Learning Performances Assessment Models For Online Collaborative Learning Systems

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Abstract—**As the quest for collaborative e-learning continues to grow due to increase in the number of students enrolling in various academic programmes in our higher institutions, learning performances models for collaborative online learning environment that provide equal and credible assessment opportunities for all categories of learners in web-based learning environment have therefore become inevitable. Our mathematical models are developed with features for measuring level of class participation among students and instructors in online sessions of a course, their performances in collaborative studies; tests, assignment, polls and final examination in a web-based learning environment. Objects used in developing the models include Instructor (I_k), course (CO_k), student (S_j), Assessment ($A_{z,k}$) and learning performance ($P_{k,j}$).**

***Index Terms*—Assessment, Course, Instructor, Student**

I. Introduction

THE birth of online learning can be traced to the concept of Self Directed Learning (SDL). When SDL is applied to formal education contexts, it is often seen as a means to shift from a teacher-centered to a learner-centered approach to education [4]. Virtual Classrooms are designed based on the active learning approach that appears to provide a more effective learning strategy. In active learning approach, students become the "architects of their own learning". The underpinning of this approach is experiential theory [5], [3].

Web-based learning no doubt offers interesting opportunities and democratic advantage to all categories of students. It in addition provides the platform for effective collaboration among participants (Instructor and Student) in the classroom and through this medium quality knowledge in various forms and approaches can be gained.

Web-based virtual classroom systems (WebVCS) are developed based on constructivist learning model. In constructivism, knowledge is seen as a collection of concepts which fit with the experience of the individual. Learning becomes a change in meaning constructed from experience. Learners actively take knowledge, connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation [1]. Varieties of constructivism exist – generative, discovery and knowledge building, but all constructivist theories are of the view that knowledge is subjective and cannot be separated from the knower. In constructivism, free exploration of knowledge within a given framework by students is promoted. The difference here is that where a teacher gives a didactic lecture which covers the subject matter, a facilitator helps the learner to get to his or her own understanding of the content. The learner in this case plays a more active role in the learning process. That is the entire learning process becomes learner-centered. Constructivist based learning environments indeed promote experiential learning which results in concretization of knowledge being gained by the learner. However measuring learning performance in online learning environment has always been a serious issue for developers of web based virtual classrooms.

Assessment and grading have remained fairly open and unresolved area of e-learning for instructors who want to embed constructivist and learner-centered activities into their online courses. Many online instructors are satisfied with traditional examination and proctored or controlled testing centers while others are anxious about any web-based testing and evaluation [2].

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II. Learning Performances Modeling

The learning performance modeling is a process that involves modeling of the students and instructors participation in classroom activities (class attendance), students' learning performances in group/collaborative studies (e.g. projects), polls, tests and assignment.

The students participating in online sessions of the WebVCS were stored as dataset $\boldsymbol{S_j}$($j = 1 \ldots N$) in the students WebVCS database. $J = 1 \ldots N$ is the total number of students in a particular course's online session (j is the number of students online in a particular course).

A particular student's learning performance in a particular course's online sessions is:

Where:

$$P_{k,j} = g_{k,j}(CO_k, S_j) + G_{k,j}(A_k) \ldots\ldots(1)$$

$\boldsymbol{CO_k}$ - represents courses offered in the WebVCS, $k = 1. \ldots n$ is the total number of registered online courses. (k is the course a student is participating)

$g_{k,j}(CO_k, S_j)$ - represents a function that returns the weight of a particular student's participation in collaborative/group studies of a particular course $\boldsymbol{CO_k}$.

$G_{k,j}(A_k)$ - represents a function that returns the weight of a particular student's performance in a particular course $\boldsymbol{CO_k}$'s other forms of assessment (Attendance, Test, assignment, Polls).

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The weight or value returned by $G_{k,j}(A_k)$ is a cumulative value computed as follows:

For a particular course $\boldsymbol{CO_k}$

$$A_k = \sum_{z=1}^{4} A_{k,z}$$

z = 1,2,3,4 (z is assessment type)

$A_{k,1}$ represents class attendance score

$A_{k,2}$ represents polls score

$A_{k,3}$ represents score in assignment

$A_{k,4}$ represents score in test

In a particular class/level, a particular student's overall average learning performance P_j in all the online courses of the WebVCS is given as:

$$P_j = \sum_{k=1}^{n} (g_{k,j}(CO_k, S_j) + G_{k,j}(A_k)) / n \ldots\ldots(2)$$

For example, the overall learning performance of the first registered student is $P_{j=1}$

$$P_1 = ((g_{1,1}(CO_1, S_1) + G_{1,1}(A_1) + (g_{2,1}(CO_2, S_1) + G_{2,1}(A_2)) + \ldots$$
$$+(g_{n,1}(CO_n, S_1) + G_{n,1}(A_n)) / n$$

