pemrograman C++ dan Bahasa Pemrograman Python pada Algoritma Pemrograman,” *Jurnal Teknik Informatika dan Teknologi Informasi*, vol. 3, no. 3, pp. 56–63, Nov. 2023, doi: 10.55606/jutiti.v3i3.2863.

[16] N. N. Rahmah Rais, A. Wedi, and H. Praherdhiono, “Systematic Literature Review : Penggunaan Media Pembelajaran Online Berbasis LMS di Sekolah Menengah Kejuruan,” *JURNAL MANAJEMEN PENDIDIKAN DAN ILMU SOSIAL*, vol. 6, no. 2, pp. 1667–1677, Mar. 2025, doi: 10.38035/jmpis.v6i2.4096.

[17] C. N. Akpen, S. Asaolu, S. Atobatele, H. Okagbue, and S. Sampson, “Impact of online learning on student’s performance and engagement: a systematic review,” *Discover Education*, vol. 3, no. 1, p. 205, Nov. 2024, doi: 10.1007/s44217-024-00253-0.

[18] D. Afrianti Rahayu and M. Surya Laksana, “Analisis Efektivitas Penggunaan E-Learning Management System Berbasis Moodle dalam Pembelajaran Siswa,” *Jurnal Pendidikan dan Pengajaran*, vol. 2, no. 2, Sep. 2023, doi: 10.69808/pijar.v2i2.46.

[19] Y. Qian and J. Lehman, “Students’ Misconceptions and Other Difficulties in Introductory Programming,” *ACM Transactions on Computing Education*, vol. 18, no. 1, pp. 1–24, Mar. 2018, doi: 10.1145/3077618.

[20] A. Ardila and S. Hartanto, “Faktor Yang Mempengaruhi Rendahnya Hasil Belajar Matematika Siswa Mts Iskandar Muda Batam,” *PYTHAGORAS: Jurnal Program Studi Pendidikan Matematika*, vol. 6, no. 2, Nov. 2017, doi: 10.33373/pythagoras.v6i2.966.

[21] A. Rachman, E. Yochanan, A. Samanlangi, and H. Purnomo, *Metode Penelitian Kuantitatif, Kualitatif Dan R&D*. 2024.

[22] S. Online, “Digital Promise.” [Online]. Available: https://langerresearch.com

[23] D. Pérez-Marín, R. Hijón-Neira, A. Bacelo, and C. Pizarro, “Can computational thinking be improved by using a methodology based on metaphors and scratch to teach computer programming to children?,” *Comput Human Behav*, vol. 105, p. 105849, Apr. 2020, doi: 10.1016/j.chb.2018.12.027.

[24] C. Müller, T. Mildenberger, and D. Steingruber, “Learning effectiveness of a flexible learning study programme in a blended learning design: why are some courses more effective than others?,” *International Journal of Educational Technology in Higher Education*, vol. 20, no. 1, p. 10, Feb. 2023, doi: 10.1186/s41239-022-00379-x.

[25] V. Jusas, D. Barisas, and M. Jančiukas, “Game Elements towards More Sustainable Learning in Object-Oriented Programming Course,” *Sustainability*, vol. 14, no. 4, p. 2325, Feb. 2022, doi: 10.3390/su14042325.

[26] E. Lahtinen, K. Ala-Mutka, and H.-M. Järvinen, “A study of the difficulties of novice programmers,” in *Proceedings of the 10th annual SIGCSE conference on innovation and technology in computer science education*, New York, NY, USA: ACM, Jun. 2005, pp. 14–18. doi: 10.1145/1067445.1067453.

[27] J. Bojiah, “Effectiveness of Moodle in Teaching and Learning,” *Journal of Hunan University Natural Sciences*, vol. 49, no. 12, pp. 320–328, Dec. 2022, doi: 10.55463/issn.1674-2974.49.12.33.

[28] Y. Bosse and M. A. Gerosa, “Why is programming so difficult to learn?,” *ACM SIGSOFT Software Engineering Notes*, vol. 41, no. 6, pp. 1–6, Jan. 2017, doi: 10.1145/3011286.3011301.

[29] H. Belmar, “Review on the teaching of programming and computational thinking in the world,” *Front Comput Sci*, vol. 4, Oct. 2022, doi: 10.3389/fcomp.2022.997222.

[30] S. Arikunto, *Dasar-Dasar Evaluasi Pendidikan Edisi 3*. Bumi Aksara, 2021. [Online]. Available: https://books.google.co.id/books?id=j5EmEAAAQBAJ

[31] S. Aida, “Impact of E-Learning Orientation, Moodle Usage, and Learning Planning on Learning Outcomes in On-Demand Lectures,” *Educ Sci (Basel)*, vol. 13, no. 10, p. 1005, Oct. 2023, doi: 10.3390/educsci13101005.

