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Traditional Paper-Based Versus Electronic Formative Assessments in Achievement of Course Learning Outcomes

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ABSTRACT: Formative assessment serves as both a measurement and instructional tool in academia by providing continuous feedback to refine teaching strategies in real time and guides students towards achievement of course learning outcomes. While traditional paper-based method of formative assessments remains widely used in practice, electronic assessments are rapidly gaining momentum due to scalability, immediate feedback and enhanced student engagement. This study evaluated the impact of formative assessments on students' achievement of CLOs across different domains of learning and comparison of traditional versus electronic formats. Data was collected from selected courses within a six-year bachelor's degree program during the academic year 2024–2025 with predetermined inclusion and exclusion criteria to ensure consistency and reliability. Convenience non-probability sampling technique was adopted, and sample size determination was conducted using G*power software, and data analysis was performed using SPSS version 28. Pearson correlation analysis demonstrated positive relationship between performance of students in formative assessments and CLO achievement in the two learning domains out of three at the end of the course {knowledge ($r=0.80$) and values ($r=0.88$)}, with overall $r=0.86$. The number of assessments carried out in electronic mode showed a stronger correlation with CLO achievement ($r=0.61$) than the traditional paper-based methods ($r=0.29$). Furthermore, study findings indicate that the formative assessments frequency especially through electronic mode strongly influences CLO achievement and overall student learning. Hence, institutions can integrate formative assessments in its academic structure, assessment schedules, and quality of feedback, and implement digital platforms to increase student engagements in the courses.

BACKGROUND

Formative assessment is an important section of effective teaching and learning. It functions as a measurement and instructional tool that provides ongoing feedback and guides students toward defined learning goals, and helps instructors to adjust strategies in real time.^{1,2,3} It offers repeated, low-stakes opportunities for the students to monitor progress and make timely adjustments thus strengthening achievement of course learning outcomes (CLOs).^{4,5} These assessments allow institutions to measure teaching quality, learning gains and evaluation of the effectiveness of instructional strategies.⁶ Informal methods, such as instructional dialogues capture student learning processes in real time, while longitudinal data show that education system reforms can significantly affect outcomes across multiple courses.^{7,8} Regular use of these formative assessments improves academic performance, strengthens students' self-regulation, and deepens content understanding.^{1,9,10,11} In medical and health professions education, they link theoretical learning with clinical application and support the development of professional identity.^{12,13,14}

There are various modes of delivering formative assessments. Traditional paper-based formats commonly termed as manual method of formative assessments remain extensively used, while electronic platforms (digital) are recent, but evolving rapidly due to advantages like scalability, immediate feedback, and enhanced engagement.¹⁵ Various studies suggest that electronic formats encourage participation and improve the learning efficiency^{16,17} but few others report varied outcomes while comparing them with conventional methods.^{18,19} This variability raises questions about the effectiveness of the specific modality in achieving CLOs in a structured program.

The quality of interaction between students and instructors during formative assessments also modifies the learning outcomes. Motivation theories such as self-determination theory, state that competence, autonomy, and emotional support drive persistence and achievement for the participants.^{20,21,22,23} Studies have associated constructive feedback and supportive instructor relationships with resilience, active engagement, and sustained academic effort leads to success.^{24,25} Most studies use self-reported perceptions, single-course interventions, or small sample sizes, which restricts the ability to generalize findings and evaluate how formative assessments influence CLO achievement.^{4,11,26,27,28} Large-scale analyses using institutional records remain uncommon, especially in medical and health sciences programs, where constant evaluation of both theoretical knowledge and applied competencies is essential.

This study investigated formative assessment practices at a private higher education institution in Saudi Arabia. It analysed intermediate-level courses within a six-year professional bachelor degree program to evaluate the impact of formative assessments on student achievement of CLOs across knowledge, skills, and values domains. The research compared traditional paper-based method of formative assessments with digital (electronic) formats to determine their effect on the achievement of course learning outcomes (CLOs) by students at the end of the course, providing insights into how assessment type and participation influence learning outcomes in structured health professions programs.

