

**The Role of MOOC-Based Supplementary Learning in Enhancing Student Academic Performance:
Evidence from Non-Business Students in an Entrepreneurship Course**

Mutiiah Mohamad¹, *Farah Lina Azizan¹, Syazwani Ya¹, Wan Nurulasiah Wan Mustapa², Emeela Wae-esor³

¹Faculty of Business and Management, UiTM Cawangan Perlis, Malaysia

²Faculty of Business & Communication, Universiti Malaysia Perlis, Malaysia

³Faculty of International Studies, Prince of Songkla University, Thailand

Email: mutiiah@uitm.edu.my, *farahlina@uitm.edu.my, syazwani446@uitm.edu.my,
wannurulasiah@unimap.edu.my, emeela.w@phuket.psu.ac.th

Corresponding Author: Dr Farah Lina Azizan

Abstract: The increasing integration of digital technologies into higher education has created new opportunities for institutions to complement conventional classroom instruction with flexible and student-centered learning resources. This study examines the effectiveness of a curriculum-aligned MOOC-based supplementary learning intervention in supporting students' conceptual understanding and academic performance. The study was conducted among undergraduate non-business students enrolled in an entrepreneurship course at a Malaysian higher education institution. A one-group pre-test and post-test design was used. Aggregated data on students' conceptual understanding, quiz performance and satisfaction were analyzed using descriptive and comparative statistics. The results show that the MOOC-based supplementary learning intervention was found to be associated with improvements in students' conceptual understanding and academic performance. The findings also indicated a high level of satisfaction with the digital learning intervention, particularly in terms of accessibility and the usefulness of multimedia learning resources. The results suggest that curriculum-aligned MOOC-based supplementary learning can provide beneficial support for continuing learning beyond traditional classroom instruction and improve students' engagement with course content. The study contributes to the growing knowledge literature by demonstrating the potential of MOOC-based supplementary learning as a practical digital learning approach in higher education.

Keywords: *Massive Open Online Course, digital learning, academic performance, student achievement, blended learning.*

1. Introduction and Background

The quick development of digital technologies has substantially reformed the higher education setting, influencing the way students gain access, interact with and apply knowledge (de Bruijn-Smolters & Prinsen 2024). Although face-to-face learning remains a core component in university education, the use of digital learning resources has become more integrated, and students are now able to access educational content in a more flexible and personalized way. This transformation has contributed to the growing adoption of blended learning, self-paced learning and other methods of technology-enhanced instruction in higher education institutions (Elmabaredy & Gencel, 2024).

Massive Open Online Courses (MOOCs) are an important form of enhanced technology learning among the various digital learning approaches adopted by higher education. MOOCs offer a structured learning environment that can contain video-based course content, interactive materials, learning activities, formative assessment and additional resources. MOOCs are initially linked with open and large-scale online learning, but their applications are now growing at the institutional and course levels (Dinh & Phuong, 2024).

Within university teaching, MOOCs can serve as supporting materials that complement rather than replace face-to-face instruction. This method allows students to retrieve course materials beyond scheduled classroom sessions and provides opportunities for repeated exposure to concepts that may require additional explanation (Lo Hew, 2021). The flexibility of digital learning may be specifically beneficial in higher education environments where students possess different levels of prior knowledge, learning preferences and academic preparedness.

The effectiveness of digital learning, however, does not only relate to the availability of online content. The design and integration of the learning intervention also play a crucial role. Digital learning materials that are

aligned with the learning outcomes of the course and have pedagogically designed learning activities can have a higher educational value than digital learning materials that are simply presented without pedagogical orientation (Vo et al., 2017).

Recent studies have demonstrated the potential of blended learning to support student engagement and learning outcomes in higher education. A systematic review of blended learning interventions reported moderate to high positive effects on different aspects of student engagement and learning outcomes (Moreira & Lima, 2024). Similarly, previous meta-analytic evidence has demonstrated a positive effect of blended learning on higher education students' academic performance compared with conventional classroom instruction (Bingolbali et al., 2025).

Conversely, the effectiveness of digital learning interventions may depend on how they are designed and integrated into the existing learning environment (Ritz et al., 2023). Digital learning resources are unlikely to produce optimal outcomes merely because they are available online. Instead, the learning materials need to be aligned with course learning outcomes, structured according to students' learning needs and supported by appropriate learning activities and assessment mechanisms (Ali, 2018; Hristov et al., 2023).

This concern is particularly significant in entrepreneurship education. Entrepreneurship courses regularly involve students combining theoretical knowledge with practical application (Jan, 2024; Rodrigues, 2023). Students may be anticipated to understand entrepreneurial concepts, identify business opportunities, develop business ideas, use digital marketing platforms, manage basic finances and operate an online business. Thus, students require both conceptual understanding and the ability to apply knowledge from practical perspectives.

According to Li et al. (2025), the challenge becomes more significant when entrepreneurship courses are taken by students from non-business academic backgrounds. In Malaysian higher education, university-wide entrepreneurship courses are often offered to students from diverse academic disciplines. Students from fields such as applied sciences, computer science, sports science, accounting and other non-management disciplines may have limited prior exposure to entrepreneurship, financial management and digital business concepts.

In such circumstances, differences in students' prior knowledge may create disparities in classroom learning. Ledermuller and Fallmann (2017) indicate that students who have limited prior knowledge may require additional opportunities to review, repeat and apply course content. However, face-to-face classroom sessions are constrained by time and may not provide sufficient opportunities for every student to receive personalized explanations (Chen & Looi, 2007; Contrino et al., 2024; Wanner & Palmer, 2015).

