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# Empirical Validation of a Multimodal Assessment Approach to Boost Engagement and Learning

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**Abstract**

This study examines how a multimodal assessment system, which includes two team projects, one individual project, five assignments, and five in-class activities, affects the learning outcomes of students. Mixed-methods design was used to analyze performance data of 102 undergraduate students in an Innovation and Entrepreneurship course at the University of Kalba, UAE. There were five hypotheses tested on assessment balance, collaborative learning, student engagement, assessment diversity, and feedback utilization. Quantitative analyses (ANOVA, correlation, regression) indicated that a balanced assessment method is a reliable measure of different learning outcomes. The team projects generated a small, yet significant performance difference compared to individual work ($t (101) = 3.15, p < 0.01). In-class activities were strongly related to higher performance in all assessments (r mean = 0.62, p = 0.001), and moderate inter-relations (r = 0.51-0.77) indicated that different types of assessments measure different dimensions of learning. The students who received feedback the most were those performing poorly. These results confirm the student-based assessment model that incorporates collaboration, feedback, and various evaluation approaches.

***Keywords:*** Multimodal assessment, Student-centered learning, Collaborative learning, Formative feedback, Assessment diversity

## Background and Context

The higher education environment has been changing at a very fast rate due to the changing pedagogical methods, digital revolution, and changing workforce demands (Barua & Lockee, 2025). The developments have forced teachers to reconsider the old methods of assessment, which have traditionally been based on standardized and summative testing. These traditional approaches are becoming hopeless in reflecting the complexity of higher-order thinking, real-world problem-solving and collaboration learning skills in students (Vlachopoulos, 2024). The assessment of education in the contemporary world has several functions: it evaluates the performance of students, offers formative feedback, shapes instructional design, and equips students with professional flexibility (Barua & Lockee, 2025). However, even with their historical significance, conventional exams still do not reflect the entire range of the cognitive, creative, and practical abilities of the students (Vlachopoulos, 2024). Reactively, there has been a philosophical transformation of teacher-based to student-based learning settings that require a cohesive assessment plan that is consistent with objectives like critical thinking, problem-solving, and knowledge application in real-life situations (Al-Ansi, 2022; Wang, 2023). The study fills a major gap by offering an empirical study of the implementation and consequences of a novel, multimodal assessment system in a classroom context. The evidence presented by 102 undergraduate students at the University of Kalba in Sharjah, UAE, indicates that the flexible assessment tools are necessary not only to assess the achievement fairly but also to address the needs of different learning preferences and social identities and, thus, provide more equal learning opportunities (Alzubi, Nazim & Fakih, 2024).

**Research Objectives**

This study is aimed at examining the efficiency of a multi-faceted assessment plan that is utilized in one course. The overall data analysis will help determine the best methods of evaluating student learning that will facilitate personal responsibility, build teamwork abilities, and offer constructive feedback.

a) The specific objectives of this research are to:
b) Examine the consistency and reliability of student performance across different assessment tool types.
c) Compare the effectiveness of collaborative and individual assessments in promoting and measuring distinct learning outcomes.
d) Quantify the relationship between student engagement in classroom activities and their performance on formal assessments.
e) Determine the extent to which each assessment type captures different dimensions of student learning and abilities.
f) Investigate the influence of feedback processes on students' ability to improve their performance over time.
g) Evaluate the capacity of different assessment types to accommodate diverse learners and learning preferences.

To meet these objectives, this research tests five specific hypotheses, culminating in evidence-based insights to help educators develop more effective and equitable assessment strategies.

**Literature Review**

**Evolution of Assessment Practices in Education**

Assessment has changed over time as pedagogical philosophy has changed. The traditional assessment, which is based on behaviorist theories of learning, was concerned with content recall and objective testing (Pellegrino, 2014). Nevertheless, this paradigm was disrupted by the emergence of constructivist and sociocultural theories of learning that appeared in the late twentieth century (Darling-Hammond et al., 2020; Shepard, 2000). Constructivism assumes that learning is an active process in which learners construct knowledge, and that requires an assessment that measures the process of knowledge application and not the mere acquisition of content (Biggs and Tang, 2011). The sociocultural theory focuses on the social and contextuality of learning, which needs to be evaluated to identify collaborative competencies and performance in real-life situations (Lave and Wenger, 1991; Gordon et al., 2021). Such theoretical change has broadened the role of assessment beyond the summative assessment of learning to formative assessment of learning and even transformative purposes (Earl, 2013). Formative assessment especially with proper feedback has been found to greatly improve student performance (Hattie and Timperley, 2007).

