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The Correlation Between the Implementation of Chemistry Learning and Student Learning Outcomes Using a Google Classroom-Based Blended Learning Model

Muhammad Yunus[1], Islawati[2]*, Nining Febrianti[3], Sugiarti[4]
Department of Chemistry, Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Negeri Makassar
Corresponding Author: Islawati islawati@unm.ac.id

A R T I C L E I N F O

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A B S T R A C T

This study aims to examine the correlation between the implementation of Chemistry learning and student learning outcomes through a Google Classroom-based Blended Learning model. This research is a type of descriptive quantitative study. Data were collected in the form of the implementation of learning and student learning outcomes, which were then analyzed using the Pearson correlation test. The observations showed that the implementation of learning reached 100% for both pre- and post-online learning sessions, and 86% for face-to-face learning. The average score of student learning outcomes in the experimental group was 80.25 with a standard deviation of 10.65. The analysis revealed a very strong and significant correlation between the implementation of learning and student learning outcomes, with a correlation value (r) of 0.957, indicating that the higher the implementation of learning, the better the student learning outcomes. This indicates that the use of the Google Classroom platform in the Blended Learning model contributes significantly to improving student learning outcomes.

INTRODUCTION

The development of information technology in the past five years has driven a transformation in the field of education, including the development of new learning models that combine digital technology with traditional teaching methods. One widely recognized model is Blended Learning, which integrates face-to-face learning with online learning. This model offers flexibility in the learning process, allowing students to access materials more easily, anytime and anywhere, making it highly relevant to the educational needs of the digital era. Chemistry is often considered one of the challenging subjects for students due to its abstract nature and the need for a deep understanding of concepts. Recent studies have shown that Blended Learning can enhance students' comprehension of difficult concepts by providing them with the opportunity to learn independently at their own pace (George, 2020; Cheng et al., 2023).

Previous research has indicated the effectiveness of Blended Learning across various disciplines. For example, a study by Zafirah et al. (2021) demonstrated that Blended Learning could increase students' motivation and learning outcomes through the integration of flexible online learning and interactive face-to-face sessions. Another study by Batubara et al. (2022) found that Blended Learning has great potential in improving the quality of education, particularly in the context of distance learning, which has become increasingly prevalent due to the COVID-19 pandemic. However, despite numerous studies on the effectiveness of Blended Learning, there is still a lack of research specifically evaluating its application in Chemistry at the high school level, especially using the Google Classroom platform. A deeper understanding of the effectiveness of this model is crucial, given the challenges in teaching Chemistry, which often involves complex concepts that require more flexible and interactive learning support.

This research becomes even more relevant considering the need to strengthen adaptive and effective learning approaches to address the various challenges students face in learning Chemistry. By evaluating the correlation between the implementation of learning and student learning outcomes in the context of Google Classroom-based Blended Learning, this study not only contributes to the educational literature but also provides empirical evidence that can be used by educators to design and implement more effective learning models. Additionally, the findings of this study are expected to serve as an important reference for schools in optimizing the use of technology in education, particularly in subjects that require more dynamic teaching approaches, such as Chemistry.

LITERATURE REVIEW

Blended Learning is a learning approach that combines face-to-face and online methods, offering flexibility to students in the learning process. Over the past five years, this approach has become increasingly popular in Indonesia, particularly in the context of distance education driven by the COVID-19 pandemic. A study by Batubara et al. (2022) showed that Blended Learning in Indonesia has been able to enhance student engagement and learning outcomes, especially in distance learning situations. Another study by

Nelliraharti & Murnia Suri (2021) found that Blended Learning helps students understand complex concepts by allowing them to review material independently.

Blended Learning offers various attractive elements that can boost student motivation and learning outcomes. The flexibility to access materials anytime and anywhere enables students to learn at their own pace and style, fostering independence and a sense of responsibility. The use of interactive media and both online and face-to-face collaboration makes learning more engaging and actively involves students. Quick and personalized feedback from online assessments helps students understand their mistakes immediately, while access to additional resources and the ability to review material as needed enriches the learning experience and strengthens concept comprehension. These elements together create a more dynamic and adaptive learning environment, enhancing students' motivation and overall learning outcomes.

