ISSN 2278-3091
Volume 8, No.1.1, 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse0181.12019.pdf
https://doi.org/10.30534/ijatcse/2019/0181.12019

Assessment Instruments for Accreditation: A Data Management System Design & Implementation

A.S. Elhassan[#1], W.S. Elhassan[*2]

[#1]College of Computer Engineering & Science
[*2]Preparatory Program
Prince Mohammad Bin Fahd
University Al-Khobar, Kingdom of
Saudi Arabia
[#1]aelhassan@pmu.edu.sa
[*2]welhassan@pmu.edu.sa

ABSTRACT

The requirements for regional and international quality and accreditation standards are such that assessment of students' performance is carried out routinely and measures are taken to a) identify weaknesses and shortcomings and introduce measures to remedy these shortcomings, and b) relate/map the classroom assessments to higher-level standards such as ABET
student outcomes. These requirements imply that some mechanism needs to be applied to collect large volumes of data and then aggregate this data to enable informed decision making by
academic administrators. Current Learning Management Systems (LMS) cater for several of these requirements but fail to address some of the more important ones in the area of transformation from data to information. We show a design and implementation in C# and Oracle of a LMS system that addresses several of these issues and produces analysis results to show correctness of the design.

Keywords—accreditation, ABET, AACSB, ADAMS, C#, Course Learning Outcomes (CLO's), Learning Management Systems (LMS), Oracle, Schema, remedial action, rubrics.

1. INTRODUCTION

The last 20 years have witnessed major changes and challenges in the way we rank and prioritize education, research and development metrics. In terms of education, the world university rankings including the QS list [1] and the UK's Guardian list for universities [2] are but two of the most prominent references with others specific to research like Elsevier list [3] or web site access/hit rates like the Webometrics list [4] also playing significant roles in determining the international value and rank of an academic entities and institutes. Another significant change that has occurred in this same period is the significant increment in focus on Quality Assurance and Accreditation at both regional, for example NCAAA in Saudi Arabia [5], as well as international levels, for example ABET [6], AACSB [7] and also AQA [8].

The advantages of *healthy* competition for the main stakeholders of academic institutes is given, but what is lacking in most university literature and postings is the hidden cost, mainly on the instructors, of the constant drive for higher rankings and quality assurance or accreditation accolades.

This research article presents, frontline experiences of a small computing college in the successful implementation of business process model for meeting regional and international quality assurance standards minimum requirements in a way that maximizes return-on-investment. This is achieved partly through the implementation of ADAMS: Accreditation Data Analysis and Management System which was developed to operate alongside current Learning Management Systems including Blackboard Learn [9] and Ellucian's Banner [10]. We will describe the shift in education strategy from the traditional textbook driven, teacher-led approach to a more student-centered, outcome-based [11] approach in which formative and summative assessments were emphasized without compromising the quality of teaching by utilizing the systems and utilities in ADAMS.

This paper includes a background section that will explain the current challenges facing academic administrators in order to meet regional and international quality accreditation requirements. Section III discusses some of the current common solutions for data collection and management and also introduces the proposed design. Section IV presents the technical aspects of the system implementation and shows some of the obtained results and finally, Section V concludes the work and highlights potential areas for further investigation and research.

2. BACKGROUND

The traditional, education model that is teacher-led and textbook-driven has many issues that render it unsuitable for the demands of quality and accreditation. Regardless of the quality assurance agency whose license is sought, a fundamental element of the set of requirements for achieving the required accreditation license is that the candidate program conducts regular, learner-centered [12] assessments (direct and indirect) to measure the *health status* of the program in terms of attainment rates for program learning outcomes (student outcomes) [13] or functions and competencies [14, 15]. In fact, accrediting agencies require continuous assessment and measures to "close loops" [16] as part of their initial accreditation or reaffirmation processes, and while thousands of institutions have successfully applied and achieved accreditation, this is contrasted by a culture of rubrics-based assessment that remains conspicuous by its absence [17].