A particular student's average level of participation in a particular course's online session (Class Attendance only) is given as:

$$(A_{k,z=1})_j = \frac{1}{L}(\sum_{l=1}^{L} V_{l,m}(SO_{l,m})).....(3)$$

Where: $A_{k,z=1}$ representing performance in class attendance

$$\boldsymbol{V_{l,m}} \begin{cases} 1.00 \text{ for } 26 \text{ mins} \le \boldsymbol{V_{l,m}} \le 30 \text{ mins} \\ 0.75 \text{ for } 21 \text{ mins} \le \boldsymbol{V_{l,m}} \le 25 \text{ mins} \\ 0.50 \text{ for } 16 \text{ mins} \le \boldsymbol{V_{l,m}} \le 20 \text{ mins} \\ 0.25 \text{ for } 10 \text{ mins} < \boldsymbol{V_{l,m}} \le 15 \text{ mins} \\ 0.00 \text{ for } \boldsymbol{V_{lm}} < 10 \text{ mins} \end{cases}$$

z = 1 (class attendance), l = course topics, L = total number of topics/online sessions for a course, $SO_{l,m}$ = sub-topics or lesson pages/screen.

All students' average level of participation in a particular course's online session (class attendance only) is given as:

$$G = \sum_{j=1}^{N}((A_{k,z=1})_j / N.....(4)$$

z = 1 (class attendance)

$A_{k,z}$ representing performance in class attendance

N representing total number of students participating in the online session of the course

In a particular class/level, the average learning performance of all students in all online courses is given as:

$$P = \sum_{j=1}^{N} P_j / N \ldots..(5)$$

recall:

N represents total number of students participating in a particular class's online sessions

P_j is a particular student's overall average learning performance in all the online courses of the WebVCS (P_j is already define in equation (2)).

A particular instructor's average level of participation in a particular course's online session is given as:

$$I_k = \frac{1}{L}(\sum_{l=1}^{L} T_{l,m}(SO_{l,m})).....(6)$$

Where:

l represents course topics (l = 1 ….L), m represents lesson units or pages (m = 1 ……)

k represents the course an instructor is participating

$$\boldsymbol{T_{l,m}} \begin{cases} 1.00 \text{ for } 26 \text{ mins} \le \boldsymbol{T_{l,m}} \le 35 \text{ mins} \\ 0.75 \text{ for } 21 \text{ mins} \le \boldsymbol{T_{l,m}} \le 25 \text{ mins} \\ 0.50 \text{ for } 16 \text{ mins} \le \boldsymbol{T_{l,m}} \le 20 \text{ mins} \\ 0.25 \text{ for } 10 \text{ mins} < \boldsymbol{T_{l,m}} \le 15 \text{ mins} \\ 0.00 \text{ for } \boldsymbol{T_{lm}} < 10 \text{ mins} \end{cases}$$

All instructors' average level of participation in all the courses's online sessions is given as:

$$\varnothing(I_k) = \sum_{k=1}^{n} (I_k) / n \ldots..(7)$$

Observation:

It is expected that in a WebVCS, the time ($\boldsymbol{T_{l,m}}$ and $\boldsymbol{V_{l,m}}$) start counting for every student who has logged on and admitted by the instructor as well as the instructor himself. The maximum time for each online session of a course is 30 minutes for students and 35 minutes for instructors (these can be adjusted by the instructor). The instructor at the end of the lecture uses the extra 5 minutes to eject all students that he admitted into the online session.

III. SYSTEM IMPLEMENTATION

The learning performances assessment system model was implemented using MySQL backend engine, Hypertext Pre-processor (PHP) as frontend engine and Apache as web server. A case study of some level one students of Computer Science Department, Federal College of Education Kano was selected using course materials in different courses. The results obtained were validated, and analyzed to determine the efficiency and effectiveness of the system developed.

IV. RESULT AND DISCUSSION

For each student, the following assessment parameters such as collaboration, assignment, test, attendance and project were obtained and stored in the student learning profile. Through this, the system was able to compute the learning performances of each student in a course, and in all his registered courses, as well as all students' overall learning performance in the online learning system as shown in table 1.

