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[Research Article]

ANALYZING ASTRONOMY LEARNING OUTCOMES BASED ON IN-CLASS AND AT-HOME WORDWALL QUIZZES

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ABSTRACT

This study analyzes the differences in astronomy learning outcomes based on the timing of WordWall post-tests administered either in-class or at home. Conducted in two face-to-face classes with 70 university students, one class completed the quiz immediately after instruction, while the other completed it later from home. A quantitative approach was applied using descriptive statistics and the Mann-Whitney U test to examine differences in mean scores and variability. The results showed that students who took the quiz at home had slightly higher average scores but greater score dispersion. In contrast, students who completed the quiz in class had more consistent results. These findings suggest that immediate post-tests better reflect uniform understanding than delayed assessment. Factors influencing these differences include student motivation, regulation, and engagement. The study highlights the importance of post-test timing when using digital tools like WordWall for evaluating learning outcomes in astronomy education.

Keywords: astronomy, at-home quiz, in-class quiz, digital assessment, wordwall

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1. INTRODUCTION

The rapid development of information and communication technology (ICT) in the digital era has significantly transformed the educational landscape, including the implementation of digital tools to support assessment in the classroom (Escala et al., 2024; Sugiani, 2023). One such tool is WordWall, an interactive quiz platform that offers game-based features to enhance student engagement and motivation (Aprilia et al., 2024; Ionescu-Feleagă et al., 2025; Maisuroh et al., 2024). WordWall has been widely adopted in various educational contexts due to its user-friendly interface, flexibility, and ability to create a more dynamic learning environment (Juniardi et al., 2020).

Several studies have shown that the integration of WordWall in instruction can improve student interest and support personalized learning experiences (Launin et al., 2022; Ubis & Nuriadin, 2022). However, while most studies have focused on the effectiveness of WordWall based on different learning modes, less attention has been given to how the timing of post-test delivery using WordWall influences learning outcomes — especially when the content and delivery method remain consistent, such as in face-to-face settings.

Assessment timing can affect students' focus, motivation, and performance (Scheel et al., 2022; Segbenya et al., 2022). Immediate post-tests conducted in class may encourage more authentic responses reflective of students' actual understanding. On the other hand, delayed assessments done at home may introduce external influences, both positive (e.g., time flexibility) and negative (e.g., distractions, reduced motivation). In astronomy education, which often involves conceptual complexity, evaluating the optimal timing for formative assessments is particularly important.

Based on this background, the objective of this study is to analyze differences in astronomy post-test outcomes between two face-to-face student groups: one that completed WordWall quizzes immediately in class, and another that completed the same quizzes later at home. This research offers a novel perspective by isolating the variable of post-test timing while keeping instructional delivery and content consistent. The findings are expected to guide future instructional strategies, especially in the use of digital tools for formative assessment in science education.

2. METHOD

This study employed a quantitative approach with a descriptive-comparative design to examine the impact of post-test timing on student learning outcomes in astronomy education. The research was conducted systematically, beginning with the identification of instructional consistency, followed by controlled variation in assessment timing.

2.1 Time and Place of Research

The study was conducted over one academic semester (August–December 2024) in the Physics Education Department, Faculty of Mathematics and Science Education, University of Jember, Indonesia.

2.2 Subject and Sampling

The research involved fifth-semester students enrolled in two astronomy classes (N = 70). Both classes received the same instructional content, methods, and duration, delivered face-to-face by the same lecturer. The key difference was in the timing of the WordWall post-tests:
Class A (n = 41): Completed WordWall quizzes immediately after class (in-class)
Class B (n = 29): Completed the same quizzes later at home via online access.
Sampling was conducted using non-probability convenience sampling, involving students who were already enrolled in the astronomy course and willing to participate in the study (Creswell, 2012).

2.3 Tools and Materials

The main tool used for assessment was WordWall, a web-based platform that allows the creation and deployment of interactive quizzes. Ten quizzes were developed based on astronomy topics aligned with the course syllabus. Additional tools included SPSS software for statistical analysis and Microsoft Excel for data management and visualization.

