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Assessment for Learning (AfL) in Project-Based Physics Learning: Mapping Students' Collaboration and Discipline Skills

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Abstract. This study aims to determine the implementation of Assessment for Learning (AfL) instruments in project-based physics learning to map collaboration and discipline skills of high school students in Bandar Lampung City. This descriptive quantitative research used samples of class SMA X (n=36), SMA Y (n=36), and SMA Z (n=35) which were selected using purposive sampling technique. Data were collected using observation sheets to monitor collaboration and discipline skills during project learning. Data were analyzed using descriptive statistics. The results showed that students at SMA Y, located in the suburban area (between the city center and the peripheral), achieved the highest average scores for both collaboration and discipline skills compared to the other two schools, namely SMA X in the city center and SMA Z in the peripheral area.

Keywords: Assessment for Learning (AfL), Project-Based Physics Learning, Collaboration Skills, Discipline Skills.

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INTRODUCTION

Education is a continuous process aimed at improving human resources and advancing various life aspects (Ningsi & Nasih, 2020; Dodi, 2019). UNESCO highlights that enhancing education quality is crucial for national progress (Hidayat & Abdillah, 2019). In 2019, the Ministry of Education, Culture, Research, and Technology introduced the Curriculum Merdeka Belajar, focusing on developing 21st-century skills such as communication, critical thinking, collaboration, and creativity (Maulidia et al., 2023; Rahmawati & Salehudin, 2021). Collaboration is vital for globalization and can improve students' learning and social awareness (Miroh et al., 2019). The project-based learning (PjBL) model, part of this curriculum, aims to enhance collaboration and discipline (Agustanti et al., 2022; Faiza, 2021; Festiyed et al., 2022). Discipline regulates behavior and time, affecting academic achievement (Agustina, 2023; Mu'min et al., 2022).

Assessment for Learning (AfL) supports learning through constructive feedback and can measure collaboration and discipline through observation (Wulan, 2018; Faiza, 2021). AfL has been shown to improve learning outcomes, higher-order thinking skills, and student attitudes (Hidayat & Qudsiyah, 2018; Safithri & Muchlis, 2022; Tamaela, 2016). Despite this, systematic mapping of collaboration and discipline skills remains limited (Karpudewan et al., 2016; Wurdinger & Qureshi, 2015). This research seeks to provide deeper insights into AfL's implementation within PjBL and its

impact on mapping student skills, aiming to contribute to more effective and targeted teaching strategies.

METHOD

This study employed a descriptive quantitative approach to assess students' collaboration and discipline skills in project-based physics learning using an Assessment for Learning (AfL) instrument with observation sheets. The research was conducted at three senior high schools in Bandar Lampung, Indonesia: SMA X (city center), SMA Y (suburban), and SMA Z (peripheral). The participants consisted of 107 students from three classes: SMA X (n=36), SMA Y (n=36), and SMA Z (n=35), selected using a purposive sampling technique. The study utilized learning tools like Lesson Plans and Student Worksheets, and an AfL observation sheet developed by Anjani (2021) for evaluation. Validity and reliability tests show high scores (validity of 0.75 and reliability of 0.88), confirming the instrument's effectiveness. Data collection is done through systematic observations, and descriptive statistics are used to analyze and categorize students' skills into high, moderate, and low levels based on relative frequencies.

Table 1. Categorization Criteria

No.	Criteria	Category
1.	$x \geq M + 1\ SD$	High
2.	$M - 1\ SD < x < M + 1\ SD$	Medium
3.	$x \leq M + 1\ SD -$	Low

Source: Sudijono, 2018, p.(kurang menyebutkan halaman)

Explanation:

$$x = Obtained\ value$$
$$M = Mean$$
$$SD = Standard\ Deviation$$

Each skill criterion is analyzed using the Relative Frequency Distribution table, where frequency is divided by the total number of responses and multiplied by 100%.

