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Designing Effective Computerized Assessments for Promoting Higher-Order Thinking Skills in Online Environments

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Abstract

Developing higher-order thinking is crucial to promoting in-depth learning in virtual learning environments. The study investigates the possibility of computerised tests that align with Bloom's Taxonomy to improve higher-order thinking among a varied population of online students to fill the current research gap. Qualitative data via structured student interviews and quantitative data from computerised assessments were collected. Online students participating in the "Essentials of Spoken and Presentation Skills" course were given various evaluation items corresponding to Bloom's Taxonomy's hierarchical structure. The research results provide evidence-based recommendations for using computerised tests to encourage higher-order thinking skills successfully. These insights can assist educators and instructional designers in creating interesting and valuable learning experiences for the online learning environment. Based on their comments in the structured interviews, students in the experimental group strongly believed that the course contents and activities had improved their higher-order thinking. The outcomes of performance tests showed that students participating in higher-level activities significantly improved. A thorough understanding of the efficiency of computerised examinations in promoting critical thinking, analysis, evaluation, and creativity among online students will result from such extensive research endeavours.

Keywords: *Adaptive learning, Computerised assessments, Higher-order thinking skills, Online education. Critical thinking*

Introduction

Online education has recently acquired immense popularity, giving students access to various courses and educational resources. As the demand for online education continues to increase, ensuring the quality of education provided through this medium is pivotal (Barak et al., 2016; McCombs, 2015). Utilising computerised assessments is crucial to attaining this objective. Zheng et al. (2021) assert that computerised evaluations have become an indispensable online component. Online assessments provide numerous benefits compared to conventional pen-and-paper examinations, such as enhanced scalability, prompt feedback, and automated grading. Technological advancements enable the possible enhancement of the learning experience and learning outcomes in online contexts by implementing computerised assessments (Elaish et al., 2021).

According to Lin (2018), Computerised examinations generate a substantial amount of data that may be evaluated to obtain significant insights into student achievement, learning patterns, and instructional effectiveness" (p.3). In contrast to conventional pen-and-paper examinations, computerised examinations can be administered simultaneously to many students. Computerised assessments have the potential to mitigate the need for manual grading by human instructors, hence resulting in a reduction in administrative workload. Computerised evaluations are advantageous in online education because they can simultaneously evaluate many pupils. In addition, these attributes of convenience, flexibility, and accuracy are also evident. One of the primary advantages of computerised examinations is their ability to offer prompt feedback to learners, enabling them to discern their areas of proficiency and areas for improvement and then adapt their learning approaches. Further, these educational resources can be customised according to the unique requirements of individual students, hence facilitating a more individualised and personalised approach to learning.

Educators can use data analytics to identify trends, patterns, and opportunities for improvement in online exams. Making decisions based on data-driven instructional design and delivery enables better outcomes. Teachers can identify specific areas of difficulty or misconceptions, enabling them to give pupils tailored interventions and support. The evaluation of assessment data can assist in locating problems with curriculum design and serve as a model for developing instructional materials that better fit the needs of students. They ensure that every student is evaluated using the same standards and guidelines. This standardisation helps to minimise the bias and subjectivity that might result from manual grading, retaining the reliability and objectivity of judgements. Computerised tests follow a regulated evaluation process, ensuring objectivity and comparability among students and institutions. Students can have more faith in the educational outcomes of online education programmes when they know that specified criteria will be a part of their evaluations. According to research by Wei et al. (2021), we can determine that adaptive assessments dynamically adjust the difficulty level of questions based on the learner's responses, ensuring a suitable level of challenge and preventing unnecessary frustration or indifference. By adapting the assessment's content to the learner's proficiency level, adaptive assessments provide a personalised learning experience that meets the unique requirements of each student.

Moreover, computerised assessments can include interactive elements such as simulations, multimedia content, and graphs. These elements make the assessment more engaging in real-world contexts, thereby promoting a deeper level of comprehension and transfer of learning. The credibility of online education programmes is increased by standardisation and reliability, which guarantee fairness and comparability in evaluation. While continuous evaluation and formative feedback facilitate iterative learning and growth, adaptive and interactive assessment styles engage students and encourage deeper knowledge

Promoting Higher-order Thinking Skills in Online Spaces

Bloom's Taxonomy categorises cognitive abilities in ascending order, progressing from lower-level to higher-level talents. Complex cognitive processes are necessary for the development of higher-order thinking skills. The acquisition of these skills necessitates the development of critical thinking, analytical prowess, and creative aptitude. The higher-order cognitive talents identified in Bloom's Taxonomy encompass the application, analysis, evaluation, and creation processes. Applying refers to employing new knowledge in real-world settings, transferring knowledge and concepts to solve issues, make connections, or complete tasks. Students demonstrate their comprehension by applying their knowledge and abilities in multiple circumstances (Barak et al., 2020). Analysing involves deconstructing complicated ideas and concepts and examining their links. Critical thinking helps students understand components, patterns, and systems. They identify motives, causes, and effects and assess evidence or arguments to draw meaningful conclusions (Tan et al., 2023). Evaluating entails judging based on arguments and claims. Holistic evaluation requires learners to reflect, examine many perspectives, and make evidence-based conclusions. Bloom's Taxonomy's highest cognitive processing is creating. Synthesis and higher-level thinking create new ideas, products, and solutions. Learners apply their knowledge and abilities to create new outputs, show creativity, and solve complicated issues (Widiana et al., 2023). Based on the context of the study, the following research objectives were formulated.

- Analyse the online education landscape critically, concentrating on automated tests.
- Examine how computerised testing might help students develop higher-order thinking skills in online learning environments.
- Use computerised tests to evaluate cognitive capacities and compare the results to Bloom's higher-order thing.
- Collect student opinions on personalised tests and evaluate their cognitive growth.
- Utilise data-driven insights from assessments to enhance teaching methods and student performance.

Literature Review

Theoretical Background

Bloom's taxonomy can be utilised in online education to create content and tests that encourage higher-order thinking abilities. Online learning has grown in popularity recently, but student participation has decreased, especially among those accustomed to using digital gadgets. Therefore, creating well-planned courses that are explicit about their learning objectives and evaluation systems will be essential for developing effective

online education in the future. The popularity of online education is evident, but it is necessary to be mindful of its difficulties, such as students' disinterest in using digital learning tools. Promoting higher-order thinking abilities is crucial for online evaluation to reach its full potential. In addition to addressing the problem of student indifference, the emphasis on HOTS will ensure that students have the analytical and critical thinking abilities necessary in the twenty-first century. Although Bloom's taxonomy is widely used in e-learning, its linguistic component has received less attention.

Review of Previous studies on Bloom's Taxonomy in online spaces

Amin and Mirza (2020) investigated the use of Bloom's in online spaces. According to the survey, virtual university students were more familiar with digital technologies than their counterparts at traditional universities. In particular, virtual university students were more likely to use digital tools to understand and apply Bloom's taxonomy. Students in traditional universities, however, tended to use digital tools more frequently for lower-order cognitive activities. The results of the study have several applications to educational practice. First, the results indicate that instructors in online spaces should be ready to employ various digital technologies to aid student learning and evaluation. Second, the findings advise teachers to include more higher-order tasks in their lesson plans and performance tests. Third, the results point to the need for educational institutions to offer teachers chances for professional development using digital tools. Overall, the study contends that in both online and face-to-face learning settings, digital technologies help foster higher-order thinking abilities.

