

Utility of Online Assessments for Postgraduate Students in Medical Biochemistry: Perspectives of Students and Teachers

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Abstract

Background: During COVID-19 pandemic, online written theory exams were found to be essential for internal assessments. The aim of the study was to evaluate the influence of online exams on the following: (i) ability to motivate students to study for their upcoming summative exams, (ii) adoption of online mode of assessment by the students and (iii) educational outcomes with respect to the confidence that may be attached to the judgements.

Methods: We conducted online assessments for two batches of postgraduate Medical Biochemistry students: nine second-year and eight third-year Master of Science (M.Sc.) students of our institute. Online feedback forms were administered to the students and the teachers after declaring the exam results.

Results: The teachers were not fully convinced about the usefulness of online assessments. The teachers strongly prefer tests under supervision and were of the opinion that malpractices can be reduced by questions from higher levels of cognition during the online assessments. The students found online assessments highly useful in their learning process. The adoption of online assessment by the students and its impact on the educational outcomes were found to be inferior to the conventional exams. The scores of the students in online exams were comparable with their previous in-class internal assessment scores as well as with their scores in the final university exams.

Conclusion: It is suggested that online assessment is a suitable tool for promoting the learning process. It can also serve as an effective tool for summative assessments; although its educational outcome and the readiness to adopt are inferior to conventional exams.

Keywords: Formative assessments, Summative assessments, Educational outcome, Adoptability of assessments

Introduction

The conduct of examinations under direct supervision was a challenge when the lockdown was implemented due to the COVID-19 pandemic since 2020. One option to address

this problem was to conduct the examinations online. However, the conduct of online examinations has its own difficulties and limitations. Kavitha *et al* found online formative assessments as beneficial tools in Obstetrics and Gynaecology for promoting self-directed learning and in tailor learning for individual style and need (Nagandla *et al*; 2018). Kühbeck *et al* have carried out correlation analyses of the various online assessment parameters with summative exam performance among undergraduate medical students in pharmacology (Kühbeck *et al*; 2019). In the

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online platform, the clinical reasoning that is based on knowledge is reported as oversimplified compared to real-life scenarios (Pedro *et al*; 2021). Online formative assessments were helpful for the medical students in their learning Physiology (Snekalatha *et al*; 2021). Hillier *et al* described some of the benefits of online examinations even before the covid pandemic (Hillier, 2014). The lockdown provided an opportunity to establish some these benefits around the world. However, barriers for the conduct of online exams, the technical difficulties, insufficient infrastructure and unreliable connectivity were reported before the outbreak of COVID-19 (James, 2016). Boitshwarelo *et al.* had reviewed the concerns of academic integrity in online assessments (Boitshwarelo *et al*; 2017).

There are numerous practices of cheating which the students can engage while undertaking online tests. These problems are largely addressed by the e-proctoring systems in higher education institutions. However, such facilities are not affordable in developing countries like India.

Practice exams are conducted as model exams to prepare the students for their final summative examinations in many universities. During the lockdown, we conducted online written theory exams for two batches of our postgraduate students in Medical Biochemistry: the second and third-year M.Sc. (Medical Biochemistry) students. After the conduct of online written theory exams, we took feedback from both the students and teachers to gain insights on the utility of unsupervised online exams with regard to the influence of online exams on the following: (i) ability to motivate students to study for their upcoming summative exams, (ii) adoption of online assessments by the students and (iii) educational outcomes with respect to students' understanding of pertinent subject matter. Also, the marks awarded were compared with the students' previous in-class internal assessment marks and the marks they scored in their final university exams to check the reliability of online assessments for decision making.

Methodology

The M.Sc. (Medical Biochemistry) course is a three-year postgraduate program conducted in our institute. Students join this course after their bachelor's degree in life sciences. In the first year, they learn fundamental aspects of Human Anatomy, Human Physiology and Medical Biochemistry. In the second and third years, they learn various aspects of Medical Biochemistry at the postgraduate level and are also involved in their project work. The present study was conducted among two batches of students, including nine students of second-year batch and eight students of the third-year batch. While the second-year students deal with the general aspects of Biochemistry like 'Enzymes', 'Vitamins' and 'Biological oxidation', etc., the third-year students learn the topics in 'Clinical Biochemistry', 'Metabolism' and 'Molecular Biology' etc.

We conducted the theory practice exams online. It involved only change in the mode of conduct of the exams from physical to the online. There were four theory papers each in the second and third years. Although we took oral consent from the study participants, we did not obtain the approval of the institutional ethics committee since this was part of the online assessments adopted by the institute during the COVID-19 time for other courses. The question papers administered for the second year M.Sc. students are given in Appendices A and B.

