

# Designing Formative e-Assessments to Prepare Students for the Summative Assessment in Massive Online Courses

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**Abstract**—Massive Online Courses (MOC) usually contains learners of several thousands and they create new challenges in teaching and learning environments that must be addressed using ICT enabled interactive tools. Such courses represent a learning community rather than a group, with various types of learners with varying knowledge and skill levels. Learners' main objective is to obtain a certification by following learning activities and they could be hardly got individual attention from facilitators. However, the certification depends on the final summative assessment in the course. To obtain effective results, learning and assessment have to be carried out together but it could create unmanageable workload for facilitators. Hence, they need to use automated tools to assess the students and to provide effective feedback to prepare learners for final examination. Facilities available in a virtual learning management system could be used to design such formative assessments which will prepare learners to face the challenges of summative assessment. In this paper, we are presenting our experience of developing formative e-Assessments in Moodle based Virtual Learning Environment for an external online degree programme. The paper presents the challenges and practical issues together with our design of formative e-Assessments. This design approach helps to improve the learners' performance as well as to maintain the sustainability of Massive Online Courses.

**Index Terms**—Massive online courses, formative e-Assessment, summative assessment, virtual learning environment (VLE).

## I. INTRODUCTION

Distance Learning and Education (DLE) heavily depends on its underline framework and the technology since the learners, teachers and learning resources are related in a triangular structure for the interaction. e-Learning based on the Information Communication Technology (ICT) has become the best framework for DLE [1]. Among the many benefits, the removal of constraints on number of participants in a DLE programme was the foundation for the open DLE of massive online courses. Traditional, smaller groups with one-to-one facilitation based instructional design approach for both learning and assessment doesn't work in massive online programmes. Multi-directional interaction among peers and facilitators has resulted in an interesting collaborative web-based learning environment where assessments of learners have to redesign considering both pedagogical aspects and technological affordances [2].

In this paper, we are presenting our experience in designing e-Assessments for the massive online courses developed for the Bachelor of Information Technology (BIT) [<http://www.bit.lk>] conducted by the University of Colombo School of Computing (UCSC) as its DLE initiative to produce IT graduates and to meet the national demand for IT Professionals. This programme has become very popular in Sri Lanka since its design for learning and evaluation is based on the open distance learning, as well as the affordability of cost of registration and examination compared to average income of the general public. BIT is a three year degree programme where examinations are held at the end of each semester after 15 weeks of course online work. First year of BIT programme, discussed in this paper, has 8 courses and there are approximately 3000 registered learners including repeaters. Hence, the automation of the evaluation is very important to keep the learners engaged in the courses as well as to follow the programme according to the time schedule.

At the beginning of the BIT in the year 2000, UCSC offered the programme as an external degree where the university conducted only testing based on the published curriculum and teaching was carried out by third party institutes who had never trained candidates for degree level programmes. After few years of its commencement, students' performance at the semester exams was decreasing gradually together with the popularity to attract new students (registration). A Learning Management System (LMS) was introduced as an alternative way to guide the learners using the supplementary Multiple Choice Question (MCQ) based online assignments [3]. This had some effects on reducing the failure rate and dropout rate of the programme but the curriculum based testing was not enough to make a significant effect on the learners' performance as we observed while conducting the programme. At the same time, the web-based LMS was an effective environment that can be used to create self-assessments of learning process, in addition to collaborative learning activities.

In the next stage, the BIT LMS [4] was expanded with the learning resources and continuous integrated assessment activities to guide learners to follow the curriculum and to achieve the specified learning objectives. This integrated environment of learning and assessment is called the BIT Virtual Learning Environment (VLE) [<http://vle.bit.lk>]. Once the learning and assessment are integrated together, it became an effective environment for the certification than the previous one where only testing with respect to curriculum was carried out. The roadmap (design guidelines) that we followed to develop the VLE is logically structured as presented in this paper, but the burden and workload was challenging experience to test the team work of teachers. In

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this paper, we are presenting this roadmap together with our experience that encountered to develop the e-assessments of BIT VLE.