Crompton et al. (2019) conducted a scoping review of online learning and student cognition in the K-12 setting. The authors employed Bloom's taxonomy as a theoretical framework. According to the study, students engage in activities at all six levels of Bloom's taxonomy, but there is a tendency towards higher-level thinking activities in online environments. The results of the study have several applications to educational practice. First, the results imply that higher-order thinking abilities can be encouraged through online learning. The results also show that educators should not just rely on online platforms to deliver content but should plan their online learning activities carefully. Third, the results imply that educational institutions must efficiently offer teachers professional development on online learning platforms.

According to a recent study on online learning platforms, various factors influence student academic achievement and satisfaction (Abuhassna et al., 2020). The study involved 243 college students who used online learning environments. For this investigation, the researchers employed a quantitative research method. The results demonstrated that the students' background, experience, group projects, interactions, and autonomy had a beneficial impact on their contentment. Additionally, there was a strong correlation between the student's application, retention, comprehension, analysis, and satisfaction with their academic success. The study's conclusions validate the integrative relationship between online learning and Bloom's Taxonomy. The results of the study have several applications to educational practice. First, the results imply that higher education teachers should give course structure design for online learning more consideration. The course structure should be developed to support student evaluation. Second, online learning systems require instructors and course designers to be familiar with technology. They should be knowledgeable about the software and resources at their

disposal and capable of establishing a learning environment that promotes student learning. Third, the results imply that prior knowledge and experience with online learning are important factors in determining students' enjoyment and academic success. The study results can improve the design and implementation of online learning programmes.

The Current Study

Before their adoption in online education, computerised assessments had already made strides in traditional learning settings. (Wei et al., 2022) These tests had many benefits, such as scalability and immediate response. However, a knowledge gap remained on their effectiveness in fostering higher-order thinking abilities, particularly in distance learning. Furthermore, many online platforms mainly rely on lower-level cognitive tasks and fail to include higher-order thinking abilities successfully. Therefore, this work sits at the nexus of online learning, computerised evaluations, and the development of higher-order cognitive abilities. While the benefits of computerised testing have been the subject of numerous studies, more is needed to know how well these tests encourage higher-order thinking abilities. This study bridges this vacuum by giving course developers and educators evidence-based advice. Based on the literature review findings, the research questions were formulated.

Four research questions were formulated to check the effectiveness of the study. They are

- RQ1: In their business presentations, do students in the traditional class exhibit higher-order thinking skills at the applying level to a greater or lesser extent than students in the online class?
- RQ2: Regarding higher-order thinking abilities at the analysis level, how do students in the traditional class and those in the online programme differ in their business presentation abilities?
- RQ3: Focusing on the evaluating level, what are the variations in higher-order thinking abilities displayed by students in traditional and online schools during business presentations?
- RQ4: How do students in the traditional class differ from those in the online class in demonstrating higher-order thinking abilities at the Creation level in their business presentations?

In the modern world of online education, this research is significant because it addresses the urgent need to improve computerised assessments for developing higher-order cognitive skills. It is crucial to ensure that as digital learning platforms grow, they impart knowledge and foster creativity, analysis, and critical thinking. This study aims to match these online assessments with the renowned Bloom's Taxonomy. Its conclusions are positioned to provide educators and curriculum designers with invaluable insights and evidence-based tips for improving online teaching methodologies. The findings of this investigation ultimately aim to improve the standard of online education, ensuring profound intellectual growth.

Methodology

Design

A mixed-methods approach was used to examine the educational difficulties thoroughly. This strategy combines qualitative and quantitative research approaches to examine the topic being studied comprehensively. Mixed approaches have gained popularity in

analysing complicated educational processes, according to Sosu et al. (2018). The benefit of this design is further highlighted by König et al. (2023), who note that the combination of qualitative data (such as interviews and observations) and quantitative data (such as surveys and test scores) provides thorough insights. This deeper awareness aids the decision-making process for educators and policymakers.

Participants

Two groups of students from the B.S. Abdur Rahman Crescent Institute of Science and Technology conducted the investigation. The first group consisted of 28 students in their fifth semester of aeronautical engineering, while the second group comprised 30 students in their fifth semester of automobile engineering. Two students from the control group and three from the experimental group were excluded due to incomplete participation, resulting in a sample size of 26 students. The average age of the participants was 20.5 years. They were selected using stratified sampling.

Instruments

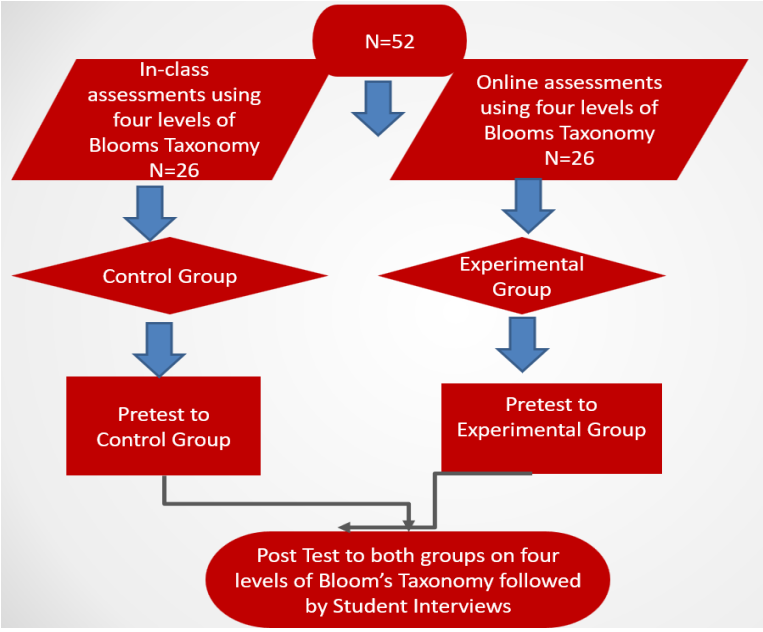
The study utilised two primary tools for data gathering. Quantitative data was collected using computerised examinations to quantify the direct outcomes of educational activities. Conversely, structured interviews were conducted with the students to get qualitative insights, which provided valuable information regarding their perceptions, experiences, and self-reported cognitive improvements.

Data Collection Procedure

At the outset, computerised evaluations were delivered to both cohorts to collect quantitative data. The performance assessments were afterwards accompanied by structured interviews designed to gather qualitative perspectives directly from the pupils. The primary objective of this sequencing was to create objective measures of learning outcomes before delving into the exploration of deeper, subjective viewpoints on the learning process. According to Hammad Bush (2021), combining computerised test scores and student interviews offers a comprehensive perspective on the subject matter. Qualitative research helps explain the underlying reasons for events, while quantitative data measures the magnitude of these phenomena.

Figure 1.

