

Impact of E-learning adoption on students' performance: A case study of portfolio management course at ENCG-Casablanca

Impact de l'adoption du E-learning sur les performances des étudiants : Cas du cours de gestion de portefeuille à l'ENCG-Casablanca

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Abstract:

After the advances of information technologies (IT), education has taken great advantage of them, relying on IT to provide the technological infrastructure that enables new forms of access, interaction, and learning ; now widely known as E-learning. The adoption of E-learning has become a vital shift in higher education, transforming traditional learning models and reshaping student engagement. This study aims to examine the impact of E-learning adoption on student performance in a portfolio management course at Hassan II University of Casablanca, spanning three academic years (2022–2024). Using a dataset of 832 students' grades collected before and after the adoption of Miratrrading E-learning platform, we apply a comparative mixed-methods approach. Employing descriptive statistics, ANOVA, t-tests, and effect size calculations to assess variations in academic performance. Findings reveal a significant improvement in overall grades post-adoption, highlighting the positive influence of digital learning. However, increased variability in exam scores suggests disparities in student adaptation, underscoring the need for structured support mechanisms to ensure equitable learning outcomes.

Keywords: E-learning, student performance, blended learning, higher education, Morocco, instructional technology.

Classification JEL : I21; A22; I23; O33.

Paper type: Empirical Research

Résumé:

Après les avancées des technologies d'information, l'enseignement en a largement tiré profit, en s'appuyant sur ces technologies pour fournir l'infrastructure numérique permettant de nouvelles formes d'accès, d'interaction et d'apprentissage, désormais connues sous le nom d'E-learning. L'adoption de l'E-learning représente un tournant essentiel dans l'enseignement supérieur, transformant les modèles pédagogiques traditionnels et redéfinissant l'engagement des étudiants. Cette étude vise à analyser l'impact de l'intégration de l'E-learning sur la performance des étudiants dans un cours de gestion de portefeuille à l'Université Hassan II de Casablanca, sur une période de trois années académiques (2022–2024). À partir d'une base de données comprenant les notes de 832 étudiants, collectées avant et après l'adoption de la plateforme d'E-learning Miratrrading, nous appliquons une approche mixte comparative. Des statistiques descriptives, des tests ANOVA, des tests t ainsi que des calculs de taille d'effet ont été utilisés pour évaluer les variations de performance académique. Les résultats révèlent une amélioration significative des notes globales après l'adoption du numérique, soulignant l'effet positif de l'apprentissage en ligne. Toutefois, une variabilité accrue des résultats aux examens indique des disparités dans l'adaptation des étudiants, mettant en évidence la nécessité de dispositifs d'accompagnement structurés pour garantir l'égalité des chances en matière d'apprentissage.

Mots clés : E-learning, performance académique, apprentissage hybride, enseignement supérieur, Maroc, technologie éducative.

JEL Classification : I21 ; A22 ; I23 ; O33.

Type du papier : Recherche empirique

1. Introduction

Information and Communication Technologies (ICTs) have transformed many facets of modern life, and education is no different. The integration of E-learning platforms into traditional educational settings is a rapidly evolving trend. E-learning – as the application of ICT in education – has become an integral component of educational systems worldwide, offering interactive, flexible and accessible learning opportunities beyond traditional classroom settings (Ouajdouni, 2024). The COVID-19 crisis forced educational institutions to urgently adopt this alternative to face-to-face learning. Since then, the E-learning option has been gradually incorporated in the Moroccan educational system; following the initiatives led by the Ministry of Education in Morocco. Many Moroccan universities – University of Casablanca alike – have made significant advances in adopting E-learning platforms, promoting a mixed learning approach that combines digital and traditional face-to-face instruction (Ghazali & Benbrahim, 2024).

The growing pace of E-learning adoption stems from the increasing demand for flexible, accessible, and technology-driven education. E-learning offers numerous advantages, such as personalized learning experiences, self-paced study, and a wider range of educational resources beyond geographical limitations. It enables students to engage with interactive content, develop digital skills, and access diverse learning materials that traditional classrooms may lack (Reyaz Ahmad Bhat, 2023). However, despite these benefits, challenges persist, including disparities in digital infrastructure, the lack of direct social interaction, and potential distractions in online learning environments. Thus, some students may struggle with self-discipline and motivation in the absence of structured in-person guidance (Akhter et al., 2021).