Blended Learning has gained significant attention for its positive impact. For instance, a study by Cheng et al. (2023) in Taiwan found that this approach not only improves learning outcomes but also motivates students to be more active in the learning process. Sjukur (2013) added that Blended Learning allows for personalized learning, where students can learn at their own pace and style, leading to a deeper understanding of the material. This finding aligns with George (2020), who showed that students engaged in Blended Learning achieved higher learning outcomes compared to those who only participated in face-to-face learning.

Research conducted by Nugraha et al. (2019) supports the view that Blended Learning is highly effective in improving student learning outcomes. They found that the integration of online and face-to-face learning can overcome the limitations of each method, creating a more comprehensive learning environment. In their study, Herlina et al. noted a significant increase in concept comprehension among students involved in Blended Learning, particularly in subjects requiring in-depth analysis like Chemistry.

Google Classroom is one of the most widely used platforms in implementing Blended Learning in Indonesia and globally. This platform offers various features that facilitate learning management, such as assignment distribution, assessment, and communication between students and teachers. Nugraha et al. (2019) showed that the use of Google Classroom enhances teaching efficiency, with teachers better managing classes and students more easily accessing learning materials. The study also found that using Google Classroom strengthens student-teacher interactions, positively impacting material comprehension.

Google Classroom supports more collaborative learning, where students can interact and discuss more intensively through the online platform (Nugraha et al., 2019). This finding is supported by Zhang (2018), who emphasized that Google Classroom facilitates better learning management and makes the learning process more structured and efficient. The platform enables more adaptive teaching, where teachers can adjust materials and teaching

methods according to students' needs and abilities. This is crucial in subjects like Chemistry, where difficult concepts often require a more flexible and personalized teaching approach.

Learning implementation refers to the extent to which a learning plan can be effectively implemented in the classroom. In the context of Blended Learning, implementation is a key factor that determines the effectiveness of learning. A study by Laila Ariyanti (2020) found that good learning implementation, especially in the integration of online and face-to-face methods, can enhance student engagement and learning outcomes. The study shows that teachers who successfully integrate these two methods can create a more engaging learning environment and support better concept comprehension. In developing countries, challenges in implementation often arise from a lack of adequate technological access, which can hinder the effectiveness of Blended Learning. However, in the right context, good implementation can improve students' learning outcomes and overall learning experience.

METHODOLOGY

This research employs a descriptive quantitative approach aimed at examining the relationship between the implementation of chemistry learning and student learning outcomes applied through a Google Classroom-Based Blended Learning Model. The research instruments are designed to efficiently and thoroughly collect data, facilitating a more accurate, comprehensive, and systematic analysis (Arikunto, 2006). The instruments used in this study include observation sheets for learning implementation and documentation. The observation sheets are used to assess various aspects of the learning process, including student behavior, teacher activities during teaching, student engagement in discussions, participation in simulations, and the use of teaching aids. Observations were conducted from the beginning to the end of the chemistry learning activities, while student learning outcomes were measured through a post-test. The data were analyzed to examine the correlation between learning implementation and student learning outcomes.

The analysis of learning outcomes data employs descriptive statistical techniques to provide a general overview of the characteristics of student achievement in classes taught using the blended learning model. To examine the correlation between the implementation of learning and learning outcomes, Spearman's correlation formula was used, as this research utilizes ordinal data. The formula used is as follows:

$$r_s = 1 - \frac{6\sum d_i^2}{n\left(n^2 - 1\right)}$$

Explanation:

- **rs**: Spearman correlation coefficient
- **d**: Difference between X and Y ranks
- **n**: Number of data pairs

The correlation coefficient is a value that describes the strength of the relationship between two or more variables, and it can also indicate the direction of that relationship. The value of the correlation coefficient falls within the range (rs) = ($-1 \leq rs \leq 1$). The following table illustrates the correlation and the strength of the relationship according to Siregar (2013):