Even though agreeing on a recognized set of regional or international standards/metrics can be a difficult task we are not concerned in this article with the types or numbers of standards or outcomes to be assessed as long as they are significant [18] standards in accordance with recognized agencies [19] or science/engineering bodies [20, 21].

Nonetheless, the process of quality and accreditation for education remains hindered by issues of data explosion, data management challenges and how to achieve a seamless transformation from data to information [22], these same issues can become doubly difficult when program administrators attempt to cater for established paradigms that link education objectives, methodologies and assessment strategies [22] with the net effect of alienating the main quality and accreditation player; the classroom instructor.

Table 1:. CLASSROOM/STUDENT ASSESSMENT SUMMARY (CLO-BASED)

Student ID	**…**	
Student Name	**…**	
Test	**Major 1**	
Date	**20 January 2016**	
Course Learning Outcome	**Test Question**	**Obtained Score/ Max Score**
CLO2. Ability to differentiate …..	2	3/5
CLO3. Ability to analyze a set of ..	3	2/3
CLO5. Ability to associate design ..	1	2/2
Total		**7/10**

Learning Management Systems like blackboard and others play a significant role in facilitating the process of record keeping and enabling instructors to utilize rubrics functionality at formative as well as summative phases of the academic semester, however, this process is also time consuming and un-intuitive. For example, the process of creating an outcome-based assessment rubric for a course and associating this rubric with a blackboard section to enable the instructor to upload student assessment grades is roughly made up of the following steps:

A. *Assumptions*

Syllabus has clearly defined set of Course Learning Outcomes (CLO's) (Subset of) Course Outcomes to assess is determined Instructor has designed the test such that the questions are linked to the outcomes and it is possible to produce a CLO based performance summary per student as in Table I:

B. *Blackboard Rubric Grading Steps (rough guide)*

i. Log on to blackboard and select Tools_Rubrics_Create
ii. Select type and name of rubric
iii. Add a line for each course outcome to be assessed
iv. Add the 3 or 4 performance standards and associate the relevant narrative per standard per outcome
v. Save the rubric
vi. Return to Grade Center
vii. Add Exam/Grade Column
viii. Select 1st student
ix. Select Edit/Enter Grade
x. Select Rubric
xi. Tick the score ranges
xii. Optional – Edit Mean Total to Enter Actual Total
xiii. Click Submit
xiv. Click Submit Again
xv. Click ">" arrow to select next student
xvi. Repeat
xvii. Return to Grade Center

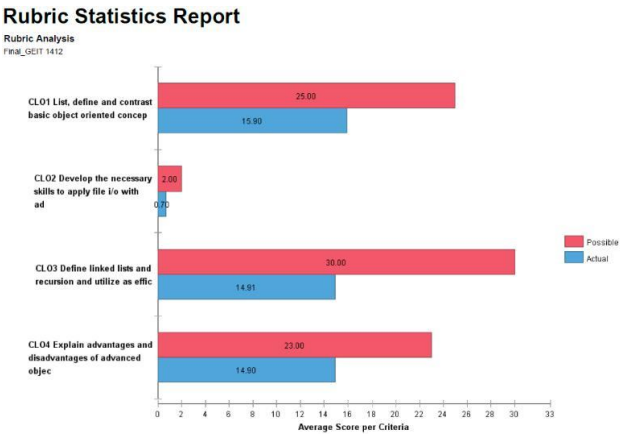

Figure 1: Rubrics evaluation report for 1 assessment of 1 section

While the built-in tools that are offered by LMS systems can produce good data analyses from above process as in Figure. 1

there remains a major issue with this approach in that this is specific to one assessment in one single section that cannot be aggregated with other assessments from other sections to produce a health status report for a program outcome or a student outcome. The steps described above have to fit (at step 4) within an overall quality assessment process that supports measurement of Student Outcomes (SO's) as described in the steps and in Fig. 2 below:

i. identify the set of program learning outcomes (SO's)

ii. identify within each taught course a set of learning outcomes (CLO's). These will constitute the KPI's by which student performance is measured within each course.

