A Modified Evaluation Approach for Direct Assessment of Program Outcomes: Medical Equipment Technology Program as Case Study

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Abstract—Academic accreditation criteria require a powerful method to evaluate program outcomes (POs). The most recent studies recommend the use of both direct and indirect assessments to evaluate the actual achievements of POs. This study aimed to provide an easily implemented method based on direct assessment and other integrated variables that reflect the reality of students' achievement of POs. The suggested method, based on weight average equation, was presented and compared with the other two methods. The comparative study was designed on the basis of two steps. First, the results of each method were compared with the result of the general capacity exam, using root mean square error (27 students, male, from level four with 6 courses). The second step was based on statistical analysis (paired t-test) of results from the methods for the same batch of students (from level 3 to level 6, with 22 courses). In the first step, the suggested method resulted in the lowest root mean square error relative to the general capacity exam (9%). In the second step there was a significant difference between the mean of the suggested method and other methods (69.8040 ± 6.59, P-value < 0.05). The evaluation procedure for POs is an integral component of the education process. Various variables are integrated to reflect the actual achievement of students. The suggested method reflected the reality of PO achievements more accurately than the other methods, which proved sensitivity to the number of course learning outcomes (CLOs).

Keywords—Evaluation of assessment methods; medical equipment technology; program outcomes; course learning outcome; weight average equation.

1 Introduction

Quality systems are one of the most important trends in the new wave of technology and have attracted great attention as a dominant and desirable administrative style of the current times. It has been described as the third revolutionary wave after the industrial revolution and the computer revolution [1]. The concept of quality as a management philosophy relies on many modern management theories that establish links between basic administrative resources and innovative efforts, besides specialized technical skills, to enhance the level of performance, accomplish business improvement, and sustain continuous development [2].

It is not surprising that Arab institutions of higher education and universities suffer from great problems and serious challenges and threats. The changes that have shaped a new world order have created these problems and challenges. These changes stem from new trends in science and technology that leave no room for unwillingness to develop and modernize academic programs. New technological advances ensure that educational institutions have the ability to provide deep reinforcement learning and overcome pedagogical problems and weak patterns [3].

It should be noted that the concept of quality management systems and its application is no longer limited to institutions and organizations that are operated with the sole aim of earning profit, but also to public institutions and universities wishing to achieve high quality outputs, irrespective of profit [2].

As indicated by Hoy et al. [4], in the realm of instruction, quality is a tool for assessing the educational process, which helps to accomplish and bolster students' learning outcomes, while also fulfilling the responsibility to the guidelines set by customers who pay for the procedure. UNESCO likewise emphatically stressed the desirable dimensions of quality as identified by the Dakar Framework. The five key elements that are essential for defining quality in education are learners, environments, content, processes, and outcomes [5].

It is important to describe the framework applied to the quality process. Figure 1 shows the educational quality process that was applied to the Medical Equipment Technology department (MET) in the College of Applied Medical Sciences (CAMS), Majmaah University. The inputs included students, faculty members, program curriculum, stakeholder requirements, logistics facilities, laboratory equipment and so on. Procedures and activities included all processes that were essential for every input in order to achieve the targeted outputs. Outputs comprised highly qualified graduates in the MET field, the number of scientific research articles published per year, and the number of social activities conducted by the department per year. Each output was assigned measurable indicators to evaluate its performance and to conduct a SWOT (Strength, Weakness, Opportunity, and Threat) analysis for continuous improvement of inputs or procedures. Highly qualified graduates are a very important output, because other outputs will depend on this in the future.

Highly qualified graduates can be evaluated by measuring satisfaction to learning outcomes after participating in program activities. These outcomes may relate to behavior, skills, knowledge, attitudes, values, conditions, or other attributes [6].

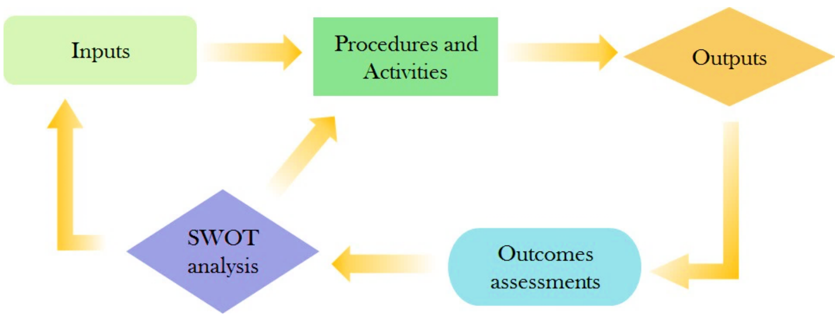

Fig. 1. Educational quality process

Educational systems around the world have adopted outcome-based methods at multiple levels [7-8]. At the end of the 20th century, United States, Australia and

South Africa were among those who had been implementing an outcome-based education system over the years [7-9]. As of 2017, most of the countries around the world have signed the Washington Accord, which is an agreement to accept graduates who have obtained their engineering degrees using outcome-based education methods [10].

