ISSN 2278-3091
Volume 8, No.1.3, 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse5981.32019.pdf
https://doi.org/10.30534/ijatcse/2019/5981.32019

Decision Support Approach for Enhancing Course Learning Outcomes Achievement and Accuracy of Continuous Improvement

Dr. Mohammed Al-Shargabi
Department of Information Systems, Faculty of Computer Science and Information Systems, Najran University.
mashargabi@nu.edu.sa

ABSTRACT

Assessing and Enhancing Course Learning outcomes (CLOs) achievement is an important task for any educational institution in Outcome-Based Education (OBE) systems, due to its scientific significance, it improves the educational process, and meets the needs of the labor-market x. Course decision-makers (example: head of department or schools, course instructors, or course coordinators) are often encountered with decision taking on course improvement plans due to the complexity of the assessment process, large amount of data, and lack of experience in the assessment and continuous improvement process. Very few tools are available for decision-making in the enhancement of CLOs achievement and guide the education institution about the accuracy of the continuous improvement process. This paper proposes a decision support approach that systemically assesses and evaluates CLOs to provides the decision support that enhances the educational process in the course level. Moreover, it provides the decision support for the educational institution in regards to the accuracy of the assessment, evaluation, and continuous improvement process. This approach provides more relevant, accurate, useful, valid and unbiased results for better decision support in the improvement of the educational process to ensure best fit between the needs of the educational institution, satisfaction, validity, and affordability (time, effort, and money).The proposed approach uses course-embedded assessment that focuses mainly on the actual work produces by students in CLOs that relates to student performance on a particular activity. The application of fourty courses in different semesters has been conducted, and the results are analyzed to illustrate the model's efficiency. The results show that the proposed approach provides decision support for enhancing CLOs achievement, and the accuracy of continuous improvement process, which will lead to the enhancement of the educational process.

Key words : Decision Support Approach, Continuous Improvement, Course Learning Outcomes (CLOs), PLOs Assessment plan.

1. INTRODUCTION

The continuous improvement of an academic program is critical to maintain excellence in an educational program [1]. The continuous quality improvement of a program focuses on several critical processes such as planning and designing of assessment methods, collecting data, evaluating results, designing and implementing improvement actions. Thus, planning and designing of the assessment methods is considered to be one of the most important processes for continuous improvement of teaching and learning processes in Outcome Based Education (OBE) system [2]. Effective assessment involves direct, indirect, Summative, formative, quantitative, qualitative, objectives, and subjective [3] methods to measure the attainment of CLOs [4]. However, course decision-makers find difficulty with collecting the direct, relevant, accurate and correct measurable data for taking the decision in regard to student's improvement. In addition, the assessment methods that would be selected needs to show validity and reliability of evaluation results [5, 6]. Moreover, the assessment of CLOs uses one assessment method is quite limited to generate relevant, accurate, useful and unbiased results. Therefore, it is crucial to use multi-method assessment of CLOs in order to maximize validity and reduce bias in the assessment and to ensure continuous improvement of CLOs to correctly take the decision regarding student's improvement. However, using multi-method assessment of CLOs is a difficult and misleading task, which might lead to inability to take accurate decision, and propose correct CLOs improvement plans without the support systematic decision-making [7] aids.

(Marsh et al., 2006) in [8] proposes data-driven decision-making framework for making decisions to improve school' student success. The proposed framework focus on federal and state test-based at schools' level. thus, it cannot be implemented in higher education academic programs. (Fulantelli et al., 2015) in [9] proposes a task-interaction framework to support educational decision making in mobile learning. The proposed framework revolves around the relationships among learners' interactions and educationally relevant tasks. Yet, the proposed framework doesn't revolve around learning outcome achievement. (Livieris et al., 2016) in [10] proposes a decision support system for predicting students' performance to support student admission procedures and strengthen the service system in educational institutions. The proposes tool doesn't support enhancement of course learning outcome achievement. (Muqsith et al., 2017) in [11] proposes a decision support system that help teachers to improve themselves through self-diagnostic. The proposed system concentrates on teacher's improvement through teacher engagement index, but not student's achievement.