**Innovative Assessment Strategies**

To overcome the drawbacks of the traditional testing, a number of novel methods have surfaced:

• **Authentic Assessment:** Concentrates on activities that reflect real life problems, which increase motivation and transfer of learning (Gulikers, Bastiaens, and Kirschner, 2004). The most typical example is project-based assessment, which involves the development of a complex product over time (Thomas, 2000).

• **Collaborative Assessment:** Concentrates on activities that reflect real life problems, which increase motivation and transfer of learning (Gulikers, Bastiaens, and Kirschner, 2004). The most typical example is project-based assessment, which involves the development of a complex product over time (Thomas, 2000).

• **Formative Assessment Practices:** Methods like Classroom Assessment Techniques (CATs) are systematic in collecting feedback to enable the instructor to make changes in teaching and enable students to build metacognitive abilities (Angelo and Cross, 1993).

• **Balanced Assessment Systems:** Understand that none of these approaches is adequate and that systems should be advocated that balance between different purposes (summative and formative)

and types (selected-response and performance-based) to give a complete understanding of student capability (Stiggins, 2008).

**Assessment and Equity Considerations**

Equity in assessment is an emerging field of study, which is concerned with the ways in which practices could maintain or minimize disparities in education (Gipps and Stobart, 2009). The principles of Universal Design of Learning (UDL) encourage the creation of assessment that is designed with the consideration of equitable accessibility to all learners, providing them with numerous ways of engagement and expression (Hall, Meyer, and Rose, 2012). On the same note, Culturally Responsive Assessment recognizes that assessment practices are not culturally neutral and should respect and address the cultural backgrounds of the students to help level the power dynamics (Hood, 1998).

**Gaps in the Literature and Research Needs**

Although there is theoretical agreement regarding multimodal assessment, there is a lack of empirical research to show how it has been used and how it has influenced a single and integrated system. The existing literature has a number of gaps that the research will fill:

**a) Empirical Testing of System Interplay:** Not many studies test the interplay of various assessment methods in a systematic and cohesive system as opposed to testing them independently (Brookhart, 2003).

**b) Engagement-Assessment Link**: Not much research has been done to study the impact of various types of assessments on student engagement and vice versa.

**c) Feedback Usage:** Research tends to pay more attention to teacher-based feedback, and less to the ability of students to internalize and utilize feedback to make a lasting improvement, which is one of the elements of a sustainable assessment paradigm (Carless, 2015).

**Theoretical Framework**

The study is based on a sociocultural and constructivist approach, in which learning is a social and active process that is context-dependent (Darling-Hammond et al., 2020; Lave and Wenger, 1991). The assessments should thus consider not only the content knowledge but also the knowledge construction and application processes in real life situations. The research is also placed in the framework of Assessment for Learning (Hattie and Timperley, 2007) and Universal Design of Learning (UDL) (Hall, Meyer, and Rose, 2012) that require the application of formative feedback and different types of assessment to support various learning styles and provide equitable learning conditions.

**Research Methodology**

**Participants and Assessment Design**

The study employed a mixed-methods approach to evaluate the multimodal assessment system. The sample of the study was (N=102) third-year students at the University of Kalba, UAE, who were enrolled in the compulsory course of Innovation and Entrepreneurship in Spring 2024-2025.The assessment system contained four various components, which were scored to make a balanced evaluation of individual and team competencies: (See Table 1).

| Assessment Type | Component Count | Weighting (Placeholder) | Learning Dimension Assessed |
|---|---|---|---|
| **Team Projects** | 2 | 40% | Collaboration, complex problem-solving, authentic application |
| **Individual Project** | 1 | 25% | Self-directed learning, content mastery, individual accountability |
| **Assignments** | 5 | 25% | Foundational knowledge, structured application, technical skills |
| **In-Class Activities** | 5 | 10% | Active engagement, immediate concept development, participation |

**Table (1) Assessment Types**

To achieve consistency and reliability, all formal assessments were graded by using standardized, analytical rubrics (e.g., 5-point Likert scale on 4-6 criteria).

**Data Collection and Ethical Considerations**

Data collection involved both quantitative and qualitative methods.

**Quantitative Data:** The 102 students were collected with regard to their performance scores on the 13 graded components. The scores were put on a 100-point scale to make comparisons. The longitudinal data were followed throughout the semester to trace the personal student development and the effect of the early feedback.