Section II describes the learning structure and the design of assessments to evaluate the student progress. This contains both formative and summative assessments with respect to the curriculum of the courses, question base for e-Assessments and informal formative assessments. Multiple Choice Questions (MCQs) are the main types of questions in BIT VLE and Section III presents how such questions are managed with respect to difficulty and scope. Section IV shows the tool and mechanism used to improve the MCQs in formative assessments. Current indicators are given in Section V. We finally conclude the paper discussing work carried out and mentioning future work towards the e-Assessments in BIT VLE in Section VI.

## II. FORMATIVE AND SUMMATIVE ASSESSMENTS

Whether it is an online or face-to-face (f2f) course, the assessment of those who have followed the course is very important to certify their learning [6]. When we separate the learning and assessment, as in the early stage of BIT, only the summative assessment (semester end exams) is meaningful. This summative assessment is designed considering the overall outcome (learning objectives) defined in the curriculum. The teachers select a set of aspects to design the summative assessment within limited time allocated. Hence, parameters such as the number of participants, resources available, etc. affect the design of summative assessment. For example, preparing an assessment for final exams using essay type open-ended questions for massive online course is not a feasible approach due to manual marking.

The formative assessments are conducted as a continuous learning activity during the learning process of course. The results and feedback of formative assessments must be made available as soon as possible to make it effective for the learning process. Generally, a percentage of overall mark is decided based on the formative assessments to give the recognition for the active participation in the course. At the same time, the formative assessments prepare the learner to face the summative assessment with more confidence. However, if they are focused (evaluated) on two different disjoint learning objectives, it would result disappointments among learners. We were able to observe this situation in the BIT VLE, when the course and formative assignments were developed by one teacher and another teacher set the final course evaluation (summative assessment).

Whether it is summative or formative, the assessments must be aligned with the curriculum which is a kind of informal agreement between teachers and students. Since the formative assessments are usually designed based on the content in the course, it is easier to align the course syllabus. When high percentage of students in a course fails to complete a course successfully, it could be an indicator of poor constructive alignment. Learners may ask more questions or provide some feedback when they fail to response correctly during the formative assessment. On other hand, when a course consists of a small number of learners, teachers could use the strategy of giving questions outside

syllabus (evaluating at a higher learning objective) to direct them deep learning of the subject matter. However, this is not a practical strategy in massive online courses where we have to practice a structured communication. In BIT VLE, questions outside the given syllabus resulted many students complaining about them as wrong questions or incomplete teachers note in the online course.

In addition to the alignment of assessments with the syllabus with respect to content of subject matter, time allocated to the assessment must be proportionate to the study time defined in the syllabus. This can be observed with respect to number of questions given in an assessment and time allocated with respect to different topics in the syllabus. To make this correlation more visible, the curriculum must be prepared in a structured manner dividing topics into sub-topics and identifying time allocated for each sub-topic. Hence, all courses in the BIT programme were prepared in a structured way, giving more details (page numbers for reference materials) as a self-learning guide, as shown at [www.bit.lk, Home Information]. For example, if a section is allocated "R" number of hours in a syllabus of the course conducted during "H" hrs, and the time allocated for the assessment is "A" hours, then relevant time allocated for assessment of section is  $(R/H)*A$ . This design method ensures that each lesson (learning objective) the students prepares for is evaluated and due credit is given through the evaluation scheme. In the next section, we will describe how to decide the number of questions within this allocated time, considering the difficulty level.

### A. Question Base for e-Assessments

In the BIT VLE, the formative assessments were designed by developing a question base of MCQs with respect to curriculum covering all learning objectives [5]. It was a tedious exercise but the questions given in the past examinations were very useful resource to develop the question base. Questions were gathered from all past examination papers and structured them according to syllabus to develop this question base. Due to the syllabus changes, some questions were modified to align them with the current version. At the same time, three difficult levels of MCQ questions are assessed to group them into a structured collection. The policy was to develop the initial question base of 300 questions to start a formative assessment and to increase it annually by adding 50 new questions selected from semester exams. A special care was taken not to include identical or very similar question since it doesn't enhance the quality of question base. Since the formative assessment is a learning activity, the feedback for the each choice in the MCQ and also overall question is very important. This feedback varies with respect to the learners' response. The trivial feedback is to say it is correct or wrong. However, descriptive feedbacks are more valuable to guide the learners. Practically, developing a MCQ question with descriptive feedback is more difficult and time consuming exercise for teachers. In BIT VLE, the development of question base was carried out by the relevant instructional designer using past questions and also communicating with the Subject Matter Expert (SME) / teacher in the course. In our evaluation of the process, teachers usually do not like to spend more time to

develop descriptive feedback and they expect instructional designer (ID) to attend the work. Due to time schedule and time required, we were forced to limit the number of questions with descriptive feedback in the question base. However, when students raised questions about MCQs, the appropriate feedback for choices was identified and incorporated to the question base to facilitate more learning.