iii. map the CLO's of each course in the program to that program's SO's (this mapping is normally many to many, i.e., CLO1 of Course 9 may support SO-m and SO-n while SO-n is also supported by at least another 5 CLO's from other courses.

iv. identify the set (subset) of the course CLO's that will be measured in every assessment in the teaching semester.

v. assign a weight to each CLO and project the student's accumulated grade in that assessment per CLO.

vi. in a typical assessment, the total weights of CLO's will be the same as the total weight of the assessment.

vii. enter the scores for the students using a rubrics containing the CLO's in the assessment and save to a database, Blackboard, for example.

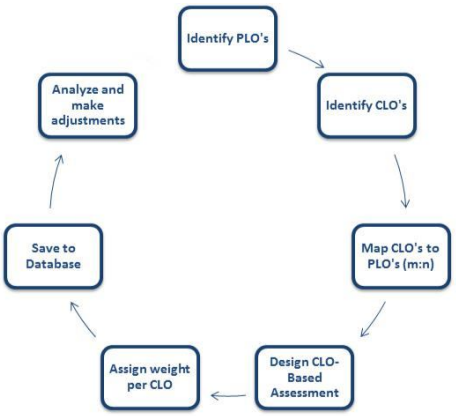

Figure. 2: Student outcomes assessment overview

It is quite clear that attempting to achieve meaningful assessments from the above process using the available tools is quite cumbersome, inefficient and fails to provide the information necessary to enable informed decisions for meaningful process improvement catering for international and region-specific quality requirements [23] including gender segregated assessments.

3. State of the Art and Proposed Process

The majority of academic leaders rushing to meet assessment deadlines resort to basic office/publishing packages like Excel in last minute efforts to produce analyses for their Self Study Reports (SSR). And even though there are several tools/packages that are available on the market to automate some of the required elements [24], there are still significant questions that remain unanswered. For example, there is a gap in the available portfolio of assessment and LMS tools to aggregate assessments as per CLO-SO mappings (step 3 in Fig. 2 and discussed below) in order to produce meaningful assessment information. There are also stringent restrictions related to rubric standards boundaries (step iv in the blackboard rubric design list above) that means once a rubric standard has been defined and grades of students associated with that standard it is impossible to analyze the students' performance in terms of any other standard boundary value. For example, if the instructor decides that the standards are:

- **Unsatisfactory: 0 – 66,**
- **Minimal: 67-76,**
- **Adequate: 77-86 and**
- **Exemplary: 87-100**

then whatever grades are entered into the database against these standard ranges cannot be categorized elsewhere. Hence if, hypothetically, all the students score above 46% and below 75% then 100% of the section will be categorized **Minimal** or worse, and if academic administrators decide later that the standards will be changed to:

- **Unsatisfactory: 0 – 30**
- **Minimal: 30-45**
- **Adequate: 46-66 and**
- **Exemplary: 66-100**

It will not be possible to correct the category of our group of students to the now valid **Adequate**, not unless the instructor re-enters the grade into the new rubric designed with the new standards.

A full analysis of the shortcomings of the available solutions and challenges facing academics is beyond the scope of this research, however the business process and technical solutions proposed here have been designed from the outset to address as many of these issues as possible while at the same time minimizing the extra overhead required by the classroom instructors, thus maximizing return on investment for assessment and quality.

3.1 Decoupling of In-Class Processes

The main *business process* strategy of the proposed approach is to decouple teaching/academic in-classroom process from the admin/politics processes that take place at program administration and institute/ministry levels such that a set of CLO based assessments as shown in Table 1 above will constitute valid, low granularity, long life ingredients for a wide range of assessments conforming to as many standards' requirements as possible, this is as illustrated in Figure. 3 which implies that long after a classroom window has lapsed or the students/instructor have moved on it is still possible to *feed-in* the respective assessments for newly required standards.