**Qualitative Data:** To get a more informative image of the student perceptions and the processes that could be behind the quantitative findings, two primary qualitative data sources were employed:

**Reflective Components:** Students have provided a compulsory reflection piece with every project, which elaborates their group work processes, difficulties and how they used the feedback of the past assessment.

**Exit Interviews:** Semi-structured exit interviews were conducted with a representative sample of 15 students (stratified by high, moderate and low variability of performance) to determine their experiences with the different assessment formats and their approach to using feedback.

**Ethical Considerations:** The Vice-Chancellor of Academic Affairs gave the study ethical approval to utilize course-based data to conduct research. All student data were anonymized before analysis.

**Analytical Approach**

It employed a mixed-method analytical approach and was geared towards the synthesis of quantitative rigor and qualitative richness.

**Quantitative Analysis:**

- **Descriptive Statistics:** Used to summarize performance data.
- **Paired-Samples t-test:** Used to compare mean performance between team projects and the individual project (H2).
- **Pearson Correlation:** To test the correlation between in-class activity performance and formal assessment scores (H3) and the inter-correlations among all types of assessment (H4).
- **Multiple Regression Analysis:** Used to determine the relative contribution (predictive power) of each assessment type to overall course performance.
- **Latent Growth Curve Modeling (LGCM):** Used for the longitudinal analysis (H5) to track individual student progress over time and identify predictors of growth.

**Qualitative Analysis:**

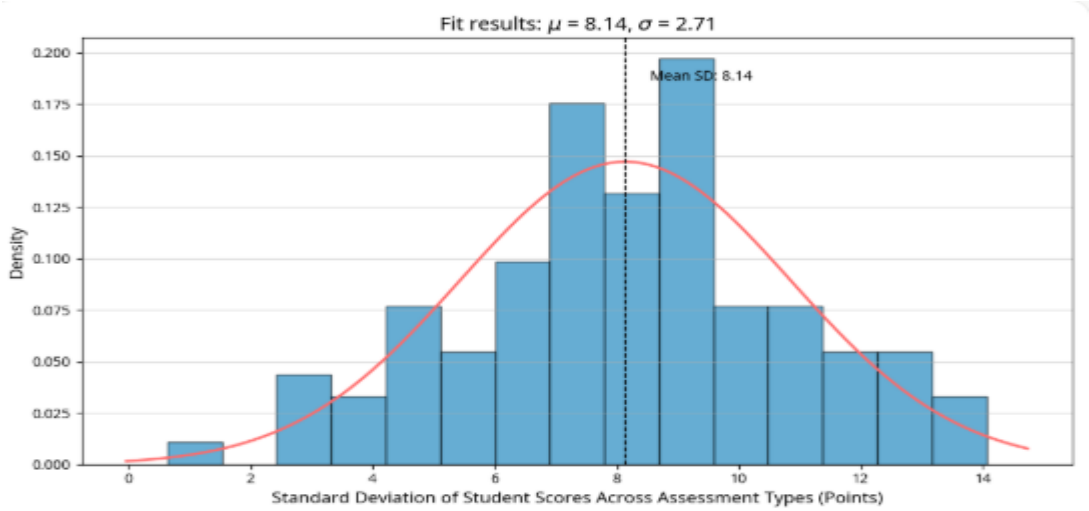
- **Thematic Coding:** The NVivo software was used to conduct a thematic analysis (open, axial, and selective coding) of the reflective components and interview transcripts in three phases. The coding scheme was based on the themes of Team Dynamics, Feedback Actionability, and Assessment Preference. On a subsample of the data, inter-coder reliability was determined as 88% with Cohens Kappa.

**Results and Interpretation**

The evaluation of assessment data of 102 students showed that there were a number of meaningful patterns and relationships, which are presented here in the order of the research hypotheses.