A MOOC-based supplementary learning resource may provide a potential solution to this pedagogical challenge (Azami & Ibrahim, 2019). Through video materials, interactive notes, formative quizzes and self-paced learning activities, students may revisit difficult topics and obtain additional learning support outside the classroom. The incorporation of formative assessment may also enable students to monitor their own learning progress. Therefore, the study aims to examine whether students demonstrated improvement in conceptual understanding and academic performance following the integration of the MOOC. Specifically, the study evaluates changes in students' understanding of entrepreneurship-related concepts, changes in quiz achievement and students' satisfaction with the MOOC.

The study contributes to the literature in three ways. First, it provides empirical evidence from a Malaysian higher education context. Second, it focuses on students who do not necessarily possess prior academic knowledge in business and management. Third, it demonstrates how a curriculum-aligned MOOC can be integrated as a supplementary learning intervention within a conventional university course.

2. Literature Review

MOOC-Based Learning in Higher Education: MOOCs have become an increasingly visible component of digital learning in higher education (Alhazzani, 2020; Azami & Ibrahim, 2019; Williams, 2024). Their primary characteristics include online accessibility, structured learning content, multimedia resources and

opportunities for learner interaction and assessment. The flexibility offered by MOOCs enables students to access learning materials at different times and locations. This feature may be particularly beneficial for students who require additional time to process course content or who prefer to revisit learning materials independently (Berezi, 2025; Zuhairi et al., 2024). In the context of formal higher education, MOOCs can be integrated into existing courses as supplementary learning resources (Azami & Ibrahim, 2019). Such integration may allow students to benefit from the flexibility of online learning while retaining the instructional support provided through face-to-face teaching. The pedagogical value of a MOOC therefore depends on the relationship between technology, content and learning design. A well-designed MOOC may provide students with opportunities for repeated exposure, self-assessment and independent learning (Pilli & Admiraal, 2017; Zhu, 2024).

Blended Learning and Academic Performance: Blended learning combines face-to-face instruction with online learning resources and activities. The approach assumes that the strengths of physical and digital learning environments can complement one another. Face-to-face instruction provides direct interaction, explanation and feedback, while online learning can provide flexibility, accessibility and opportunities for self-paced engagement. A meta-analysis by Vo et al. (2017) found a positive effect of blended learning on academic performance in higher education. Their findings indicated that students in blended learning environments generally achieved better academic outcomes than students in traditional classroom settings. More recent evidence has further highlighted the relationship between blended learning, student engagement and learning outcomes. A systematic review by de Bruijn-Smolters and Prinsen (2024) found that blended learning interventions generally demonstrated moderate to high positive impacts on student engagement and learning outcomes. These findings suggest that digital learning may contribute to academic performance when students are meaningfully engaged with the learning environment.

Self-Directed and Self-Regulated Learning in Digital Environments: Digital learning environments provide students with greater control over their learning activities. Students can often determine when to access content, how long to spend on a topic and whether to repeat learning activities. These characteristics are closely associated with self-directed and self-regulated learning. Self-regulated learning involves students actively monitoring and managing their learning processes. In digital environments, this may involve setting learning goals, monitoring understanding, revisiting difficult materials and evaluating performance through formative assessments. Recent research has investigated the integration of self-regulated learning into digital learning platforms. Elmabaredy and Gencel (2024), for example, examined a digital platform designed to integrate self-regulated learning features and reported positive implications for student achievement and performance. Similarly, Dinh and Phuong (2024) examined the relationship between student characteristics, self-regulated learning strategies, satisfaction and academic performance in MOOCs. Their findings reinforce the importance of students' learning strategies in shaping the effectiveness of online learning experiences. Accordingly, the present study conceptualizes MOOC-based supplementary learning as a digital learning intervention that may support self-directed learning through flexible access, repeated engagement and formative assessment.

Digital Learning and Conceptual Understanding: Conceptual understanding represents an important learning outcome in higher education. Students are expected not only to recall information but also to understand relationships between concepts and apply knowledge in appropriate contexts (Elmabaredy & Gencel, 2024; Siregar, 2024). Digital learning resources may support conceptual understanding by presenting information through multiple formats. Video, visual materials, interactive content and formative quizzes may provide students with different ways to engage with complex information. Repeated access to learning materials may also support the consolidation of knowledge (Din & Phuong, 2024). Students who experience difficulty during classroom instruction can revisit the relevant content at a later time. Therefore, the use of MOOC-based supplementary learning may be particularly valuable when students have diverse levels of prior knowledge.

Digital Learning and Academic Performance: Academic performance is commonly used to evaluate the effectiveness of teaching and learning interventions (Panadero et al., 2023). It may be assessed through examinations, quizzes, assignments, course grades or other forms of academic assessment. The relationship between digital learning and academic performance may be explained through several mechanisms (Chen, 2025). First, online learning increases access to learning materials. Second, repeated engagement may support

knowledge retention. Third, formative quizzes may allow students to identify learning gaps. Fourth, flexible access may enable students to allocate additional time to difficult topics. The present study focuses on quiz achievement as one indicator of academic performance. Although quiz scores do not represent students' overall academic achievement, they provide a measurable indicator of learning performance within the course context.