Table 1. Level of Correlation and Strength of Relationship

Correlation Coefficient (rs)	Strength of Relationship
0.00 - 0.19	Very weak or no correlation
0.20 - 0.39	Weak correlation
0.40 - 0.59	Moderate correlation
0.60 - 0.79	Strong correlation
0.80 - 1.00	Very strong correlation

RESEARCH RESULT

Implementation Results

Table 2. Observation Results of Learning Implementation

No	Syntax	Achievement Percentage (%)	Description
1	Pre-Learning (online)	100	Excellent
2	Scheduled Learning (face-to-face)	86	Excellent
3	Post-Learning (online)	100	Excellent

The implementation of the learning model using Google Classroom-based Blended Learning shows excellent results overall, with very high implementation rates for both pre- and post-online learning stages and face-to-face sessions.

Learning Outcomes

Table 3. Description of Student Learning Outcomes

Descriptive Statistics	Post-Test Statistics
Sample Size	36
Highest Score	95
Lowest Score	45
Average Score	80
Median	86
Mode	84
Standard Deviation	10.65

The relatively high average score (80) and the high median score (86) indicate that most students have a good understanding. However, the lowest score of 45 and a standard deviation of 10.65 show that some students' post-test

scores are significantly below the average, suggesting considerable variation in students' abilities.

Correlation Between Learning Implementation and Learning Outcomes

Table 4. Correlation Between Learning Implementation and Chemistry Learning Outcomes

Implementation	Learning Outcomes
Pearson Correlation	0.957*
Sig. (2-tailed)	0.029

There is a very strong and positive correlation between the implementation of learning and chemistry learning outcomes. This means that improvements in learning implementation are likely to be followed by improvements in chemistry learning outcomes.

DISCUSSION

Based on Table 2, the implementation of learning in the Google Classroom-based Blended Learning model can be categorized as excellent overall. The discussion of each phase of the learning process is as follows:

1. Pre-Learning (Online):

   The implementation of learning during the pre-learning online phase reached 100%, indicating that all planned activities in this phase were executed very well. This phase is crucial as it serves as an introduction for students to understand the initial material before entering face-to-face learning. This perfect result indicates that the Google Classroom platform is effectively used to prepare students before they enter more intensive learning sessions. The 100% success rate also reflects the students' readiness to use digital technology as a learning medium, as well as the effectiveness of teachers in managing and facilitating online learning.

2. Scheduled Learning (Face-to-Face):

   In the face-to-face scheduled learning phase, the implementation rate reached 86%, which is also categorized as excellent. Although this percentage is slightly lower compared to the pre- and post-online learning phases, it still shows that most of the learning activities were carried out as planned. This small difference may be due to factors such as time constraints, logistical challenges, or variations in student participation during face-to-face learning. However, overall, the results indicate that the combination of online and face-to-face methods in Blended Learning can still be effectively implemented, despite challenges in direct classroom implementation.

3. Post-Learning (Online):
The implementation of learning in the post-learning online phase also reached 100%, indicating that students were able to complete all planned activities after the face-to-face session very well. This shows that students have utilized the material and experiences from the face-to-face session to optimally complete online tasks or activities. Additionally, this achievement demonstrates consistency in using Google Classroom as an effective tool to support continued learning, where students can consolidate their understanding of the material learned.

The results from these three learning phases indicate that the Google Classroom-based Blended Learning model can be implemented very well, positively impacting student engagement and learning outcomes. The nearly perfect implementation in the pre- and post-online learning phases reflects that this digital platform not only helps in preparing students but also supports them in understanding and deepening the material after face-to-face learning. Meanwhile, the very good implementation results in face-to-face sessions show that the Blended Learning model can also function effectively in traditional learning contexts. This success also indicates that a balance between online and face-to-face learning can enhance overall learning effectiveness. Good implementation at all stages of learning plays a crucial role in improving student learning outcomes, which has been proven in various studies that effective application of learning models leads to better learning results.