The integration of the decoupling principle above (Figure. 3) together with the overall assessment process (Figure. 2) forms an ideal implementation blueprint for an LMS system like ADAMS which shows the following essential assessment elements and their relation to each other including:

```
COURSEs (Course_ID, Title, Credit_Hours,
Has_Lab)
CLOs (Course_ID, CLO, CLO_DESCRIPTION)
PLOs (PLO, PLO_Description)
PLO_CLO_Master(PLO, COURSE_ID, CLO)
RUBRICSDATA
(COURSE_ID, SECTION, ASSESSMENTMETHOD,
CLO, PLO,
U, M, A, E, POPULATIONSIZE, CheckSum,
SEMESTER)
PEOs (PEO, PEO_Description)
PEO_SO_Mappings(PEO, PLO)
```

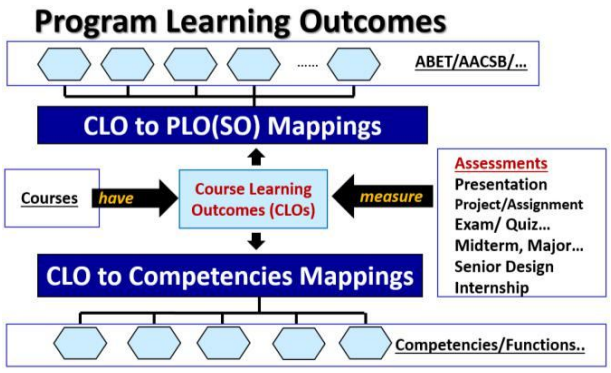

Figure 3: CLO assessment decoupling for multi-standard use

This structure supports the incremental and hierarchical assessment cycle that enables a seamless progression from in-class (CLO) assessment to agency-specific SO/PLO assessment, for example, the assessment and measurement process can be viewed as one whose building blocks are the CLO p**erformance of the students** in individual courses which are percolated as per preset mappings and relational *rules* to give indications of **course performance**, which are in turn aggregated to produce **program outcomes performance** and then even **program objectives performance**, additional layers can be added with their respective mappings to the previous layer as required. The prerequisite is: as long as there is a relational mapping between two groups of items then it should be possible to calculate one from the other using the correct relational algebra terms.

4. IMPLEMENTATION AND RESULTS

A system interface was developed in C# with an Oracle background based on the Entity Relationship schema design with data from several academic semesters loaded and tested to show assessments for courses, student outcomes as well as competencies and functions.

Some of the results obtained are shown here for illustration, a full analysis of all the output assessment results can be obtained by contacting the authors. It can be seen that the assessments are suitable to enable academic administrators to make informed decisions, for example, Figure. 4, below shows the average, aggregated Student-Outcome-Level percentage of unsatisfactory rate. Which is very informative to enable academic administrators to focus curriculum review or tutorials as remedial actions to improve outcome attainment rates for students.

According to the information shown in Figure. 4., outcomes 'a: An ability to apply knowledge of computing and mathematics appropriate to the discipline', 'h: Recognition of the need for and an ability to engage in continuing professional development' and also 'j: An ability to use and apply current technical concepts and practices in the core information technologies.' which are the 3 outcomes with the highest unsatisfactory rates.

This is an example of the kind of information that enables academic administrators to make informed decisions about the overall status of the program in terms of a defined set of standards, the authors have been unable to identify LMS systems that show hierarchical, mapped assessments as featured here although this example (and others below) constitutes one of the common and basic requirements of administrators who oversee assessments in academic programs.

A further example of the information rather than data scenario is provided by ADAMS where it is also possible to check which is the course playing the highest *detrimental* role in the results of Figure. 4. This is achieved by *zooming in* on outcome 'a: An ability to apply knowledge of computing and mathematics appropriate to the discipline' and then obtaining assessments at course level from ADAMS which (when sorted by Max to Min on the Unsatisfactory Column) shows course ITAP1311 has a relatively high rate of 27% in Major 2 assessment for section 201 as illustrated Figure. 4 below. Figures 5 and 6 show similar information by course for **Unsatisfactory** and Exemplary assessment standards respectively.