2.4 Research Procedure

Throughout the 16-week course, instruction was delivered through active learning methods including student presentations, discussions, and instructor-led clarification. After completing each topic, students received a post-test quiz via the WordWall platform:

Students in Class A completed the quiz immediately at the end of the lesson.

Students in Class B received a quiz link to complete at home, with a 24-hour submission deadline.

2.5 Data Collection

The main data source was student scores from 10 WordWall quizzes administered after each astronomy topic. The quizzes assessed conceptual understanding and were graded automatically by the platform.

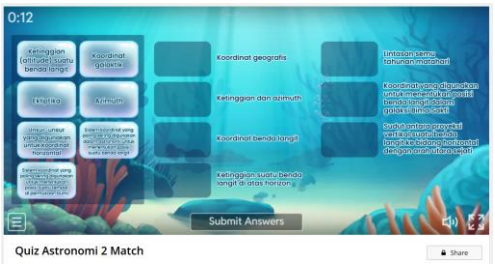
2.6 Data Analysis

The data were analyzed using descriptive statistics (mean, median, standard deviation, variance) to observe score trends in each class. In addition, inferential statistical analysis was conducted using the Mann-Whitney U test, given that normality assumptions were not consistently met based on the Shapiro-Wilk and Kolmogorov-Smirnov tests. Visualizations including boxplots and histograms were used to illustrate score distributions and variability. This systematic methodology ensured the comparison was valid, with instructional consistency maintained and only the timing of assessment varied across groups.

3. RESULT AND DISCUSSION

Representing the WordWall quizzes used for the astronomy post-test, four of the ten quiz interfaces are shown in Figure.

Quiz 1. Formation of the solar system



Quiz 2. Coordinate Systems of Celestial Objects

Quiz 3. Telescope

Quiz 4. Position and Time in Astronomy

Figure 1. Representative Interfaces of WordWall Quizzes Used for Astronomy Post-Test (4 out of 10 quizzes shown as examples)

Table 1. Descriptive Statistical Analysis Results of Astronomy Quiz Data for In-Class and At-Home Quiz Groups Using SPSS

Quiz	N	Range	Min	Max	Mean	Std. Deviation	Variance	Skewness	Kurtosis
At-home 1	29	80	20	100	68.97	24.83	616.75	-.354	-.828
In-class 1	41	80	20	100	61.46	22.97	527.81	.163	-1.027
At-home 2	29	100	0	100	68.97	24.83	981.70	-.644	-.357
In-class 2	41	71.43	28.57	100	66.55	23.61	557.24	.090	-1.048
At-home 3	29	80	20	100	71.72	22.37	500.49	-.396	-.545
In-class 3	41	60	40	100	71.71	17.31	299.51	-.033	-.569
At-home 4	29	100	0	100	64.83	29.11	847.29	-.751	-.012
In-class 4	41	80	20	100	61.46	23.83	567.81	.132	-.922
At-home 5	29	50	50	100	85.06	18.55	344.14	-.551	-.1477
In-class 5	41	100	0	100	58.94	20.78	431.91	.157	1.211
At-home 6	29	80	20	100	83.45	27.29	744.83	-1.421	.793
In-class 6	41	100	0	100	57.07	28.83	831.220	.269	-.849
At-home 7	29	80	20	100	65.52	26.13	682.76	-.553	-.563
In-class 7	41	100	0	100	59.02	24.06	579.02	-.355	-.347
At-home 8	29	66.67	33.33	100	72.99	26.88	722.49	-.397	-1.496
In-class 8	41	80	20	100	80.49	23.02	529.76	-1.395	1.542
At-home 9	29	83.33	16.67	100	68.39	31.29	979.06	-.508	-1.266
In-class 9	41	100	0	100	61.79	26.15	683.94	-.017	-.766
At-home 10	29	66.67	33.33	100	75.86	19.71	388.62	-.689	-.290
In-class 10	41	100	0	100	63.01	20.25	409.89	-.699	1.110

Table 1 presents the descriptive statistical analysis results for each of the ten astronomy quizzes, comparing students who completed the quizzes in class with those who completed them at home. The descriptive statistics derived from the ten astronomy post-test quizzes demonstrated noticeable differences in student achievement between the in-class and at-home quiz groups. Specifically, the mean scores obtained in the at-home quizzes were predominantly higher than those in the in-class quizzes, excluding quiz 8. This disparity may reflect increased flexibility or extended response time for students completing the quizzes at home, or possible access to external resources.