$$P = \frac{f}{N} \times 100\% \quad [1]$$

Explanation:

$$P = Percentage$$
$$f = Frequency$$
$$N = Total\ number\ of\ frequencies$$

Prior to conducting comparative analyses, the assumptions of normality and homogeneity were examined. Data normality was assessed using the Shapiro–Wilk test, while homogeneity of variance among groups was evaluated using Levene's test. The significance level for all statistical tests was set at $\alpha = 0.05$. Since the data did not fully satisfy the assumptions required for parametric analysis, nonparametric statistical procedures were employed. Differences in students' collaboration and discipline skills among the three school-location groups, namely city center (SMA X), suburban (SMA Y), and peripheral (SMA Z), were analyzed using the Kruskal–Wallis H test. When significant differences were identified, post hoc pairwise comparisons were conducted using the Dunn–Bonferroni procedure to determine which groups differed significantly. Bonferroni adjustment was applied to control the family-wise error rate resulting from multiple comparisons. To evaluate the magnitude of differences among groups, the effect size was calculated using eta-squared for the Kruskal–Wallis test (η^2_H). The effect size was interpreted according to Cohen's criteria: 0.01 (small),

0.06 (medium), and 0.14 or greater (large effect). All statistical analyses were performed using IBM SPSS Statistics version 26, with a significance level of 0.05.

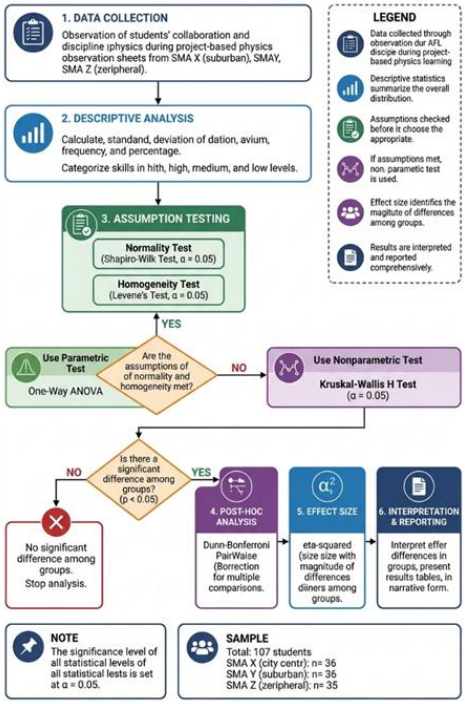

Figure 1. Statistical decision-making procedure used in the study.

RESULT AND DISCUSSION

This study aims to use the Assessment for Learning (AfL) instrument, specifically observation sheets, to map students' collaboration and discipline skills at three schools in Bandar Lampung City: SMA X (city center), SMA Y (suburban), and SMA Z (peripheral). The selection of these schools, based on their different locations, helps provide a comprehensive view of students' skills dynamics (Herlina & Kusnadi, 2019). All classes at these schools employ the same learning model, Project-Based Learning (PjBL). The study involves validated observation sheets adapted for physics-based project learning. The process includes several stages: introducing basic concepts and project goals, formulating key questions, researching and designing the project, and creating a tangible product based on research results. The AfL instrument assesses collaboration skills through 25 statements focused on collaboration aspects. Descriptive statistical analysis of these skills is detailed in Table 2.

Table 2. Descriptive statistical data of collaboration skills results

Parameter	SMA X	SMA Y	SMA Z
Mean	80.03	84.56	80.17
Median	80.5	85.5	80
Variance	58.313	17.225	16.617

Based on Table 2, it can be observed that there are differences in students' collaboration skills among SMA X, SMA Y, and SMA Z. SMA Y obtained the highest average collaboration skill score (84.56) and the highest median (85.5), indicating that students at this school generally have better collaboration skills compared to those at SMA X and SMA Z. The results of the descriptive statistical analysis were then analyzed based on the categorization according to Arikunto & Jabar (2008), resulting in the percentage and category of collaboration skills for each school, which can be seen in Table 3.