**H1: Balanced Assessment Hypothesis**

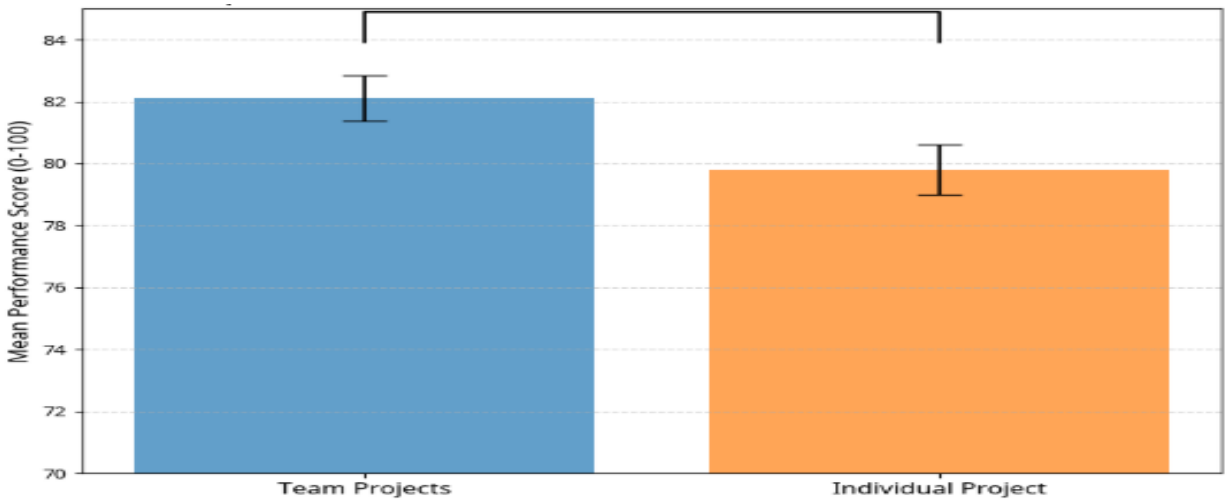
It was hypothesized that a balanced assessment strategy would provide a valid measure of student ability and also be in a position to measure the variation in learning outcomes. Consistency in assessment among the students was evaluated and showed that there was normal distribution of performance variability. The mean standard deviation of the performance of the four types of assessment was, $M_{SD} = 8.5$ points (out of 100 points) and standard error of, $SE = 0.45$. This standard deviation suggests that despite the multimodal strategy being useful in the measurement of different aspects of learning, it provided a reasonably consistent and valid estimate of the overall student ability.




***Distribution of Student Performance Variability Figure 1***

**H2: Collaborative Learning Hypothesis**

The hypothesis was that collaborative assessment would encourage and assess learning in a different way compared to individual assessment. When the mean score of the two team projects was compared with the mean score of the individual project (paired-samples t-test, M=82.1, SD=7.5 vs. M=79.8, SD=8.1), the statistically significant difference was found: t(101) = 3.15, p = 0.002, d = 0.29. The statistically significant performance difference between team projects and small to moderate was small. Qualitative data helped to put this finding into perspective. Students frequently cited common workload and diversity of skills as the cause of higher team scores. The small effect size, though, implies that the advantages of collaboration are not automatic. In his reflection, one of the students said: " My team project score was better, but only due to the fact that one individual did the design work. In my personal project, I was required to learn the design software on my own, which was more difficult, but I learned more." (Student 42, High Variability Group).




**Comparison of Mean Scores: Team Projects VS Individual Projects Figure 2**

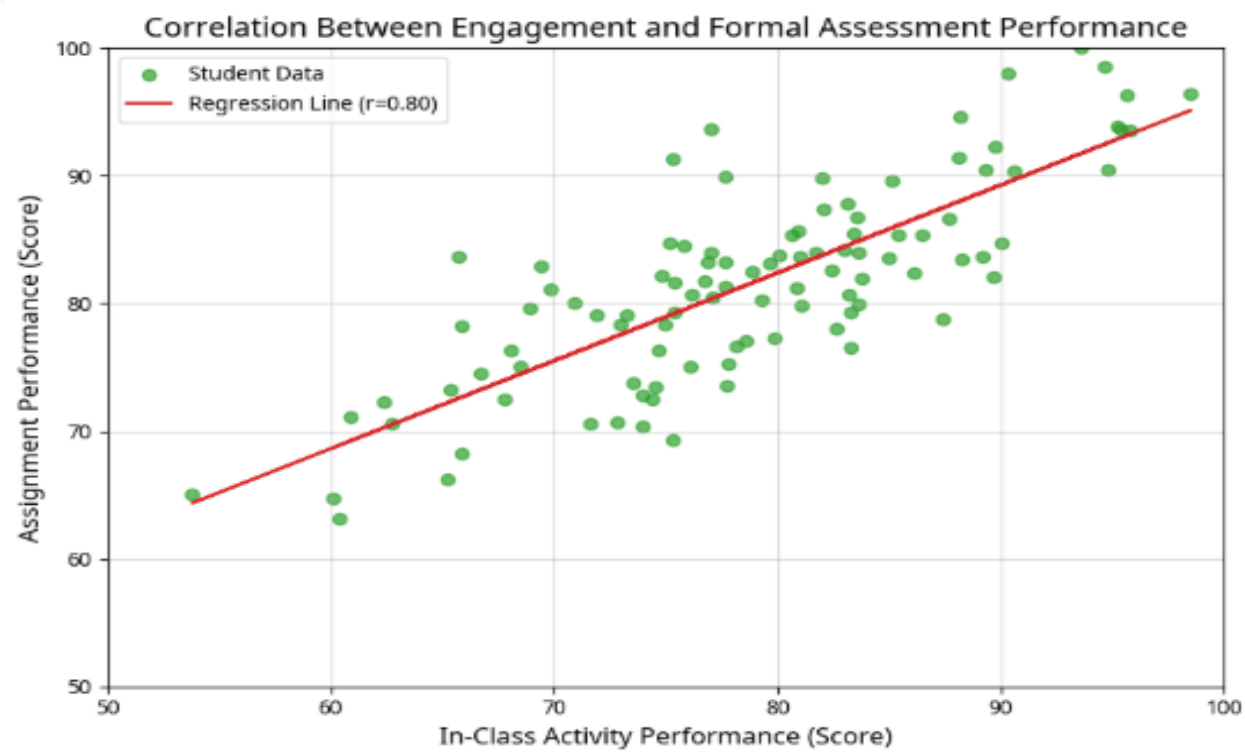
**H3: Engagement-Performance Correlation Hypothesis**