However, the variability in scores, as indicated by the standard deviation (quizzes 1, 2, 3, 4, 7, 8, and 9), also tended to be greater in the at-home group. This suggests a wider dispersion of student comprehension levels, where some students may achieve exceptionally high scores while others may perform significantly lower. In contrast, the in-class quiz scores exhibited a more homogeneous distribution, characterized by lower variability.

The range of scores also varied between the two groups. Several at-home quizzes exhibited a wider range, indicating greater heterogeneity in comprehension. This may be attributed to differences in motivation, distractions, or varying levels of commitment when working independently outside the classroom setting.

Skewness and kurtosis—measures of distribution shape—also showed distinct patterns. Most at-home quizzes demonstrated negative skewness, indicating that more students earned higher scores. Meanwhile, several in-class quizzes (such as quizzes 1, 2, 4, 5, and 6) exhibited positive skewness, where lower scores were more frequent.

In terms of kurtosis, some at-home quizzes showed negative kurtosis, suggesting flatter distributions, while several in-class quizzes

(quizzes 5, 8, and 10) displayed positive kurtosis, indicating sharper peaks in score clustering.

Standard deviation reflects how far individual scores deviate from the mean. A lower standard deviation implies greater consistency or homogeneity in performance, whereas a higher value suggests wider variability. Similarly, variance—often used in further statistical analysis—indicates the spread of the data. For ease of interpretation, standard deviation is commonly used to compare the uniformity of student outcomes. Visual representations, including histograms and boxplots, are presented in Table 2.

Overall, the data shows a clear difference in student performance between the in-class and at-home quiz groups in the astronomy post-test. Students who completed the quizzes at home tended to achieve higher average scores; however, their results also displayed greater variability. In contrast, students who took the quizzes immediately in class demonstrated more consistent and homogeneous performance. This consistency suggests that in-class post-tests may better reflect actual understanding with fewer external influences.

Additionally, the in-class group had a larger number of participants (N=41) compared to the at-home group (N=29), which may contribute to greater stability in statistical trends, as larger sample sizes generally offer more representative insights. Despite the higher averages in the at-home group, the wider score dispersion indicates that delayed assessments may not provide a reliable measure of group learning outcomes.