Entrepreneurship Education and Digital Learning: Entrepreneurship education increasingly incorporates digital technologies. Modern entrepreneurship requires students to understand not only traditional business concepts but also digital platforms, online marketing, content creation, e-commerce and digital financial management (Primario et al., 2022). The integration of digital learning into entrepreneurship education may therefore provide students with opportunities to connect theoretical knowledge with practical business activities (Zeng et al., 2024). In the present study, students were required to apply their learning through an online business project. The project involved business idea development, digital content creation, social media management, sales management and preparation of business performance information. This practical component makes the course particularly appropriate for MOOC-based supplementary learning because students can refer to the digital learning materials while implementing practical business activities.

Self-Regulated Learning Theory: Self-Regulated Learning (SRL) Theory provides an appropriate theoretical foundation for explaining how MOOC-based supplementary learning may support students' learning processes and academic outcomes. Self-regulated learning refers to the active process through which learners plan, monitor, regulate, and evaluate their own learning. Rather than being passive recipients of information, self-regulated learners exercise greater control over their learning goals, strategies, behaviors, and learning progress (Zimmerman, 2002). SRL encompasses cognitive, metacognitive, behavioral, motivational, and affective dimensions of learning and has been widely applied to explain how learners manage their learning processes across different educational environments (Panadero et al., 2023).

Zimmerman's model conceptualizes self-regulated learning as a cyclical process involving three interrelated phases: forethought, performance, and self-reflection (Zimmerman, 2002; Panadero, 2017). The forethought phase involves processes that occur before learning, including task analysis, goal setting, strategic planning, and self-motivation. The performance phase occurs during learning and involves self-control and self-observation as learners implement learning strategies and monitor their progress. The self-reflection phase occurs following learning activities and involves evaluating one's performance and responding to the learning outcomes. The outcomes of self-reflection may subsequently influence students' planning and learning strategies in subsequent learning activities.

The characteristics of MOOC-based supplementary learning are particularly compatible with these self-regulatory processes. Digital learning environments provide learners with greater flexibility in determining when, where, and how they engage with learning materials. Such flexibility enables students to manage their learning pace, revisit difficult content, allocate additional time to areas in which they experience difficulty, and monitor their progress through formative learning activities. Previous research has highlighted the importance of self-regulated learning in digital learning environments and demonstrated that incorporating SRL-supportive features into digital platforms can contribute positively to students' achievement and performance (Elmabaredy & Gencel, 2024). Similarly, Dinh and Phuong (2024) emphasized the role of self-regulated learning strategies in shaping students' satisfaction and academic performance within MOOC environments.

In the context of the present study, the curriculum-aligned MOOC incorporated video lectures, interactive notes, infographics, formative quizzes, reinforcement activities, supplementary reading materials, and self-directed learning resources. These features provided opportunities for students to engage in learning behaviors consistent with the three phases of SRL. Flexible and self-paced access to learning materials may support the forethought phase by allowing students to organize and plan their learning activities. During the performance phase, students can revisit videos and learning materials, engage with formative activities, and monitor their understanding through quizzes. Formative assessment and repeated learning opportunities may subsequently support self-reflection by enabling students to evaluate their progress, identify gaps in their understanding, and adjust their subsequent learning strategies.

Accordingly, SRL Theory provides an explanatory mechanism linking the design of the MOOC-based

supplementary learning intervention with the learning outcomes examined in this study. The theoretical premise is that the educational value of the MOOC does not arise merely from providing additional online materials. Instead, its value may lie in providing an environment that enables students to exercise greater control over their learning, monitor their understanding, revisit learning materials, and evaluate their progress. These self-regulatory opportunities may subsequently contribute to stronger conceptual understanding and academic performance.

However, the present study does not directly measure students' level of self-regulated learning. Therefore, SRL Theory is employed as a theoretical lens to explain how the affordances of the MOOC may support learning rather than as an empirically tested mediating mechanism. The findings should consequently be interpreted as being consistent with SRL principles rather than as direct evidence that the intervention improved students' self-regulated learning capabilities.

3. Research Methodology

The unit of analysis is individual who are involved of 92 undergraduate students at a Malaysian higher education institution. The participants attended a blended learning environment that combined face-to-face instruction with a MOOC-based supplementary learning intervention. Data were collected from three sources: (1) pre- and post-intervention assessments of students' conceptual understanding, (2) quiz performance before and after the intervention, and (3) a student satisfaction survey.

This study employed a one-group pre-test–post-test design to evaluate changes in students' learning outcomes following the implementation of a curriculum-aligned MOOC-based supplementary learning intervention. The participants comprised 92 undergraduate non-business students enrolled in an entrepreneurship course at a Malaysian higher education institution. Purposive sampling was employed to select participants who met the specific criteria relevant to the study. The participants comprised undergraduate students from non-business academic backgrounds who were enrolled in the entrepreneurship course and participated in the MOOC-based supplementary learning intervention. This sampling technique was considered appropriate because the study aimed to evaluate the learning outcomes of a specific group of students who had direct exposure to the intervention, rather than to generalize the findings to the broader university student population. Data were collected at two measurement points, before and after the MOOC intervention, to examine changes in students' perceived conceptual understanding and quiz performance. Following the intervention, students' satisfaction and perceived benefits of the MOOC were also assessed.

The research procedure was conducted in several stages. First, eligible non-business undergraduate students enrolled in the entrepreneurship course were identified and briefed on the purpose and procedures of the study. Prior to the implementation of the MOOC-based supplementary learning intervention, a pre-intervention assessment was administered to establish students' baseline perceived conceptual understanding and quiz performance. Subsequently, students were provided access to the curriculum-aligned MOOC, which complemented the existing face-to-face classroom instruction. The MOOC incorporated video lectures, interactive notes, infographics, formative quizzes, reinforcement activities, supplementary reading materials, and self-directed learning resources. Students were given flexible access to these materials throughout the intervention period to support preparation, revision, and independent learning.