The Research Design

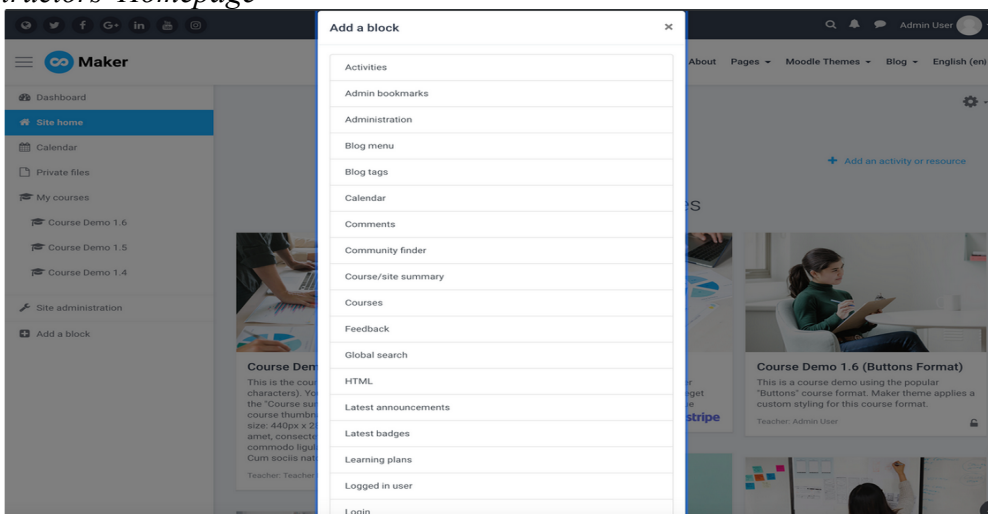


Description Of The Platforms Used

Students enrolled in the course Essentials of Spoken and Presentation Skills were given various computerised assessment items designed to correlate with the hierarchical structure of Bloom's Taxonomy. This research employs a Moodle-based Learning Management System (LMS) called "Moodle Cloud. "The screenshot of the instructor's homepage is given in Figure 2.

Figure 2.

The Instructors' Homepage



Moodle Cloud is a cloud-based version of Moodle that enables educators to create and administer online courses, assessments, and other learning activities on a hosted and user-friendly platform (Paragina et al., 2011). Due to its usability and scalability, it is particularly well-liked by educators and small institutions, making it an excellent choice for computerised assessments in online learning environments. Due to its customisable assessment tools, rich multimedia materials, and collaborative features, Moodle Cloud is a powerful platform for fostering higher-order thinking in online classrooms.

Moodle is a preferred option for education since it provides several benefits for conducting online tests. Teachers and students can easily access evaluation tools with Moodle's user-friendly interface. Second, it supports multiple assessment methods by supporting multiple-choice, essay, and interactive question kinds. Third, Moodle's integrated grading and feedback features expedite the evaluation process while giving students pertinent feedback (Barge & Londhe, 2014). The portal also offers password-protected access to exams, question banks that are generated randomly, and quizzes. Last, Moodle's data tracking features enable teachers to examine student performance patterns, spot learning gaps, and modify lessons accordingly, encouraging customised and efficient learning experiences. Moodle improves the educational process by enabling effective, secure, and data-driven online examinations.

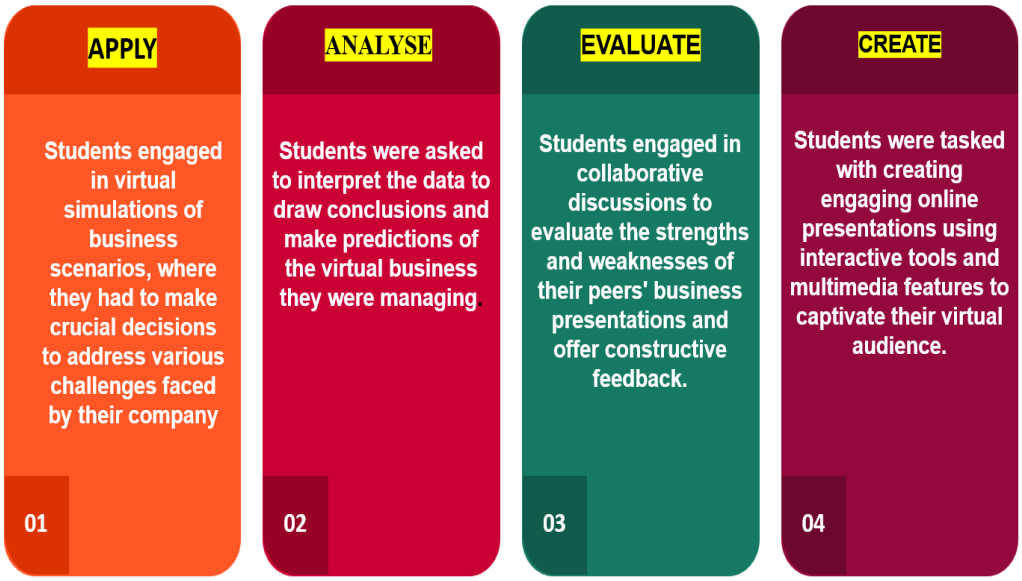
According to Chung & Ackerman (2015), "Educators can create rigorous computerised assessments aligned with Bloom's Taxonomy to assess students' higher-order thinking skills. Students are encouraged to engage in critical analysis, evaluation, and creative problem-solving by incorporating diverse multimedia elements and nurturing peer interaction through discussion forums" (p. 3). The platform's immediate feedback and self-assessment features empower students to take responsibility for their learning and evaluate their progress. According to Afini Normadhi et al. (2015), "Moodle Cloud supports adaptive learning, personalised learning pathways, and project-based learning, promoting higher-order thinking and knowledge application in authentic contexts. Moodle Cloud increases intrinsic motivation and student engagement through gamification elements, thereby fostering the development of critical thinking and a deeper understanding of course content" (p.5).

Application of Four Levels of Taxonomy

Computerised assessments can effectively measure and evaluate learners' higher-order thinking skills by crafting assessment items that align with specific cognitive levels, providing valuable feedback on their abilities to apply, analyse, evaluate, and create. The nature of the application of the four higher-order levels of Bloom's Taxonomy in the context of teaching Business presentations is shown in Figure three.

Figure 3

Four levels of application



These evaluation tasks and questions foster critical thinking, higher-order thinking, creativity, and problem-solving. By creating tests that require higher-order thinking, educators may more accurately evaluate students' capacities to apply knowledge, analyse data, appraise evidence, and develop creative solutions (Mohammed Osman et al., 2022)

Although they usually emphasise lower-order cognitive abilities like recalling facts and concepts, computerised tests effectively measure information acquisition and retention. In today's complex and rapidly changing world, learners require higher-order thinking abilities, including critical thinking, problem-solving, and creativity. Online education hinders higher-order cognitive skills since there is little face-to-face interaction and self-directed learning (Greenhow et al., 2022). Computerised tests must, therefore, evaluate and improve these crucial skills. By containing tasks that call for information analysis, evaluation, and synthesis, computerised tests help students develop higher-order thinking skills and get ready for difficulties in the real world. A comparative analysis of traditional and online classes implemented in the study is shown in Table 1.

