

ORIGINAL ARTICLE

ONLINE VERSUS CONVENTIONAL PAPER-BASED FORMATIVE ASSESSMENT: DO THEY PREDICT SUMMATIVE SCORES?

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Background: Different mechanisms and methods to conduct formative assessments may influence the learning environment and the learning outcomes. Present study aims to compare the effect of online formative assessments with conventional paper-based formative assessments on summative scores of medical students. **Methods:** It was a prospective-observational study conducted from Oct to Dec 2018 at Shifa College of Medicine, Islamabad. A total of 93 undergraduate students participated in this study. Students were assigned two online formative assessments before the summative assessment of one module and two paper-based formative assessments before the summative assessment of another module. ClassMarker[®] software was used for online assessments. Data were analysed on SPSS-21. Continuous variables were expressed in Mean \pm SD. For qualitative variables, frequencies and percentages were calculated. Comparison of quantitative data was done using paired *t*-test and student's *t*-test. Association between performance in online and paper-based formative assessment to their respective summative scores was performed by Pearson's correlation coefficient and regression analysis, and $p < 0.05$ were considered significant. **Results:** Mean summative score (75.17 \pm 9.18) of the module with online formative assessments was significantly higher in comparison to the mean summative score (63.66 \pm 10.12) of the module with paper-based formative assessments. Students who performed better in online formative assessments had significantly higher scores in the summative assessment in comparison to the other students. There was a significant ($p < 0.001$) and positive ($r = 0.45$) correlation between scores of online formative tests and summative tests. **Conclusion:** Online formative assessments have a positive effect on the summative scores of medical students in comparison to the conventional paper-based formative assessments.

Keywords: Assessment, feedback, formative, performance, summative

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INTRODUCTION

Educational delivery has experienced remarkable methodological shifts in the past to maximise student achievement.¹ An imperative component of the educational process is knowledge assessment.² Formative assessments are one such means of assessment, aimed to ensure a deeper understanding of the syllabus and the application of knowledge in the medical field. Formative assessment comprises of academic activities that can provide information to be used as feedback to modify teaching and learning methodologies.³

The main objective of formative assessments is to gather focused feedback about the delivered content with the intent of further clarification of important concepts.^{4,5} The purpose of summative assessment is to evaluate students' knowledge, formative assessment provides feedback to students about their knowledge to positively influence their learning.⁶ Frequent formative testing results in greater continuous study throughout a course. As a result, summative scores increase.⁷ Moreover, by receiving feedback on their quiz answers, formative assessment enables teachers and learners to direct their effort towards their weaknesses.⁸ Henceforth, the entire

process of conducting formative assessments strengthens self-reflection thereby eventually enhancing the overall learning experience. Evidence also suggests that formative assessments can play an important role in helping students evolve as life-long learners.⁹ However, this strategy is believed to be useful only when there is no presumed evaluation stress present in the minds of students.¹⁰

Conventional paper-based formative assessments are conducted in a classroom setting and have some limitations which include supervision of a large number of students, the extensive time required for one-on-one feedback and post-hoc analysis of validity and reliability of the questions.¹¹ Recent trends of use of technology are providing innovative solutions for many aspects of medical education and web-based formative assessments can be used to address the above-mentioned challenges. Potential advantages of conducting computer-based formative assessments include personalised and immediate feedback, flexibility in scheduling, comfortable environment and opportunity for interactive and consistent reinforcement.^{12–14}

Kibble assessed 350 learners with two online formative quizzes prior to summative examinations. The results showed quiz scores to be significantly correlated

with summative test performance.¹⁵ However, in some instances, online formative assessment has not been associated with improved learning outcomes. For example, in a developmental psychology course, access to computerized formative assessment in preparation for summative assessment resulted in poorer exam performance.¹⁶

As evident, research comparing the efficacy of online formative assessment with traditional paper-based formative assessments is sparse and divergent in its findings¹⁷ and many institutions have been reluctant to integrate such assessments into the medical curriculum.¹⁸

With this background, the objective of this study was to investigate and compare the effect of conventional paper-based formative assessment with computer-based online formative assessment on the performance of medical students in summative modular assessments. This study has explored online formative assessments as an optional addition to the curriculum of pre-clinical integrated medical program in order to improve the academic performance of medical students.

METHODOLOGY

The ethical approval for the study was granted by the Institutional Review Board and Ethics Committee of Shifa International Hospitals Ltd. and Shifa Tameer-e-Millat University, Islamabad.