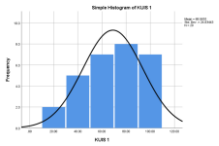
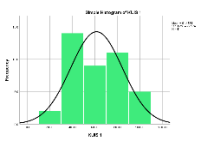
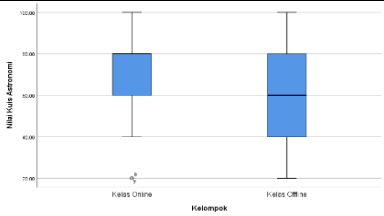
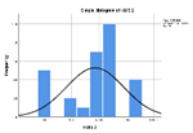
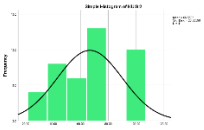
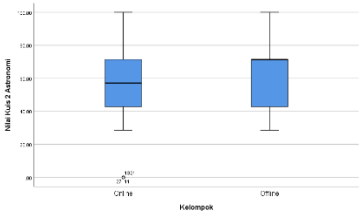
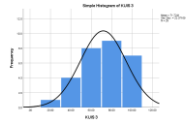
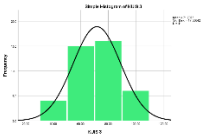
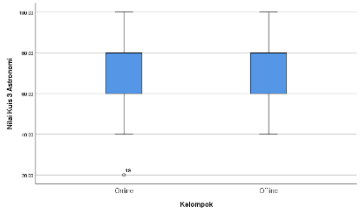
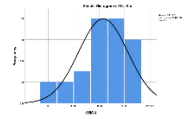
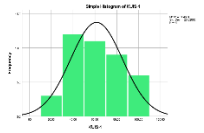
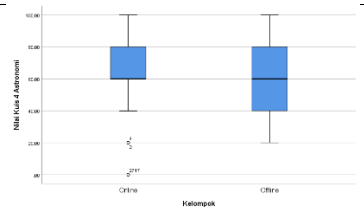
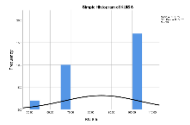
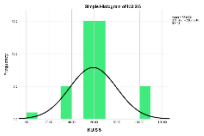
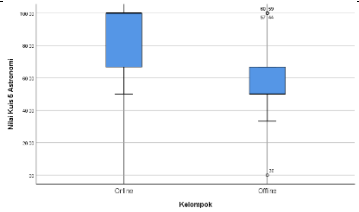
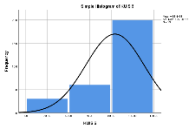
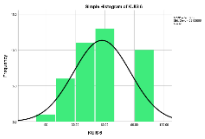
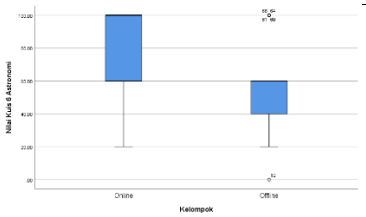
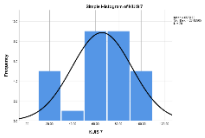
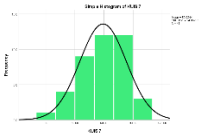
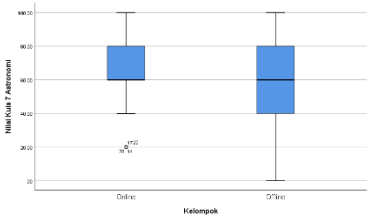
These findings suggest that the timing of digital assessments such as WordWall can significantly impact the interpretation of student performance. Simply integrating technology into assessments without considering implementation factors may reduce their effectiveness. Therefore, further research is essential to identify the most pedagogically sound ways to integrate digital tools into instructional design (Galvis & Carvajal, 2022).

To examine potential differences, student scores from the in-class and at-home WordWall post-tests were compared. An independent samples t-test was applied when the data met normality assumptions; otherwise, the Mann-Whitney U test was used. The results of the normality and comparative tests are presented in Table 3.

The significance (Sig.) values for both the in-class and at-home quiz groups were found to be less than 0.05 in most cases, indicating that the data did not follow a normal distribution. Given the relatively small sample sizes, this lack of normality is common and expected. Therefore, hypothesis testing was conducted using a non-parametric approach, specifically the Mann-Whitney U test. The results revealed significant differences in average scores between the two groups in some quizzes, particularly quizzes 5, 6, and 10, while other quizzes did not show statistically significant differences. These findings suggest that the timing of post-test administration may have influenced performance on certain topics more than others.

Previous studies (Contrino et al., 2024) have noted that student characteristics, such as academic maturity and experience with independent learning, can influence learning outcomes. Students in higher semesters generally demonstrate greater self-regulation and responsibility compared to those in their first year. In this study, the participants were fifth-semester students, who are expected to possess a higher level of academic maturity. To ensure instructional consistency and minimize external factors affecting performance, both classes were taught by the same instructor using identical teaching materials and strategies. Furthermore, all students completed the same WordWall post-tests, with the only variable being the timing of quiz administration—either immediately in class or later at home. This controlled design helps isolate the influence of assessment timing on student performance.