Table 1

Comparison of Traditional and Online Class

Taxonomy Levels	Traditional Class	Online Class
Applying	In-class application exercises and real-life situational topics for Business Presentations	Online interactive simulations and virtual samples
Analysing	Discourse analysis of the presentation's classroom discussions	Discourse analysis and collaborative discussion through Moodle Cloud
Evaluating	In-class evaluation discussions and Peer assessment activates	Online collaborative discussions and virtual peer assessment activities.

Creating	Classroom presentations for evaluation	Online presentations and recordings for assessments

The comparative table illustrates how Bloom's Taxonomy's four higher-order thinking levels, namely applying, analysing, evaluating, and creating, are integrated into the traditional class (control group) and the online class (experimental group) to test different presentations. The table lists the precise teaching strategies and evaluation techniques applied at each level in the two learning settings. Higher-order thinking skills are developed in the traditional class through in-class application exercises and real-life scenarios created exclusively for business presentations. These activities demand that students apply their knowledge and skills in realistic situations. Discourse analysis of the presentations made during class discussions helps students critically evaluate and reflect on their and their classmates' performance, allowing them to pinpoint areas for improvement and where they excel.

On the other hand, interactive simulations and virtual examples are used in the online course to build higher-order thinking skills. Students can practise and use their corporate skills in a virtual environment by using online interactive simulations to create immersive learning experiences. Students are exposed to various presentation methods and styles through virtual samples, enabling them to evaluate and learn from various examples. Regarding evaluation, the typical class uses peer evaluation exercises and in-class evaluation discussions to analyse students' business presentations. These evaluation components give students insightful feedback that helps them comprehend their performance and learn how to improve. Peer assessment exercises help students critically analyse their peers' presentations, improving their capacity to evaluate the efficacy of communication and presentation strategies. Like in-person classes, online collaborative discussions and virtual peer assessment exercises are used for evaluation. Students can critically evaluate their and their classmates' presentations using online collaborative conversations, encouraging active involvement and thoughtful analysis. Students can provide constructive criticism to their classmates through virtual peer evaluation activities, which helps them grasp successful presentation techniques and improves their capacity to evaluate presentations impartially. The typical classroom includes classroom presentations for evaluation to develop higher-order thinking skills. Students' creation and delivery of business presentations are graded according to several factors. Students are challenged to use their creativity and presentation abilities to capture their audience effectively are challenged to use their creativity and presentation abilities to effectively capture their audience by using this hands-on method. Students must deliver online presentations and recordings for assessments in the online course. Through multimedia and technology, this format enables students to demonstrate their innovative presentation skills in a digital setting. In conclusion, the comparative table shows that, when teaching corporate presenting skills, both the traditional class and the online class prioritise the development of higher-order thinking skills (applying, analysing, evaluating, and producing). Both learning environments strive to foster critical thinking, application, and creativity, which are crucial for giving good corporate presentations in real-world circumstances despite differences in teaching methods and evaluation strategies.

Assessments at the applying level are conducted in the control group (conventional class) through in-class application exercises and real-life situational issues designed for business presentations. To complete these tasks, students must use their

knowledge and abilities in real-world situations that mimic the difficulties they could face in the workplace. However, the experimental group (an online class) uses interactive simulations and virtual samples to conduct assessments at the Application level. Students can immerse themselves in interactive settings using virtual platforms, where they can hone their corporate presenting abilities in a lively virtual environment. Moving on to the Analysing level, the control group uses discourse analysis of the presentations during class discussions for assessment reasons. Students focus on communication strategies and the success of presentations while critically analysing their own and those of their colleagues. The experimental group, on the other hand, makes use of Moodle Cloud for discourse analysis and group discussion. Students can participate in interactive discussions, review recorded presentations, and offer helpful criticism using the online platform, which promotes in-depth analysis and a more thorough assessment of presentation skills. The control group conducts evaluations for the evaluating level through peer evaluation exercises and in-class evaluation discussions. The need for critical analysis and self-reflection is emphasised as students actively participate in conversations where they evaluate their own and their classmates' presenting performances. The experimental group, however, uses virtual peer assessment activities and online collaborative forums for evaluation. Students are encouraged to provide helpful criticism and ratings for each other's business presentations using collaborative forums and online platforms, improving their capacity to analyse presentations impartially and collectively. The control group's evaluations for the Creating level also include classroom presentations that are assessed using various criteria. Students must prepare and deliver business presentations to demonstrate their originality and presentation abilities. The experimental group, on the other hand, uses online presentations and recordings to conduct assessments. Students digitally deliver business presentations using online tools and technology, utilising multimedia components to strengthen their creativity and inventiveness.

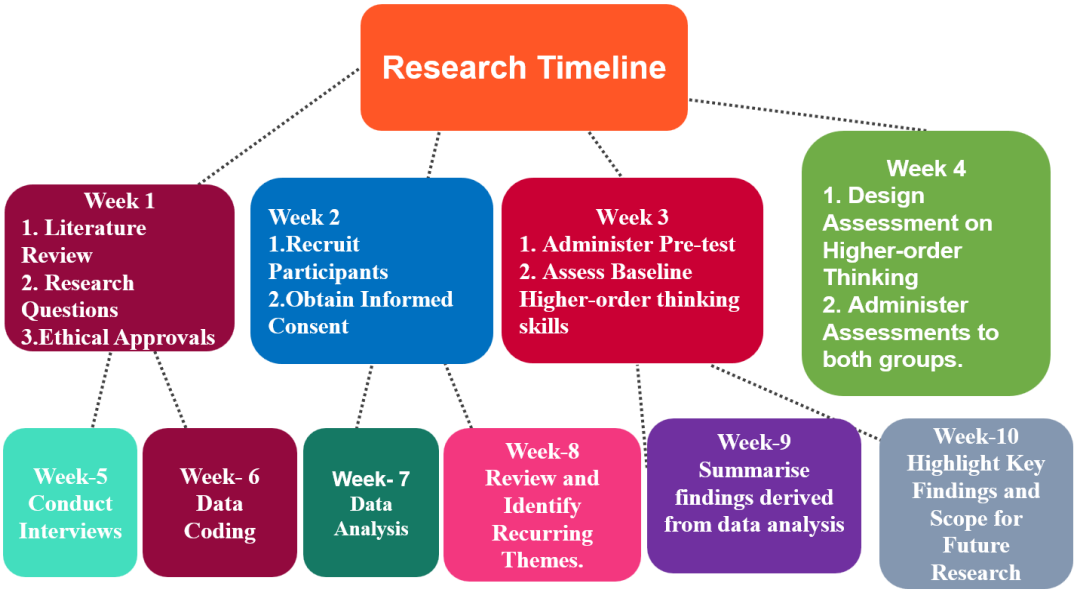
In conclusion, the comparative shows that in their evaluations of corporate presenting skills, both the control and experimental groups strongly emphasise the four levels of Bloom's Taxonomy (Applying, Analysing, Evaluating, and Creating). However, the online course takes advantage of the adaptability and interactivity of online tools and platforms, enabling a more lively and interactive evaluation process. In business presentation exams, virtual simulations, Moodle Cloud, and online presenting tools improve students' higher-order thinking abilities, foster critical analysis, encourage collaborative review, and nurture creativity.