Table 3. The average percentage of collaboration skills.

School	Persentase	Category

SMA X	80.03%	Good
SMA Y	84.56%	Excellent
SMA Z	80.17%	Good

Based on Table 3, it can be seen that the average collaboration skills of students at SMA X and SMA Z fall into the Good category, while those at SMA Y fall into the Excellent category.

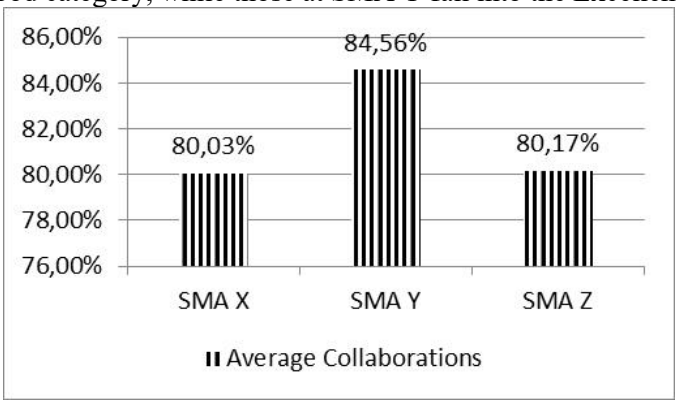

Figure 2. Average Collaboration Skills

Figure 2 shows that the average collaboration skills of students at SMA Y, located in a suburban area, reached 84.56%, categorized as 'Excellent'. In contrast, SMA X in the city center and SMA Z in the peripheral area reported percentages of 80.03% and 80.17%, respectively, both categorized as 'Good'. This indicates that the school environment in suburban areas may positively impact students' collaboration skills. The suburban environment offers a balance between competition and support, creating a more inclusive and less pressuring atmosphere compared to schools in city centers, which often face highly competitive pressures. Social support from the school environment, including positive interactions between students and teachers, contributes to better collaboration skills. Conversely, competitive pressures in city schools can disrupt positive social interactions and make students more focused on individual achievement rather than teamwork (Anwar & Arief, 2020; Wulandari & Nugroho, 2021). On the other hand, schools in peripheral areas often face resource limitations that can hinder the development of collaboration skills. These limitations reduce opportunities for students to engage in activities that promote social and collaborative skills, leading them to focus more on individual tasks rather than team cooperation. Additionally, resource shortages often lead to lower student involvement in collaborative activities, resulting in less optimal development of collaboration skills compared to schools in more supportive environments (Pang et al., 2018; Franke et al., 2020).

The results of the Kruskal-Wallis statistical test also showed that there was a strong influence of school location on the variation in students' collaboration skills. Test results are shown in Table 4.

Table 4. Kruskal-Wallis Test Results of Collaboration Ability

Statistics	Value
H	16.486
p-value	0.000263
η^2_H	0.139

Furthermore, the results of the Pairwise Comparison test also show that students' collaboration ability in suburban schools is significantly higher than that of city center and peripheral schools. There is no difference in collaboration capabilities between city center and peripheral groups.

Table 5. Pairwise Comparison Test Results for Collaboration Ability

Comparison	p-value	Decision

City Center vs Suburban	0,0061	Significant differences
City Center vs Peripheral	0,9770	No different
Suburban vs Peripheral	<0.001	Significant differences

Data on the distribution of students' collaboration skills percentages at each school is presented in Table 6.

Tabel 6. Distribution of Collaborations Skills Percentages

School	Persentase		
	Low	**Medium**	**High**
SMA X	13.9%	63.9%	22.2%
SMA Y	13.9%	72.2%	13.9%
SMA Z	8.6%	71.4%	20.0%

The following presents the data on the distribution percentage of students' collaboration skills, as shown in Figure 3.