Based on the descriptive data of student learning outcomes presented in Table 3, several indicators illustrate the distribution of post-test scores from 36 students. The average score (mean) of learning outcomes is 80, indicating that, overall, students have a good level of understanding of the material studied. The median score, which is 86, is slightly higher than the average score, indicating that more than half of the students achieved scores above this average. This suggests a tendency for relatively high scores among most students. The highest score achieved by students is 95, while the lowest score is 45. The significant difference between the highest and lowest scores indicates considerable variation in student learning outcomes. Students who achieved the highest scores are considered to have a very good understanding of the material, while those with the lowest scores may need additional assistance.

The mode, or the most frequently occurring score, is 84. This indicates that a score of 84 is the most common among students. As the most frequent score, it may be an indicator that most students are in a range of understanding that is quite good. The standard deviation of 10.65 indicates the spread of scores from the average. This relatively large standard deviation shows significant differences between individual student scores and the average. It indicates considerable variation in students' ability to understand the tested material. Overall, these descriptive results show that the majority of students have a good understanding of the tested material, with most scores clustering around

the relatively high average and mode. However, the substantial difference between the highest and lowest scores and the relatively high standard deviation indicate variation in understanding among students. Therefore, more differentiated learning efforts may be needed to help students who are below average to catch up and achieve better learning outcomes.

Based on the Pearson correlation analysis results presented in Table 4, there is a very strong correlation between learning implementation and chemistry learning outcomes. The Pearson correlation value of 0.957 indicates an almost perfect positive correlation. This means that as the implementation of learning improves, the learning outcomes achieved by students also tend to increase. The statistical significance of 0.029 shows that the relationship between the two variables is significant at a 95% confidence level. In other words, the probability that this correlation is due to chance is very low, less than 5%. This indicates that the results are highly reliable and dependable. Although this very strong and significant correlation provides an indication of a close relationship between learning implementation and chemistry learning outcomes, the small sample size may limit the generalizability of these results to a broader population. Therefore, it is recommended to conduct further research with a larger sample size to confirm these findings.

In the context of chemistry learning, these results provide important insights that efforts to improve learning implementation, such as the quality of teaching, the use of appropriate methods, and student engagement, can have a significant impact on improving student learning outcomes. In other words, interventions focused on enhancing learning implementation are likely to lead to improved student performance in chemistry. These research findings align with the study by Basilaia & Kvavadze (2020), which shows that the application of blended learning combining face-to-face and online learning through platforms like Google Classroom significantly contributes to improving student learning outcomes. This is because the model allows flexibility in learning, material accessibility, and greater student engagement. Another study by Suhairi et al. (2022) shows that Google Classroom as a platform in the blended learning model is very effective in organizing learning content, providing quick feedback, and facilitating discussions between students and teachers. The effectiveness of this platform directly supports your findings about the strong correlation between learning implementation and learning outcomes..

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings obtained from the correlation analysis in this study, it can be concluded that there is a very strong and significant relationship between the implementation of chemistry learning using the Google Classroom-based Blended Learning model and student learning outcomes. The nearly perfect positive correlation ($r = 0.957$) indicates that improvements in the quality of learning implementation directly impact increases in student learning outcomes. This underscores that the use of technology in learning, such as Google Classroom, can enhance material accessibility, student engagement, and provide prompt and effective feedback. The application of the blended learning model proves not only to improve

students' conceptual understanding in chemistry but also to contribute to overall academic performance enhancement. Thus, the implementation of this learning model can be a highly effective strategy for improving learning outcomes, especially in science subjects, in the current digital era. This finding also emphasizes the crucial role of teachers in ensuring optimal learning implementation to achieve the best possible learning outcomes for each student.

ADVANCED RESEARCH

This study has limitations, particularly concerning the short duration of the research. The brief research period may not be sufficient to capture long-term changes or developments in the implementation of learning and student learning outcomes. Therefore, this study might not fully reflect the long-term effects of using the Blended Learning model. It is recommended that future research explore the long-term impact of Blended Learning on learning outcomes.

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