MATERIALS AND METHODS

Study design and participants: The present study used data from different courses of a 6-year bachelor's degree professional program during the 2024–2025 academic year across two semesters. Courses were selected from a designated program at the intermediate level to reduce the influence of competencies associated with either lower or higher levels of studies. Selection followed predetermined inclusion and exclusion criteria to ensure uniformity and reliability.

Inclusion and Exclusion Criteria: The study included those courses which provided clear, accessible data on student performance in both formative assessments and overall outcomes. The analysis considered only face-to-face courses to ensure active communication, consistent formative assessments, and immediate feedback. Courses with both theoretical and practical components were selected to maintain a balanced learning experience. Only courses that completed the full 15-week semester were qualified for the study, allowing assessment of the long-term impact of formative assessments on student achievement. Courses that used combination of both traditional paper-based and electronic formative assessment methods were selected.

The study excluded courses lacking a formal policy for administering formative assessments or delivering student feedback. Entries with incomplete or unclear data were removed to maintain reliability. Classes with fewer than 30 students were excluded to ensure adequate statistical representation. Courses restricted to only theoretical or only practical components, without a balanced approach, were also excluded.

Data Collection: The study obtained data from course files of the selected program. Course specifications, guides and assessment blue prints were reviewed to determine the structure of formative and summative assessments and their alignment with course learning outcomes. Student final grades and formative assessment scores were collected from course reports and institutional databases. Surveys and questionnaires that captured instructors and student perspectives on the design, implementation, and reporting of assessments within these courses were used to arrive at the conclusions regarding the implementation of policies related to conduction of the sessions and formative assessments.

Sampling: A convenient nonprobability sampling technique was used and the sample size was selected from designated courses within a program and the calculation of the student number was based on G*Power software, the minimum required sample size was calculated based on the following parameters: Alpha (α): 0.05; Power ($1-\beta$): 0.95; Effect size: 0.30; Degrees of freedom: 5.

Statistical analysis: Statistical Package for the Social Science (SPSS) version 28 was utilized to conduct data analysis, MS Excel was used for data entry, cleaning, and coding. Different suitable test of significance was utilized to study association between variables. Level of significance was 0.05.

Ethical Considerations: Institutional Research Review Board (IRRB) approval was taken prior to the commencement of data collection. The study posed no risk, and the review of records had no impact on students' grades, academic progression, or standing. Strict measures were taken to preserve confidentiality of the accessible data throughout the research process. Subject matter experts and experienced faculty evaluated the clarity, relevance, content alignment, and equivalence of both formats of formative assessments. The expert review ensured appropriate, credible, and acceptable level alignment of formative assessments of the selected courses reflection on the course learning outcomes.

RESULTS

Table - 1 shows the formative assessments across 12 courses in years 3 to 5. The number of formative assessments conducted varied from 9 (Course - 8) to 38 (Course - 4). Average scores of students obtained in formative assessments continuously throughout the course were generally high, ranging from 89% to 100%. Average Achievement of CLOs by the students at the end of the course following final summative assessments across the three domains of learning (knowledge, skills, and values) ranged from 79% to 91%. Courses 1, 4, 5, 7, and 12 recorded the highest CLO performance (91%), while Course 9 had the lowest (79%). Pearson correlation analysis showed strong positive associations between students' performance in formative assessment and CLO achievement in different domains, particularly for knowledge ($r = 0.80$), and values ($r = 0.88$), and "overall" CLO achievement ($r = 0.86$).