Upon completion of the intervention, a post-intervention assessment was administered to evaluate changes in students' perceived conceptual understanding and quiz performance. Students were also invited to complete a satisfaction and perception survey to evaluate their learning experience with the MOOC, including its accessibility, usefulness, ease of use, and support for self-paced learning. The pre- and post-intervention data were subsequently matched, coded, and analysed using IBM SPSS Statistics Version 30. Appropriate descriptive statistics were used to summarise changes in students' learning outcomes and their perceptions of the MOOC-based supplementary learning intervention.

Validity for Research Instrument

Content validity was established by mapping the assessment items to the relevant course learning outcomes and MOOC learning content. This alignment ensured that the instruments assessed the knowledge and

competencies specifically targeted by the intervention.

To establish content validity, the instruments were reviewed by two experts with relevant expertise in entrepreneurship education, digital learning, and/or educational assessment. The reviewers evaluated the relevance, clarity, and appropriateness of the items in relation to the study objectives and course learning outcomes. Revisions were made based on the feedback received prior to data collection.

4. Results

Pre-MOOC Learning Needs: Table 1 presents the students' reported learning needs prior to the implementation of the MOOC-based supplementary learning intervention. The findings indicate varying levels of prior understanding and confidence across the assessed learning areas. The lowest level of understanding was reported for basic financial management in a business context, with only 23.3% of students indicating that they understood the area, while 76.6% reported a lack of understanding. Similarly, only 16.5% of students expressed confidence in their ability to produce digital content, representing the lowest level of confidence among the assessed areas.

Students also reported limited understanding of the use of digital platforms to create business value, with only 34.9% indicating that they understood the concept. In comparison, understanding of basic course-related concepts was relatively higher at 43.2%, although more than half of the students (56.8%) still reported a lack of understanding.

Overall, the findings reveal substantial learning gaps before the implementation of the MOOC-based supplementary learning intervention. The most pronounced gaps were observed in students' confidence in producing digital content and their understanding of basic financial management in a business context. These findings suggest that students entered the course with varying levels of prior knowledge and required additional learning support to strengthen their understanding of the assessed concepts.

Table 1: Students' Pre-MOOC Learning Needs

Learning Area	Understanding (%)	Lack of Understanding (%)
Basic financial management in a business context	23.3%	76.6%
Basic course-related concepts	43.2%	56.8%
Use of digital platforms to create business value	34.9%	65.1%
Confidence in producing digital content	16.5%	83.5%

Changes in Conceptual Understanding: Table 2 presents the changes in students' reported understanding before and after the implementation of the MOOC-based supplementary learning intervention. The findings indicate substantial improvements across all four measured learning outcomes. Understanding of key course concepts increased from 43.8% before the intervention to 91.7% after the intervention, representing an increase of 47.9 percentage points. Similarly, students' understanding of the entrepreneur support system increased from 39.6% to 87.5%, representing an improvement of 47.9 percentage points.

Understanding of e-entrepreneurship concepts increased from 42.7% to 89.6%, reflecting a 46.9 percentage-point increase. The largest relative improvement was observed in students' understanding of basic financial management, which increased from 43.8% before the intervention to 88.5% after the intervention, representing a 44.7 percentage-point increase.

Overall, the findings demonstrate a substantial increase in the proportion of students reporting understanding across all assessed learning outcomes. The post-MOOC percentages ranged from 87.5% to 91.7%, compared with 39.6% to 43.8% before the intervention. The greatest percentage-point improvements were observed in understanding key course concepts and understanding of the entrepreneur support system, both increasing by 47.9 percentage points. Although understanding of basic financial management recorded the smallest percentage-point increase (44.7 percentage points), the post-MOOC understanding level still reached 88.5%, indicating a substantial improvement.

These findings suggest that the MOOC-based supplementary learning intervention was associated with improved perceived understanding of the assessed concepts. The improvement may reflect the contribution of structured digital learning materials, including multimedia content, interactive resources and supplementary learning activities, which provided students with additional opportunities to access and revisit the learning content.

Table 2: Changes in Students' Conceptual Understanding Before and After MOOC Implementation

Learning outcome	Pre-MOOC	Post-MOOC	Percentage-point change
Understanding of key course concepts	43.8%	91.7%	+47.9
Understanding of the entrepreneur support system	39.6%	87.5%	+47.9
Understanding of e-entrepreneurship concepts	42.7%	89.6%	+46.9
Understanding basic financial management	43.8%	88.5%	+44.7

Changes in Quiz Performance: Table 3 shows a substantial improvement in students' quiz achievement after the implementation of the MOOC. Before the MOOC implementation, only 15 students (15.7%) achieved a score of 80% and above. After participating in the MOOC, this number increased considerably to 65 students (67.7%), representing an increase of 52.0 percentage points (pp). This indicates that the number of high-achieving students increased by more than four times after the MOOC implementation. Similarly, the number of students who scored below 50% decreased from 14 students (14.6%) before the MOOC to none after the MOOC implementation (0.0%), representing a reduction of 14.6 percentage points. This indicates that the MOOC may have been useful for students who primarily demonstrated weaker performance to improve their quiz achievement. Overall, the findings indicate a positive change in students' achievement levels, with fewer students remaining in the low-achievement category and a significant increase in the number of students attaining high scores.