Table 2. Data Visualization

Quiz	Histogram		Boxplot	
	At-home quiz	In-class quiz	At-home quiz	In-class quiz
1				
2				
3				
4				
5				
6				
7				

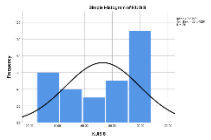
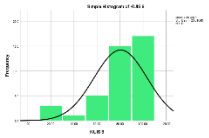
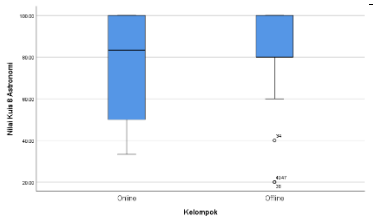
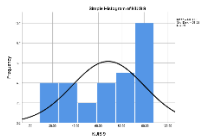
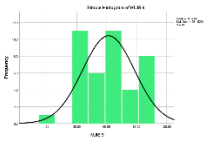
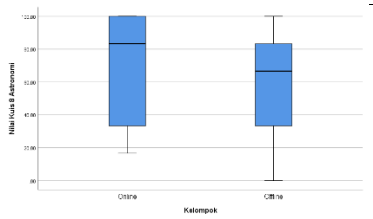
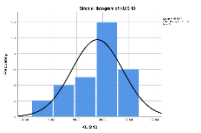
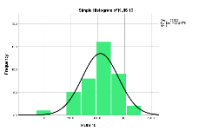
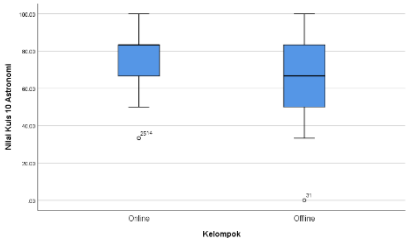
8			
9			
10			

Table 3. Normality and Comparative Test

Class	Kolmogorov-Smirnov[a]		Shapiro-Wilk		Asymp. Sig (2-tailed)
	df	Sig.	df	Sig.	
At-home 1	29	.010	29	.011	.179
In-class 1	41	.000	41	.001	
At-home 2	29	.000	29	.001	.278
In-class 2	41	.003	41	.001	
At-home 3	29	.006	29	.010	.856
In-class 3	41	.000	41	.000	
At-home 4	29	.007	29	.008	.382
In-class 4	41	.002	41	.003	
At-home 5	29	.000	29	.000	.000
In-class 5	41	.000	41	.000	
At-home 6	29	.000	29	.000	.000
In-class 6	41	.000	41	.000	
At-home 7	29	.002	29	.002	.240
In-class 7	41	.003	41	.012	
At-home 8	29	.001	29	.000	.487
In-class 8	41	.000	41	.000	
At-home 9	29	.004	29	.001	.304
In-class 9	41	.015	41	.003	
At-home 10	29	.000	29	.003	.008
In-class 10	41	.000	41	.004	

Further analysis was conducted to identify factors contributing to differences in student performance between the in-class and at-home quiz groups. The quiz design was identical across both groups, consisting of the same items created through the WordWall platform. Likewise, the

teaching method was consistent, employing a student-centered approach in which sessions began with student presentations, followed by class discussions, question-and-answer segments, and lecturer-guided reinforcement. This active learning model has been shown to be effective across various instructional modes, including blended and face-to-face learning environments (Galvis & Carvajal, 2022).

Given that all instructional elements were held constant, the variation in post-test outcomes is likely influenced by student motivation and engagement at the time of quiz completion. In-class assessments promote shared focus and immediate cognitive engagement, potentially fostering more uniform understanding. By contrast, at-home quizzes may expose students to distractions or differing levels of intrinsic motivation. While some students may take advantage of the flexible conditions to achieve higher scores, others may demonstrate reduced effort, leading to greater score variability. This aligns with prior findings that reduced structure and interaction in individual learning environments can negatively impact consistency in performance (Segbenya et al., 2022).

These results align with prior research emphasizing the role of interaction and structure in supporting student motivation and performance. Although previous studies such as (Assi & Rashtchi, 2022) focused on the shift between online and face-to-face learning, their findings highlight the importance of peer and instructor interaction in reducing anxiety and enhancing engagement. In this study, such interaction was equally present during instructional sessions; however, it was absent during the at-home quiz sessions, which may have contributed to less consistent performance.