The integration of E-learning platforms in education has been widely studied, with numerous research findings indicating a positive correlation between digital learning tools and student performance. Studies suggest that the structured use of Learning Management Systems (LMS) and other E-learning solutions contributes to improved academic outcomes.

For instance, Ahmed and Mesonovich (2019) examined the impact of an LMS on student performance in a pre-calculus course, concluding that students who engaged with structured online assignments within a blended learning environment demonstrated higher academic achievement. Similarly, Demaidi et al. (2019) observed that students enrolled in a blended learning model achieved significantly better academic results compared to those in traditional learning settings. They attributed these improvements to the immediate feedback provided by online platforms, which enabled students to assess their progress. Another study performed in India featuring undergraduate students reported that the implementation of blended learning contributed to a 10% reduction in failures and a 17% increase in overall grades (Tulasi. B & Suchithra. R, 2020). Beyond individual courses, broader research on E-learning adoption supports these findings. Nicholas-Omoregbe et al. (2017) explored the relationship between E-learning management systems (eLMS) and student performance, highlighting key factors such as attitude, perceived usefulness, and performance expectancy as determinants of successful adoption (Nicholas-Omoregbe et al., 2017). Their study suggests that students who perceive E-learning as beneficial and easy to use are more likely to engage with digital tools, leading to improved academic outcomes. Additionally, Bhat (2023) emphasized that technology integration enhances student motivation and engagement. His research indicates that E-learning fosters personalized learning experiences that cater to diverse learning styles, ultimately contributing to higher student performance. These studies collectively highlight the potential benefits of E-learning in improving academic outcomes. While underscoring the role of well-organized digital resources in reinforcing learning and improving grades.

These findings align with the Community of Inquiry framework, which argues that in order to maintain a deep and meaningful learning experience, three key components are required – social

presence, teaching presence and cognitive presence (Garrison et al., 2009). Blended learning initiatives are expected to strengthen and improve the interplay of these dimensions enhancing therefore the learning experience.

However, while previous studies highlight the benefits of E-learning in enhancing student performance, some research suggests that its effectiveness is not guaranteed. Paul and Jefferson (2019) conducted an eight-year comparative analysis of student performance in online versus face-to-face environmental science courses. Their findings revealed no significant difference in overall student performance, indicating that merely shifting traditional teaching methods to an online format does not automatically lead to better outcomes. These findings suggest that the positive effects of E-learning may fade over time eventually becoming insignificant, which stresses the importance of sustainable instructional design rather than short-term technological fixes.

Beyond pedagogical considerations, technical challenges remain a significant barrier to successful E-learning integration. Lukianenko and Vadaska (2020) examined students' experiences in an online English course and found that issues such as internet connectivity problems and the absence of face-to-face interaction hindered learning. Their study highlights the importance of reliable digital infrastructure and effective communication strategies in ensuring a seamless E-learning experience. Similarly, Ismail et al. (2018) identified both technical and pedagogical limitations in blended learning environments. Their research pointed to challenges related to technology accessibility, interaction processes, and student characteristics, such as motivation, ability, and attitude. These findings emphasize that the success of E-learning is contingent not only on the availability of digital tools but also on the pedagogical strategies used to foster meaningful engagement and knowledge retention.

Given these factors, it remains imperative to assess the actual impact of E-learning on student performance. Understanding this relationship is crucial for educators to develop effective strategies that leverage digital tools to enhance learning outcomes. This study evaluates the impact of E-learning adoption on student performance at Hassan II University of Casablanca (UH2C), focusing on the Portfolio Management course taught at the National School of Business and Management (ENCG). This course is a fourth-year finance module for Business Administration majors. In 2024, students were introduced to a blended learning approach, where they had access to an online course via the "Mirattrading" platform. This platform provided structured learning capsules summarizing key concepts in a concise and articulated manner while preserving the course content. To assess the effect of this introduction, we will first compare the grades of students before and after the integration of this platform. In addition to the quantitative analysis of grades, qualitative insights are drawn from student feedback regarding the platform.