Time Line of the research

It took around ten weeks for the researchers to complete the study. Over ten weeks, the study "Designing Effective Computerised Assessments for Promoting Higher-Order Thinking Skills in Online Education" was conducted.

Figure 4.

Research Timeline



The initial week was devoted to conducting an extensive literature review, delving into relevant research on Bloom's Taxonomy, computerised assessments, and higher-order thinking skills in online education. The research questions and objectives were carefully formulated and finalised during this phase. All necessary ethical approvals and permissions were obtained to ensure the study's compliance with ethical guidelines. In the second week, participants were recruited for the study. The target was to enlist 28 students from the aeronautical engineering V semester and 30 from the automobile engineering V semester. A comprehensive introduction to the study's purpose was provided to the students, and informed consent was obtained from each participant, emphasising the voluntary nature of their involvement. During week three, a pre-test was administered. The pre-test comprised computerised assessments meticulously designed based on Bloom's Taxonomy to assess the participants' baseline higher-order thinking skills. As the study entered its fourth week, it shifted towards implementing the computerised assessments for the control group (traditional class) and the experimental group (online class).

These computerised assessments targeted higher-order thinking levels: applying, analysing, evaluating, and creating. Week five was dedicated to conducting interviews with a subset of participants from both the control and experimental groups. The interviews revealed more about the participants' attitudes toward computerised assessments and their experiences in the online learning environment. These qualitative data were critical in understanding the participants' opinions and discovering significant information that supplemented the quantitative data.

In Week 6, the emphasis shifted to data coding, where material acquired from digital examinations, questionnaires, and interviews was rigorously organised and classified. This coding technique yielded a manageable, structured dataset, the foundation for additional data analysis. Week 7's main focus was data analysis, as the researchers reviewed the quantitative and qualitative information gleaned from the exams and interviews. The performance of the control and experimental groups in computerised assessments, which indicated higher-order thinking skills, was compared using rigorous statistical analysis of quantitative data. Moreover, the qualitative data from the surveys

and interviews were thoroughly examined to understand better participants' viewpoints, experiences, and perceptions regarding the efficacy of computerised assessments in the online learning environment.

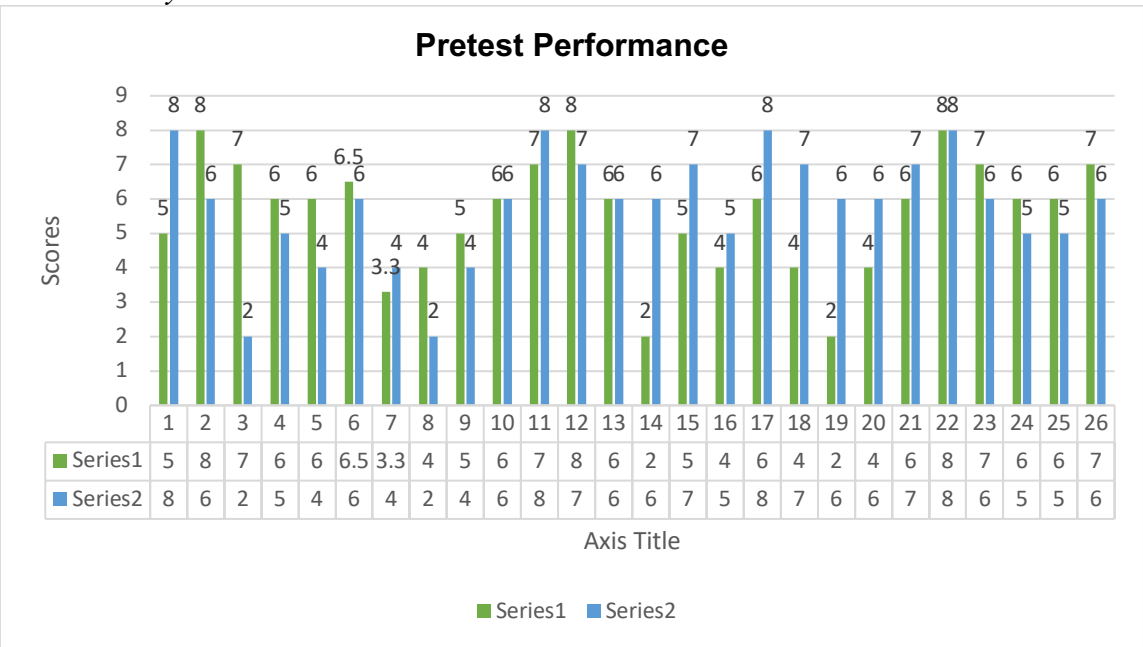
The study team completed a crucial stage in week eight when they analysed the data they had gathered and looked for repeating trends. Patterns, trends, and important themes become apparent after careful analysis, offering important details regarding how computerised exams affect the development of higher-order thinking skills in online students. In Week 9, when the study came to an end, the researchers summarised the results of the data analysis. Conclusions about the effectiveness of computerised examinations in building higher-order thinking skills in online education were meaningful and evidence-based due to data coding, analysis, and theme identification. The researchers highlighted the study's advantages and disadvantages as they outlined their main conclusions. The emphasis shifted in the final week (Week 10) to showcasing the critically important findings and suggesting directions for further investigation. In addition to providing evidence-based ways for utilising these exams to foster higher-order thinking skills across diverse online students, the research report's primary findings highlighted the advantages of integrating computerised assessments in online education. The researchers also recommended topics for further investigation, ultimately assisting teachers and instructional designers in developing effective and interesting learning opportunities for their students.

Results

As stated, the control and experimental groups took a business presentation pre-test. The study included 28 fifth-semester aeronautical engineers and 30 fifth-semester car engineers. Two students from control groups and three experimental group students who still need to complete all research phases were omitted from the analysis. Each group had 26 students. The pre-test analysis of both groups is shown in Figure 5.

Figure 5.

Pre-test Analysis



To further investigate and demonstrate if this difference is statistically significant, a paired t-test was performed. The paired t-test results provide insights into the significance of the observed differences regarding their business presentation skills. The paired t-test indicates that the difference between the groups is not discernible, as indicated in Table 2.

Table 2

Paired t-test comparison of two groups

Descriptives	**Paired Differences**					**t**	**df**	**Sig. (2-tailed)**
	Mean	Std. Deviation	Difference	95% Confidence Interval of the Difference Lower	Upper			
Control pretest Score	5.127	1.982	0.335	1.25476	1.35476	1.20	26	0.006
Experimental pretest Score	5.462	1.853	0.349	1.263542	1.27354			

The paired t-test analysis compared the pre-test scores between the control and experimental groups. The control group had a mean pre-test score of 5.127 (SD = 1.982), while the experimental group had a mean pre-test score of 5.462 (SD = 1.853). The calculated t-value was 1.20 with 26 degrees of freedom, and the two-tailed p-value was 0.006. The p-value indicates only a marginal difference in the pre-test scores between the two groups. The 95% confidence interval for the difference in pre-test scores ranges from 1.25476 to 1.35476. The test results suggest that the experimental group had slightly higher pre-test scores than the control group before applying any intervention or treatment. Overall, the results demonstrate an insignificant variation in the pre-test scores between the control and experimental groups, indicating that they are homogenous. An analysis of the post-test concerning the research question is made in the next section.