#### *B. Practice Questions*

At the end of every section of the course page in BIT VLE, a formative self-learning activity was given as "Practice Questions" with a fixed number of MCQs considering all sub-sections and time allocated for the section. They were selected considering relevant learning objectives of the section in the syllabus and the descriptive feedback was included to make these questions as a revision before moving to the next section. In the learning instructions, students were advised to do these questions but no marks were given for their interaction.

#### *C. Online Formative Assignments*

In a course, two formative assessments were given considering as online MCQ based assignments with respect to first and second halves of syllabus (declared in the course page). 40% weight was given for the first assignment and 60% for the second. The objective was to promote students doing both assignments as the pass mark was 50 out of 100 marks calculated based on 10 random questions. Two separate deadlines are set for these assignments before end of the course and marks are calculated based on the student's performances. Three attempts are given for each assignment and the best attempt is selected for grading. Each attempt shows a different set of MCQs selected from the question base with respect to the structure and relevant sections of the syllabus. There were no time restrictions for each online assignment since it is a kind of learning activity as well as self-evaluation exercise for each student. However, negative marking scheme was defined to discourage guessing. Scoring for a responsible learning activity that student should do is based on the following rules.

The minimum mark is 0, No. of choices = 5, No. of Correct choices marked = X, No. of Wrong choices marked = Y

Total number of correct choices = Z

If  $Z \neq 5$ , Score =  $\text{Max} \{ [X/Z] \times 10 + [Y/(5-Z)] \times (-10), 0 \}$

If  $Z = 5$ , Score =  $X/Z \times 10$ ,

Final mark for the online assignment = 40% of Assignment Quiz 1 + 60% of Assignment Quiz 2

Due to the nature of the evaluation scheme students get penalized for selecting incorrect choices. This penalty is high when the number of correct answers increases unless all choices of a question are correct. Similarly, the mark the student score decreases with the increase of number of correct choices within a question. Hence in most cases questions have multiple correct answers and the student is expected to evaluate if each of them is correct or not. Thus in our assessments an MCQ is a question consists of five independent parts based on a single scenario/problem.

The important advice that we communicated to students was to do these formative assignments by themselves to obtain the confidence before the final semester exams.

However, we couldn't get any verification that these were done individually or with the help of a third party since they were carried out online at the learner's location. All questions were randomized together with the ordering of choices to avoid direct copying. Practice questions in a course were not included when the assignment was generated and we considered relevant conditions to include all three levels of questions, namely easy, moderate and difficult (described below). In BIT Programme, a pass grade in the online formative assessment was considered a compulsory to obtain the diploma certificate, but the individual assessment marks were not included in the final GPA calculation as these are unsupervised assessments. However, we are now evaluating the possibility of including it in the GPA (e.g. 10%) to give more weight and recognition for the formative assessments in the future.

#### *D. Final Summative Assignment*

Summative assessment of BIT programme is conducted using printed paper based MCQs in the first year courses. Students were given a special paper to mark answers and they are captured and processed using the Optical Character Recognition (OCR) technology for electronic processing. After the examinations, answers are published in the VLE to obtain students feedback and possible mistakes/ambiguities in the exam papers. In the next semester, all these questions are added to the relevant question base to enhance the formative assessments. Students can also try out past exam papers before the semester exam as a formative activity but no marks are given for the participation.