2. Methodology

2.1. Research Design

According to studies (Rakic et al., 2020; Ahmed & Mesonovich, 2019; Demaidi et al., 2019), adoption of E-learning has a positive and significant impact on the students' grades and overall performance. However, other studies suggest that there is no significant disparity in the students' grades after implementing E-learning (El Said, 2021; Paul & Jefferson, 2019). If anything, these conflicted findings underscore the importance of the contextual factor when assessing this matter in different educational settings.

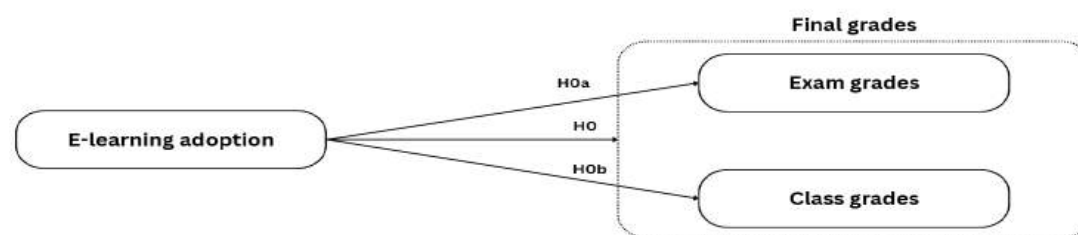
Based on our research objective, we formulate the following null hypothesis (H_0):

H0: There is no significant difference in the students' grades after adopting an E-learning platform.

This hypothesis will be tested through comparative analysis of student performance data across the three academic years (2022–2024) to determine whether the introduction of E-learning in 2024 has led to measurable improvements in student grades (Exam, class and final) in the Portfolio Management course, compared to previous years with traditional learning methods. The E-learning component was introduced two weeks prior to the exam. Given this short timeframe, we hypothesize that the class grade (which reflects participation, attendance, and project work) remains largely unaffected, while the exam grade is expected to display potential differences due to the new adoption. Therefore, our alternative hypothesis will be articulated as follows:

- H1: E-learning adoption has a positive and significant impact on final grades.
- H1a: E-learning adoption has significant but mild impact on class grades.
- H1b: E-learning adoption has a positive and significant impact on exam grades.

Figure 1: Conceptual model



Source: Elaborated by the authors

2.2. Data

The study relies on secondary data obtained from the UH2C academic database (2022–2024), covering a three-year period of observation. The sample consists of 832 students enrolled in the Portfolio Management course over this period.

Student performance is measured using the final course grade, which is calculated as follows:

- Class grade: based on participation, attendance, and project scores.
- Exam grade: represents individual performance in the final assessment.
- Final grade: weighted sum of Class (40%) and Exam (60%) scores.

Given that E-learning was introduced only before the exam, we assume that any observed performance disparities will be primarily reflected in exam scores, rather than in class grades.

2.3. Analysis Methods

The analysis follows a comparative mixed-methods research design to evaluate student performance before and after the adoption of E-learning. The analysis integrates both quantitative and qualitative approaches to provide a comprehensive understanding of the impact of E-learning on student outcomes.

Quantitative analysis

First, we compare student performance across the three years using descriptive statistics such as the mean, median, quantiles and standard deviation, supplemented by visualizations to illustrate trends across the three academic years.

Furthermore, to determine the statistical significance of observed differences, an independent sample t-test is used to compare student performance before and after the introduction of E-learning, while Levene's test is applied to check for homogeneity of variances, identifying potential disparities in variance due to E-learning adoption. Additionally, Cohen's d is calculated to measure the effect – if any – size of E-learning adoption on student performance.

Followed by an analysis of Variance (ANOVA) determines whether there are significant differences across all three years, and a Tukey's HSD test is performed to conduct post hoc pairwise comparisons, identifying specific years where significant differences exist.

We specify the following econometric model of our research:

$$Y_t = \alpha + \beta * X_t + \epsilon_t$$

Where:

- Y: the performance of student *i* in year *t*.
- X: the adoption of E-learning, 0 before and 1 after the adoption.
- β : Coefficient of impact of E-learning adoption.
- ϵ : error term.

Qualitative analysis

To complement the quantitative findings, a qualitative content analysis is conducted using student feedback on the E-learning experience. Student testimonials from course evaluations are examined to identify key themes related to engagement, comprehension, and perceived effectiveness of E-learning. These qualitative insights provide context to the statistical results, offering a deeper understanding of how students perceived and adapted to the new learning method.