Thus, this paper is proposed to secure auto assessment of CLOs, to help in decision-making plans for enhancement of CLOs achievement, and to provide feedback about the accuracy of the assessment, evaluation, and continuous improvement process for the enhancement of the educational institution performance as well.

This paper is organized as follows: Section 2 gives an overview of CLOs continuous improvement framework. Section 3 describes the decision support approach for enhancing course learning outcomes achievement and accuracy of continuous improvement process. Section 4 shows the implementation of decision support approach for assessing and enhancing course learning outcomes achievement using multi assessment methods. Finally, Section 5 will end with conclusive remarks.

2. CURRENT COURSE LEARNING OUTCOMES CONTINUOUS IMPROVEMENT FRAMEWORK

One of the most critical factors of the suitability of any framework is good planning and the designing of the framework. Figure 1 shows the high-level view of course continuous improvement framework. As it can be seen in Figure 1, the CLOs assessment plan is the first step in continuous improvement framework [12] followed by the designing of the assessment methods and data collection. In more details, the data are collected from various sources (assessment methods) and evaluated to produce attainment level of each one of CLOs. Using the evaluation results of CLOs, improvement plans including a set of actions that might affect any aspects of the course are designed, approved and implemented to ensure a systematic quality assurance system. Given the above limitations of using one assessment method, it is crucial to build a continuous improvement framework for CLOs assessment based on multi-method assessment methods to ensure more valid, accurate, and useful evaluation results.

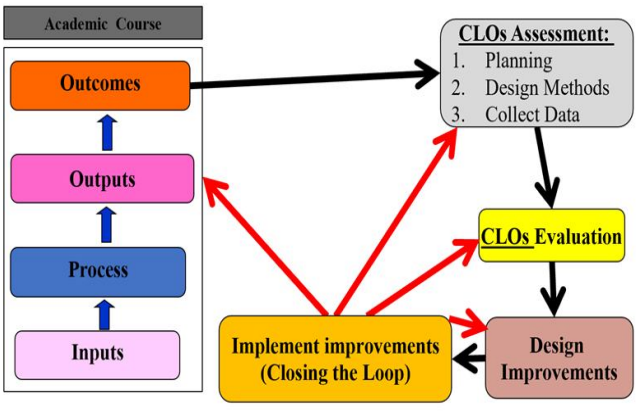

Figure 1: Generic Continuous Improvement Framework based on CLO Outcome-based assessment

Table 1 illustrates CLO assessment Plan to collect the appropriate data, then, design questions based on assessment methods and source of assessment, and then collect the appropriate data. As shown in Fig 1 CLO evaluation is the second stage in the course learning outcomes continuous improvement framework to determine the extent to which student outcomes are being attained. The evaluation results will be used to design improvement methods and plans for the improvement of the course. Finally, Implementation of approved actions are necessary to close the loop.

Table 1: Illustrates CLO assessment Plan

Source of Assessment	CLO1	CLO2	CLO3	CLO	CLON
Assignment					
Midterm 1					
Lab Midterm					
Midterm 2					
Mini Project					
Lab Final exam					
Final exam					
Survey					

As can be seen, course decision-makers often encounter taking decisions on which course improvement plans due to assessment process complexity, large amount of data, and lack of confidence and experience in the assessment process and its results. Thus, our approach will help course decision-makers to assess and to implement the process of auto decision-making for enhancement of Course Learning outcomes achievement to enhance the educational process in the course level. Moreover, the proposed approach auto checks the accuracy of the assessment, evaluation, and continuous improvement process.

3. DECISION SUPPORT APPROACH FOR ENHANCING COURSE LEARNING OUTCOMES ACHIEVEMENT AND ACCURACY OF CONTINUOUS IMPROVEMENT PROCESS

The proposed decision support approach is based on systematic steps that include mathematical equations to guide course decision-makers to conduct assessment process of the course learning outcomes and build and implement continuous improvement plans with confidence in its accuracy.