### III. INFORMAL FORMATIVE E-ASSESSMENTS

Student participation in online discussion forums is also very important activity and it could be easily considered as a part of formative assessments as learning happens through focused discussions. However, manual evaluating learners' participation in discussion courses in massive online courses of more than 1500 active participants is not a practical exercise. Although the quantitative approach could be used to identify number of postings in a course, it is not an accurate indicator since it could be easily abused by posting trivial replies or meaningless messages. Instead of giving marks for students' participation, we designed criteria to identify best e-learners in BIT massive online courses. Initially, the number of posting in a course is used as a quantitative indicator to identify suitable candidates and facilitators were asked to short list them based on the content in the posting. To select the best e-Learners with respect to each semester of the programme, following criteria is used;

Identify the forum participation ranking ( $w_j$ ) for each course using following conditions:

- $\text{avg} = (\text{Total postings in the given course} / \text{Total number of users in the forum discussions})$

$$W_j(j \geq \text{avg}) = 1, \quad W_j(j \geq 200\% \times \text{avg}) = 1.2,$$

$$W_j(j \geq 80\% \times \text{avg}) = 0.8, \quad W_j(j \geq 60\% \times \text{avg}) = 0.6,$$

$$W_j(j \geq 40\% \times \text{avg}) = 0.4, \quad W_j(j \geq 20\% \times \text{avg}) = 0.2,$$

- Calculate the forum score (FS) for each student using their online formative assignments marks

$FS = \text{Assignments avg (for the given student)} \times W_j$

- Calculate the average forum score (FSavg) for all compulsory courses in the given semester.
- Select the best 10 % based on the FSavg
- Choose the best student from qualitative analysis of forum postings provided they are eligible for the diploma and not a repeat student.

By giving a special award for students at the annual diploma award ceremony, the recognition was given for students' participation and this is considered as informal formative e-assessment to enhance the effectiveness of BIT VLE.

#### IV. MANAGING DIFFICULTY LEVELS AND SCOPE OF MCQs

There are different types of MCQs which could be used to classify and identify the difficulty level of questions. There are three types of MCQs used in the BIT VLE to develop the question base, namely "True/False", "Single Correct Answer", and "Multiple Correct Answers". The difficulty level of a MCQ is calculated considering the average time taken to answer the question and it depends on both content (description of problem and phrases in the choices) as well as above types. True/False type is the simplest type, followed by the single answered questions. When a question contains more than one correct answer or when a question consists of multiple statements its difficulty level increases with respect to readability and reasoning. Although a MCQ generally has more than one correct answer, poor wording or phrasing in a question could make it a good or weak question.

- Difficulty Level 1 (*Simple*): A question could be read and answered within 30 Sec. to 1 Minute. These questions tests if students remember or understand concepts.
- Difficulty Level 2 (*Intermediate*): A question could be read and answered within 1 Minute – 2.5 Minutes. These questions tests if students can explain ideas and use if new ways.
- Difficulty Level 3 (*Advanced*): A question could be read and answered within 2.5 Minutes – 5 Minutes. These questions tests if students can distinguish between parts and solve problems.

In a BIT examination paper (summative assessment), there could be around 30-60 questions to be answered within 2 hrs and the exact number depends on the difficulty level of questions included in the paper which is also linked with the level of learning outcome. In the moderation process, all questions are also reviewed with respect to time allocation in the syllabus, in addition to subject matter of the question. As a policy, teachers were given the guidelines to prepare the questions considering the full syllabus in normal circumstances without reusing existing questions. The same rule is applied in selecting questions for formative online assignments, one of which consists of 10 randomized questions in each attempt out of three.

A weak question could be difficult or easy. Therefore, teachers are given advised to minimize their mistakes when they set MCQs. An independent reviewer who possesses the subject matter knowledge is appointed to moderate all these

questions with respect to subject content and the scrutinizer helps the process going through readability of MCQs. The policy is very strict in the summative assessment since there is a less room to correct mistakes in questions. Since the formative assessment is given in a digital online interface, the time taken to answer a MCQ question may increase due to visibility and screen resolution, as well as the ICT literacy level of the learner. This fact was observed when the digital version of BIT selection/aptitude test was launched in a monitored e-Assessment environment. Hence, a special interface was designed for e-Testing system. Details of the system are given at the <http://www.e-learning.lk/node/79>.

In a MCQ based assessment, when a person encounters a similar or same question, it is considered as a simple question since he/she may not take more time to answer it like in the first time. However, with respect to ordering of choices and position of the question will prevent the guessing based on what he/she remembers. Therefore, we assumed the same difficulty level for MCQ question, when it is presented at later assessment to the same candidate (usually a year later). We were able to verify our assumption by examining performances of repeat students who took e-Selection test of BIT programme.