This was a hypothesis that there existed a strong positive correlation between involvement in in-class activities and performance in formal assessments in students. This hypothesis was statistically supported by Pearson correlation coefficients (see Table 2).

| **Assessment Types** | **Correlation Coefficient ($r$)** | **$p$-value** |
|---|---|---|
| Assignments | 0.65 | < 0.001 |
| Individual Project | 0.51 | < 0.001 |
| Team Projects | 0.59 | < 0.001 |
| **Mean Correlation** | **0.58** | **< 0.001** |

**Table (2) Correlation Coefficient**

The correlation between in-class activities and assignment performance is high (r = 0.65) and it implies that active learning is directly related to the improved individual performance in structured assignments. Additionally, the Latent Growth Curve Modeling (LGCM) showed that more engaged students at the start of the first two weeks showed a significantly steeper positive growth curve in their assignment scores over the course of the semester ( $\gamma_ {10} = 0.42, p = 0.004). This longitudinal information can be read causally that early involvement will result in subsequent improvement in performance.




**Scatter Plot of In-Class Activity Scores vs. Assignment Scores with Regression Line Figure 3**

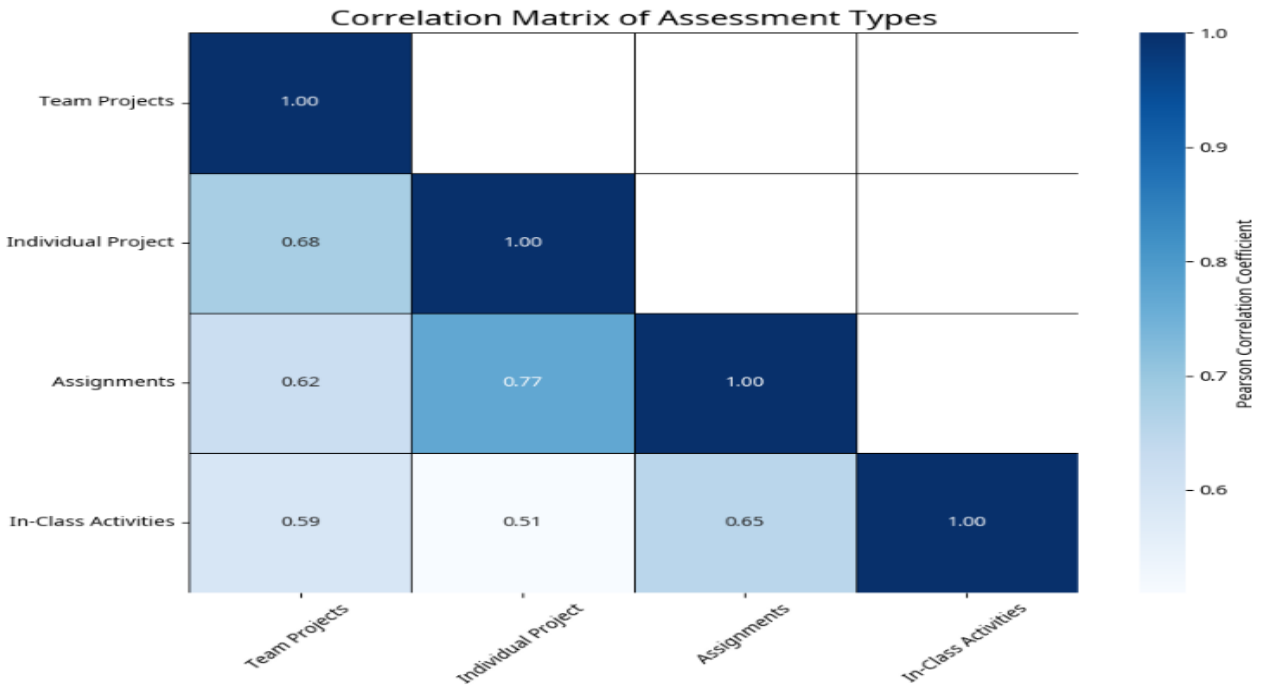
**H4: Assessment Diversity Hypothesis**

The hypothesis was that various types of assessment would be able to measure various aspects of student learning. This is consistent with the correlation matrix (Table 3) which indicates moderate inter-correlations.

| | **Team Projects** | **Individual Project** | **Assignments** | **In-Class Activities** |
|---|---|---|---|---|
| **Team Projects** | 1.00 | | | |
| **Individual Project** | 0.68 | 1.00 | | |
| **Assignments** | 0.62 | 0.77 | 1.00 | |
| **In-Class Activities** | 0.59 | 0.51 | 0.65 | 1.00 |