The online practice theory exams were conducted as per the timetable for 3 hours according to the university model. The soft copies of the question papers were sent to the students by email at the start of the exam. The students could write the exams from the places of their residence. The students were told to take a pledge not to get indulged in any form of exam malpractice. At the end of three hours, the students were instructed to stop writing, scan their answer scripts in their cell phones and immediately forward them as PDF files to the respective teachers for evaluation through emails.

The same faculty members who prepared the questions evaluated the answer sheets. The results were communicated to the students via email.

After communicating the results to all the students and faculty members, the feedback was taken from both students and faculty members with separate questionnaires. The feedback questionnaires prepared by the investigators for administering among the students and teachers were validated by the experts in the medical education department. The final statements in the questionnaires sent to the students are presented in Tables 1-3 and those sent to the teachers are presented in Tables 4-6. The feedback questionnaires were prepared to assess the usefulness, adoption of online exam by students and the educational outcome of the online assessments. The feedback from the students was collected anonymously. The students and teachers were informed that responding to the feedback questionnaires imply their consent to participate in this academic research and the confidentiality of the data collected would be maintained. The students were asked to send their filled feedback forms to their class representative by email after converting them to PDF files. The class representative decoded the identity of the students and sent them to the principal investigator of the study. The faculty members had the choice of either sending the feedback directly to the principal investigator of the study after converting them to PDF files or submitting the completed questionnaire in the departmental office without revealing the identity of the faculty. The feedback files received by emails from the teachers were de-identified before the analysis of the data. The feedback forms were prepared with the Likert scales of Strongly Agree, Agree, Neither Agree nor Disagree, Disagree and Strongly Disagree

and were assigned the response numbers of 5,4,3,2 and 1. The mean of the response numbers marked by all the participants was considered for deriving the average response against the item.

To assess the reliability of the unsupervised online practice exams, we compared the average percentage of marks of the M.Sc. students with the average percentage of the marks they had scored in the already conducted in-class internal assessments during the current academic year and the marks which they scored in the final university exams which were conducted under direct supervision. The correlations between the scores of the practice exams and in-class internal assessment as well as the university exams were assessed by Pearson correlation analysis as the marks followed a normal distribution.

Results

All the students submitted their answer sheets within half an hour on an average after the exams got over. All the seventeen students submitted their feedback forms. Among the ten faculty members of the department, only six had submitted their feedback forms. Among the six, four sent them directly to the principal investigator and two in confidential forms.

The feedback from the students and teachers were analyzed under the following headings: (1) Usefulness (2) Adoptability and (3) Education outcome.

Feedback from the students

Usefulness: The feedback from the students on the usefulness of the online assessment is presented in Figure 1 and Table 1.

Table 1: The mean and the SD of the response numbers marked by the students on the usefulness of online assessment for deriving the average response (n=17)

No.s in the X-axis of Figure 1a	Statement	Mean of Response numbers with SD	Average Response
1	Online exams acted as a guide for me to prepare for the final end of course exams	4.4 ± 0.7	Agree
2	Online exams assisted in my learning the topics	4.5 ± 0.6	Strongly agree
3	Online exams helped me to identify my areas of weaknesses	4.3 ± 0.9	Agree
4	Online exams were enjoyable in a non-threatening atmosphere	4.1 ± 0.9	Agree
5	Online exams motivated me to study further	4.4 ± 0.6	Agree
6	Online exams are helpful in keeping me engaged in useful academic activities	4.1 ± 0.7	Agree
7	I gained the confidence to attend more online exams in the future	4.0 ± 0.7	Agree