Table 1: Impact of formative assessments on achievement of course learning outcomes

Course & Year	Total Number of formative assessments conducted in course	Average Score of Students in formative assessments	Achievement percentage of the CLO based on graded assessments at end of the course			
			Knowledge Domain	Skills Domain	Values Domain	Overall (Average)
Course – 1 (3rd year)	35	95%	88%	93%	91%	91%
Course – 2 (3rd year)	26	91%	85%	83%	94%	87%
Course – 3 (3rd year)	12	96%	76%	84%	85%	82%
Course – 4 (3rd year)	38	98%	89%	90%	95%	91%

Course – 5 (4 th year)	23	93%	91%	89%	92%	91%
Course – 6 (4 th year)	11	91%	83%	86%	80%	83%
Course – 7 (4 th year)	30	92%	89%	91%	92%	91%
Course – 8 (4 th year)	9	89%	76%	79%	84%	80%
Course – 9 (5 th year)	13	93%	78%	76%	83%	79%
Course – 10 (5 th year)	19	100%	80%	76%	84%	80%
Course – 11 (5 th year)	23	94%	90%	90%	89%	90%
Course – 12 (5 th year)	31	96%	92%	88%	94%	91%
R value	-	0.409	0.80*	0.70*	0.88*	0.86*

Table 2: Correlation of the traditional versus electronic formative assessments in achievement of CLOs

Year in the course	Traditional Formative Assessments		Electronic Formative Assessments		Total Formative Assessments		Overall Achievement % of the course learning outcomes in three domains
	Number	Average Score	Number	Average Score	Number	Average Score	
Course – 1 (3 rd year)	12	94%	23	96%	35	95%	91%
Course – 2 (3 rd year)	6	90%	20	91%	26	91%	87%
Course – 3 (3 rd year)	3	94%	9	98%	12	96%	82%
Course – 4 (3 rd year)	7	100%	31	97%	38	98%	91%
Course – 5 (4 th year)	11	94%	12	93%	23	93%	91%
Course – 6 (4 th year)	6	92%	5	90%	11	91%	83%
Course – 7 (4 th year)	18	92%	12	92%	30	92%	91%

Course – 8 (4 th year)	5	89%	4	90%	9	89%	80%
Course – 9 (5 th year)	8	93%	5	94%	13	93%	79%
Course – 10 (5 th year)	7	99%	12	100%	19	100%	80%
Course – 11 (5 th year)	8	94%	15	94%	23	94%	90%
Course – 12 (5 th year)	14	95%	17	97%	31	96%	91%
R value	0.65*	0.34	0.70*	0.43			No of Traditional Assessments – 0.29 No of Electronic Assessments – 0.61 Average score traditional – (-0.27) Average score electronic – 0.23

Table - 2 compares traditional and electronic formative assessments with CLO achievement. Traditional assessments per course ranged from 3 to 18, with students' scores between 89% and 100%. Electronic assessments ranged from 4 to 31, with students' scores between 90% and 100%. Correlation analysis showed moderate positive associations for traditional assessments ($r = 0.65$) with their scores and stronger associations for electronic assessments ($r = 0.70$). The frequency of electronic assessments correlated more strongly ($r = 0.61$) than traditional assessments ($r = 0.29$) with overall attainment of CLOs. These findings indicate that assessment frequency, particularly electronic assessments, influences CLO achievement.

Table 3: Pearson Correlation Matrix: Pairwise correlations among assessment variables and CLO outcomes ($n = 12$ courses)

Variable	Total FA	Traditional FA	Electronic FA	Avg Scores in FA	Knowledge	Skills	Values	“Overall” CLO
Total FA	1.00	0.60	0.91	0.41	0.80	0.70	0.88	0.86
Traditional FA	0.60	1.00	0.20	0.73	0.69	0.54	0.51	0.65
Electronic FA	0.91	0.20	1.00	0.12	0.62	0.57	0.81	0.70
Avg Scores in FA	0.41	0.73	0.12	1.00	0.57	0.18	0.53	0.46
Knowledge Domain	0.80	0.69	0.62	0.57	1.00	0.80	0.77	0.94
Skills Domain	0.70	0.54	0.57	0.18	0.80	1.00	0.63	0.91
Values Domain	0.88	0.51	0.81	0.53	0.77	0.63	1.00	0.86
Overall, CLO Achievement	0.86	0.65	0.70	0.46	0.94	0.91	0.86	1.00

*Strong relationships ($r \geq 0.70$) are highlighted in bold.