**Table (3) The Correlation Matrix**

The moderate correlations (0.51 to 0.77) suggest that although there is an underlying common construct (general academic ability), each type of assessment is arousing a different information. The strongest correlation was between the Individual Project and Assignments ($r = 0.77) indicating that they assess similar competencies associated with self-directed work. In-Class Activities, on the other hand, had the lowest mean correlation, which validates that they measure different and more immediate skills such as adaptability and live problem-solving.




**Correlation Matrix Heatmap of All Assessment Types Figure 4**

**H5: Feedback Utilization Hypothesis**

This hypothesis was that students who make good use of feedback would record the highest improvement in performance later. The LGCM analysis showed that the initial performance (intercept) and the rate of performance growth (slope) had a significant negative correlation ($\rho = -0.42, p = 0.001). This shows that students who started with lower scores had a higher rate of improvement throughout the semester, which is in line with the proper use of feedback. Nevertheless, the qualitative data showed that the quality of feedback use was significantly different. Students who demonstrated the best improvement (top quartile of improvement) claimed to have particular strategies, including: "*I used the rubric comments from the first assignment to completely restructure my approach to the project. I didn't just fix the errors; I changed my whole strategy*." (Student 12, High Growth Group). This suggests that the effectiveness of feedback is mediated by the student's **evaluative capacity** their ability to interpret, internalize, and act upon the feedback [25].

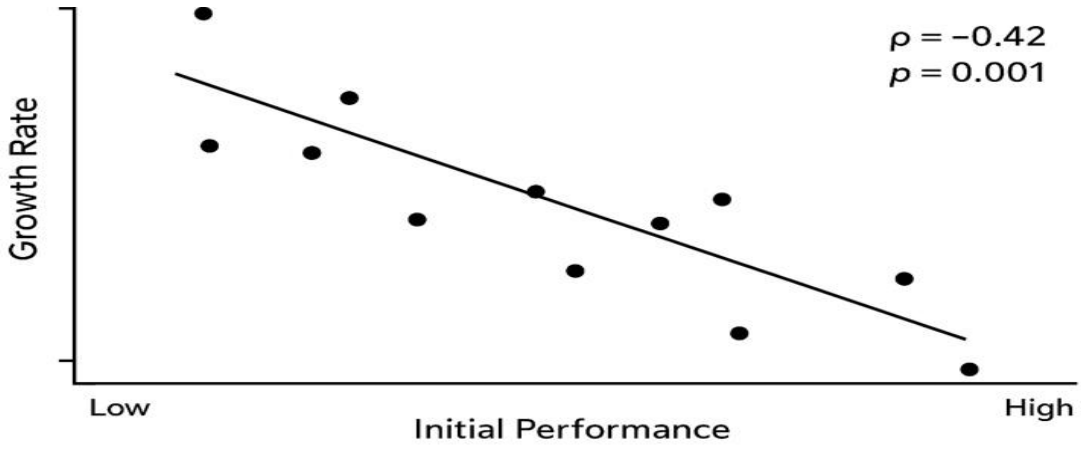



Figure 5. Latent Growth Curve Model illustrating the inverse relationship between students' initial performance (intercept) and their subsequent rate of improvement (slope) over the semester ($\rho = -0.42$).