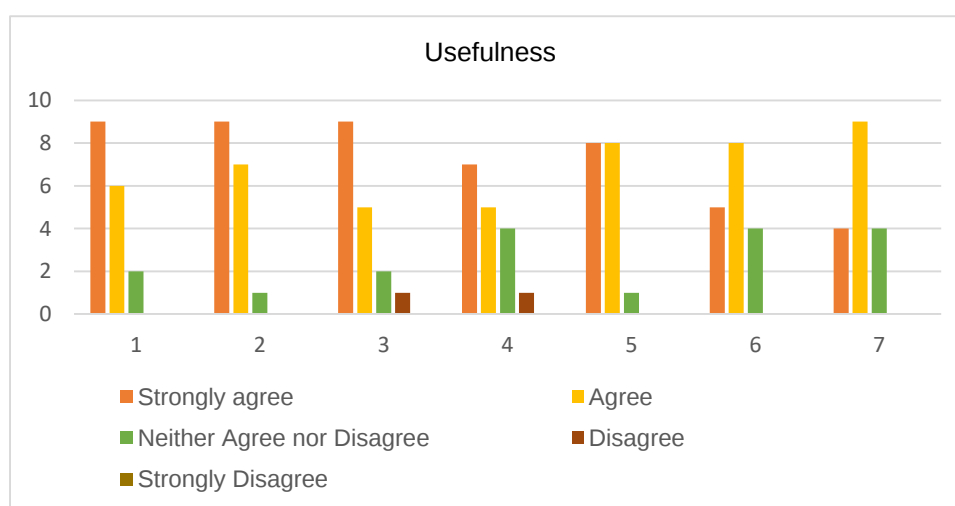


Figure 1: Distribution of feedback responses from students: Usefulness of online assessments. The numbers in the X-axis indicate the questions and are presented in Table 1.

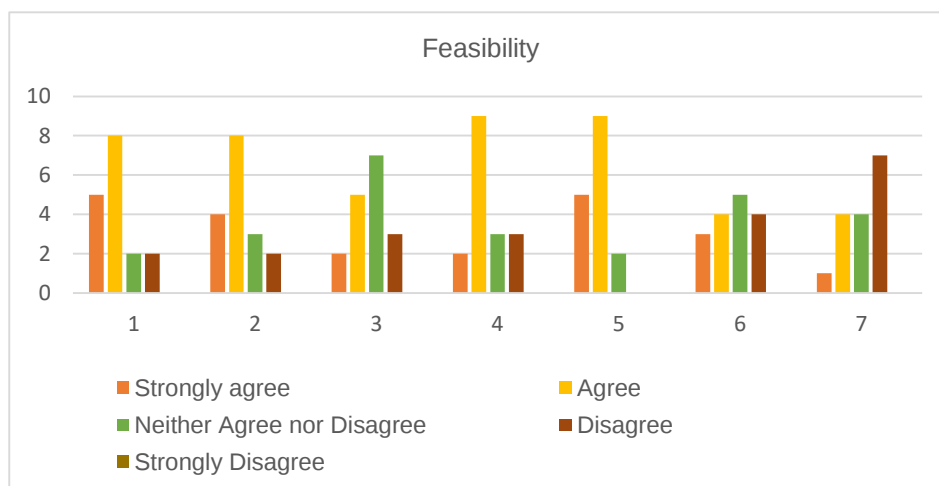
The students felt that online exams were useful in their preparation for the end of course exams. They helped them in identifying their areas of weaknesses. They enjoyed in participating in the online tests as it was conducted in a non-threatening atmosphere. It motivated them to study further. According to them the

assessments engaged them in useful academic activities during the pandemic as they were away from their educational institute.

Adoptability: The feedback from the students on the adoptability of the online assessment is presented in Figure 2 and Table 2.

Table 2: The mean and SD of the response numbers marked by the students on the adoptability of online assessment for deriving the average response (n=17)

No.s in the X-axis of Figure 1b	Statement	Mean of Response numbers with SD	Average Response
1	I always have the availability of a laptop/system to take up the online exams	3.9 ± 0.9	Agree
2	I possess adequate technical skills to attend online exams	3.8 ± 0.9	Agree
3	I have access to optimal internet connectivity	3.4 ± 0.9	Neither Agree nor Disagree
4	My residential environment was conducive to take up online exams	3.6 ± 0.9	Agree
5	Taking a pledge at the beginning of exams will help me to deter from malpractices	4.2 ± 0.6	Agree
6	I did not feel stressed to use the laptop/cell phones for my online exams	3.4 ± 1.1	Neither Agree nor Disagree
7	I did not face any technical problem in taking up the online test	2.9 ± 1.0	Neither Agree nor Disagree

**Figure 2: Distribution of feedback responses from students: Adoptability of online assessments. The numbers in the X-axis indicate the questions and are presented in Table 2.**