Table 3 presents Pearson correlations between assessment variables and achievement of course learning outcome (CLOs) across 12 courses. Total formative assessments (FAs) showed strong correlations with knowledge ($r = 0.80$), values ($r = 0.88$), and overall CLOs ($r = 0.86$), and a moderate correlation with skills ($r = 0.70$). Traditional FAs correlated moderately with overall

CLOs ($r = 0.65$), knowledge ($r = 0.69$), skills ($r = 0.54$), and values ($r = 0.51$). Electronic FAs showed strong correlations with values ($r = 0.81$) and overall CLOs ($r = 0.70$), and moderate correlations with knowledge ($r = 0.62$) and skills ($r = 0.57$). Average formative assessments scores had weaker associations, ranging from $r = 0.18$ for skills to $r = 0.57$ for knowledge. These results indicate that assessment frequency, especially electronic and total FAs, influences CLO achievement more than the scores in formative assessments.

Fig - 1 shows a scatter plot of students' average formative assessment scores (x-axis, 65%–90%) versus overall achievement of course learning outcome (y-axis, 78%–92%) across 12 intermediate-level courses. Pearson's correlation coefficient was $R = 0.86^*$ ($p < 0.05$), indicating that formative assessment scores explained 74% of the variation in CLO achievement. Data points followed an upward trend, showing that higher formative assessment performance consistently corresponded to higher CLO achievement.

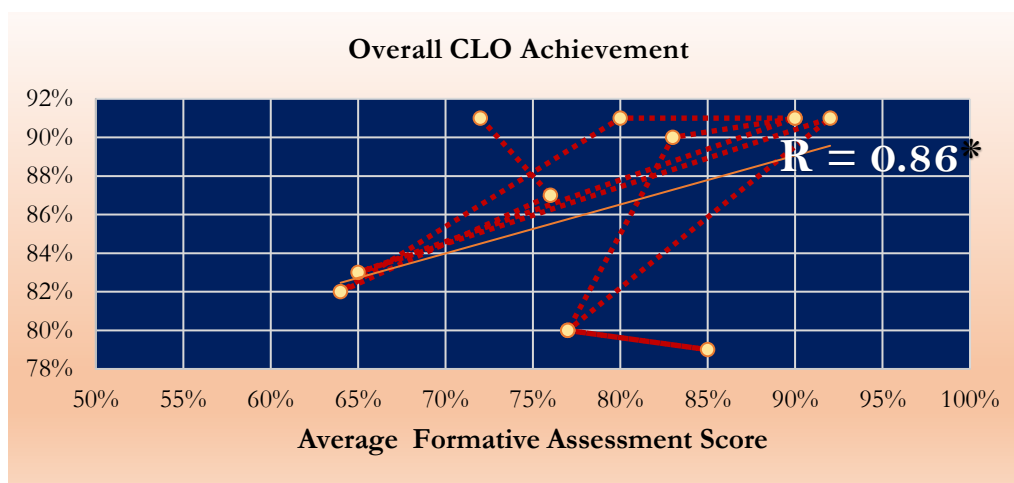


Figure 1: Scatter Plot of Formative Assessment Score vs. Overall CLO Achievement

Fig - 2 compares average scores of traditional and electronic formative assessments (FAs) with CLO achievement across 3rd, 4th, and 5th-year courses. In 3rd-year courses, traditional FAs averaged 95%, electronic FAs 92%, and overall average 94%, corresponding to 95% CLO achievement. In 4th-year courses, traditional FAs scored 96%, electronic 91%, “overall” 94%, with CLO at 96%. In 5th-year courses, traditional FAs averaged 88%, electronic 86%, “overall” 87%, while CLO achievement declined to 85%. These results indicate that both traditional and electronic assessments closely reflect CLO performance, with higher scores predicting better outcomes.