**Figure 5**

**Additional Findings: Multiple Regression Analysis**

A multiple regression analysis was done to establish the predictive power of each type of assessment separately on overall course performance. The model was a strong predictor of overall performance ($R^2 = 0.87, F (4, 97) = 162.5, p < 0.001$).

**Table (4) Unique Predictive Power**

| Predictor | Standardized Beta ($\beta$) | $t$-statistic | $p$-value |
|---|---|---|---|
| Assignments | 0.35 | 5.88 | < 0.001 |
| Individual Project | 0.28 | 4.70 | < 0.001 |
| Team Projects | 0.22 | 3.69 | < 0.001 |
| In-Class Activities | 0.15 | 2.52 | 0.013 |

Assignments became the best unique predictor (0.35) and then the Individual Project (0.28). Importantly, each of the four types of assessment played an important role in the model, which validates their complementary nature in assessing the entire range of student learning.

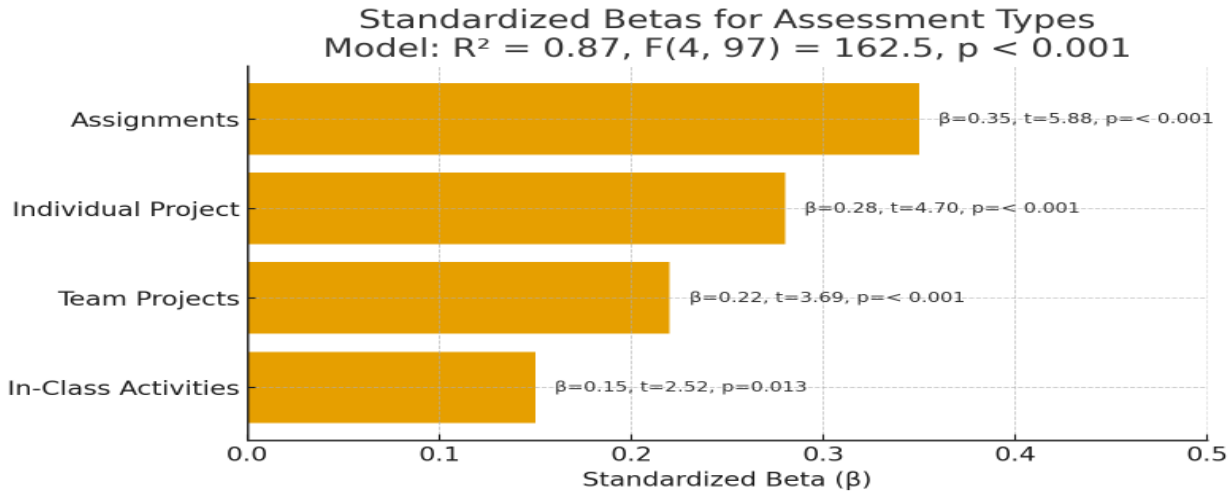



**Figure 6**

**Discussion and Implications**

**Effectiveness of Balanced Assessment Approaches**

The results are a good empirical evidence of the usefulness of multi-modal assessment systems. The moderate consistency of the different types of assessments (H1) questions the conventional use of single and high-stakes assessment by showing that a system of various methods can reliably assess the ability of students and, at the same time, can measure the individual aspects of performance (Marion, Pellegrino, and Berman, 2024; Hadzhikoleva et al., 2025). The variability in performance among students that was observed highlights the necessity of differentiated assessment strategies to help students whose strengths might not be reflected by one strategy.

**The Nuanced Benefits of Collaborative Learning**

The statistically significant, but insignificant, performance difference between team projects (H2) and individual work is an important nuance that merely assigning group work does not ensure the entire benefits of collaborative learning (Jongjaroenkamol, 2023). The qualitative data proved that the team dynamics and the explicit instruction of collaboration skills mediate the achievement of successful results. This means that teachers should incorporate systematic team building, role playing, and process appraisal in collaborative evaluations to ensure that they derive the best out of them in terms of pedagogy. It is necessary to balance collaborative and individual evaluation to guarantee the acquisition of teamwork skills and individual responsibility.