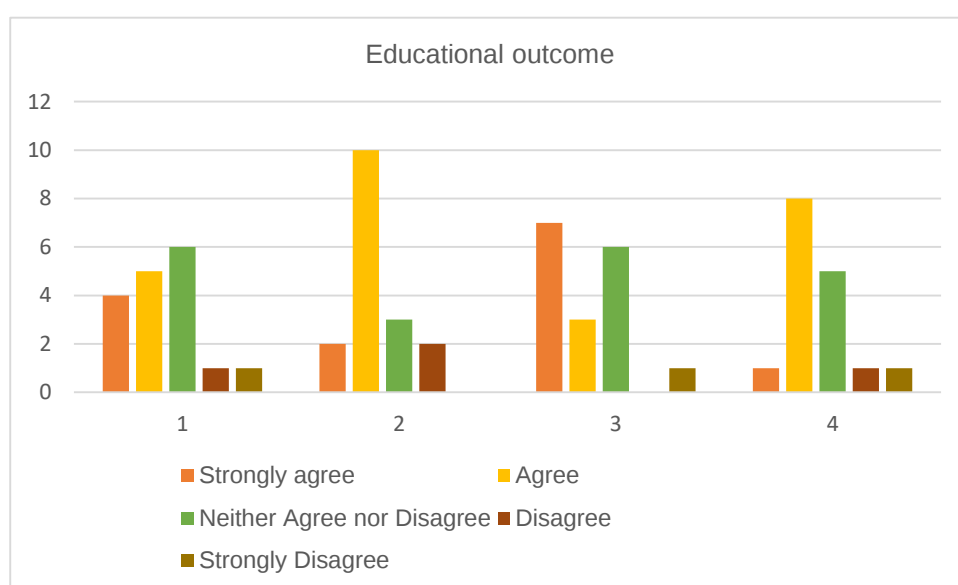
In general, the students agreed that laptops/computer systems were available for them to participate in the online exams. However, there was variation in their feedback as evident from the SD of their feedback responses. They possessed adequate technical skills for the operation and that their residential environments were conducive for appearing in the online exams. The students believed that taking a pledge at the beginning of exams helped them to deter from malpractices. However, they appear to be not

fully satisfied with the internet connectivity. From their feedback it appears that they were stressed out to some extent while using the gadgets. Also, to some extent they faced technical problems during the conduct of the exams.

Educational outcome: The feedback from the students on the educational outcome of the online assessments is presented in Figure 3 and Table 3.

Table 3: The mean and SD of the response numbers marked by the students on the educational outcome of online assessments for deriving the average response (n=17)

No.s in the X-axis of Figure 1c	Statement	Mean of Response numbers with SD	Average Response
1	I recommend including marks obtained in the unsupervised online exam for deciding pass/fail or for ranking as they are reliable	3.6 ± 1.1	Agree
2	Online exams are valuable overall	3.7 ± 0.8	Agree
3	I still prefer tests under supervision rather than unsupervised online tests	3.9 ± 1.1	Agree
4	Unsupervised online exams did not motivate me to adopt unfair means	3.4 ± 0.9	Neither Agree nor Disagree

**Figure 3: Distribution of feedback responses from students: Educational outcome of online assessments. The numbers in the X-axis indicate the questions and are presented in Table 3.**

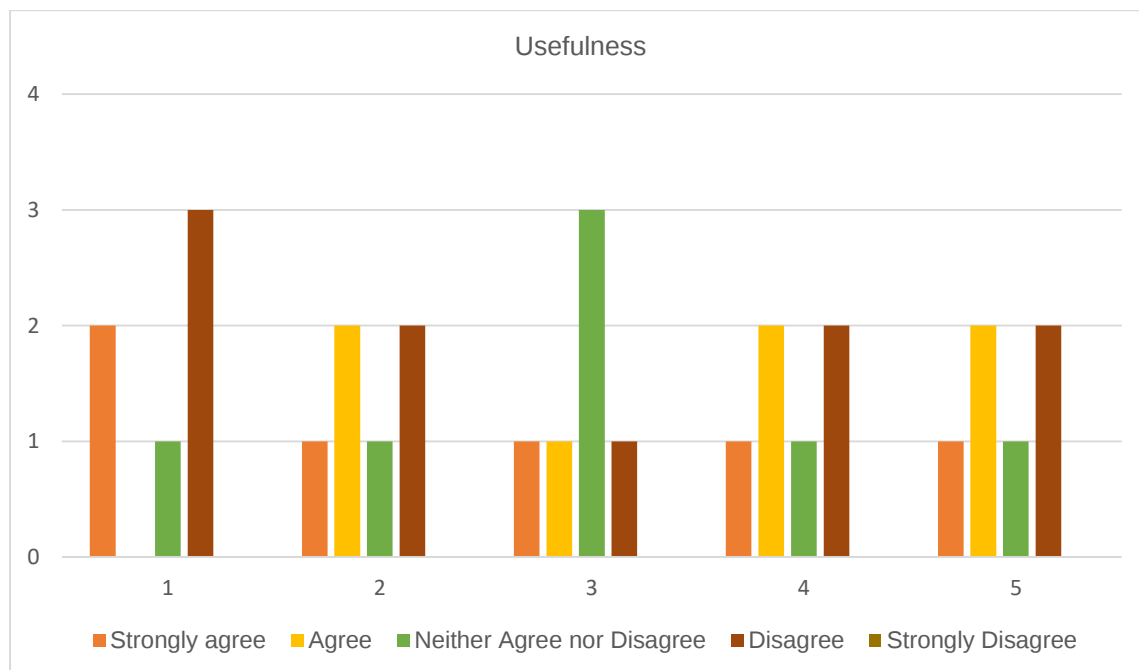
The students recommended the inclusion of the marks they obtained in the unsupervised online exams to decide pass or fail and for ranking them. However, the students still preferred tests under supervision rather than unsupervised online tests. The students were hesitant to declare that the unsupervised online exams did not motivate them to look for malpractices.