Segbenya et al. (2022) suggest that blending structured, interactive environments with flexible digital tools may help optimize learning outcomes. Moreover, Scheel et al., (2022) report that students with lower self-regulation tend to struggle more in unstructured digital learning environments. Given the complexity of astronomy topics and the independent nature of delayed assessments, it is plausible that students with weaker self-regulation may have underperformed in the at-home quiz group. Thus, timing and context of assessment delivery should be carefully considered to support all learners effectively.

Interestingly, students with strong independent learning skills do not always prefer digital learning environments. (Scheel et al., 2022) found that such students often value direct interaction with instructors and peers, which they perceive as essential for meaningful engagement and understanding. Social relationships and interpersonal connections, typically more accessible during structured in-person settings, contribute to learners' motivation and sense of academic belonging.

Although both groups in this study experienced the same face-to-face instruction, the at-home quiz group lacked the immediate structure and social atmosphere present during in-class assessments. This absence of collective learning cues may have led some students to feel isolated during the quiz-taking process, potentially impacting their performance. These findings are in line with research by (Harper et al., 2024), which showed that blending independent digital components into traditional learning can, in some cases, lead to lower individual module scores.

Therefore, careful planning is needed when integrating digital tools like WordWall into instructional practice. In particular, determining the optimal timing and context for using such tools can help ensure they enhance, rather than hinder, students' understanding—especially in content-heavy subjects like astronomy.

Previous research has shown that the quality of communication differs significantly between in-person interactions and online chat-based discussions (Bagheri & Zenouzagh, 2021). While this study did not involve online lectures, the findings still highlight the importance of

synchronous, structured environments in fostering meaningful engagement. In both astronomy classes observed, instruction was delivered face-to-face; however, students who completed the post-tests in class likely benefited from the immediate reinforcement of concepts through peer interaction and classroom atmosphere. In contrast, those completing the quizzes at home may have lacked these social and contextual supports, potentially contributing to greater variability in outcomes.

Given that WordWall is intended to support active learning and engagement, and considering the more consistent performance observed in the in-class quiz group, it is recommended that its use as a post-test tool be prioritized within structured classroom environments. This recommendation aligns with the findings of this study, which suggest that timing and context significantly influence the effectiveness of digital assessment tools in astronomy education.

Although this study involved students from two classes with consistent instruction, the relatively small sample size, particularly in the at-home group, limits the generalizability of findings. Future research involving larger and more diverse populations is recommended. This study focused on quantitative score analysis, and did not explore students' motivations or experiences. Learners in digital spaces tend to experience anxiety or lower self-efficacy because there are no peers to compare themselves to (Tong & Shakibaei, 2025). This can be true for students taking online astronomy quizzes. A mixed-method approach may provide deeper insight into why certain students perform better in either in-class or at-home settings.

During at-home quizzes, students completed the assessments independently without direct supervision. While academic integrity was expected, the potential for collaboration or accessing additional resources could not be fully controlled. Students' readiness to receive learning materials in e-learning also depends on a good internet connection (Nedi Lawu et al., 2023). This limitation may influence score variability.

Another potential factor affecting the at-home group's performance is time flexibility and technical conditions, such as internet reliability. It is true that unreliable internet connections are problematic during online learning and in-person contact between peers (Váradi et al., 2024). Students with better connectivity may have experienced smoother test-taking, while others may have faced disruptions.

4. CONCLUSION

This study revealed significant differences in student performance based on the timing of WordWall post-test administration in two face-to-face astronomy classes. Students who completed the quizzes at home tended to achieve higher average scores, yet their results were marked by greater variability. In contrast, students who completed the quizzes immediately in class demonstrated more consistent and homogeneous outcomes.
Suggestions for future researchers include adding qualitative data to explore students' experiences and motivations, involving larger samples and across institutions for generalization, and testing blended assessment models to optimize the advantages of both.

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