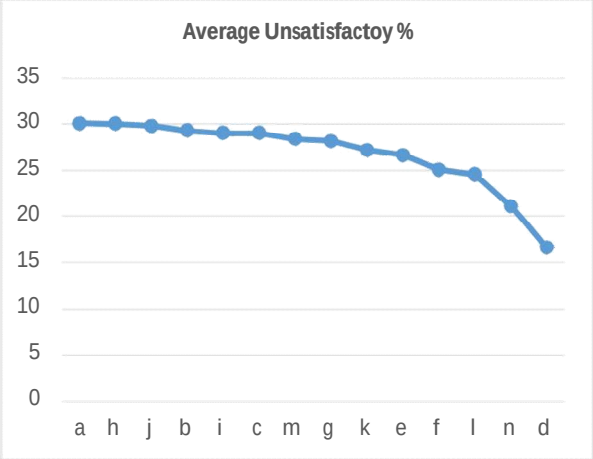

Figure. 4: Unsatisfactory Outcomes (*health status*)

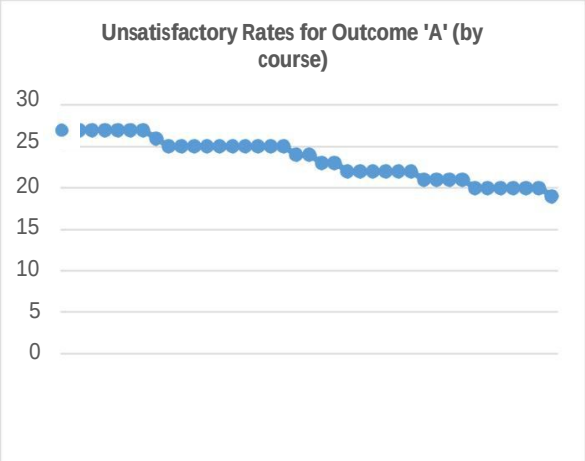

Figure. 5: Unsatisfactory rates for outcome 'A' (by course)

By sorting on the Exemplary column, we can also see the course with a highest positive impact on Outcome 'A: An ability to apply knowledge of computing and mathematics appropriate to the discipline' as in Figure. 6 below which shows GEIT3351 as the candidate course.

These figures can be changed 'on the fly' with a few clicks in the interface which retrospectively re-fits all student grades in the newly applied rubric standards, for example, in Figure. 7 and Figure.8 below we can see the *health status* of all outcomes based on the two distinct rubrics standards. Comparison of the figures shows that the dynamic flexibility of the system allows it to cope well with several rubrics standards, for example, in Figure. 7 we have a maximum Exemplary rate of 49% for outcome d where as in Figure. 8, we have a rate of around 68% for the same outcome.

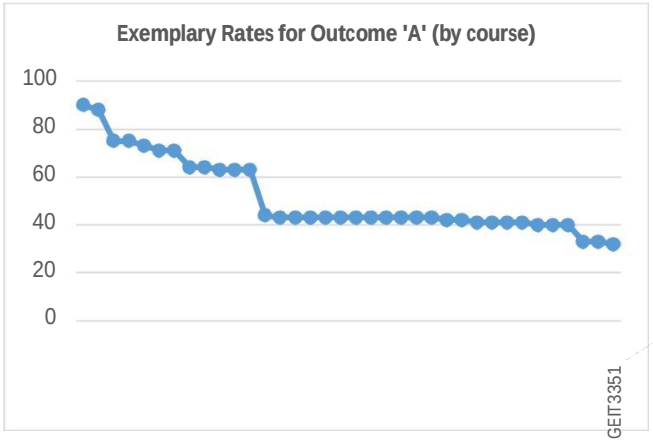

Figure. 6: Exemplary rates for outcome 'A' (by course)