Learning outcomes defined as attributes the fruitful understudy/student is relied upon to have in order to accomplish the program module/course unit or capability [11]. Learning outcomes are articulations of what a student is required to know and comprehend, and furthermore have the capacity to demonstrate after the fulfillment of a procedure of learning [12].

The results of outcomes assessment not only show the effectiveness of procedures and activities but also, the expected achievement of outcomes. Program managers can use outcome data to reinforce existing procedures, expand effective services, recognize staff training requirements, develop and validate budgets, and formulate long-range plans [6].

National qualifications framework (NQF) for higher education in the Kingdom of Saudi Arabia classifies learning outcomes into five domains at the bachelor level: knowledge, cognitive skills, interpersonal skills and responsibility, communication, information technology and numerical skills and psychomotor skills. The MET program outcomes (POs) were established to satisfy NQF requirements, and consists of two outcomes for knowledge, three for cognitive skills, three for interpersonal skills and responsibility, one for communication, information technology and numerical skills and one for psychomotor skills [13]. The MET program contains seven levels after the preparatory year (levels 1 and 2), with 37 courses in total; each course has a minimum of five course learning outcomes (CLOs), which are mapped against PO (see Appendix 1, Part A).

The most recent research recommends the use of both direct and indirect assessments to evaluate the real achievement of POs [14-17]. Students' specific knowledge or skills can be assessed more effectively by using direct assessment techniques, for example, the final examination, quizzes, homework, and projects, if the mapping between the course learning outcomes (CLO) and PO are established in good manner [18].

Many recent studies provide different techniques for learning outcomes assessment, some of them very complex and effort intensive. One of these methods is the use of two complex mathematical equations for CLO and PO measurements [19]. A software application was developed that uses this method to accomplish CLO-PO measurements, with an automatic iteration process. Turkmen et al. reported a direct assessment method that includes the determination of weightage and uses several mathematical equations for each assessment tool [20]. Wahab et al [21], created a weighted average equation to evaluate the achievement of PO; Biney and Bryant calculated the mean achievement for each PO from CLO [18].

In the current study, the author has suggested a modified procedure that simply calculates the achievement of each PO by weighing the accumulative data resulting from the direct assessment of each course and compares between the suggested procedure and the other methods to verify which method is the closest to reality.

2 Materials and Methods

Data was collected in the form of quantitative methods using a direct assessment sheet for MET CLOs, and a general capacity test based on learning outcomes for verification of our method. The author chose one batch of students as an example and followed their achievements from level 3 to level 6.. The average number of students was 24, all of who were male (The program runs only for men).

Figure 2 shows an excel sheet of the direct assessment of MET CLO at the end of one semester. The direct assessment sheet contains the following information: course name, course code, course credit hours, all assessment methods used, mapping between assessment methods and CLO, mapping between CLO and PO, and achievement of each CLO. During the phase when the MET curriculum was being established, the department requested the course coordinators to map CLOs of the courses for which they were responsible against the matched POs. In addition, the faculties determined the proper assessment methods for measuring the achievement of each CLO, based on the POs.

Additionally, an optional general capacity exam was administered to level 4 students, mainly to measure POs. This exam was designed under the supervision of the faculty members who teach courses at this level. The exam was then reviewed by consultants from the same fields to ensure that all questions were appropriately matched with POs (see Appendix 1 Part B). This exam was implemented at the beginning of the fifth semester, after the summer vacation, and used as a reference model in the comparison process between the different assessment methods during this study.

Figure 3 shows the assessment methods that were used to determine the accumulative achievement for each PO. Level 4 results were used to verify the appropriateness of the methods by determining the mean square error between the three methods and the results of the general capacity exam. The paired t-test was applied on the students' results to reveal the significant differences between the three methods used in this study.