Post-test tasks- Application level

RQ1: In their business presentations, do students in the traditional class exhibit higher-order thinking skills at the Applying level to a greater or lesser extent than students in the online class?

In the traditional class, the instructor designed assessment tasks aligned with Bloom's Taxonomy to evaluate students' business presentation skills. For the "Applying" level, students were given in-class application exercises and real-life situational topics to deliver their business presentations. The instructor observed and evaluated their ability to apply theoretical concepts to practical scenarios and engage the audience effectively. The instructor replicated the assessment tasks in the online class using Moodle Cloud, an online learning platform. For the "Applying" level, students engaged in interactive simulations and virtual samples, demonstrating their ability to apply business presentation skills in realistic scenarios. The instructor facilitated using Moodle Cloud tools to create engaging virtual experiences. Based on Research Question 1 (RQ1), the table presents the paired sample statistics for the "Applying" level of Bloom's Taxonomy in both the traditional class (control group) and the online class (experimental group). The table

provides information on each group's pre-test and post-test total scores and their means, standard deviations, and standard error means.

Table 3

Paired Samples Statistics, Application Level

Descriptives	Mean	N	Std. Deviation	Std. Error Mean
Pre-test Total Score (Control group)	14.2034	26	2.40506	.22789
Post Total Score	20.6173	26	4.40826	.42031
Pre-Total Score	15.3091	26	2.41345	.22931
Post Total Score	24.5545	26	4.48765	.42097

The data in Table 3 show that both the control group (traditional class) and the experimental group (online class) experienced an improvement in their mean total scores from the pre-test to the post-test, indicating progress in their business presentation skills. However, the experimental group's mean post-test total score (24.5545) is substantially higher than the control group's mean post-test total score (20.6173). This performance suggests that students in the online class, who engaged in interactive simulations and virtual samples through Moodle Cloud, exhibited higher-order thinking skills at the "Applying" level to a greater extent than students in the traditional class who participated in in-class application exercises and real-life situational topics. The findings support the research question that integrating Moodle Cloud-based interactive activities enhances students' ability to apply theoretical concepts to realistic scenarios, resulting in improved business presentation skills at the "Applying" level. The study also aligns with the previous study on the application level of Bloom's taxonomy (Chang & Chung, 2009). The difference in mean post-test total scores between the two groups suggests that the online class format, with its virtual experiences, positively impacted students' higher-order thinking skills in the context of business presentations.

RQ2: Regarding higher-order thinking abilities at the Analysis level, how do students in the traditional class and those in the online programme differ in their business presentation abilities?

At the analysis level, the instructor encouraged collaborative discussions through Moodle Cloud, where students provided written feedback on each other's online presentations. The instructor moderated discussions to guide students effectively. At the analysis level, the instructor facilitated discourse analysis of the presentations during classroom discussions. Students presented their business pitches, and the class engaged in discussions to identify strengths and weaknesses in the presentations, analyse the logical flow and assess the effectiveness of visual aids. The instructor guided the discussions to deepen the analysis and provided feedback on presentation improvements. Based on Research Question 2 (RQ2), Table 4 presents the paired sample statistics for the analysis level of Bloom's Taxonomy in both the traditional class (control group) and the online class (experimental group). The table displays each group's pre-test and post-test total scores and their means, standard deviations, and standard error means.

Table 4

Paired Samples Statistics, Analysis

Descriptives	Mean	N	Std. Deviation	Std. Error Mean

Pre-test Total Score (Control group)	14.9341	26	2.75986	.22789
Post Total Score	22.9865	26	4.38965	.44763
Pre-Total Score	15.3975	26	2.41345	.28654
Post Total Score	26.6972	26	4.48765	.47654

Table 4 indicates that both the control group (traditional class) and the experimental group (online class) experienced an improvement in their mean total scores from the pre-test to the post-test, demonstrating progress in their business presentation. However, the experimental group's mean post-test total score (26.6972) is significantly higher than the control group's mean post-test total score (22.9865). This mean value suggests that students in the online class who engaged in collaborative discussions through Moodle Cloud demonstrated higher-order thinking abilities at the analysis level to a greater extent than students in the traditional class who participated in in-class discourse analysis and discussions. The findings support the hypothesis that integrating Moodle Cloud-based collaborative discussions enhances students' ability to analyse presentation coherence, clarity, and structure, improving business presentation skills at the "Analysis" level. A study by Crompton et al. (2015) also reports the need for analysis-level questions for holistic assessment. The substantial difference in mean post-test total scores between the two groups indicates that the online class format, with its virtual collaborative experiences, positively impacted students' higher-order thinking abilities when analysing business presentations.

RQ3: What are the variations in higher-order thinking abilities displayed by students in traditional and online schools during business presentations at the evaluation level?

For the "Evaluating" level, the instructor organised in-class evaluation discussions and peer assessment activities. After each presentation, peers provided constructive feedback, and the instructor also offered input based on predetermined evaluation criteria. The instructor encouraged students to critically evaluate each other's work, identify areas for improvement, and suggest actionable recommendations. For the "Evaluating" level, the instructor facilitated online collaborative discussions and virtual peer assessment activities. Students reviewed and evaluated their peers' presentations using standardised rubrics on Moodle Cloud. The instructor encouraged students to offer fair and constructive evaluations, fostering critical thinking in the assessment process. According to Seibert (2022), evaluation questions provide a complete framework for assessment.

Based on Research Question 3, the table presents the paired sample statistics for the "Evaluating" level of Bloom's Taxonomy in both the traditional class (control group) and the online class (experimental group). The table provides information on each group's pre-test and post-test total scores and their means, standard deviations, and standard error means.

Table 5

Paired Samples Statistics, Evaluation

Descriptives	**Mean**	**N**	**Std. Deviation**	**Std. Error Mean**

Pre-test Total Score (Control group)	17.8742	26	3.11202	.21984
Post-test Total Score	23.4690	26	4.38956	.47487
Pre-test Total Score	16.5982	26	2.98743	.29978
Post-test Total Score	27.7549	26	4.76390	.48687

RQ4: How do students in the traditional class differ from those in the online class in demonstrating higher-order thinking abilities at the Creating level in their business presentations?

Lastly, at the Creation level, the instructor challenged students to develop creative and engaging classroom presentations on self-selected business topics. Students showcased their creativity by designing visuals and incorporating multimedia elements effectively to captivate the audience. The instructor provided guidance and feedback on enhancing presentation impact and originality. The instructor leveraged Moodle Cloud's online presentation features to allow students to record and showcase their creative business presentations. The instructor encouraged students to use multimedia elements effectively and guided them on making the most of online tools to deliver engaging content. Based on Research Question 4 (RQ4), Table 6 presents the paired sample statistics for the creation level of Bloom's Taxonomy in both the traditional class (control group) and the online class (experimental group).