2.4. Assumptions and considerations

To ensure validity, the study operates under several key assumptions, presented as follows:

- Consistency in course content and evaluation, this assumption is supported by the fact that the same lecturer has taught the module throughout the study period, ensuring that teaching materials, learning activities, and exam difficulty remain constant.
- Assessment criteria and grading scales have remained unchanged, ensuring that differences in student scores reflect actual performance shifts rather than variations in grading standards.

3. Analysis and results

3.1.Descriptive Summary

Students' overall performance is determined by their final grades, measured out of 20. As discussed earlier, the final grade consists of both the Exam and Class grades. The descriptive statistics of these grades over the three years are summarized in Table 2 and Table 1 and illustrated in Figure 2 and Figure 3.

Regarding **Class performance**, the mean class grade increased from 12.86 in 2022 and 12.93 in 2023 to 14.10 in 2024, while the median rose from 13.50 to 14.50. The standard deviation decreased from 2.34 in 2022 to 1.26 in 2023, then increased slightly to 1.43 in 2024, suggesting reduced fluctuations in student performance over time. Another notable observation concerns kurtosis, which was 15.66 in 2022 and 4.12 in 2023, but rose sharply to 31.20 in 2024, suggesting a higher concentration of extremely high and low grades in the most recent year.

In terms of **Exam performance**, the mean exam grade dropped from 8.40 in 2022 to 6.86 in 2023 but then significantly improved to 10.29 in 2024. The median exam score followed a similar trajectory, rising from 6.75 in 2023 to 10.50 in 2024. This shift indicates that in 2024, more than 50% of students passed the exam, which was not the case in previous years. Notably, in 2022, a score of 10.50 corresponded to the third quartile (Q3), meaning merely 25% of students were able to achieve that mark, whereas in 2023, even more than 75% of students scored below 10, as the Q3 was 8.5. The standard deviation increased in 2024 (3.25), indicating greater variability in student exam performance.

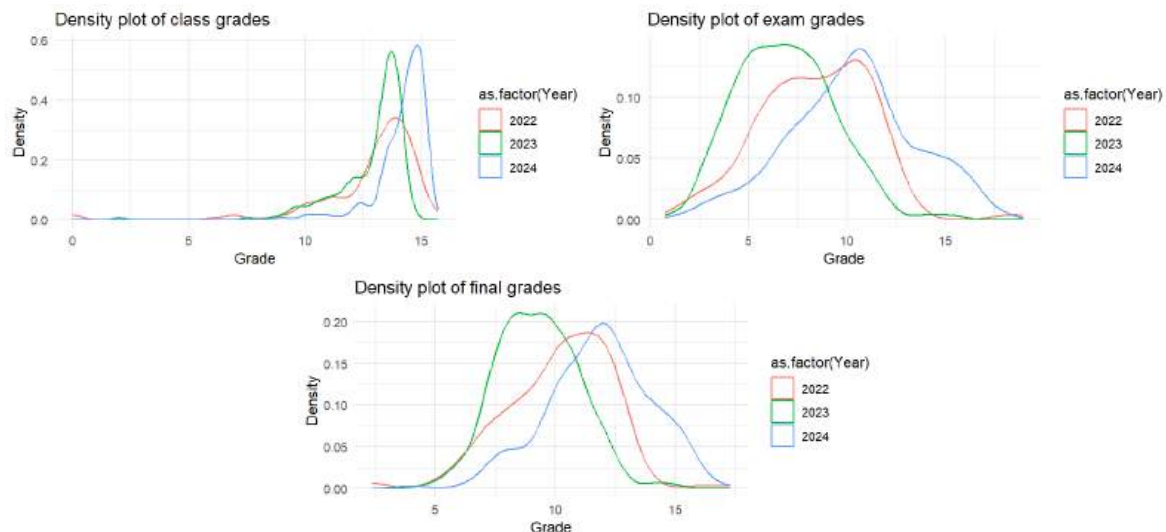
For **Final grade performance**, the mean final grade rose from 10.18 in 2022 and 9.29 in 2023 to 11.83 in 2024, with the median final grade improving from 9.25 in 2023 to 11.95 in 2024. The standard deviation remained relatively stable across the years, suggesting consistency in overall student performance distribution.