Table 3: Changes in Students' Quiz Achievement Before and After MOOC Implementation

Achievement category	Before MOOC	After MOOC	Absolute change
Score of 80% and above	15 students (15.7%)	65 students (67.7%)	+52.0 pp
Score below 50%	14 students (14.6%)	0 students (0.0%)	-14.6 pp

Students perceived benefits: The open-ended responses indicated generally positive perceptions towards the MOOC-based supplementary learning intervention (Table 4). The most frequently identified theme was the flexibility and accessibility of the MOOC, with 78 students (81.3%) highlighting the advantage of being able to access the learning materials at any time. This suggests that students value the flexibility provided by the MOOC, particularly in allowing them to learn according to their own pace and schedule. The second most frequently reported theme was the usefulness of learning videos in improving understanding, mentioned by 72 students (75.0%). Students' responses suggested that the videos helped to clarify concepts and supported their understanding of the subject matter. In addition, 65 students (67.7%) described the MOOC as easy to use and navigate, while 58 students (60.4%) indicated that the MOOC supported revision and self-paced learning. The results indicate that the MOOC was generally well-received by students, especially in terms of its accessibility, flexibility, multimedia learning materials, and usefulness for learning the course material.

Table 4: Students' Perceived Benefits of the MOOC

Perceived benefit	Percentage of students
Flexible and anytime access	81.3%
Learning videos improved understanding	75.0%
Easy to use and navigate	67.7%
Supports revision and self-paced learning	60.4%

Discussion

The present study examined the effectiveness of a curriculum-aligned MOOC-based supplementary learning intervention in supporting non-business undergraduate students enrolled in an entrepreneurship course. Overall, the findings demonstrate consistent improvements across three key learning outcomes, namely conceptual understanding, academic performance and students' perceptions towards digital learning. Although the study employed a one-group pre-post evaluation design and therefore does not establish causal relationships, the observed improvements suggest that the MOOC served as an effective supplementary learning resource within a blended learning environment.

The improvement observed in the present study is consistent with Vo et al. (2017), whose meta-analysis demonstrated a positive effect of blended learning on academic performance in higher education. Similarly, de Bruijn-Smolanders and Prinsen (2024) reported moderate to high positive effects of blended learning interventions on student engagement and learning outcomes. The present study extends these findings by demonstrating similar positive learning patterns among non-business students enrolled in an entrepreneurship course, a context in which students may have limited prior exposure to business-related concepts.

The substantial improvement in students' conceptual understanding indicates that the MOOC successfully addressed the knowledge gaps identified before implementation. Before the intervention, many students reported limited understanding of entrepreneurship concepts, digital business, financial management and digital content creation. Following the implementation of the MOOC, the proportion of students reporting understanding increased markedly across all measured constructs. These findings support the argument that digital learning resources can reinforce conceptual learning by allowing students to revisit instructional materials repeatedly, learn at their own pace, and access multiple representations of knowledge through videos, infographics and interactive activities (Chen & Looi, 2007; Contrino et al., 2024; Wanner & Palmer, 2015). Such flexibility is particularly valuable for non-business students who may lack prior exposure to entrepreneurship-related concepts (Li et al., 2025).

The improvement in quiz performance further strengthens the educational value of the MOOC-based supplementary learning intervention. The substantial increase in the proportion of students achieving scores above 80%, together with the elimination of students scoring below 50%, suggests that additional digital learning opportunities may help narrow achievement gaps among learners with different levels of prior knowledge. Rather than replacing classroom instruction, the MOOC appeared to extend learning beyond scheduled contact hours by providing continuous access to revision materials and formative learning activities. This finding is consistent with blended learning literature, which suggests that integrating online learning with face-to-face instruction can enhance academic performance through greater engagement and more frequent interaction with learning resources (Vo et al., 2017; de Bruijn-Smolanders & Prinsen, 2024).

In addition, the improvement in quiz performance supports previous evidence that integrating digital learning resources with conventional instruction can enhance academic achievement. Vo et al. (2017), for example, reported an overall positive effect of blended learning on student performance in higher education. More recently, Uygun and Cesur (2025) demonstrated positive effects of MOOC-supported instruction on learner achievement and satisfaction. While these studies were conducted in different educational contexts, the present findings provide additional evidence that MOOC-based supplementary learning may support academic performance, particularly among students studying outside their primary disciplinary background.

The positive perceptions reported by students further explain the observed learning improvements. Most participants highlighted the flexibility of accessing learning materials at any time, the usefulness of instructional videos, the ease of navigating the platform, and the support provided for revision. These findings are consistent with previous studies that identify accessibility, learner autonomy and multimedia learning as important characteristics contributing to effective MOOC implementation (Azami & Ibrahim, 2019; Dinh & Phuong, 2024). The ability to control learning pace enables students to revisit difficult concepts, thereby promoting deeper cognitive processing and reducing dependence on limited classroom time.

From a theoretical perspective, the findings align closely with self-regulated learning theory. The MOOC encouraged students to take greater responsibility for monitoring their own learning progress through flexible access, formative quizzes and repeated engagement with instructional materials. Such learning behaviors reflect important components of self-regulated learning, including planning, self-monitoring and self-evaluation. The present findings therefore support recent studies suggesting that digital learning environments become more effective when they facilitate learners' self-regulation rather than merely providing online content (Elmabaredy & Gencel, 2024; Dinh & Phuong, 2024).