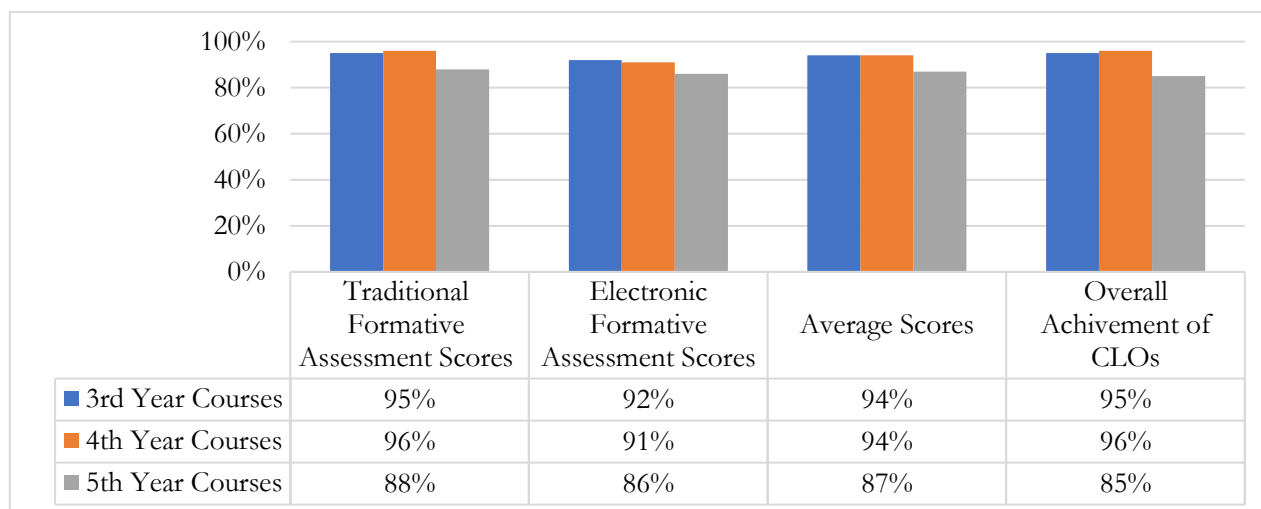


Figure 2: Formative assessment scores in traditional and electronic assessments compare to overall CLO achievement

DISCUSSION

This study evaluated how formative assessment practices influence CLO achievement in intermediate-level courses of a six-year bachelor's degree professional program. The analysis included assessment frequency, modality (traditional vs electronic), and average scores, with CLOs attained at the end of the course across knowledge, skills, and values domains. Results indicate that the frequency of formative assessments, particularly electronic assessments, strongly predicts CLO attainment, while average scores show limited predictive value. Total number of formative assessments correlated highly with overall CLO achievement ($r = 0.86$), knowledge ($r = 0.80$), and values ($r = 0.88$), and moderately with skills ($r = 0.70$). These findings were in accordance to the studies of Sirianansopa et al. and Das et al. who demonstrated that repeated low-stakes formative assessments provide structured feedback, reinforce understanding, and enhance cumulative learning across multiple domains, supporting overall summative performance.^{1,9}

Electronic formative assessments showed a stronger correlation with CLO achievement ($r = 0.70$) than traditional paper-based assessments ($r = 0.65$). Gikandi et al., showed that online assessments increase engagement through immediacy and interactivity, promoting iterative practice. Elmahdi et al., demonstrated that technology-mediated feedback enhances participation and efficiency in higher education.^{16,17} In this study, electronic assessment frequency correlated more strongly with CLOs ($r = 0.61$) than traditional assessments ($r = 0.29$), showing that digital platforms provide frequent, scalable feedback that maintains engagement and learning continuity.

Xuan et al., reported that learner motivation and institutional support influence the effectiveness of electronic assessments in K-12 classrooms, producing mixed outcomes.¹⁹ Motivated intermediate-level students and consistent faculty guidance supported effective use of electronic assessments, increasing their impact on CLO achievement. Lu et al., demonstrated that sustained online engagement with formative assessments improves course performance, confirming the role of digital platforms in reinforcing learning.¹⁵ Cong et al., reported that positive student perceptions of formative assessment in physiology emphasize electronic modalities' contribution to maintaining motivation.²