Feedback from the teachers

Usefulness: The feedback from the teachers on the usefulness of the online assessment is presented in Figure 4 and Table 4.

Table 4: The mean and SD of the response numbers marked by the teachers on the usefulness of online assessment for deriving the average response (n=6)

No.s in the X-axis of Figure 2a	Statement	Mean of Response numbers with SD	Average Response
1	Online exams help the students to prepare for their final end of course exams	3.2 $\pm$ 1.3	Neither Agree nor Disagree
2	Online exams help the students in learning the topics	3.3 $\pm$ 1.1	Neither Agree nor Disagree
3	Online exams help the students in identifying their areas of weaknesses	3.3 $\pm$ 0.9	Neither Agree nor Disagree
4	Online exams will motivate the students to study further	3.3 $\pm$ 1.1	Neither Agree nor Disagree
5	Online exams are helpful in keeping the students engaged in useful educational activities	3.3 $\pm$ 1.1	Neither Agree nor Disagree

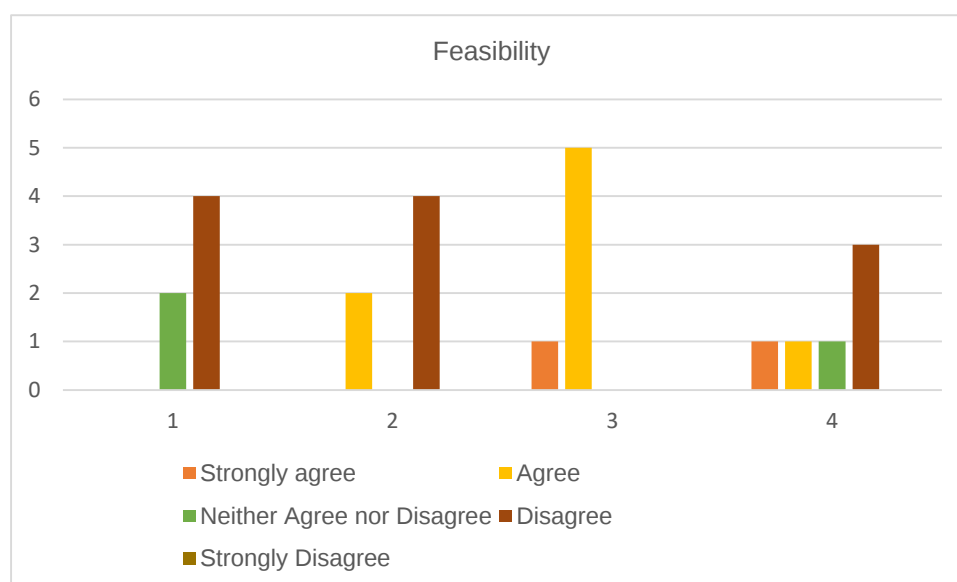
**Figure 4: Distribution of feedback responses from teachers: Usefulness of online assessments. The numbers in the X-axis indicate the questions and are presented in Table 4.**

The teachers had a neutral stand regarding the usefulness of online assessments in preparing the students for the final end course exams.