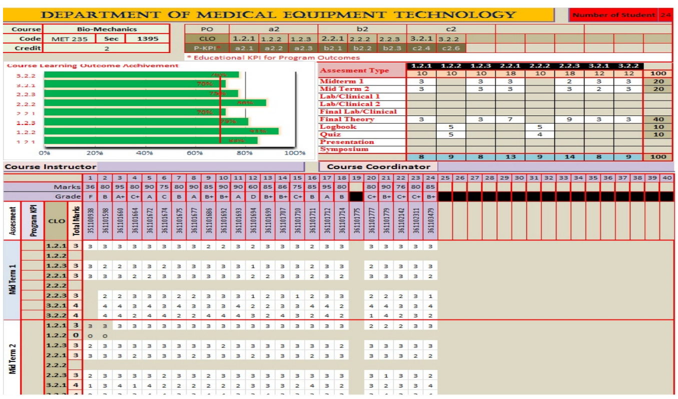

Fig. 2. Example of direct assessment sheet

The first method depends on the following weight average equation for Biney and Bryant [18]:

$$PO = \frac{\sum_{N=1}^{N} \text{CLO achievement}}{N} \tag{1}$$

Where:
PO = Achievement of POs
CLO achievement = Achievements of each CLO by each student
N = Total number of students registered in each course
The second method was based on the following weight average equation [21]:

$$\bar{O}_i = \frac{\sum_{j=1}^{NC_i} O_{i,j} C_j n_j}{\sum_{j=1}^{NC_i} C_j n_j} \tag{2}$$

Where:
$\bar{O}_i$ = Total average i obtained for all courses in a semester
$O_{i,j}$ = Average total achievement i measured by course j
Cj = Credit hours for course j
nj = Number of students who attended course j
NCi = Number of course measured outcomes i

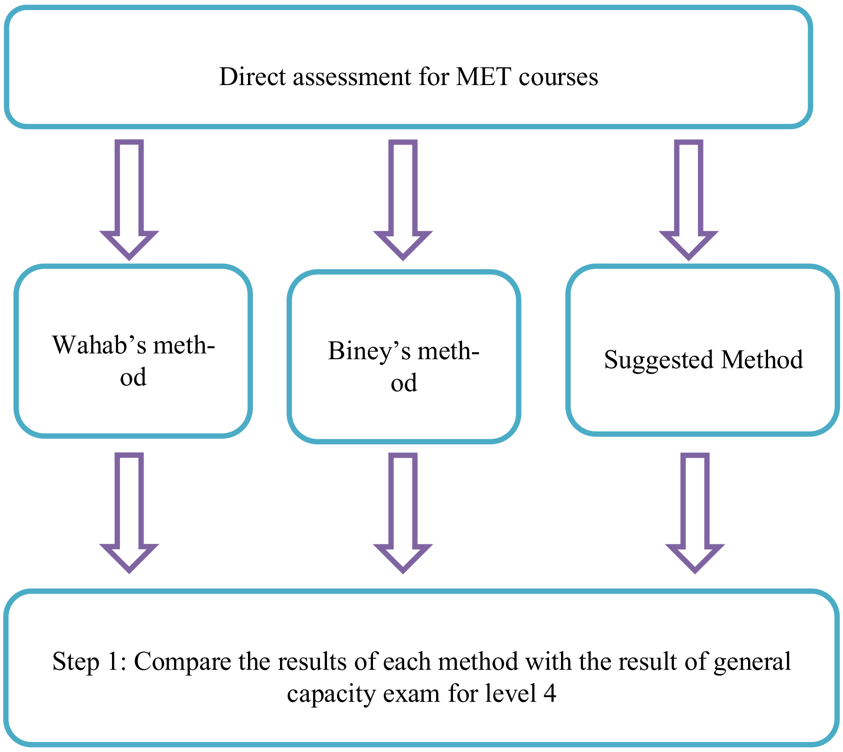

Fig. 3. Flow chart of current methodology

The third method (suggested method or equation) was based on the following equation expounded by Wahab et al. [21]:

$$\mathrm{PO} = \frac{\sum_{N=1}^{N} \text{CLO achievement}}{N} \quad (1)$$

Where:
Ei = Achievement of PO
cj = Number of courses that achieved the specific PO
eij = Student average achievements i measured by course j based on marks and attendance percentage
tj = Credit hours for each learning outcome
nj = Number of students registered for each course
wj = Number of CLOs matched with "E"
During the verification phase the methods were applied only to level 4 courses. After that, they were applied to all courses from level 3 to level 6 for the same batch of students. These courses represent 22 out of 37 from the program. The method used for the verification phase was root mean square error, which was calculated as follows:

$$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (M_i - A_i)^2} \quad (4)$$