The findings of the present study can be interpreted through the lens of Self-Regulated Learning Theory. Zimmerman (2002) conceptualizes self-regulated learning as a cyclical process involving forethought, performance, and self-reflection, through which students actively plan, monitor, and evaluate their learning. The design of the MOOC-based supplementary learning intervention provided several opportunities for students to engage in behaviors consistent with these processes.

The substantial improvements observed in students' perceived conceptual understanding and quiz performance may be partly explained by the flexibility and repeated learning opportunities provided by the MOOC. Students were able to access learning materials according to their own schedules, revisit difficult concepts, and use formative learning activities to monitor their understanding. These characteristics are consistent with the performance and self-reflection processes of SRL, in which learners monitor their progress, evaluate their performance, and modify their learning strategies accordingly (Zimmerman, 2002; Panadero, 2017).

The students' perceptions of the MOOC provide additional support for this interpretation. Flexible and anytime access was the most frequently reported benefit, while students also valued learning videos and the ability to use the MOOC for revision and self-paced learning. These findings suggest that students valued features that provided greater autonomy and control over their learning processes. This interpretation is consistent with previous research demonstrating the relevance of self-regulated learning in digital learning environments (Dinh & Phuong, 2024) and the potential of SRL-integrated digital platforms to support students' achievement and performance (Elmabaredy & Gencel, 2024).

Nevertheless, these findings should not be interpreted as direct evidence that the MOOC improved students' self-regulated learning. As SRL was not directly measured in the present study, the theory serves primarily as an explanatory framework for understanding how the learning affordances provided by the MOOC may have contributed to the observed outcomes. Future research could directly measure students' self-regulated learning behaviors and examine whether SRL mediates the relationship between engagement with MOOC-based supplementary learning and academic performance.

An important contribution of this study lies in its educational context. Much of the existing MOOC literature focuses on fully online courses or programs involving students from technology or business disciplines (e.g., Huang et al., 2022; Le & Ho, 2026; Shang et al., 2024; Uygun & Cesur, 2025). In contrast, this study demonstrates that curriculum-aligned MOOC-based supplementary learning can effectively support students from diverse non-business academic backgrounds who are required to study entrepreneurship as a compulsory university course. This finding extends current knowledge by illustrating that digital learning interventions may be particularly beneficial for heterogeneous student populations possessing different levels of prior knowledge and learning readiness.

While previous studies have established the benefits of MOOCs and blended learning across various higher education contexts, the present study extends this evidence to non-business students undertaking entrepreneurship education. This distinction is important because these students may enter the course with limited prior exposure to entrepreneurship, financial management and digital business concepts. The substantial improvements observed following the intervention therefore suggest that curriculum-aligned MOOC resources may be particularly useful as supplementary learning support for academically heterogeneous student populations.

5. Limitations and Suggestions for Future Research

Despite the positive findings, several limitations should be considered when interpreting the results. First, the study employed a one-group pre-test-post-test design without a control or comparison group. Therefore, although improvements were observed following the implementation of the MOOC-based supplementary learning intervention, the changes cannot be attributed exclusively to the MOOC. Other factors, including face-to-face instruction, students' continued exposure to the course content, maturation, and repeated assessment, may have contributed to the observed improvements. Future studies should employ experimental or quasi-experimental designs involving appropriate comparison groups to provide stronger evidence regarding the effectiveness of MOOC-based supplementary learning.

Second, the study was conducted at a single Malaysian higher education institution and focused on non-business undergraduate students enrolled in one entrepreneurship course. These contextual characteristics may limit the generalisability of the findings to other institutions, academic disciplines, courses, and student populations. Future research should therefore involve larger and more diverse samples across multiple institutions and disciplines. Comparative studies involving students with different academic backgrounds may also provide insights into whether prior disciplinary knowledge influences the effectiveness of MOOC-based supplementary learning.

Third, some of the learning outcomes were based on students' self-reported perceptions of their conceptual understanding. Although such measures provide useful information about students' perceived learning progress, they may not fully reflect actual knowledge acquisition. Future studies should incorporate validated objective assessments alongside self-reported measures to provide a more comprehensive evaluation of learning outcomes.

Fourth, the present study primarily relied on descriptive statistics to evaluate changes in students' learning outcomes. While the observed percentage changes indicate positive patterns following the intervention, future studies should employ appropriate inferential statistical analyses and report effect sizes to determine the statistical significance and magnitude of the observed changes.

Fifth, the study focused primarily on learning outcomes measured within the intervention period and did not examine whether the observed improvements were sustained over time. Future longitudinal research could incorporate delayed post-intervention assessments to determine whether MOOC-supported learning contributes to longer-term knowledge retention and application.

Finally, the study evaluated the MOOC as an overall supplementary learning intervention without examining students' actual engagement with individual MOOC components. Future research could incorporate learning analytics, including frequency of access, time spent on learning materials, video engagement, formative quiz attempts, and module completion. Such data could be used to examine the relationship between patterns of MOOC engagement and academic outcomes and to identify which specific features of the MOOC contribute most strongly to student learning.

Conclusion

This study demonstrates that a curriculum-aligned MOOC-based supplementary learning intervention has considerable potential to enhance learning outcomes among non-business undergraduate students enrolled in an entrepreneurship course. Following the implementation of the MOOC, students reported higher levels of conceptual understanding, achieved better quiz performance, and expressed positive perceptions regarding the flexibility, accessibility and usefulness of the digital learning resources.