Table 1: Descriptive summary of the grades

	Class	Exam	Final
N	832	832	832
Mean	13.19	8.02	10.09
Std Deviation	1.69	3.09	2.18
Median	13.50	7.75	10.02
Q1	12.75	5.75	8.45
Q3	14.00	10.25	11.56
Min	0.00	0.75	2.40
Max	15.70	19.00	17.30
Skewness	-2.88	0.40	0.16
Kurtosis	15.44	0.05	0.11

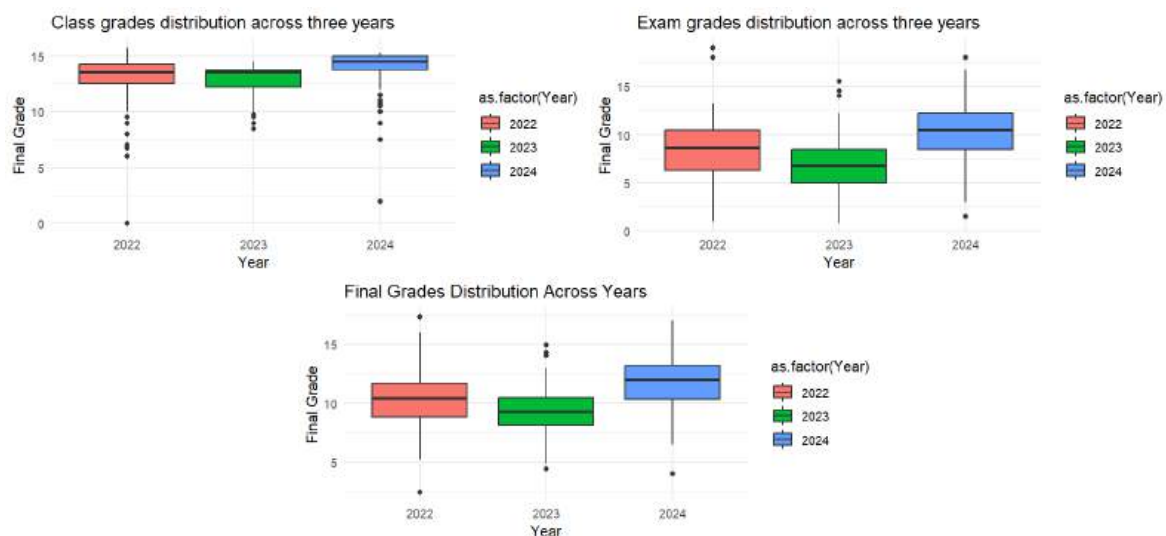
Source: Elaborated by the authors, using R.

Figure 2 : Density plot per grade



Source : Elaborated by the authors, using R.

Figure 3: Box plot per grade



Source : Elaborated by the authors, using R.

Table 2: Descriptive summary of the grades per year

	Year	2022	2023	2024
Class	Mean	12.86	12.93	14.10
	Median	13.50	13.50	14.50
	Std Deviation	2.34	1.26	1.43
	Q1	12.50	12.25	13.75
	Q3	14.25	13.75	15.00
	Max	15.70	14.50	15.25
	Min	0.00	8.50	2.00
	Skewness	-3.04	-1.36	-4.37
	Kurtosis	15.66	4.12	31.20
Exam	Mean	8.40	6.86	10.29
	Median	8.63	6.75	10.50
	Std Deviation	2.86	2.48	3.25
	Q1	6.25	5.00	8.50
	Q3	10.50	8.50	12.25
	Max	19.00	15.50	18.00
	Min	1.00	0.75	1.50
	Skewness	0.04	0.36	-0.09
	Kurtosis	3.57	3.07	2.78
Final	Mean	10.18	9.29	11.83
	Median	10.38	9.25	11.95
	Std Deviation	2.18	1.70	2.15
	Q1	8.80	8.10	10.35
	Q3	11.70	10.45	13.20
	Max	17.30	14.90	17.00
	Min	2.40	4.40	4.00
	Skewness	-0.51	0.20	-0.35
	Kurtosis	4.02	3.08	3.25

Source : Elaborated by the authors, using R.