Where:
RMSE = Root mean square error
N= Number of data points
Mi = Value returned by each method
Ai = Actual value calculated from the general capacity exam

3 Results

Table 1 shows the number of CLOs for each course in level 4 that involved achieving the corresponding PO. The table reveals that the number of CLOs is 32, represented in 6 courses. The table also shows that the maximum number of corresponding PO matches was 1.2 (10 CLO matches) followed by 2.2 (5 CLO matches), then 3.1 and 5.1 (4 CLO matches).

Table 1. Number of Course Learning Outcomes matched with Program Outcomes for each course in level 4

Courses	Program outcomes*									
	A		***B***			***C***			***D***	***E***
	1.1.	1.2	2.1	2.2	2.3	3.1	3.2	3.3	4.1	5.1
MET 241		1		1	1				1	
MET 242	1	2			1					1
MET 243		2		1		2				1
MET 244		2	2			1			1	2
MET 245		2		2		1				
MET 246	1	1		1				1		

* ***A*** refers to knowledge ****B*** refers to cognitive skills * ***C*** refers to interpersonal skills * ***D*** refers to communication and numerical skills * ***E*** refers to psychomotor skills.

Table 2 represents the achievement of POs based on students' marks and attendance of level 4 courses. This table was generated from the direct assessment sheet of CAMS program courses, which was designed by the quality assurance unit of the college.

Table 2. Program Outcome achievements based on students' marks and attendance of level 4 courses

Courses	Program outcomes									
	A		***B***			***C***			***D***	***E***
	1.1.	1.2	2.1	2.2	2.3	3.1	3.2	3.3	4.1	5.1
MET 241		71%		70%	67%				68%	
MET 242	64%	62%			64%					72%
MET 243		67%		50%		82%				82%
MET 244		60%	63%	0%		53%			55%	69%
MET 245		48%		57%		79%				
MET 246	77%	63%		65%				72%		

As shown in Table 3, the total course credit hours are divided by the number of CLOs with the same weight; for example, course MET 242 has 3 credit hours with 5 CLOs. This indicates that the time spent teaching one CLO will be 0.6 credit hours. Tables 1 to 4 were used for calculations in our suggested method (see equation 3). The results of Table 5 are used in calculations for both Biney and Wahab’s methods.

Table 3. Distribution of total credit hours per Course Learning Outcome

Courses	Program outcomes									
	A		***B***			***C***			***D***	***E***
	1.1.	1.2	2.1	2.2	2.3	3.1	3.2	3.3	4.1	5.1
MET 241		0.5		0.5	0.5				0.5	
MET 242	0.6	1.2			0.6					0.6
MET 243		1		0.5		1				0.5
MET 244		0.5	0.5			0.25			0.25	0.5
MET 245		0.8		0.8		0.4				
MET 246	0.5	0.5		0.5				0.5		

Table 4. Number of students registered per course and total credit hours for each course

Courses	No. of students	Credit hrs.
MET 241	27	2
MET 242	24	3
MET 243	22	3
MET 244	29	2
MET 245	24	2
MET 246	22	2

Table 5. Students achievements based on marks per course in level 4

Courses	Program outcomes									
	A		***B***			***C***			***D***	***E***
	1.1.	1.2	2.1	2.2	2.3	3.1	3.2	3.3	4.1	5.1
MET 241		83%		82%	79%				80%	
MET 242	74%	72%			74%					83%
MET 243		73%		55%		90%				90%
MET 244		65%	68%			57%			60%	75%
MET 245		55%		65%		90%				
MET 246	88%	73%		75%				83%		

Table 6 shows the results of the calculation of the chosen assessment methods for the achievement of POs, compared to the general outcome-based exam. Data from Tables 1 to 4 were used to calculate achievement of POs. As shown in Table 6, the results for the achievement of POs of the suggested method in the current study are closer to the general outcome-based exam results, and the root mean square error percentage is lower as well.