Figure 2 shows the proposed approach flowchart that guide course decision-makers in the first steps to conduct assessment process in the correct way, then the proposed approach auto evaluates the achievement of the CLOs, Proposed improvement actions, and auto checks the accuracy of the assessment, evaluation, and continuous improvement process.

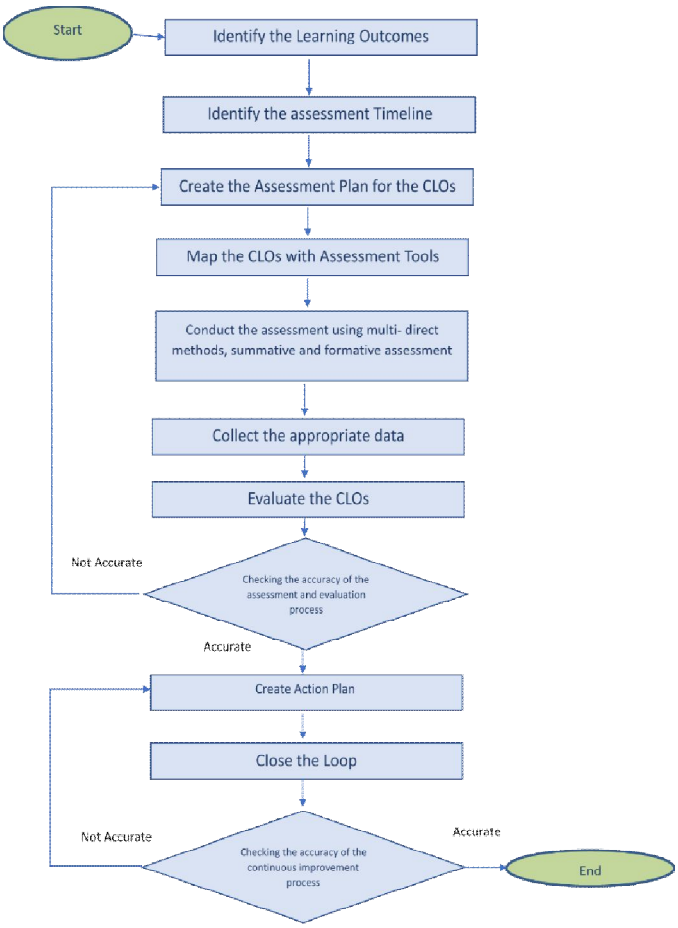

Figure 2: Flowchart of the decision support approach for enhancing course learning outcomes achievement and the accuracy of continuous improvement process

The proposed approach helps in conducting assessment process in the correct way, by the following guiding steps:

- Identify the Course Learning Outcomes: asking the lecturers to identify what the learners are supposed to know, understand, and be able to do at the end of the course. CLOs should be based upon the needs of the learner, society and what the learner should know about a particular subject. CLOs should contain an action verb: which describes the type of performance expected, the subject content: which describes the focus of the learning process, and statement of the criterion or standard for an acceptable performance (which is optional).
- Identifying the assessment Timeline: asking the lecturers to identify when to assess and collect data about the CLOs. The proposed approach guides to have summative and formative assessment.
- Creating the Assessment Plan for the CLOs: guiding the lecturers to identify the assessment methods and tools (sources of data) where the data and the time of the CLOs will be collected.
- Mapping the CLOs with Assessment Tools: designing questions in the assessment tools (ex: exam questions, survey questions) based on CLO.
- Asking the lecturers to conduct the assessment using multi- direct methods, summative and formative assessment.
- Collecting the appropriate data: inserting the marks of the students based on the questions in the assessment tools.
- Evaluating the CLOs: the proposed approach uses the below mathematical equations to evaluate the CLOs:
  - The system checks with this assessment tools, if its mapped to the CLOs in the assessment plan add the student mark $ass_{to_{s_m}}$ to array *CLOASSMARK[i]* and add the maximum value of the assessment tools $ass_{to_{m_v}}$ to array *CLOASSMAX[i]* using the following equation:

$$IF(assessment\ tools\ weight\ > 0)\ \{ \quad CLOASSMARK[i] = ass_{to_{s_m}} \quad CLOASSMAX[i] = ass_{to_{m_v}} \quad i = i + 1\ \} \tag{1}$$