Adoptability: The feedback from the teachers on the adoptability of the online assessment is presented in Figure 5 and Table 5

Table 5: The mean and SD of the response numbers marked by the teachers on the adoptability of online assessments for deriving the average response (n=6)

No.s in the X-axis of Figure 2b	Statement	Mean of Response numbers	Average Response
1	Adoptability of conducting the online exams is superior to the conventional exams	2.3 ± 0.5	Disagree
2	Malpractices during the online tests can be minimized by reducing the duration of the exams – less time for copying	2.7 ± 0.9	Neither Agree nor Disagree
3	Malpractices during the online tests can be reduced by asking questions from higher levels of cognitive domain – application and synthesis – less copying	4.2 ± 0.4	Agree
4	Malpractices can be reduced by making the students take a pledge at the beginning of the exams	3.0 ± 1.2	Neither Agree nor Disagree

**Figure 5: Distribution of feedback responses from teachers: Adoptability of online assessments. The numbers in the X-axis indicate the questions and are presented in Table 5.**

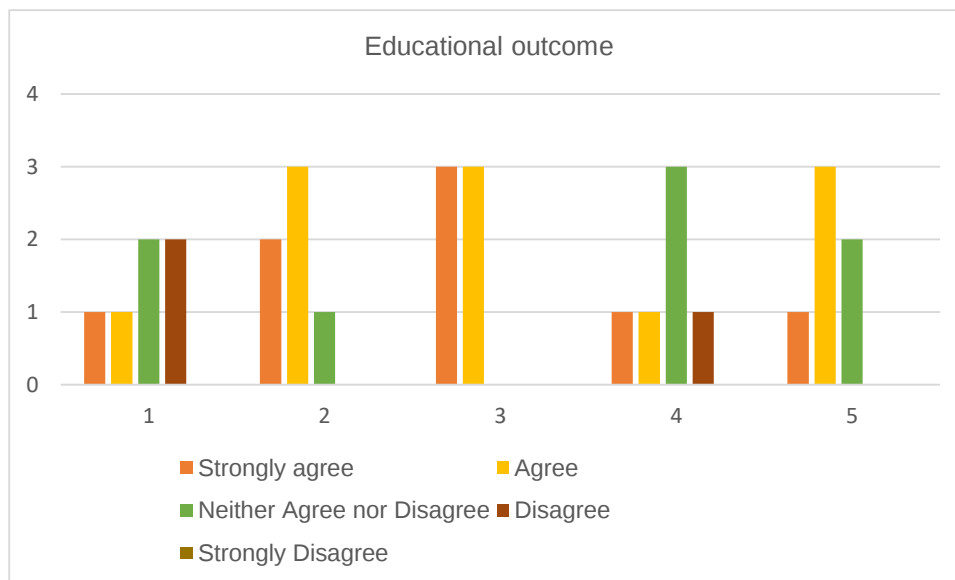
Unlike the students, the teachers did not fully agree with the concept of reduction in malpractices when an oath is taken at the beginning of the exams. The teachers were of the opinion that malpractices could be reduced to a large extent by asking questions from the higher levels of cognitive domains. However, the teachers were largely undecided regarding the effectiveness of reduction of duration of

exams in preventing the malpractices. The teachers in general felt that the adoptability of the online exams is inferior to the conventional exams.

Educational outcome: The feedback from the teachers on the educational outcome of the online assessments is presented in Figure 6 and Table 6.

Table 6: The mean of the response numbers marked by the teachers on the Educational outcome of Online Assessments for deriving the average response (n=6)

No.s in the X-axis of Figure 2c	Statement	Mean of Response numbers	Average Response
1	Online exams are valuable overall	3.2 ± 1.1	Neither Agree nor Disagree
2	The educational outcome of the online exam is inferior to the conventional exams	4.2 ± 0.7	Agree
3	I still prefer tests under supervision rather than unsupervised online tests	4.5 ± 0.5	Strongly Agree
4	I recommend including marks obtained in the unsupervised online exam for deciding pass/fail or for ranking as they are reliable	3.3 ± 0.9	Neither Agree nor Disagree
5	There is no difficulty in testing the Specific learning objectives through online	3.8 ± 0.7	Agree

**Figure 6: Distribution of feedback responses from teachers: Educational outcome of online assessments. The numbers in the X-axis indicate the questions and are presented in Table 6.**

According to the teachers, the educational outcome of online exams is inferior to conventional exams. The teachers strongly preferred tests under supervision to unsupervised online tests. The teachers were uncommitted in recommending the marks from the unsupervised exams for deciding pass or fail and in ranking the students. However, they did not find it difficult to test the specific learning objectives through the online exams.

Reliability of Online Assessments

We compared the average percentage of marks of the M.Sc. students with the average marks they had scored in the already conducted in-class internal assessments in the form of class tests during the current academic year and the marks they scored in the subsequent university exams. The internal assessments were conducted earlier and the university exams were conducted subsequently under direct supervision. The results of the comparison among the second-year and third-year M.Sc. students are presented in Table No.7.