Table-6

Paired Samples Statistics, Creation

Descriptives	Mean	N	Std. Deviation	Std. Error Mean
Pre-test Total Score (Control group)	16.5933	26	3.21435	.22113
Post Total Score	21.8328	26	4.98321	.42467
Pre-test Total Score	16.9845	26	2.21543	.27632
Post-test Total Score	29.7549	26	4.11442	.49347

The table's data indicate that both the control group (traditional class) and the experimental group (online class) experienced an improvement in their mean total scores from the pre-test to the post-test, demonstrating progress in their higher-order thinking abilities at the "Creating" level in business presentations. However, the experimental group's mean post-test total score (29.7549) is significantly higher than the control group's mean post-test total score (21.8328). The mean value suggests that students in the online class who engaged in online presentations and recording through Moodle Cloud demonstrated higher-order thinking abilities at the "Creation" level to a greater extent than students in the traditional class who participated in creative classroom presentations. The findings support the hypothesis that integrating Moodle Cloud-based online presentation features enhances students' ability to design and deliver creative and engaging business presentations, effectively incorporating multimedia elements. The substantial difference in mean post-test total scores between the two groups indicates that the online class format, with its online presentation and recording experiences, positively impacted students' higher-order thinking abilities in creating innovative and captivating

business presentations. Throughout the assessment process, the instructor ensured clear instructions and grading criteria, maintaining consistency in evaluation across traditional and online classes. The instructor's design and facilitation of assessment tasks supported the students' development of higher-order thinking skills in business presentations. The inferential and descriptive statistics have supported online assessments. Previous researchers reinforce the importance of higher-order thinking. (Thompson & Lake, 2023; Richland & Simms, 2015). The following section presents the qualitative analysis of the efficacy of online assessments.

Analysis of the Structured Interview based on HOTS

A structured interview was conducted with 26 students belonging to the experimental group. The questions tested their responses to four levels of higher order, namely application, analysis, evaluation and creation. For each category of higher order, one structured question was formulated. The questions and the responses are presented below,

Application

How did the course material or activities assist you in developing practical problem-solving skills?

All responses to the questions were positive. Some extracts are given here.

Sample Responses: 1. The course material and activities were immensely beneficial in helping me develop my practical problem-solving skills. 2. We were given real-world business problems to address, such as developing a marketing plan for a new product. The online activities allowed me to implement the learned theoretical concepts in a practical setting. 3. It was intriguing to see how our solutions translated into tangible results, and it bolstered my confidence in my ability to handle similar challenges in the future."

Analysis

Did the course enhance your ability to analyse information critically? If so, how have you utilised critical analysis in your business presentations? Some responses are given below.

Sample Responses: Unquestionably! The course significantly enhanced my critical analysis skills. One of our assignments required us to analyse and derive conclusions from market research data. It required identifying data-based trends, patterns, and underlying causes. This exercise taught me how to methodically approach complex data sets and make well-founded decisions based on the insights gained. It was an important skill to acquire for business presentations and beyond."

Evaluation

Were you required to evaluate business presentation-related arguments, claims, or evidence during the course? How has this process enhanced your comprehension and decision-making?

We were required to evaluate business presentation-related arguments and evidence on multiple occasions. We had to evaluate and provide feedback on one another's presentations for our group assignments. It taught me to be more discerning with the presented information and consider multiple viewpoints before judging. It refined my evaluative abilities, and I now view information with a more critical eye."

Creation

Describe a particular assignment or project in the course that allowed you to demonstrate your creativity and innovative thinking. How did you approach the creative process? What were its results?
"One of the most enjoyable assignments was when we were asked to create a product pitch for a startup idea of our own," said a student. I could express my creativity by designing visuals and integrating multimedia elements into the presentation. I chose to create an animated video, which was well-received by both my classmates and the professor. It was a wonderful opportunity to demonstrate my creative thinking and experiment with various presentation techniques."

Inferences of the Interview Questions

Inference for RQ1: Based on their responses to the structured interview questions, the experimental group students perceived the course material and activities to be extremely beneficial in developing their practical problem-solving skills. Students reported engaging in real-world business challenges, such as developing marketing strategies for new products, which allowed them to apply theoretical concepts in a practical setting. This positive feedback indicates that incorporating higher-order thinking activities aligned with the Applying level of Bloom's Taxonomy into the online course enhanced the students' ability to think critically and effectively apply their knowledge to real-world scenarios.

The inference for RQ2 is based on the student's responses to the structured interview question regarding critical analysis skills, revealing that the course substantially enhanced their abilities in this area. They mentioned assignments requiring them to analyse market research data, recognise trends, patterns, and underlying causes, and make well-informed decisions based on the insights. These results indicate that the online course, emphasising activities aligned with the Analysing level of Bloom's Taxonomy, effectively developed students' critical thinking and analytical skills, enabling them to dissect complex data and draw meaningful conclusions for their business presentations.

Inference for RQ3: The structured interview responses related to the Evaluating level demonstrate that students in the experimental group actively evaluated arguments, claims, and evidence related to business presentations. During group assignments, they provided feedback on their classmates' presentations, which enhanced their evaluation skills and fostered a more discriminating approach to information. According to student responses, higher-order thinking exercises matched with Bloom's Taxonomy's Evaluating level in the online course effectively promoted critical assessment and analysis of information, boosting students' decision-making skills.
Inference for RQ4: The structured interview data from the Creating level demonstrated that experimental group students had numerous opportunities to demonstrate their creativity and inventive ideas in the online course. They demonstrated their creativity by generating visuals and incorporating multimedia components into their presentations as part of their homework. Positive student response suggests that the course's concentration on activities matched with Bloom's Taxonomy's Creating level stimulated creative thinking and uniqueness in the students' business presentations. The structured interview responses show that the online course efficiently improves higher-order thinking skills in pupils. The incorporation of activities aligned with Bloom's Taxonomy at various levels provided a comprehensive learning experience that enhanced students' problem-solving,

evaluation, and creative thinking skills in the context of business presentations. The positive responses from the experimental group students highlight the importance of designing courses with a strong theoretical framework, such as Bloom's Taxonomy, to cultivate higher-order thinking skills and enhance the quality of online education.

Discussion

This study examined higher-order thinking skills (HOTS) to distinguish between students in traditional and online educational environments. According to the results, experimental group students performed better on HOTS than the traditional cohort. The experimental group demonstrated a more favourable attitude towards learning and were more willing to apply what they learned in practical settings. These findings indicated that using computerised tests to promote HOTS in online settings can be effective in higher education.