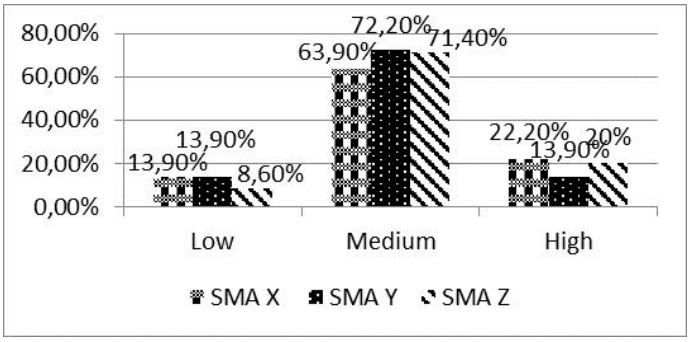

Figure 3. Analysis of the distribution of collaboration skills percentages.

Although SMA Y shows higher average collaboration skills, most students are in the moderate category (72.2%), with only 13.9% in the high category. This suggests that while the suburban environment supports collaboration skills, there is room to improve the proportion of students reaching high levels (Fang & Hou, 2019). SMA X, in an urban setting with high academic pressure and noise, has a higher proportion of students with high collaboration skills (22.2%) compared to SMA Y. Better educational resources in urban areas contribute positively, though urban challenges can impact these skills (Gonzalez & Paredes, 2020). SMA Z, in a calm peripheral environment, shows a similar proportion of students in the high category (20.0%) as SMA X, with most students in the moderate category (71.4%) and a low percentage of students with low collaboration skills (8.6%). Community support and effective teaching strategies in peripheral areas help develop collaboration skills despite limitations (Bowers, 2014; D. J. Miller & Donnelly, 2017). Overall, the school environment significantly influences students' collaboration skills, with suburban environments offering distinct advantages, while urban and peripheral environments have their own challenges. The AfL instrument for assessing discipline attitudes includes 20 statements and is detailed in Table 7.

Table 7. Descriptive statistical data of Discipline results

Parameter	SMA X	SMA Y	SMA Z
Mean	82.9167	93.8889	85.0000
Median	85.6250	93.7500	85.0000
Varians	111.696	5.159	8.180

Based on Table 7 the data revealed variations in student discipline attitudes across the three schools in SMA Y has the highest average discipline attitude (93.8889) and the highest median

(93.7500), indicating that students at this school are generally more disciplined compared to those at SMA X and SMA Z. The results of the descriptive statistical analysis were then analyzed based on the categorization according to Arikunto & Jabar (2008) resulting in the percentage and category of Discipline for each school, which can be seen in Table 8.

Table 8. The average percentage of Discipline.

School	Persentase	Category
SMA X	82.9%	Excellent
SMA Y	93.89%	Excellent
SMA Z	85%	Excellent

Based on Table 8, it can be seen that the average discipline attitude of students in the three schools in falls into the 'Excellent' category.

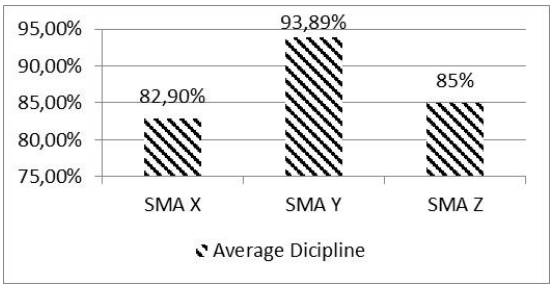

Figure 4. Average Discipline

Figure 4 reveals that SMA Y, located in an suburban area, has the highest average discipline attitude percentage (93.89%) compared to SMA X in the city center (82.9%) and SMA Z in the peripheral area (85%). Despite all three schools being rated 'Excellent', SMA Y's higher percentage suggests that environmental factors and daily social interactions greatly influence students' discipline. In urban environments like SMA X, students face high academic and social pressures, which can lead to stress and affect discipline consistency (Baker & Wong, 2017). Conversely, peripheral environments like SMA Z offer a more stable atmosphere that supports good discipline attitudes, although resource limitations may restrict student activities (Gibson & Hargreaves, 2019). SMA Y benefits from a balanced suburban environment that combines adequate facilities with moderate pressure, fostering better discipline development (Miller & Smith, 2020).