Table 7: Comparison of average percentages of marks of the second-year and third-year M.Sc. students in online assessments with the average percentage of marks they had scored in the already conducted internal assessments and subsequent university exams (n=17)

Student	Average % of marks in Online Assessments	Average % of marks in Internal Assessments	Average % of marks in University Assessments	% of difference between online and internal assessments	% of difference between online and University assessments
Second-year M.Sc. students					
1	76	77	68	-1	+8
2	58	55	58	+3	0
3	63	64	63	-1	0
4	60	56	64	+4	-4
5	66	55	69	+9	-3
6	76	81	76	-5	0
7	78	76	75	+2	+3
8	54	47	62	+7	-8
9	63	63	62	0	+1
Third year M.Sc. students					
10	62	64	60	-2	+2
11	65	56	55	+9	+10
12	58	58	55	0	+3
13	65	64	64	+1	+1
14	57	57	58	0	-1
15	66	62	61	+4	+4
16	65	58	60	+7	+5
17	64	56	53	+8	+11

The online assessment marks of the students correlated with their internal assessment marks ($r = 0.752$, $p = 0.001$) as well as with their final university assessment marks ($r = 0.859$, $p <$

0.004). The diagrammatic representation of the comparison is provided in Figure 7.

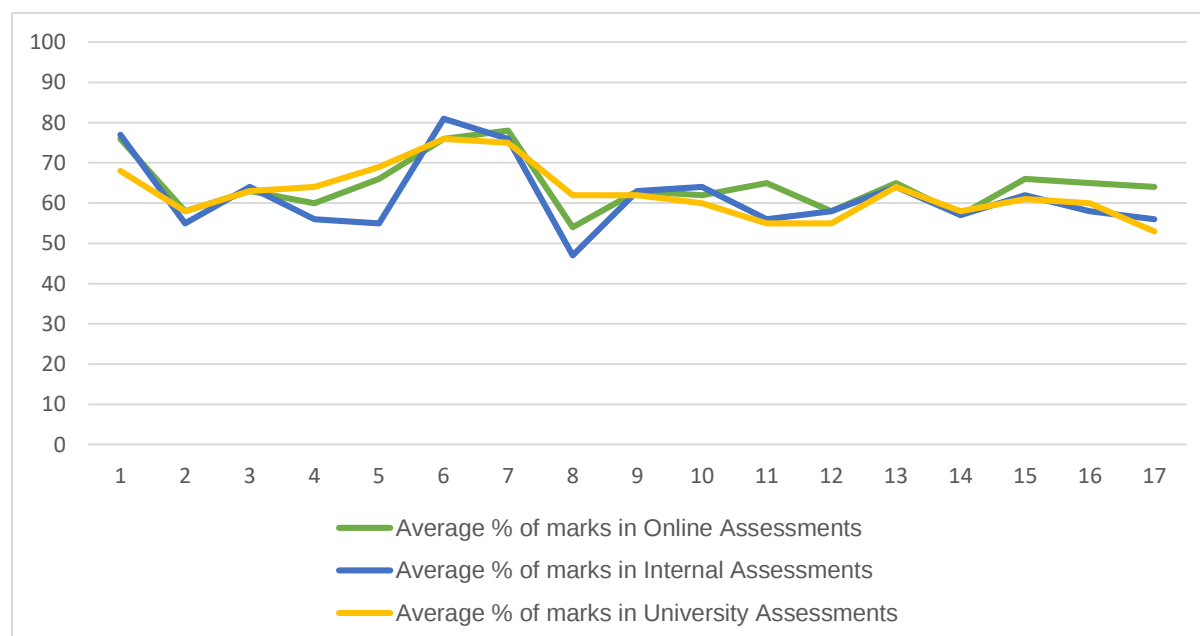


Figure 7: Comparison of average percentages of marks of the second year and third year M.Sc. students in online assessments with the average percentage of marks they had scored in the already conducted internal assessments and subsequent university exams (n=17)

Discussion

After the outbreak of COVID-19 in the beginning of 2020 there was a shift in the mode of exams world over by the educational institutions from physical to the online. In a study conducted in three Australian universities in July and August 2020 it has been found that there was a replacement of traditional invigilated exams by a non-invigilated timed online exam for 83% of the students (Alison *et al*; 2021). Under the similar circumstances we conducted online practice exams for the postgraduate students in Medical Biochemistry of our institute who were preparing for their end of the course exams.

We assessed the three aspects of the conduct of unsupervised non-proctored online exams; usefulness, adoptability and educational outcome based on the feedback we received from the students and the teaching faculty who were involved in the conduct of the exams.