It was a prospective observational study, conducted in our institute from October to December 2018. A total of 93 undergraduate medical students participated in the study. Amongst them 40 (43%) participants were females and 53 (57%) participants were males. This study was conducted in the Essentials of Medicine (EOM) module and Cardiovascular System (CVS) module of 3rd year MBBS. Two separate computer-based online formative assessments were conducted in the EOM module of 4 weeks duration followed by a summative assessment conducted in November 2018. Similarly, two separate paper-based formative assessments of the same group of students were conducted in the CVS module of 5 weeks duration followed by a summative assessment conducted in December 2018. The participants of the study included all those students who had given their informed written consent to be a part of the study. The students who were absent when the assessments were being carried out were excluded.

Final MCQs for online and paper-based formative assessments were reviewed and validated by subject experts before dissemination to students. The software tool employed for computer-based formative assessment was ClassMarker[®] which is used to develop diverse types of questions, i.e., multiple-choice questions (MCQs), extended matching questions, short essay questions, and true/false questions.⁸ Results of the

paper-based summative assessments were also collected from the Examination department of the college. The computer-based formatives had thirty multiple-choice questions each and automated feedback was provided to students after attempting each question. The paper-based formatives also had 30 multiple choice questions each and feedback was provided to the students after completion of the assessment in a large interactive group session. The average time taken for attempting MCQs, mean scores and Cronbach's alpha for each group of every formative assessment was recorded. The EOM summative had sixty multiple-choice questions while the CVS summative had eighty multiple-choice questions. Each correct answer was given a score of 1 point. There was no negative marking. Summative assessment is prepared by subject experts according to the table of specification or blueprint for all themes taught in a module and vetted by the review committee of the health profession education department. Item analysis of summative MCQs of each module is also done to ensure reliability, validity and discrimination index on a regular basis and reviewed by faculty members involved in paper setting.

The data obtained was analysed on SPSS-21. Continuous variables were expressed in Mean \pm SD; qualitative data were expressed in frequencies and percentages. Paired *t*-test and Student's *t*-test were used to compare quantitative variables between different groups. The relationship between performance in online and paper-based formative assessment to their respective summative scores was performed by Pearson's correlation coefficient and regression analysis, and $p < 0.05$ was considered statistically significant.

RESULTS

The mean time taken to complete the computer-based formative, the mean score in computer-based formative and the associated summative score, and the mean time taken to complete the paper-based formative, the mean score in paper-based formative and the associated summative score are shown in Table-1.

Results reported a shorter mean duration for completion and higher mean scores in computer-based formative assessment as compared to paper-based formative assessment. Moreover, mean summative scores were also higher among students attempting computer-based formative assessment as compared to paper-based formative assessments.

Table-2 shows the data of students who scored more than 60% in the formative assessments as compared to students scoring less than 60%.

The scores of the two online formative assessments and the respective end of the module summative assessment; and the two paper-based formative assessments and the respective end of module

summative assessment were tested for correlation. The Pearson's Correlation Coefficient showed a positive ($r=0.45$) and significant ($p<0.001$) correlation between the online formative test score and the end of module summative test scores as shown in Table-3.

Table-1: Computer-based versus paper-based formative: completion times and scores (n=93)

	Computer based online formative assessment (Mean±SD)	Paper based formative assessment (Mean±SD)	<i>p</i>
Time for completion of formative (minutes)	18.69±3.71	25.02±3.16	<0.001
Formative score (%)	61.55±21.67	45.04±19.52	<0.001
Summative score (%)	75.17±9.18	63.66±10.12	<0.001

Table-2: Difference in mean summative scores with a cut-off value of 60 percent scores in online and paper-based formative assessments

Variables	No. of students (%) (n=93)	Mean summative score (Mean±SD)	<i>p</i>
Students with more than 60 in online formative in the EOM module	60 (64.52)	77.77±7.64	<0.001
Students with less than 60 in online formative in the EOM module	33 (35.48)	70.45±9.95	
Students with more than 60 in paper-based formative in the CVS module	30 (32.26)	61.60±9.90	0.176
Students with less than 60 in paper-based formative in the CVS module	63 (67.74)	64.65±10.14	

Table-3: Correlation between formative and summative assessment scores

Formative assessments	<i>r</i>	<i>r</i> ²	Adjusted <i>r</i> ²	<i>β</i> (95% CI)	<i>p</i>
Online formative assessment in EOM module	0.45	0.20	0.19	0.189 (0.11–0.27)	<0.001
Paper-based formative assessments in the CVS module	-0.14	0.02	0.01	-0.074 (-0.18–0.03)	0.171

r=standardized coefficient; *r*²=standardized coefficient squared, *β*=non-standardized coefficient

DISCUSSION

Online formative assessments had an overall positive effect on the summative results of the students. Those students who performed well in the two successive online formative assessments in the EOM module scored significantly higher in the summative assessments in comparison to the rest of the students. In contrast, those students who performed well in the two consecutive paper-based conventional assessments in the CVS module had a summative result similar to the other students.