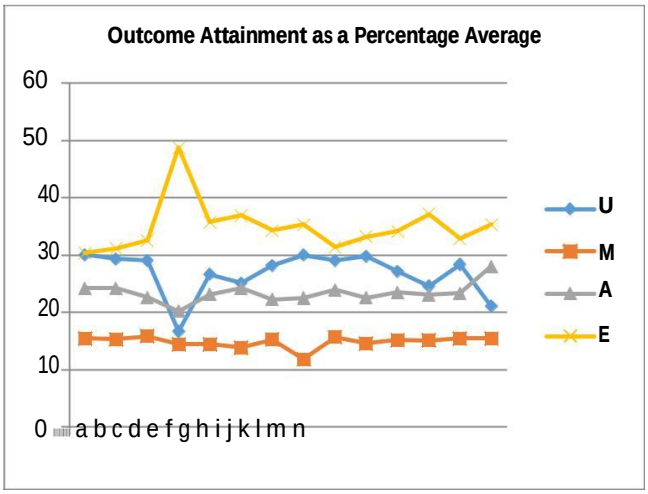

Figure. 7: Outcomes health status using rubrics rates: **Unsatisfactory: 0 – 66, Minimal: 67-76, Adequate: 77-86 and Exemplary: 87-100**

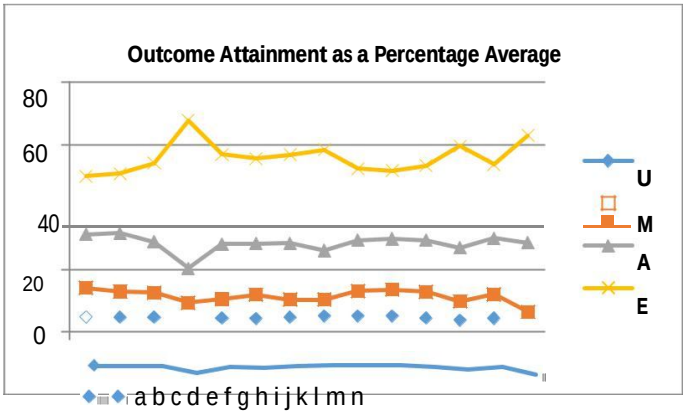

Figure. 8: Outcomes health status using rubrics rates: **Unsatisfactory: 0 – 25, Minimal: 25-50, Adequate: 50-75 and Exemplary: 75-100**

5. CONCLUSIONS AND FUTURE WORK

In this article, we have discussed some difficulties that face academics and administrators who seek regional or international quality and accreditation approval and also showed that it is possible to design bespoke LMS systems and utilities to cater for the transformation from data to information such that the impact on the pedagogical processes is minimized, thus maximizing *return on investment*. We have shown some results from the ADAMS system which enables us to answer informative questions such as which is our strongest outcome/learning area and which course is the one with highest detrimental impact on our students.

ADAMS also lends itself well for future developments in order to close the assessment loop and introduce appropriate remedies that address shortcomings in student outcome attainment rates including the application of Machine Learning techniques and Recommender Systems to suggest tutorials and curriculum changes appropriate to each student outcome or course outcome being assessed; some of these have already been applied with good success [25].

REFERENCES

[1] QS University Rankings, https://www.topuniversities.com/ university-rankings/world-university-rankings/2016, accessed in January 2017.

[2] Elsevier research rankings for institutes, https://www. elsevier.com/research-intelligence accessed in January 2017.

[3] The Guardian University Rankings Guide, https://www. theguardian.com/education/ng-interactive /2016/may/23/university-league-tables-2017, accessed January 2017.

[4]Webometrics web ranking lists, http://www.webometrics. info/en, accessed in January 2017.

[5] Kingdom of Saudi Arabia's National Commission for Academic
Accreditation and Assessment (NCAAA), http://www.mohe.gov.sa/en/aboutus/Institutions/Pages/academic-accreditation.aspx, accessed in January 2017.