  - Then, the system calculates student results for the CLO in f using the following equation:

$$f = \sum_{n=1}^{End\ of\ CLOASSMARK} CLOASSMARK(n) \tag{2}$$

  - Then, the system calculates all the considered assessment tools maximum value for the CLO in all assessment source in M using the following equation:

$$M = \sum_{n=1}^{End\ of\ \text{CLOASSMAX}} CLOASSMAX\ (n) \tag{3}$$

  - Then, the system asks the user to set achievement acceptable grades by determining the percentage of achievement acceptable grades in Y, then the system finds out the CLO achievement acceptable grades Ac using the following equation:

$$Ac = \frac{(M \times Y)}{100} \tag{4}$$

  - Then, the system calculates the number of students who achieved the CLO in NS from the total number of students in the assessment tool in TOS using the following equation:

for (int i = 0; i < TOS; i++) {
IF ($f > Ac$) {
$NS = NS + 1$}}

(5)

- Then, the system calculates the percentage of students who achieve the CLO in $CLOPres$ using the following equation:

$$CLOPres = \frac{NS}{TOS} \times 100$$

(6)

- Then, the system finds the number of students who did not achieve the CLO in SNA using the following equation:

$$SNA = TOS - NS$$

(7)

- Then, the system calculates the percentage of students who did not achieve the CLO in $NAPres$ using the following equation:

$$NAPres = 100 - CLOPres$$

(8)

- By using these mathematical equations, the system evaluates the CLOs and determines the number of students who achieved the CLOs, percentage of students who achieved the CLOs, number of students who did not achieve the CLO, and percentage of students who did not achieve the CLOs.
- Next step in the proposed approach is checking the accuracy and efficiency of the assessment and evaluation process by comparing the results of multi-assessment method of CLOs using the algorithm model as shown in the flowchart, and Figure 3:
  - *Step 1: Compared results of two assessment tools.*
  - *Step 2: If the results are equal or almost equal, it means assessment process was accurate.*
  - *Step 3: Else, it means there is a problem in assessment process itself and needs to be enhanced.*
- Next step in the proposed approach is create Action Plan based on the evaluation of the CLOS.
- Close the Loop: Implementation of approved actions are necessary to close the loop.

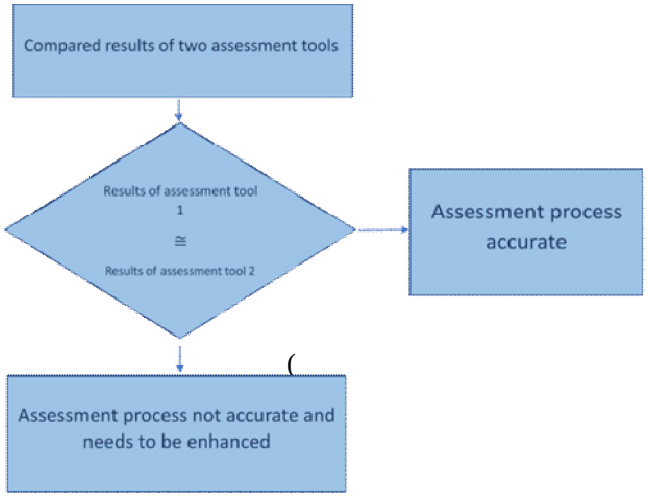

Figure 3: Algorithm model checking the accuracy and efficiency of the assessment and evaluation process