3.2.Statistical tests analysis

The correlations between our variables, presented in **Erreur ! Référence non valide pour un signet.**, show a very strong relationship between the final grade and the exam grade (0.96), which is predictable since the final grade is composed of 60% exam grade. Similarly, the moderate correlation between the final grade and the class grade (0.60) can be explained by the 40% contribution of the class grade to the final grade. It is also worth noting that the class grade and the exam grade show only a weak correlation (0.34), which can be explained by the fact that they assess different aspects of the students' performance.

To assess whether the differences in grades across the three years were statistically significant, we first conducted an ANOVA test (Table 4), followed by Tukey's HSD test (Table 5) to determine which years exhibited the most significant differences. Additionally, we performed a t-test comparing the years with 100% face-to-face (F2F) learning to 2024, which incorporated mixed learning, to evaluate differences in mean grades. We also conducted a Levene's test to assess variability in grades and used Cohen's d statistic to measure the effect size of E-learning on student performance (Table 6).

The ANOVA results confirm a significant difference in grades ($F_{\text{class}} = 40.29$, $F_{\text{exam}} = 106.12$, $F_{\text{final}} = 116.48$, $p < 0.01$). Further, Tukey's HSD test confirms that the difference between 2024 and previous years is statistically significant across all grades ($p < 0.01$). The t-

test and Levenes's results reinforced the results with highly significant difference ($p < 0.01$), except for the Levene's test of Final grade that was not significant ($p = 0.16$) suggesting that the variability remained the same before and after E-learning adoption. Cohen's d statistic suggests a notable impact of the E-learning on grades, with a medium effect size (0.74) on class grades, and a large effect size on both Exam (1.04) and Final (1.15) grades.

According to the Tukey's HSD test, the differences were more pronounced in exam grades than in class grades, with a difference of 1.89 vs. 1.24 (2022–2024) and 3.43 vs. 1.17 (2023–2024) between exam and class grades, respectively. Similarly, Cohen's d suggests that exam grades were the most affected by the shift to E-learning, highlighting the substantial impact of this educational style transition.

Table 3 : Correlation table

	Class	Final	Exam
Class	1.00	0.60	0.34
Final	0.60	1.00	0.96
Exam	0.34	0.96	1.00

Source : Elaborated by the authors, using R.

Table 4: ANOVA test's results

Variable	F-Statistic	p-value
Class	40.29	0.00%
Exam	106.12	0.00%
Final	116.48	0.00%

Source : Elaborated by the authors, using R.

Table 5: Tukey's HSD test results

Year	Class		Exam		Final	
	Difference	p-value	Difference	p-value	Difference	p-value
2023-2022	0.07	86.39%	-1.54	0.00%	-0.90	0.00%
2024-2022	1.24	0.00%	1.89	0.00%	1.64	0.00%
2024-2023	1.17	0.00%	3.43	0.00%	2.54	0.00%

Source : Elaborated by the authors, using R.

Table 6: Results of T-test, Levene's test & Cohen's d

Grade	T-test		Levene's test		Cohen's d	
	Statistic	p-value	Statistic	p-value	Statistic	Effect
Class	-9.72	0.00%	5.93	1.51%	0.74	Medium
Exam	-11.50	0.00%	6.67	0.99%	1.04	Large
Final	-13.14	0.00%	1.93	16.53%	1.15	Large

Source : Elaborated by the authors, using R.

4. Discussion

The descriptive analysis indicates a clear upward trend in student performance following the adoption of E-learning in 2024. This improvement is evident across class, exam, and final grades. While class performance showed moderate progress, exam and final grades experienced a more substantial increase, suggesting a stronger impact of E-learning on these assessments. The statistical tests further support this trend, strongly suggesting that the introduction of E-learning via the "Miratrading" platform had a significant positive effect on student performance, particularly in exam and final grades. The notable improvements in exam scores

highlight the platform's effectiveness in enhancing knowledge retention and exam readiness. This is reflected in student feedback, such as:

- ***“Having all the explanations in video format on a single platform greatly facilitated my revision and understanding of key concepts.”***
- ***“The course is very insightful and well-structured. It provided clear and thorough explanations, progressing seamlessly from basic concepts to more advanced ones.”***
- ***“It closely aligns with what we studied in class and serves as a helpful summary of the key concepts.”***
- ***“The concepts were explained clearly and supported with practical examples that made them easy to understand. The hands-on exercises were a great way to apply what I learned, and the course structure flowed perfectly.”***

This qualitative insight complements the statistical findings, reinforcing the positive impact of the Miratrading platform.