In general, the students found the online exams useful in their preparation for their final university exams. Among the various questions raised to them, they strongly agreed that the online exams assisted them in their learning the topics. However, the teachers were undecided regarding the usefulness of online exams in helping the students to prepare for their final summative exams. When feedback is provided on students' performance, it directly promotes their learning, referred to as 'test enhanced learning' (Larsen *et al*; 2008; Bobby *et al*; 2018). There are three paradigms of assessments: (i) assessment of learning, (ii) assessment for learning, and (iii) assessment as learning (Serafini, 2000). Our approach fits into the category of assessment as learning. This is because the online exams helped the students in identifying their areas of weaknesses. As it was conducted in a non-threatening atmosphere without being directly observed or proctored they enjoyed the learning process. Overall, it is concluded that the non-proctored online assessments were useful academic exercises for the students in their learning process during the pandemic.

We assessed the adoptability of the online exams. The utility of an assessment tool is governed by several attributes: validity, reliability, educational outcome and adoptability (Lambert *et al*; 2014). Timmis *et al* reported that online assessment potentially exacerbates educational and social disadvantages due to differences among the students with reference to access and literacy in digital technologies associated with age, gender, and socioeconomic factors (Timmis *et al*; 2016). Our observations were also in agreement with this report. There were variations in the students' feedback regarding adoptability. There was inequity among the students in access to optimal internet connectivity, stress while using the laptop/cell phones and the technical problems which they faced while taking up the online exams.

Yet another aspect which we assessed in the conduct of non-proctored online exams is its educational outcome. This is related to the confidence that we place on the unsupervised online exams in making decisions on pass or fail. The major challenge in the educational outcome of unsupervised non-proctored exams is the academic integrity of the students. Arnold *et al* reported cheating at online formative tests (Arnold, 2016). Based on the feedback from both the students and the teachers it can be concluded that the educational outcome of online exams is inferior to directly supervised exams. The students were hesitant to declare that the unsupervised online exams did not motivate them to look for malpractices. The teachers strongly preferred tests under supervision to unsupervised online tests. From the observations it is not possible to find out whether the students actually cheated or not. In fact, that was not the objective of this study. The issue of academic integrity of assessments is a major concern (Gamage *et al*; 2020). This is especially true in medical sciences in view of its consequences on patient care services resulting in injury or death (Azulay *et al*; 2014). Academic dishonesty in online assessments without direct supervision can take several forms (McGee, 2013). However, 46% of face to face and 71% of online students believe that referring to existing notes is not cheating at all or only trivial cheating (Burgason *et al*; 2019).

However there have been reports that students perform better in non-proctored exams than proctored exams (Eurboonyanun *et al*; 2020). An alternative approach to detect cheating suggested by Karen *et al* is the use of post-hoc assessments like oral examination for the validation of results (Karen & Judith 2020).

Restricting the time allowed for completion of the exam is another strategy to minimize cheating (Karen & Judith 2020). However, in the present study, the teachers were largely undecided on the effectiveness of reduction of duration in preventing malpractices.

The teachers were of the opinion that malpractices could be reduced to a large extent by asking questions from the higher levels of cognitive domain. According to Krathwohl *et al*, the academic integrity can be addressed by a modified Bloom's taxonomy-based approach to construct MCQs testing higher order cognitive domains (Krathwohl, 2002). Tools are available to guide writing and classifying questions using Bloom's taxonomy (Crowe *et al*; 2008).

Measures that can help to change attitudes could bring about a reduction in cheating (Azulay *et al*; 2014). The National Medical Council (NMC) of India identified the need to teach and evaluate professionalism as a formal concept.

Inclusion of an academic integrity declaration can inform and remind students of general academic integrity standards (Azulay *et al*; 2014). Hoden *et al* recommends declaration of academic integrity prior to the beginning of online exams (Olivia *et al*; 2021). In our observation the students in general believed that taking a pledge at the beginning of exams helped them to deter from malpractices. Unlike the students, the teachers did not fully agree with this concept.

There were excellent correlations between students' marks in on-line exams with their marks in the previous in-class internal assessments conducted under supervision and their marks in the subsequent university exams also conducted under direct supervision. These observations support the usefulness of online

exams as summative assessment tools in spite of its inherent limitations.

Conclusion

Online assessment is a valuable tool for helping students in their learning process. It may also be considered a summative tool, although its educational outcome and adoptability are inferior to conventional exams. Online exams may be considered for decision-making and for promoting continuous learning. The teachers were not fully convinced about the usefulness of online assessments. The teachers strongly prefer tests under supervision and were of the opinion that malpractices can be reduced by questions from higher levels of cognition during the online assessments. Even the students prefer conventional examinations over non-supervised online for summative examinations.

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