Several factors could contribute to these findings. Immediate automated feedback after attempting every question was provided to the students in the online formative assessment whereas, in case of the paper-based formative assessments, feedback was provided after completion of the whole test. The online formative assessments were conducted on the weekends which provided enough time for the students to strengthen their weak areas. In contrast, the paper-based formative assessments were conducted in a classroom setting after which students did not have enough time to improve their weak areas because of the succeeding scheduled sessions. Providing enough time on weekends to the students to improve their weak areas could be a very strong reason for the improved summative results as high achiever medical students are more likely to study more on the weekends in comparison to the low achiever students.⁹

Receiving feedback on the same screen after attempting every individual MCQs could also be an important factor for the improved summative score after taking the online formative assessments. In contrast, in the paper-based formative assessments, the key was displayed and discussed with the students after the completion of the whole assessments. A recent study showed that students were more likely to retain information on the same computer screen in comparison to the same content which was provided to the same students on the front and back sides of the pages in print.¹⁰

Preference for teaching through technology could be another factor for the difference in the summative scores. Using online formative assessments might have made the overall learning experience more attractive for the students proficient in the use of technology.^{11,12} However, we cannot be certain about this possible explanation as we did not gauge the preference of our students for incorporating more technological tools for delivery of the curriculum and means of assessment.

An important aspect of our study was that all of our formative assessments were time-bound. This aspect further strengthens our findings as a recently conducted study concluded that formative assessments can result in improved performance in summative provided the formative assessments are time-bound.¹³

A possible criticism of our findings could be that the improved summative results after online formative assessments could be the motivation of academically better students to attempt the formatives.¹⁴ This explanation certainly could not be the reason in our study as only those students who performed better in the online formative assessments performed better in the summative assessments whereas those students who performed better in the paper-based assessments had a

score similar to the other students in their respective summative assessment.

The Pearson's Correlation Coefficient for the paper-based formative assessments showed a negative ($r = -0.14$) and non-significant ($p = 0.171$) correlation between the paper-based assessments and the end of module summative test scores in the CVS module. These results are in agreement with similar studies in which online formative showed a significant correlation with a similar strength to the summative assessments.⁶

Other possible reasons for our findings could be the comfortable environment of home, feasibility and better mental engagement whereas the paper-based formative assessments were conducted in the classroom in a conventional manner which adds a little stress for the students and might affect their performance.^{6,7}

Finally, the last possible reason could be the difference in difficulty level of content of the two modules but this does not seem a very plausible reason especially when an extra effort was made to choose questions for the summative and formative assessments with the same difficulty index. An added advantage of the online assessments over conventional paper-based assessments is that they can be customized to give students multiple chances to select the correct option in case the incorrect option is selected in the first attempt by the student.^{6,15} Students in our study were allowed only single attempts but the effect of providing students multiple attempts to choose the correct options might have a further positive effect on the long term retention of important concepts.

In our study, the mean score of the EOM module summative assessment was significantly higher in comparison to the mean summative score of the CVS module. Significant difference in scores of the same class in two different modules where the only difference was that formative assessments were conducted differently gives strength to the hypothesis that the online formative assessment must have had a positive effect on strengthening and reinforcing concepts and hence improved the summative scores.¹⁶

CONCLUSION

The results of our study showed better learning outcomes with the use of online formative assessments. Keeping in mind the usefulness of formative assessment as an efficient learning tool, there is a growing need to evaluate different tools to ensure their maximum effectiveness. Online structured formative assessments on a regular basis may help students focus on the important concepts, help in better engagement and reflect on their learning. With the recent COVID-19 pandemic, there will be even more focus in the near future on online learning and assessments. Health professions educators are, therefore, encouraged to conduct multiple studies in which other technological

modes of delivery and marking should be assessed and incorporated into learning and teaching practices. The usefulness of providing students multiple attempts to select the correct answer as a formative tool should also be explored.

FUTURE RECOMMENDATIONS

Further multicentre studies are required to generalize the results of this study and to further evaluate the outcomes of online formative assessment on the educational progress of the students.

LIMITATIONS

This study was conducted on a single class of the institute. Therefore, the results may not be generalized for all medical students.

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