However, the increased standard deviation in exam scores indicates that while many students benefited from E-learning, some struggled to adapt, leading to greater performance variability. This aligns with findings in prior research, which suggest that E-learning environments tend to favor self-motivated students while potentially disadvantaging those who require more structured guidance (Mursid et al., 2021)

One of the most notable observations is the steady improvement in class grades over time, confirming our previous assumption that since the E-learning platform was introduced in the later couple weeks of the semester, its impact on class grades would be minimal.

In contrast, exam performance exhibited the most substantial shifts, as reflected in the large fluctuations in mean, median, and variability. The fact that in 2024, more than half of students passed the exam, compared to previous years where the passing rate was much lower, highlights the positive effect of incorporating new learning methods. However, the increased standard deviation in 2024 in exam scores suggests that not all students adapted equally well, highlighting the need for more structured support mechanisms to assist those struggling with the transition.

Final grades followed a similar trend, showing a significant increase in 2024, reflecting overall academic improvement. Unlike exam scores, however, the variability in final grades remained stable, as evidenced by the non-significant Levene's test. This suggests that despite changes in teaching style, the distribution of final grades remained consistent, likely due to the combined influence of both class and exam performance balancing out the fluctuations in individual assessment components.

Based on these findings, we reject the null hypothesis (H_0), confirming a statistically significant improvement in student performance following the introduction of E-learning. This aligns with the findings of prior literature (Rakic et al., 2020; Ahmed & Mesonovich, 2019; Demaidi et al., 2019), which highlight the potential of digital learning in enhancing academic outcomes. Furthermore, student feedback underscore the crucial role of accessibility, flexibility, and adaptability in fostering effective learning, as supported by Reyaz Ahmad Bhat (2023), such as:

- ***“A captivating and practical training, characterized by structured content and precise examples that make learning accessible”*** - Accessibility
- ***“The flexibility and structure allowed me to learn at my own pace, and I feel much more confident in the subject now.”*** - Flexibility
- ***“The platform itself was also impressive—user-friendly, interactive, and well-equipped with resources that complemented the learning experience.”*** - Conviviality
- ***“This platform offers excellent learning, well-organized courses, available at any time.”*** – Availability

5. Limitations

While these findings offer valuable insights, certain limitations must be acknowledged:

- **Unequal Sample Sizes** – Variations in student numbers across years may introduce slight inconsistencies. Notably, the 2023 cohort was double the size of the 2022 and 2024 cohorts, potentially affecting comparability.
- **Student Variability** – Each year, different students enrolled, meaning that individual differences in motivation, prior knowledge, and learning styles could influence the results independently of the learning method used.
- **Short Exposure to E-learning** – The online component was introduced only two weeks before the exam, limiting its potential long-term impact.

6. Conclusion

The field of information and communication applications has undergone a dramatic transformation in recent years to meet the growing demand for real-time, high-value digital services. Universities, like other institutions, must embrace technological advancements by committing to digitization to remain effective and competitive in the evolving educational landscape (Ouajdouni, 2024).

This study aimed to assess the viability and efficiency of this shift, particularly in the context of E-learning adoption. The findings highlight a significant impact of E-learning on student performance, particularly in exam and final grades, following the adoption of the Miratrading platform. A clear upward trend in student achievement reinforces the idea that digital learning environments can enhance academic outcomes when properly implemented. However, the increased variability in exam scores suggests that while many students benefited from the shift, others faced challenges in adapting, emphasizing the need for structured guidance and support mechanisms. To maximize the effectiveness of E-learning, instructors must actively engage students, fostering autonomy and sustained motivation to bridge potential disparities in student performance (Outoukarte et al., 2023).

Overall, this study underscores the potential of blended learning approaches in Moroccan higher education and highlights the necessity of continuous improvement in E-learning strategies to ensure equitable access and sustained academic success. Looking ahead, the integration of adaptive learning tools powered by artificial intelligence (AI) and machine learning (ML) presents promising opportunities to personalize education, cater to diverse student needs and optimize learning experiences (Gligorea et al., 2023)

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