Generally, many people consider MCQs can be used only for knowledge assessment with respect to the subject content. Our experience tells us a MCQ could be drafted to assess some other levels [5] defined in the Bloom's taxonomy as briefly identified when defining difficulty levels, however details are not presented in this paper. For example, a MCQ could be formulated using images in the question and/or choices to verify the skill of past experience with respect to given scenario. This may not be the best approach to evaluate skill of a person but it is a good alternative for massive online courses where we need automation to evaluate students. For instance, the first year course called "PC Applications" in which the knowledge and skill of general application packages are taught consists of these types of MCQs with graphical content. Some of these questions are designed to ensure students have had hands on experience on the recommended software packages/tools.

#### V. EVALUATING AND CORRECTING E-ASSESSMENTS

Assessment is a sensitive activity where teachers must take extra care when drafting and moderating questions. Sometimes, everything may have been done correctly but a mistake could occur when a question is posted to the question base or online assessment is created by academic support staff (facilitator or instructional designer). This was an issue we faced when we developed online formative assessments in BIT VLE which had been developed using Moodle Learning Management System. Sometimes, the published questions may be correct with respect to content and the mistake may be due to connecting the right choice. In many cases, when such questions appeared in assessments, students complain about the mistake to force the relevant facilitators to take necessary actions. It is very important not to penalize students in an assessment when such mistakes appears and remarking feature of Moodle quizzes could be used to compensate them.

However, there were cases of wrong questions without any complains in the BIT VLE as the student is not competent to challenge the teacher. At the same time, it is culturally considered as inappropriate interaction. The analysis tool in the BIT quiz module as shown in the Fig. 1(a), is useful to identify such mistakes when the assessments were reviewed at regular intervals. Here we have removed the question description column to make the figure readable.

Answer's text Hide	partial credit Hide	R. Counts Hide	R.% Hide	% Correct Facility Hide	SD Hide	Disc. Index Hide	Disc. Coeff. Hide
Because they are bulky.	(-0.25)	20/254	(8%)	75%	0.420	0.88	0.59
Because they may contain viruses.	(-0.25)	14/254	(6%)				
For security reasons	(-0.25)	45/254	(18%)				
For privacy reasons	(-0.25)	27/254	(11%)				
Because the email system is designed to handle text messages only.	(1.00)	197/254	(78%)				

Fig. 1(a). Item analysis tool for MCQs in the question base, showing statistics based on students' performance

Do nothing	(-0.25)	18/403	(4%)	56%	0.452	0.67	0.52
It contacts the 'www.bit.lk' and request the index.html	(1.00)	254/403	(63%)				
It blinks the words "BIT home page"	(-0.25)	48/403	(12%)				
It deletes the highlighted text	(-0.25)	3/403	(1%)				
It contacts the 'www.bit.lk' and request the "BIT home page"	(-0.25)	182/403	(45%)				
Only web browsers running on clients with the linux OS can view the web pages.	(-0.25)	21/107	(20%)	71%	0.411	0.80	0.56

Fig. 1(b). Identifying a weak MCQ

Item analysis could be used to identify weak MCQs which result due to poor readability of the question. As shown in Fig. 1(b), when more than 20% of students are considering a particular wrong choice as correct, such questions are needed to recheck whether there is readability issue for misunderstanding. However, in some cases, choices are purposely worded to examine learner's knowledge and skill while minimizing guessing in a question. Hence, every case, when more students make mistakes, it is not a readability issue in the question.