Formative assessment scores showed weak to moderate correlations with attainment of CLOs (0.18–0.57), indicating that high scores on individual assessments do not ensure long-term mastery. Karaman et al., and Kulasegaram et al., found that the design and frequency of formative assessments, rather than single high scores, drive learning through iterative practice and self-regulation. Regular engagement with formative content enhances performance across knowledge, skills, and values.^{5,11}

Year-level comparisons showed that 3rd and 4th year courses, with higher formative assessment performance (traditional FAs 95–96%, electronic FAs 91–92%), achieved CLOs of 91%, whereas 5th year courses, with lower formative scores (traditional FAs 85%, electronic FAs 86%), recorded CLOs of 80%. This pattern indicates that continuous, frequent formative assessment throughout a program supports knowledge retention and application. Arja et al. showed that consistent formative assessments strengthen clinical reasoning and professional skill development.¹² Sirianansopa and Das et al. reported that repeated low-stakes assessments improve achievement in knowledge, skills, and values. Longitudinal formative assessment supports mastery and application.^{1,9}

Formative assessments increased values domain achievement ($r = 0.88$) and developed professional attitudes and ethical reasoning. Witheridge et al. showed that formative approaches promote reflection and metacognition, linking theoretical knowledge with clinical practice.¹³ Arja et al. reported that these assessments foster reflective practice and professional identity.¹² Cong et al. found that positive student experiences boost motivation and engagement.¹⁰ Repeated assessments reinforced self-regulation, competence, and active engagement, consistent with self-determination theory.²⁰ Constructive feedback and instructor guidance-maintained effort, and a structured framework with clear assessment and feedback cycles strengthened these effects in both traditional and electronic formats.²⁹

Moderate correlations existed between paper-based formative assessments and CLOs ($r = 0.65$), knowledge ($r = 0.69$), skills ($r = 0.54$), and values ($r = 0.51$), showing their educational value but limited scalability. Electronic assessments offered frequent practice and immediate feedback, enhancing efficiency and engagement. Previous studies reported that technology-supported formative assessments promote active learning, iterative practice, and integration of knowledge and skills, aligning with the stronger correlation between electronic assessment frequency and CLO achievement observed in this study.^{10,15,16,17,18}

Average formative assessment scores showed weaker predictive value than assessment frequency, indicating that formative assessments work best as learning processes rather than summative measures. Karaman et al. and Das et al. reported that

repeated low-stakes assessments consolidate knowledge and enhance self-regulation, confirmed here as consistent engagement across multiple assessments improved learning more than isolated high scores.^{1,9} Analysis of 12 intermediate-level courses, using institutional records, quantified how assessment frequency and modality affect CLO attainment, providing practical guidance for curriculum design in medical and health professions education.

Faculty should prioritize frequent formative assessments to enhance CLO achievement. Iterative engagement, immediate feedback, and orientation with course outcomes improve mastery across cognitive, skills, and professional domains. Structured, repeated assessments with digital platforms provide consistent feedback, guide learning, and support professional development.

Strengths and Limitations

The use of actual institutional data from 12 intermediate-level courses with a large, representative sample supports the validity of the findings. Inclusion of both traditional paper-based and electronic formative assessments allows direct comparison of their effects on knowledge, skills, and values domains of learning. Analysis across multiple CLO domains with Pearson correlations gives clear insights into assessment effectiveness. The use of real performance data reduces reliance on self-reported perceptions seen in prior studies. Limitations include data from a single institution, which may limit generalizability, and exclusion of courses with incomplete data or small cohorts.

CONCLUSION

Frequent formative assessments, particularly electronic ones, strongly predict student achievement of course learning outcomes in all domains of learning. Scores in formative assessments alone do not reliably indicate performance. Incorporating regular formative evaluations into course design with consistent feedback, promotes active learning, and develops skills. Institutions can apply these findings to structure assessment schedules, enhance feedback quality, and implement digital platforms to increase engagement. Future studies should examine multi-institutional datasets, long-term retention, and interactions between formative assessments and teaching strategies. Prioritizing assessment frequency and feedback improves student mastery and professional competence in structured academic programs in health professions education.

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