The findings suggest that the effectiveness of the intervention was not merely attributable to the availability of online materials but to the purposeful integration of the MOOC within the existing curriculum. By complementing face-to-face instruction with structured multimedia resources, formative assessments and self-paced learning opportunities, the MOOC provided continuous academic support beyond conventional classroom teaching.

From a practical perspective, the findings offer valuable implications for higher education institutions seeking to strengthen digital transformation initiatives. Curriculum-aligned MOOCs can function as scalable supplementary learning resources capable of supporting students with diverse educational backgrounds while promoting independent learning and greater engagement with course content. Such approaches are particularly relevant for entrepreneurship education, where students are expected to integrate conceptual knowledge with practical digital business skills.

Overall, the study contributes to the growing body of literature on blended learning by providing empirical evidence that MOOC-based supplementary learning can enhance students' conceptual understanding, academic achievement and learning experience within a Malaysian higher education context. Future research involving larger samples, multiple institutions and more rigorous experimental designs is recommended to further validate these findings and identify the specific MOOC features that contribute most significantly to student success.

References

- Alhazzani, N. (2020). MOOCs' impact on higher education. *Social sciences & humanities open*, 2(1), 100030.
- Ali, L. (2018). The design of curriculum, assessment and evaluation in higher education with constructive alignment. *Journal of Education and e-learning Research*, 5(1), 72-78.
- Azami, H. H. R., & Ibrahim, R. (2019). Development and evaluation of massive open online course (MOOC) as a supplementary learning tool: An initial study. *International Journal of Advanced Computer Science and Applications*, 10(7).
- Berezi, I. U. (2025). Virtual learning environment: Redefining higher educational delivery for efficiency and accessibility. *International Journal of Educational Management, Rivers State University*. 1(1), 451-467.
- Bernard, R. M., Borokhovski, E., Schmid, R. F., Tamim, R. M., & Abrami, P. C. (2014). A meta-analysis of blended learning and technology use in higher education: From the general to the applied. *Journal of Computing in Higher Education*, 26(1), 87-122.
- Bingolbali, A., Aslan, A., Batdi, V., & Cinkara, E. (2025). Mixed-meta method concerning the effect of blended learning practices on students' academic achievement in higher education settings. *SAGE Open*, 15(2), 21582440251336646.
- Bond, M., Bedenlier, S., Buntins, K., Kerres, M., & Zawacki-Richter, O. (2020). Facilitating student engagement in higher education through educational technology: A narrative systematic review in the field of education. *Contemporary Issues in Technology and Teacher Education*, 20(2), 315-368.
- Chakraborty, M., & Al Rashdi, S. (2018). Venkatesh et al.'s Unified Theory of Acceptance and Use of Technology (UTAUT) (2003). In *Technology adoption and social issues: Concepts, methodologies, tools, and applications* (pp. 1657-1674). IGI Global Scientific Publishing.
- Chen, F. (2025). The relationship between digital literacy and college students' academic achievement: the chain mediating role of learning adaptation and online self-regulated learning. *Frontiers in Psychology*, 16, 1590649.
- Chen, W., & Looi, C. K. (2007). Incorporating online discussion in face-to-face classroom learning: A new blended learning approach. *Australasian Journal of Educational Technology*, 23(3).
- Contrino, M. F., Reyes-Millán, M., Vázquez-Villegas, P., & Membrillo-Hernández, J. (2024). Using an adaptive learning tool to improve student performance and satisfaction in online and face-to-face education for a more personalized approach. *Smart Learning Environments*, 11(1), 6.
- de Bruijn-Smolters, M., & Prinsen, F. R. (2024). Effective student engagement with blended learning: A systematic review. *Heliyon*, 10(23), e39439. <https://doi.org/10.1016/j.heliyon.2024.e39439>
- Dinh, C.-T., & Phuong, H.-Y. (2024). Examining student characteristics, self-regulated learning strategies, and their perceived effects on satisfaction and academic performance in MOOCs. *Electronic Journal of e-Learning*, 22(8), 41-59. <https://doi.org/10.34190/ejel.22.8.3446>
- Elmabaredy, A., & Gencel, N. (2024). Exploring the integration of self-regulated learning into digital platforms to improve students' achievement and performance. *Discover Education*, 3, Article 262. <https://doi.org/10.1007/s44217-024-00233-4>
- Fayolle, A., & Gailly, B. (2015). The impact of entrepreneurship education on entrepreneurial attitudes and intention: Hysteresis and persistence. *Journal of Small Business Management*, 53(1), 75-93.
- Fredricks, J. A., Filsecker, M., & Lawson, M. A. (2016). Student engagement, context, and adjustment: Addressing