## VI. STUDENTS PERFORMANCES IN E-ASSESSMENT

The student performances are kind of indicators to show the progress of revised environment where we have combined both learning and assessments in BIT online

degree programme. Detail student performance statistics of the programme is published at [www.bit.lk, Home Examination Statistics] and this paper presents only the brief analysis of students' performance. TABLE I shows the performances of students who passed all formative assignments and students who passed all summative assignments including repeaters from previous years. These data illustrate that all students who are successful in formative assessments may not be successful in summative assignments. However, unsuccessful in formative assessments (including non-participants) indicates that a similar decrease in summative assessment. This promoted us to carry out further analysis of the case, where we identified a significant amount (almost 50%) of registered students had not accessed the online formative assessments and learning environment. Several hours have to be spent to go through the VLE material and hence those with limited internet access and those preparing for exams at the last minute are unable to benefit from the formative assessments. Dropouts after the semester 1 examinations also contribute towards this high unsuccessful percentage. This can be seen in the Fig. 2. Students who were accessing online learning environment could easily perform well in the formative assessments and it is helping their summative assessment. However, students who are directly taking summative assessment without following formative assessments results a lower in a success rate. At the same time, increase in the registration process has resulted in a lowering in the pass rate too. Enrolment fee is very low (USD 20) and several non-committed students joins the programmes contributing towards the high dropouts. It means all students who are registering the programme may not be capable enough to pass the summative assessment. Unfortunately, the increase in the registration process has not reflected a positive development in the access to online environment as shown in the Fig. 2.

In our overall observation, at least 80% of those who are successful in the formative assessment would be able to pass the summative assessment. However, if there is a significant deviation, then it must be investigated, specially the design of VLE to maintain effectiveness. At the same time, by combining formative and summative assessments provides better evaluation of the larger scope of the curriculum.

Distance Learning Education programmes usually have high dropout rates and low pass rates which will aggravate for massive online courses. BIT is a paid programme at an affordable cost and number of registrations was going down before introducing e-Assessment environment. However, during last four years the programme popularity has increased significantly as shown in the TABLE I and Fig. 2, although the percentage of pass rate has decreased.

## VII. CONCLUSION

In this paper, we presented the design we followed to set up e-Assessments in Massive Online Courses (MOC) in the BIT degree programme of University of Colombo School of Computing. Formative assessments play an important role preparing the learner to be successful at the end of course. It is a sensitive learning and assessment activity that takes place based on the curriculum of the course. In this paper, we

described our experience as well as observations designing components of both formative and summative assessments together with the policy adopted.

BIT was evolved from a traditional external degree programme to a modern online degree programme where we

have used ICT to integrate both learning and assessments together. Learning and assessments have to go together to certify someone competent in applying the given subject matter.

TABLE I: PASS RATE OF YEAR 1 FORMATIVE AND SUMMATIVE ASSESSMENTS

Year	Passed all online Assignments (Formative)		Attempted Summative wrt online access	Passed all Semester Exams (Summative)		Applied Exams wrt to registration	Total Registered
2008	718	48%	65%	576	33%	66%	2681
2009	746	47%	69%	445	23%	69%	2776
2010	529	28%	64%	361	17%	64%	3490

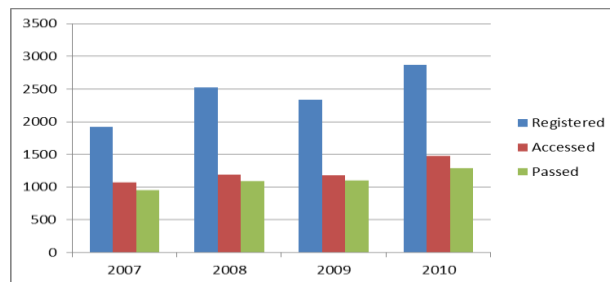


Fig. 2. Semester 1 students' registration, online accessibility and success in formative assessment

If we do not combine these two assessments methods, it could be very difficult to prepare students to perform well in their final examinations. At the same time, combination of these two assessments gives more opportunity for teachers to test the larger scope of the curriculum. However, if the formative assessment doesn't facilitate learners to prepare summative assessment, it demotivates them that one of key objective has not been met. In massive online courses, combing formative and summative assessments will definitely enhance the effectiveness of the course. Due to large number of students, it would be required to use automated tools to develop formative assessments.

The testing is usually done to verify selected aspects in a particular curriculum. It is a kind of "black box" testing since it doesn't consider the learning aspect of the person. It doesn't certify whether the person has learned the curriculum and capable to perform considering all aspects in the curriculum. On the other hand, assessment is a complete test ("white box") that covers all aspects in the curriculum and it carries out together with the learning. It is more powerful way to certify a person's capabilities with respect to a given curriculum.

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