- Checking the accuracy and efficiency of the continuous improvement process by comparing the results of summative and formative assessment; where data for summative assessment was collected after the formative assessment. using the algorithm model as shown in the flowchart, and Figure 4:
  - *Step 1: Compared results that are obtained through formative and summative assessment methods.*
  - *Step 2: If summative results are the same or better than formative results it means continuous improvement process was correct.*
  - *Step 3: Else, the continuous improvement process was not correct and needs to be enhanced by itself.*

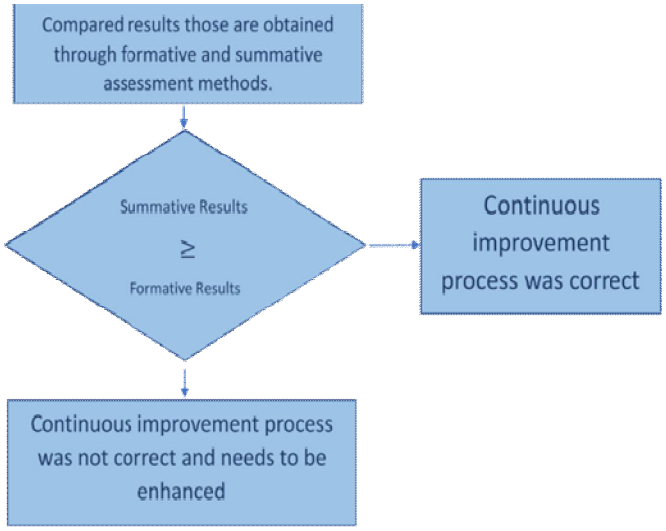

Figure 4: Algorithm model checking the accuracy and efficiency of the continuous improvement process

4. IMPLEMENTATION OF DECISION SUPPORT APPROACH FOR ASSESSING AND ENHANCING COURSE LEARNING OUTCOMES ACHIEVEMENT USING MULTI ASSESSMENT METHODS

The proposed approach has been implemented in Bachler level courses with collaboration of head of the department (decision makers), course instructors, and coordinators to validate the ability of the proposed approach, to provide decision support for them on course improvement plans and to provide decision support for them in improving their assessment, evaluation, and continuous improvement planning skills.

The proposed approach used course-embedded assessment that focuses mainly on the actual work produced by students in Course Learning Outcomes that relate to student performance on a particular activity, such as an exam question, project, or report, and correlate to a particular outcome. Forty courses in different semesters has used the proposed approach.

The proposed approach shows efficiency in auto evaluation of the achievement of the CLOs. Moreover, it shows efficiency in providing decision support in the enhancement of the CLOs achievement. Figure 5 shows CLOs achievement report for a course, which shows the number of students who achieved the CLOs, CLO achievement percentage in the course, number of students who did not achieve the CLOs, and the percentage of non-achievement.

CLOs acheivement Report					
Department: XXX	Class: BSc		Semester: 2nd Semester 201X/201X		
Section: XXX	Course Code: XXXXX		Course Title: XXXXXXX		
Credit Hours: 3	No. of Students: 35		Instructor Name. XXXXXXX		
CLO Number	CLO_1	CLO_2	CLO_3	CLO_4	CLO_5
Number of Students Achieved the CLOs	26.00	30.00	34.00	21.00	16.00
CLO Achievement percentage	74.29%	85.71%	97.14%	60%	45.71%
Number of Students did not Achieved the CLOs	9.00	5.00	1.00	14.00	19.00
Percentage of non-achievement of the CLO	25.71%	14.29%	2.86%	40%	54.29%

Figure 5: CLOs achievement report for a course

The proposed approach can guide the decision makers, course instructors, and coordinators on the CLOs that need to have an improvement plan in an easy and graphic presentation. Figures 6 and 7 show a comparison of the CLO achievement percentage in the course, and a comparison of the number of students in accordance with achieving the CLOs in a graphic presentation, which will provide decision support for the course and students enhancement in an easy way.