Figures 1 to 7 show the appropriate learning performance determination output screen. The performance in each assessment type is rated as follow:

5 – Excellent, 4 – Very Good, 3 – Good, 2 – Fair, 1 – Poor

0 – Very Poor

The result shows that the students performed better in test assessment with an overall average performance of 3.0, followed by collaborative studies with an overall average of 2.90, performance in project with an overall average of 2.65 and so on.

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In all the assessment types used in determining learning performances of the students, the result also shows the overall average learning performance of each student. For example, for the first student (Muhd Abdurahman) has an overall average learning performance in all the assessment types as 3.44, and that of the second student (Imrana Musa) is 2.25, and so on.

TABLE I
STUDENTS' LEARNING PERFORMANCES ASSESSMENTS STATISTICS

Bio Data	User name	Assessment Type	Assessment Scores (Courses k)					
			CSC111 (k=1)	CSC112 (k=2)	CSC113 (k=3)	CSC114 (k=4)	Average Performance	Overall average learning performance
Name: Muhd Abdurahman Reg.No: 0010 State: Kano Sex: Male Year&Level: 2012(100 L)	muhd0010	Collaboration Assignment Test Project	4 0 4 4	4 3 3 3	4 3 5 4	3 4 4 3	3.75 2.50 4.00 3.50	3.44
Name: Imrana Musa Reg.No: 0012 State: Kano Sex: Female Year&Level: 2012(100 L)	imrana0012	Collaboration Assignment Test Project	3 0 2 3	3 - 4 0	3 2 3 3	2 3 2 4	2.75 1.25 2.75 2.25	2.25
Name: Hadiza Ahmad S. Reg.No: 0023 State: Jigawa Sex: Female Year&Level: 2012(100 L)	hadiza0023	Collaboration Assignment Test Project	4 2 2 2	2 2 2 2	2 1 4 3	1 2 3 1	2.25 1.75 2.75 2.25	2.25
Name: Nura Ayuba A. Reg.No: 0024 State: Kano Sex: Male Year&Level: 2012(100 L)	nura0024	Collaboration Assignment Test Project	4 4 4 4	4 4 4 4	2 4 2 2	2 3 3 3	3.00 3.75 3.25 3.25	3.31
Name: Maryam Umar H. Reg.No: 0039 State: Katsina Sex: Female Year&Level: 2012(100 L)	maryam0039	Collaboration Assignment Test Project	3 3 3 3	3 2 3 2	3 2 3 2	2 1 0 1	2.75 2.00 2.25 2.00	2.25

Fig 1 A Student's assignment assessment in all his registered courses

Fig 2 A Student's Test assessment in all his registered courses

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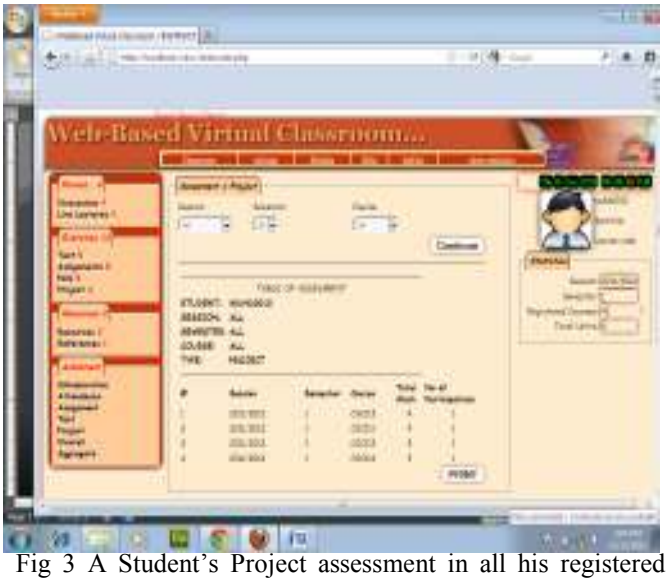

Fig 3 A Student's Project assessment in all his registered courses

Fig 4 A student's overall assessment report in all his registered courses

Fig 5 All Students' Test assessment in a course

Fig 6 All Students' Overall assessment in a course

Fig 7 Students' Exercises and assessments screen

V Conclusion

The importance of unbiased assessment in every learning process cannot be overemphasized. The learning performance assessment models presented in this work unarguably will help developers of e-learning systems address the critical issue of delivering fair and unbiased assessments to all categories of learners in a virtual classroom.

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