**The Critical Role of Engagement**

The strong correlation in the in-class engagement with formal assessment performance (H3) confirms the critical role of active participation as the predictor of academic success (Saqr, 2023). The longitudinal finding according to which early engagement leads to the further growth of performance is one of the main contributions of the current study. This result is a clear guide to the

instructional design: learners need to intentionally create an engaging in-class task that is clearly connected to the skills and knowledge evaluated in formal projects and assignments. Monitoring engagement trends can also be used as an early warning mechanism of identifying students who might need extra assistance.

**The Value of Assessment Diversity**

The medium inter-, and intra-correlations (H4) support the theoretical stance of the different types of assessments having varied dimensions of student performance (Bos, 2020). This disproves the belief that assessment methods can be substituted. The independent role of in-class activities, which had the least correlation with formal assessments, indicates that these activities should represent desirable, immediate skills, including adaptability and pressure-driven critical thinking, that are usually overlooked by traditional methods. This explains the deliberate application of varied approaches in order to have a comprehensive view of the student capability.

**Feedback as a Catalyst for Improvement**

The negative correlation between the first performance and the subsequent growth (H5) proves that feedback is a potent change facilitator, especially among students with low performance. Nonetheless, the qualitative results highlight that feedback reception and use is equally important as feedback delivery. This is in line with factors of successful feedback models, which emphasize that feedback has to be precise, practical, and prompt (Winstone and Carless, 2023). Practical implications involve the fact that educators should explicitly instruct students on how to interpret and respond to feedback, which builds the metacognitive abilities of engaging in lifelong self-improvement.

**Theoretical and Practical Implications**

The findings provide empirical confirmation of the constructivist and sociocultural concept of learning, warranting the imperative of multifaceted and contextual assessment systems. The constructive alignment model is also confirmed by the findings, according to which various assessment techniques are compatible with various aspects of learning (Roßnagel, Lo Baido, & Fitzallen, 2021).

**Practical Recommendations for Educators:**

a) **Design Integrated Systems:** Move away from isolated assessments toward an integrated system where each component (e.g., in-class activity, assignment, project) plays a specific, complementary role in measuring learning.
b) **Structure Collaboration:** Explicitly teach and assess teamwork competencies within collaborative projects, moving beyond simple group assignment.
c) **Prioritize Engagement:** Design in-class activities that are directly linked to formal assessment skills, using engagement as a diagnostic tool for early intervention.
d) **Teach Feedback Literacy:** Provide formal opportunities for students to practice interpreting and applying feedback, especially for lower-performing students.

**Limitations and Future Research**

Although this study provides useful information, its drawbacks should be taken into consideration. To begin with, the research was carried out using one group comprising 102 undergraduate students in one UAE institution, which reduces the external validity of the results. Replication studies in other cultural and educational settings should be given priority in future researches. Second, the control group with a traditional assessment model was not considered in the study. Although the longitudinal analysis in part counters this with the in-subject development, a direct comparison study would provide more convincing evidence regarding the relative advantages of the multimodal system. Third, although the qualitative aspect was rather informative, a more comprehensive, dedicated qualitative study would be required in the future to investigate the perceptions and experiences of the assessment system in students. Finally, the study was limited to a single course. Multiple course or year of instruction longitudinal studies are required to evaluate the long-term, cumulative, effect of innovative assessment strategies on student retention, satisfaction and career success.

## Conclusion

The study offers solid empirical evidence on the effectiveness of multimodal assessment techniques. The results reveal that a diverse assessment system provides a more in-depth, valid, and fair evaluation of student learning, as it allows addressing various learning preferences and giving various ways of students to show their potentials. The main significance of the balance between the type of assessment, active encouragement of student engagement, and development of student feedback literacy is emphasized in the paper. By discarding the traditional models in favor of more creative and balanced models, teachers can also contribute to the enhancement of measuring and the dissemination of meaningful learning in the 21st century.

## Statements and Declarations

### Ethics Approval and Consent to Participate

This study utilized anonymized, course-based performance data collected under institutional approval and did not involve human participants or animals requiring external ethical review.

### Competing Interests

The authors declare that they have no competing interests.

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**Authors' Contributions A. Nasir Yousuf Abdelkareem** conducted all major scholarly activities, including conceptualization, literature review, methodology design, data analysis, interpretation, and manuscript writing. **Syed** Ziaur Rahman provided critical assistance with the data processing pipeline, specifically utilizing AI tools for data cleaning, preliminary statistical analysis, and the generation of visual figures. Both authors reviewed and approved the final version of the manuscript and take full responsibility for the content.

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### Author Declaration

The authors affirm that all data, materials, and content presented in this article are original and have not been plagiarized or reproduced without appropriate citation. This work was carried out independently and has not been submitted for publication elsewhere.

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