Moreover, it can help the decision makers, course instructors, and coordinators in taking decision concerning the students' level. Fig 8 shows CLOs achievement report on the level of each student with easy and graphic presentation on each student achievement in each CLO. Thus, decision makers, course instructors, or coordinators can take the decision and have an improvement plan for each student based on his CLO achievement.

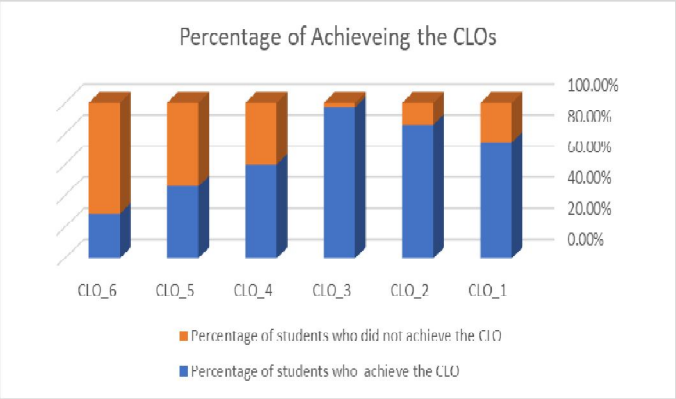

Figure 6: A comparison of CLO achievement percentage

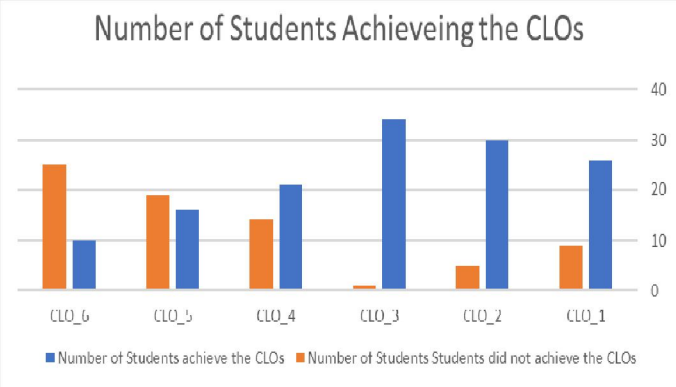

Figure 7: comparison of the number of students according achieving the CLOs

CLO No		CLO_1	CLO_2	CLO_3	CLO_4	CLO_5	CLO_6	MARKS OBTAINED
		10	10	10	10	10	10	60
1	xxxxxx	6.00	7.00	8.00	9.00	4.00	3.00	37.00
2	xxxxxx	6.00	2.00	7.00	3.00	7.00	9.00	34.00
3	xxxxxx	10.00	10.00	10.00	10.00	10.00	10.00	60.00
4	xxxxxx	9.00	4.00	7.00	5.00	6.00	9.00	40.00
5	xxxxxx	2.00	3.00	4.00	1.00	0.00	1.00	11.00
6	xxxxxx	6.00	4.00	7.00	3.00	9.00	1.00	30.00
7	xxxxxx	6.00	7.00	8.00	9.00	4.00	3.00	37.00
8	xxxxxx	6.00	2.00	7.00	3.00	7.00	9.00	34.00
9	xxxxxx	10.00	10.00	10.00	10.00	10.00	10.00	60.00
10	xxxxxx	9.00	4.00	7.00	5.00	6.00	9.00	40.00
11	xxxxxx	2.00	3.00	4.00	1.00	0.00	1.00	11.00
12	xxxxxx	6.00	4.00	7.00	3.00	9.00	1.00	30.00
13	xxxxxx	6.00	4.00	7.00	3.00	9.00	1.00	30.00
14	xxxxxx	6.00	7.00	8.00	9.00	4.00	3.00	37.00
15	xxxxxx	6.00	2.00	7.00	3.00	7.00	9.00	34.00
16	xxxxxx	10.00	10.00	10.00	10.00	10.00	10.00	60.00

Figure 8: CLOs achievement report on the level of each student

On the other hand, the proposed approach provides decision support for decision makers, course instructors, and coordinators in improving their assessment, evaluation skills by checking the accuracy and efficiency of the assessment and evaluation process by comparing the results of multi-assessment method of CLOs using the proposed algorithm model in Figure 3.