- definitional, measurement, and methodological issues. *Learning and Instruction*, 43, 1-4.
- Hristov, S., Nakov, D., & Miočinović, J. (2023). Constructive alignment between objectives, teaching and learning activities, student competencies and assessment methods in higher education. *Journal of Agriculture and Plant Sciences*, 21(2), 21-36.
- Huang, Z., Yang, J., Wang, H., Chen, B., Zheng, D., & Chen, H. (2022). Integration of massive open online course (MOOC) in ophthalmic skills training for medical students: outcomes and perspectives. *The Asia-Pacific Journal of Ophthalmology*, 11(6), 543-548.
- Jan, I. (2024). Experiential Learning Theory in Academic Technology Entrepreneurship: Preparing Students for Technopreneur Development. *Journal of Academic Technology Entrepreneurship*, 6(1), 45-60.
- Jovanović, J., Gašević, D., Dawson, S., Pardo, A., & Mirriahi, N. (2017). Learning analytics to unveil learning strategies in a flipped classroom. *The Internet and Higher Education*, 33, 74-85.
- Kuratko, D. F., & Morris, M. H. (2018). Corporate entrepreneurship: A critical challenge for educators and researchers. *Entrepreneurship Education and Pedagogy*, 1(1), 42-60.
- Le, H. V., & Ho, T. T. N. (2026). Balancing act: exploring the integration of Coursera MOOCs in Vietnamese higher education through a phenomenographic lens. *Interactive Learning Environments*, 34(2), 590-614.
- Ledermuller, K., & Fallmann, I. (2017). Predicting learning success in online learning environments: Self-regulated learning, prior knowledge and repetition. *Zeitschrift für Hochschulentwicklung*.
- Li, H., Ma, H., Hui, X., & Wang, Q. (2025). Exploring the impact of entrepreneurship module on employability development among non-business students. *The International Journal of Management Education*, 23(3), 101278.
- Lo, C. K., & Hew, K. F. (2021). Developing a flipped learning approach to support student engagement: A design-based research of secondary school mathematics teaching. *Journal of Computer Assisted Learning*, 37(1), 142-157.
- Mayer, R. E. (2021). *Multimedia learning* (the 3rd edition). Cambridge University.
- Moreira, F. P., & Lima, D. A. (2024). Systematic literature review on the impact of Blended Learning in promoting student engagement and autonomy: findings and recommendations. *Revista Brasileira de Informática na Educação*, 32, 242-269.
- Neck, H. M., Greene, P. G., & Brush, C. G. (2014). Teaching entrepreneurship: A practice-based approach. In *Teaching Entrepreneurship*. Edward Elgar Publishing.
- Panadero, E., Jonsson, A., Pinedo, L., & Fernández-Castilla, B. (2023). Effects of rubrics on academic performance, self-regulated learning, and self-efficacy: A meta-analytic review. *Educational Psychology Review*, 35(4), 113.
- Pilli, O., & Admiraal, W. (2017). Students' Learning Outcomes in Massive Open Online Courses (MOOCs): Some Suggestions for Course Design. *Journal of Higher Education/Yükseköğretim Dergisi*, 7(1).
- Primario, S., Rippa, P., & Secundo, G. (2022). Rethinking entrepreneurial education: The role of digital technologies to assess entrepreneurial self-efficacy and intention of STEM students. *IEEE Transactions on Engineering Management*, 71, 2829-2842.
- Ritz, E., Rietsche, R., & Leimeister, J. M. (2023). How to support students' self-regulated learning in times of crisis: An embedded technology-based intervention in blended learning pedagogies. *Academy of Management Learning & Education*, 22(3), 357-382.
- Rodrigues, A. L. (2023). Entrepreneurship education pedagogical approaches in higher education. *Education Sciences*, 13(9), 940.
- Secundo, G., Gioconda, M. E. L. E., Del Vecchio, P., Gianluca, E. L. I. A., Margherita, A., & Valentina, N. D. O. U. (2021). Threat or opportunity? A case study of digital-enabled redesign of entrepreneurship education in the COVID-19 emergency. *Technological forecasting and social change*, 166, 120565.
- Shang, D., Chen, Q., Guo, X., Jin, H., Ke, S., & Li, M. (2024). Exploring the determinants of massive open online courses continuance learning intention in business toward accounting context. *arXiv preprint arXiv:2411.16700*.
- Siregar, R. S. (2024). Students' Preferences for Varied Learning Methods: An Empirical Study of the Effectiveness and Appeal of Diverse Instructional Approaches. *Jurnal Profesi Guru Indonesia*, 1(2), 140-152.
- Sweller, J. (2011, June). Cognitive load theory and E-learning. In *International Conference on Artificial Intelligence in Education* (pp. 5-6). Berlin, Heidelberg: Springer Berlin Heidelberg.
- Uygun, E., & Cesur, K. (2025). Teaching English for general purposes through a MOOC in higher education: A quasi-experimental study to explore its effects on learner achievement and satisfaction. *Education and*

- Information Technologies*, 30(3), 3389-3409.
- Vo, H. M., Zhu, C., & Diep, N. A. (2017). The effect of blended learning on student performance at course-level in higher education: A meta-analysis. *Studies in Educational Evaluation*, 53, 17-28. <https://doi.org/10.1016/j.stueduc.2017.01.002>
- Wanner, T., & Palmer, E. (2015). Personalizing learning: Exploring student and teacher perceptions about flexible learning and assessment in a flipped university course. *Computers & Education*, 88, 354-369.
- Williams, R. T. (2024). An overview of MOOCs and blended learning: integrating MOOC technologies into traditional classes. *IETE Journal of Education*, 65(2), 84-91.
- Zeng, X., Chieng, S. L., & Liu, H. (2024). Bridging theory and practice: Exploring digital transformation in entrepreneurship education through a conceptual curriculum development framework in TVET. *Vocation, Technology & Education*, 1(2).
- Zhu, M. (2024). Designing and delivering MOOCs to motivate participants for self-directed learning. *Open Learning: The Journal of Open, Distance and e-Learning*, 39(4), 353-372.
- Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory into Practice*, 41(2), 64-70.
- Zuhairi, Z., Andayani, S., & Jarudin, J. (2024). Online Learning Model to Improve the Students' Achievement in Design of Information and Communication Technology. *Conhecimento & Diversidade*, 16(42), 193-218.