The results of the Kruskal-Wallis statistical test also show that the location of the school is a very strong factor in differentiating the level of discipline of students. Test results are shown in Table 9.

Table 9. Results of the Kruskal-Wallis Discipline Test

Statistics	Value
H	52.855
p-value	< 0.001
η^2_H	0.489

Furthermore, the results of the Pairwise Comparison test also show that student discipline in suburban schools is significantly higher than that of students in city center and peripheral schools. There were no significant disciplinary differences between the city center and peripheral groups.

Table 10. Results of Pairwise Comparison Test Discipline

Comparison	p-value	Decision
City Center vs Suburban	<0.001	Significant differences
City Center vs Peripheral	0,876	No different

Suburban vs Peripheral	<0.001	Significant differences

Data on the distribution of students' Discipline percentages at each school is presented in Table 11.

Table 11. Distribution of Discipline Percentages

School	Persentase		
	Low	**Medium**	**High**
SMA X	16.7%	69.4%	13.9%
SMA Y	11.1%	66.7%	22.2%
SMA Z	11.4%	62.9%	25.7%

The following presents the data on the distribution percentage of students' Discipline, as shown in Figure 4.

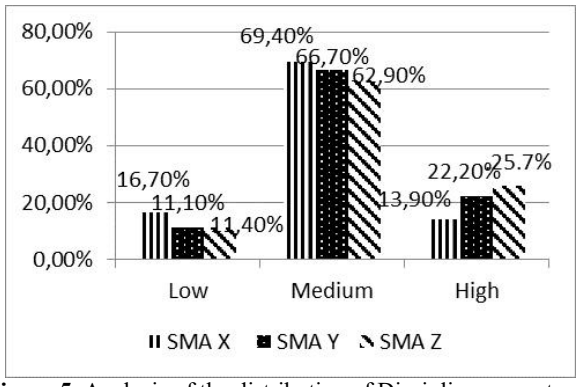

Figure 5. Analysis of the distribution of Discipline percentages

Based on Figure 5, SMA Y has the highest average discipline percentage (93.89%) among the three schools. However, SMA Z has a higher percentage of students with high discipline (25.7%) compared to SMA Y (22.2%). This indicates that SMA Z, located on the outskirts, is more effective at increasing the proportion of students with very high discipline than SMA Y, despite SMA Y having a higher overall average discipline. SMA X, in the city center, has a lower percentage of students with high discipline (13.9%) due to additional challenges such as competition pressure and environmental distractions, which negatively impact student discipline (Harris & Goodall, 2015). Although SMA Z faces resource limitations, it achieves higher discipline levels (25.7%) through effective managerial strategies and community support (Ladd & Dinella, 2016). SMA Y, situated in a suburban area, has a balanced approach between challenges and support but is less effective than SMA Z in promoting very high discipline. Schools in stable environments like SMA Y generally achieve good discipline outcomes (Murray et al., 2018). Overall, SMA Z demonstrates that, despite being in the outskirts, effective management and community support can lead to superior discipline outcomes compared to schools in city centers and suburban areas.

CONCLUSION

The study applied the Assessment for Learning (AfL) instrument through observation sheets to evaluate students' collaboration and discipline skills in project-based physics learning at three high schools in City. SMA Y, situated in a suburban area, showed the highest average scores in both collaboration and discipline due to its supportive environment and balanced pressures. SMA X, located in the city center, faced higher social and academic pressures, affecting discipline, while SMA Z in the peripheral area benefitted from a stable environment with close student-teacher relationships. Recommendations include using additional data collection tools, consistently applying AfL, tailoring project-based learning to each school's environment, and incorporating triangulation in future research to improve validity and reliability.

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