Fig 9 shows assessment and evaluation process accuracy report for a course. The report provides decision support about the accuracy of assessment and evaluation process for each CLO in the course. Also, the report shows if assessment and evaluation process was conducted correctly, or the assessment and evaluation process have a problem and needs to be enhanced.

CLO Number	Results of assessment tool 1	Results of assessment tool 2	Assessment and Evaluation Process Accuracy
CLO 1	75	73	Assessment and Evaluation Process is Accurate
CLO 2	100	25	Assessment and Evaluation Process is NOT Accurate
CLO 3	80	78	Assessment and Evaluation Process is Accurate
CLO 4	100	100	Assessment and Evaluation Process is Accurate
CLO 5	25	60	Assessment and Evaluation Process is NOT Accurate
CLO 6	30	70	Assessment and Evaluation Process is NOT Accurate

Figure 9: Assessment and evaluation process accuracy report for a course

In addition, the proposed approach can provide a comparison of the assessment and evaluation process accuracy percentage as shown in Fig 10 to help decision makers, course instructors, and coordinators checking their assessment and evaluation performance in general and take decisions on enhancing their assessment and evaluation skills.

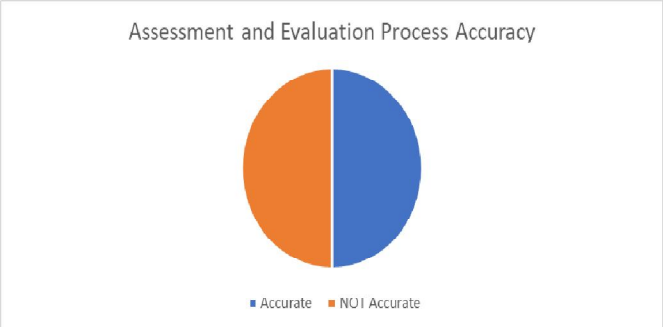

Figure 10: A comparison of the assessment and evaluation process accuracy percentage

Alternatively, the proposed approach provides decision support for decision makers, course instructors, and coordinators in improving their continuous improvement planning skills checking the accuracy and efficiency of the assessment and evaluation process by comparing the results of summative and formative assessment; where data for summative assessment was collected after the formative assessment. using the algorithm model shown in Figure 4. Figure 11 shows continuous improvement process accuracy report for a course. The report provides decision support about the accuracy of continuous improvement process for each CLO in the course. Also, the report shows if continuous improvement process was conducted correctly, or whether the continuous improvement process has a problem and needs to be enhanced.

CLO Number	Summative Results	Formative Results	Continuous Improvement Process Accuracy
CLO 1	80	65	Continuous Improvement Process is Accurate
CLO 2	100	70	Continuous Improvement Process is Accurate
CLO 3	60	75	Continuous Improvement Process is NOT Accurate
CLO 4	100	100	Continuous Improvement Process is Accurate
CLO 5	25	35	Continuous Improvement Process is NOT Accurate
CLO 6	90	70	Continuous Improvement Process is Accurate

Figure 11: Continuous improvement process accuracy report for a course

In addition, the proposed approach can provide a comparison of the continuous improvement process accuracy percentage as shown in Figure 12 to help decision makers, course instructors, and coordinators checking their continuous improvement planning performance in general in taking decision on enhancing their continuous improvement planning skills.