[32] A. Suad, O. Tapalova, A. Berestova, and S. Vlasova, “Moodle’s communicative instruments: The impact on students academic performance,” *Innovations in Education and Teaching International*, vol. 62, no. 6, pp. 1828–1842, Nov. 2025, doi: 10.1080/14703297.2024.2437117.

[33] A. LW *et al.*, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom’s Taxonomy of Educational Objectives*. 2001.

[34] S.L. Clavinova, I.G.P. Suharta, and G. Suweken, “Peningkatan Pemahaman Konsep Matematika Siswa Kelas XI Agama Man 1 Jembrana Melalui Penerapan Blended Learning Tipe Flipped Classroom Menggunakan Moodle,” *Jurnal Pendidikan dan Pembelajaran Matematika Indonesia*, vol. 9, no. 2, pp. 45–51, Oct. 2020, doi: 10.23887/jppmi.v9i2.1689.

[35] U. Dari, R. Putri, Y. Silvini, and A. Arivatussaqdiyah, “Pemanfaatan Learning Management System (LMS) Berbasis Moodle dalam Pembelajaran Fisika terhadap Kemampuan Kognitif Siswa,” *Pedagogika: Jurnal Ilmu-Ilmu Kependidikan*, vol. 4, no. 2, pp. 34–38, Dec. 2024, doi: 10.57251/ped.v4i2.1536.

[36] Erlianda Cibro and Yahfizham Yahfizham, “Mengidentifikasi Dasar Algoritma Pemrograman,” *Jurnal ilmiah Sistem Informasi dan Ilmu Komputer*, vol. 4, no. 1, pp. 194–206, Jan. 2024, doi: 10.55606/juisik.v4i1.763.

[37] O. Erol, “How do Students’ Attitudes Towards Programming and Self-Efficacy in Programming Change in the Robotic Programming Process?,” *International Journal of Progressive Education*, vol. 16, no. 4, pp. 13–26, Aug. 2020, doi: 10.29329/ijpe.2020.268.2.

[38] N. N. Nurfa, A. Aripin, and E. Susanti, “Pengembangan Media Pembelajaran Learning Management System Berbasis Moodle Sebagai Daya Dukung Pembelajaran Fisika,” *JURNAL EKSAKTA PENDIDIKAN (JEP)*, vol. 6, no. 2, pp. 143–151, Nov. 2022, doi: 10.24036/jep/vol6-iss2/663.

[39] S. H. P. W. Gamage, J. R. Ayres, and M. B. Behrend, “A systematic review on trends in using Moodle for teaching and learning,” *Int J STEM Educ*, vol. 9, no. 1, p. 9, Dec. 2022, doi: 10.1186/s40594-021-00323-x.

[40] J. A. Fredricks, M. Filsecker, and M. A. Lawson, “Student engagement, context, and adjustment: Addressing definitional, measurement, and methodological issues,” *Learn Instr*, vol. 43, pp. 1–4, Jun. 2016, doi: 10.1016/j.learninstruc.2016.02.002.

[41] J. W. M. Lai and M. Bower, “How is the use of technology in education evaluated? A systematic review,” *Comput Educ*, vol. 133, pp. 27–42, May 2019, doi: 10.1016/j.compedu.2019.01.010.

[42] J. Wang, P. Lin, Z. Tang, and S. Chen, “How problem difficulty and order influence programming education outcomes in online judge systems,” *Heliyon*, vol. 9, no. 11, p. e20947, Nov. 2023, doi: 10.1016/j.heliyon.2023.e20947.

[43] Z. Khrisat and H. N. Fakhouri, “Impact of E-learning Tools (Moodle, Microsoft Teams, Zoom) on Student Engagement and Achievement at Jordan Universities,” *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 18, no. 18, pp. 125–145, Sep. 2024, doi: 10.3991/ijim.v18i18.49895.

[44] E. R. Kahu, “Framing student engagement in higher education,” *Studies in Higher Education*, vol. 38, no. 5, pp. 758–773, Jun. 2013, doi: 10.1080/03075079.2011.598505.

[45] G. Mellander, *College Presidents Respond to COVID-19*. 2021.

[46] C. Gordon, R. Lysecky, and F. Vahid, “Programming learners struggle as much in Python as in C++ or Java,” in *2022 ASEE Annual Conference & Exposition Proceedings*, ASEE Conferences. doi: 10.18260/1-2--41410.