[6] ABET accreditation agency, http://www.abet.org /accreditation/ accessed January 2017.

[7] AACSB accreditation agency, http://www.aacsb.edu/ accreditation accessed January 2017.

[8] British AQA accreditation agency, http://www.aqa.org.uk/programmes/unit-award-scheme, accessed January 2017.

[9]Blackboard Learn, http://en.wikipedia.org/wiki/ Blackboard_Learning_System, accessed in January 2017.

[10] Ellucian's Banner and SAS system, http://www.ellucian. com/Software/Banner-Student/ accessed in January 2017.

[11] M.S. Jaafar, N. K. Nordin, R. Wagiran, A. Aziz, M.J.M.M. Noor, M.R. Osman, J. Noorzaei and F.N.A. Abdulaziz, "*Assessment Strategy for an Outcome Based Education*", International Conference on Engineering Education, July 2008.

[12]Huba, Mary. E. and Freed, Jann. E, "Learner-centered assessment on college campuses: Shifting the focus from teaching to learning", Community College Journal of Research and Practice, Jan 2000.

[13] L.R. Gardiner, G.C. Corbitt and S.J. Adams, "Program assessment: getting to a practical how-to model", The Journal of Education for Business, Dec 2009. https://doi.org/10.1080/08832320903258576

[14] A. Elhassan, R. Sinno, Z. Huneti and A. Ahmed, "Assessing functions and competencies", 2015 IEEE 7th International Conference on Engineering
Education (ICEED), Kanazawa, 2015, pp. 59-63. doi: 10.1109/ICEED.2015.7451493.
https://doi.org/10.1109/ICEED.2015.7451493

[15] M.R.N. Schmitt, A. Aschenbrener, C.A., Viggiano and R. Thomas, "Core competencies for inter-professional collaborative practice: Reforming health care by transforming health professionals' education", Journal of the Association of American Medical Colleges, vol. 86, issue 11, 2011.

[16] P. Arcario, B. Eynon, M. Klages, and B. A. Polnariev, "Closing the loop: how we better serve our students through a comprehensive assessment process", Metropolitan Universities Journal, vol. 24, no. 2, Fall 2013.

[17] M.R. Lane, P.L. Lane, J. Rich and B. Wheeling, "Improving assessment: creating a culture of assessment with a change management approach", Journal of Case Studies in Accreditation and Assessment, Dec 2014.

[18] W. Spady, "Choosing outcomes of significance", Educational Leadership. vol. 51, no. 6, 1994, pp. 18–22.

[19]Texas International Education Consortium, TIEC, http://www.tiec.org/ accessed in January 2017.

[20] AssociationofComputingMachinery(ACM), http://www.acm.org/education/curricula-recommendations, accessed in January 2017.

[21] Bodies of Knowledge, https://www.computer.org/ web/education/bodies-of-knowledge, accessed in January 2017.

[22] T.W. Banta, L. Suskie, B.E. Walvoord, "Three assessment tenors look back and to the future", Assessment Update 27(1), January 2015, DOI: 10.1002/au.30008.
https://doi.org/10.1002/au.30008

[23] A.K.H. Alghamdi and W-S El-Hassan, "Multiliteracies and the pedagogy of empowerment: The perspective of Saudi female students, The Journal of Teaching English for Specific and Academic Purposes, vol. 4, no. 2, 2016, pp. 417-434.

[24] L. Alzubaidi, "Measurement of course learning outcomes for data structure using the combination approach", International Journal of Computer Science and Network Security (IJCSNS) vol. 16, 1, pp. 57-61, January 2016.

[25] I. Jenhani, G. Ben Brahim and A. Elhassan, "Course learning outcome performance improvement: A remedial action classification based "International Conference on Machine Learning and Applications,

December 18, 2016 - December 20, 2016, Los Angeles, USA, DOI10.1109/ICMLA.2016.0072.
https://doi.org/10.1109/ICMLA.2016.0072