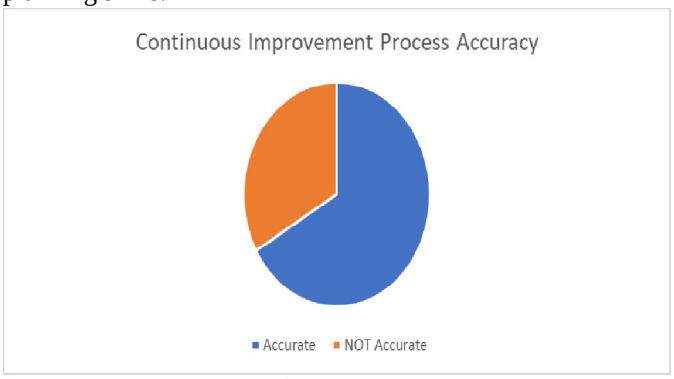

Figure 12: A comparison of the continuous improvement process accuracy percentage

5. CONCLUSION

In this paper, the development of a very sustainable and efficient decision support approach for enhancing course learning outcomes achievement and accuracy of continuous improvement process that will enhance the education process and outcomes has been described. Moreover, the proposed approach shows validity in supporting the education institution in taking decision about the accuracy of the assessment, evaluation, and continuous improvement process. The implementation of the proposed approach demonstrates a high degree of validity, usefulness, and accuracy of assessing, evaluating and improving the achievement of the CLOs. Moreover, it supports education institution in improving the assessment, evaluation, and continuous improvement planning skills. The proposed approach will support educational institutions with accurate decision to enhance and improve the educational process and its outcomes.

REFERENCES

1. N, Abdallah, Taleb, A., Al-Shargabi, M., and Benaida, M. **A Learning Outcome Inspired Survey Instrument for Assessing the Quality of Continuous Improvement Cycle**, *International Journal of Information and Communication Technology Education (IJICTE)*, 15.2: 108-129, 2019. https://doi.org/10.4018/IJICTE.2019040107
2. W. G. Spady. **Outcome-Based Education: Critical Issues and Answers**. 1st ed American Association of School Administrators, USA, 1994, ch. 1, pp 1- 24.
3. A. Leskes. **Beyond confusion: An assessment glossary**, Peer Review, 4(2/3), 42-43, 2002.
4. D. Boud, and R. Soler. **Sustainable assessment revisited**. *Assessment & Evaluation in Higher Education*, 41(3), 400-413, 2016. https://doi.org/10.1080/02602938.2015.1018133

5. T, Ahmad, M. Al-Shargabi, and N. Taleb. **Multi-Direct Assessment Methods for Better Program Improvement**, in *Proc. the 6th International Arab Conference on Quality Assurance in Higher Education (IACQA'2016)*, Sudan, 2016.
6. K. Shryock, and H. Reed. **ABET Accreditation: Best Practices For Assessment**. *in Proc. the ASEE Annual Conference and Exposition*, The University of New Mexico, Albuquerque, 2009.
7. M. Bohanec. **Decision Support,** *Data mining and decision support*. Springer, Boston, MA, 23-35, 2003. https://doi.org/10.1007/978-1-4615-0286-9_3
8. J. Marsh, A., Pane, J. F., and L. S. Hamilton. **Making sense of data-driven decision making in education**, *Evidence from recent RAND research*, Santa Monica, CA, RAND Corporation, 2006
9. G. Fulantelli, D. Taibi, and M. Arrigo. **A framework to support educational decision making in mobile learning**, *Computers in Human Behavior*, 47, 50-59, 2015. https://doi.org/10.1016/j.chb.2014.05.045
10. I. E. Livieris, T. A. Mikropoulos, and P. Pintelas. **A decision support system for predicting students' performance**, *Themes in Science and Technology Education*, 9(1), 43-57, 2016.
11. A. M. Muqsith, D. Widhyatmoko, Y. Indrianti, and A. Khan. **Indonesian teacher engagement index (ITEI): Decision support system for education**. in *Proc. 5th International Conference on Cyber and IT Service Management (CITSM)*, IEEE, 2017. p. 1-5.
12. M. McLean. **Continuous improvement in higher education: A change model using predictive analytics to achieve organizational goal**, Ph.D. dissertation, Ralph C. Wilson, Jr. School of Education, St. John Fisher College, 2017.