This study's findings provide valuable insights into the efficacy of computerised assessments aligned with Bloom's Taxonomy in fostering higher-order thinking skills in the context of online education. The efficacy of online assessments has already been studied (Mayer, 2022; Halawi et al., 2009). However, previous studies have yet to use the HOTS framework in the context of online assessment. Therefore, this study makes a significant contribution to online assessments. The study set to determine how such assessments could be developed and implemented strategically to promote critical thinking and in-depth learning among online students. The course material and activities were extremely beneficial in developing their practical problem-solving skills (Applying level), enhancing their critical analysis skills (Analysing level), encouraging critical evaluation of arguments and evidence (Evaluating level), and encouraging creativity and innovation in their presentations (Creating level). These results indicate that computerised assessments aligned with Bloom's Taxonomy effectively met the research objectives by fostering higher-order thinking skills in online students. The findings of this study highlight the effectiveness of computerised assessments aligned with Bloom's Taxonomy in promoting higher-order thinking skills (HOTS) in online education. These results are consistent with earlier investigations into the usefulness of online tests (Prakash & Litoriya, 2022; Miri, David, & Uri, 2007). Bloom's Taxonomy is responsible for the computerised exams' efficacy in developing HOTS in our study. According to the findings, each task builds on the knowledge and abilities students have mastered in previous assessments, ensuring that students are continuously challenged. The study aligns with Muhayimana et al. (2022), who used Bloom's taxonomy to analyse the cognitive levels of English test questions in Rwandan schools. Students in our study have benefited from the use of Bloom's Higher-Order Thinking Skills (HOTS) in online learning, which has increased engagement, improved comprehension, and sharpened critical thinking. Online platforms provided a variety of tools, such as forums and simulations, to support participatory experiences that advance HOTS. These platforms' collaborative tasks promoted peer-based learning, helping students hone their critical thinking abilities. Real-world problem-solving tasks in an online environment also made learning more pertinent and prepared students for difficulties at work. In essence, using HOTS in online education provides students with the abilities they need to successfully navigate the online environment.

The advent of digital learning platforms and the use of well-defined theoretical frameworks such as Bloom's Taxonomy have indicated a transformative change in educational paradigms. This research, firmly grounded in Bloom's theoretical framework, illuminates how these platforms can facilitate the development of higher-order thinking skills (HOTS) in students. At the core of our discussion lies the fundamental significance of Bloom's Taxonomy. The cognitive skills are organised hierarchically and serve as a compass for learners during the learning process. In virtual educational environments, where the physical interaction between teachers and students is constrained, Bloom's taxonomy is of utmost importance. This approach guarantees that learners are exposed to carefully designed tasks that systematically guide them through various cognitive levels, leading them from the fundamental understanding of content to complex problem-solving and creative thinking. The research conducted by Amin & Mirza (2020) and Crompton et al. (2019) emphasises an important aspect: the impact of online platforms on the development of higher-order thinking skills is significantly influenced by their design and the educator's proficiency in utilising technology. The present study places significant importance on utilising organised theoretical frameworks, such as Bloom's Taxonomy, in conjunction with computerised evaluations within online courses. Abuhassna et al. (2020) support this perspective by demonstrating a clear correlation between course design and student happiness, emphasising the importance of a comprehensive and well-informed design approach. The present study builds upon the existing literature by examining computerised assessments within the framework of these previous findings. This statement highlights the notion that computerised tests provide the advantages of scalability and immediacy. However, their true potential in fostering higher-order cognitive skills is realised when they are effectively integrated into a framework such as Bloom's Taxonomy. According to our research, this integrated method is crucial in advancing online education beyond basic levels and facilitating holistic cognitive growth.

The findings from our structured interviews revealed that students held a positive perception of the course contents, perceiving them as highly advantageous. The act of actively participating in real-world corporate challenges emphasises the fundamental nature of experiential learning. The practical implementation of abstract knowledge aligns with the Applying stage of Bloom's Taxonomy. The input received from the students indicates a strong inclination towards augmenting critical thinking abilities. When considering analytical ability, students frequently mentioned tasks that required them to analyse complex data and discern underlying patterns. This technique aligns with the Analysis level of Bloom's Taxonomy. Incorporating these exercises into online courses can foster analytical skills and empower students to approach complex situations. The study revealed that evaluation as a higher-order skill goes beyond merely comprehending. Our results concur with Bloom's Taxonomy's Evaluating level, highlighting the value of assignments that ask students to evaluate and reflect. The study shows that carefully crafted online tasks can enhance learning outcomes. The improved creative outputs from the experimental group confirm Widiana et al.'s (2023) sentiments and emphasise how HOTS can foster effective learning. Bloom's taxonomy emphasises comprehensive cognitive development rather than just sequential learning.

In summary, the symbiotic link between formal theoretical frameworks and contemporary online learning environments has the potential to reshape the educational landscape completely. Educators must provide students with skills to help them negotiate the challenges of the 21st century as they pursue their academic and professional goals. The promise of online education in fostering holistic cognitive growth is highlighted by the combination of Bloom's Taxonomy with computerised tests, which offers an invaluable approach. Inferring from the theoretical underpinnings, it is clear that pedagogical models like Bloom's Taxonomy have always placed a strong emphasis on a logical progression in cognitive development. The integration of this framework with contemporary online learning platforms enhances the scope and intensity of educational engagements. As learning progresses into the era of digitalization, the integration of traditional ideas with technical breakthroughs in the field of assessment serves to affirm the enduring significance and emphasises the necessity of ongoing pedagogical adaptation. The synchronisation of HOTS and practical applications is of utmost importance in cultivating an enhanced educational setting that is both relevant and firmly grounded in established pedagogical principles.

Implications of the Study

This study's conclusions have several ramifications for online education. First, the study contends that computerised tests are useful for fostering HOTS. Second, the study results imply that technology can improve HOTS for online students. This result is possible because technology can produce interactive simulations and virtual samples that aid real-world problem-solving and analytical thought. Third, the study's findings indicate that group conversations help corporate presentations be evaluated and creatively.

Limitations of the Study

The study includes several constraints. First, the study's small sample size limited how far the results could be applied. Second, because just one online learning environment was used for the study, it is not easy to extrapolate the results to other online learning environments. Third, the study did not examine the long-term impacts of computerised assessments on HOTS.

Suggestions for Future Researchers

It is recommended that future researchers undertake a study of greater magnitude, with a wider range of participants, to enhance the results' applicability. It is recommended that a study be conducted across several online learning environments to ascertain the generalizability of the findings to different contexts. Furthermore, it is essential to assess the enduring impact of computerised evaluations on higher-order thinking skills (HOTS) to ascertain their long-term efficacy. Moreover, it is imperative to investigate how the findings can be applied to various disciplines and subject matters. Ultimately, it is advisable to integrate qualitative methodologies such as focus groups or surveys to gather students' perspectives and input, enhancing comprehension of their encounters with computerised examinations.

Conclusion

The present study revealed that the utilisation of computerised tests that are under Bloom's Taxonomy has the potential to enhance higher-order cognitive abilities within

the context of online education. The results indicate that computerised tests that are well structured have the potential to enhance profound learning and foster critical thinking skills among individuals engaged in online learning. Further investigation is warranted to explore the generalizability of these findings across various academic fields and subject matters and examine the influence of technology on cognitive scaffolding. The ongoing influence of technology on the educational domain necessitates additional investigation and improvement of computerised assessment methodologies. These efforts are crucial for maximising the educational achievements of online learners and augmenting the overall excellence of online educational programmes.

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