Table 6. Program Outcome achievements calculated by three assessment methods for level 4 course

Program outcomes	Suggested method	Wahab's method	Biney's method	General outcome-based exam
1.1	69.37%	79.29%	81.07%	59.67%
1.2	61.38%	70.50%	70.17%	52.80%
2.1	62.53%	67.74%	67.74%	53.78%
2.2	60.39%	68.40%	69.36%	51.95%
2.3	65.19%	75.87%	76.24%	56.07%
3.1	75.58%	78.92%	79.05%	65.01%
3.3	72.33%	83.33%	83.33%	62.22%
4.1	63.46%	69.64%	70.00%	54.59%
5.1	73.67%	83.11%	82.78%	63.37%
Root mean square error	9.4%	17.7%	18.0%	

The suggested method was applied to calculate the achievement of POs of the selected batch of students from level 3 to level 6 (see Figure 4). As shown in Figure 4, the achievement of PO 3.1 has the highest value, while the achievement of PO 2.1 has the least value. All the achievements of POs were above the target level (60 %).

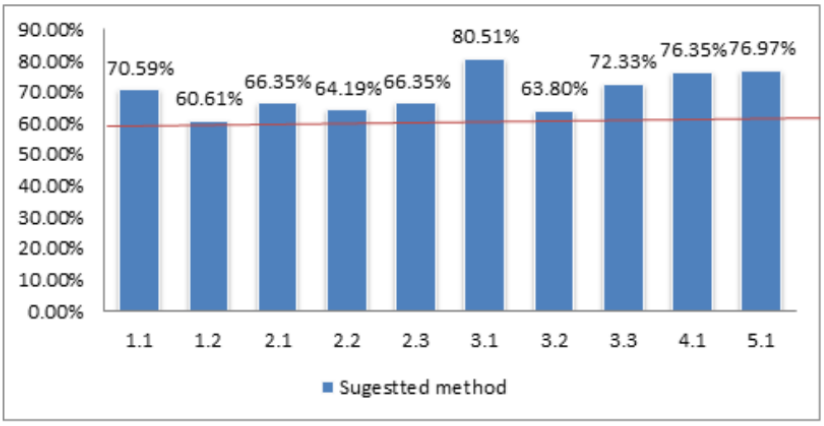

Fig. 4. Accumulation of Program Outcome achievements of the same batch of students from level 3 to level 6

Tables 7 and 8 show the mean achievement of POs using the three methods. A paired t-test using SPSS version number 24 revealed a significant difference between the suggested method and the other two methods, at confidence level 95% (69.8040 ± 6.59, p value < 0.05). However, the correlation test gave a high positive correlation between the three methods.

Table 7. Pair t-test between Wahab's method and suggested method

Pair	Mean	Std. deviation	Std. error mean	Correlation	t -value	P- value
Wahab's method	78.9514	6.63540	2.09830	0.947	13.418	0.000
Suggested method	69.8040	6.59568	2.08574			

Table 8. Pair t-test between Biney's method and suggested method

Pair	Mean	Std. deviation	Std. error mean	Correlation	t -value	P- value
Biney's method	78.7457	6.17812	1.95369	0.941	12.71	0.000
Suggested method	69.8040	6.59568	2.08574			

4 Discussion

At the end of the 20th century, many countries around the world, such as the United States, Australia and South Africa, were implementing outcome-based education systems [7-9]. The results of outcomes assessment show not only the effectiveness of procedures and activities but also the expected achievement of outcomes [10]. Students' academic performance can be ascertained from actual achievement of POs. This indicates that CLO and PO mapping is very important to distinguish obvious gaps, avoid pointless reiteration, and prevent poor arrangement in a way that encourages profound, broad and extensive learning [22].

As shown in Table 6, there was a clear variation in achievement of POs of the level 4 courses based on the assessment method used. This variation can be ascribed to the formulas used in each equation of the applied methods. The suggested method calculates the achievement of POs based on students' achievements in each course, which depends on their marks and attendance percentage. However, both Wahab and Biney's methods did not include attendance percentage in their calculations (Tables 2 and 5). Many earlier studies have examined the relationship between attendance percentage and achievement of CLO [23], and it has been proved that students who attend class regularly achieve higher levels of performance in their courses. A meta-analysis of the relationship between attendance in college classes and grades proved that attendance has a strong positive correlation with class grades [24]. Additionally, better academic performance was positively correlated with better attendance rates [25].

The current study revealed that course credit hours is one of the most important factors affecting the variations among the different methods. As shown in the equations used to assess outcomes, Biney's method did not use course credit hours in the formula, rather depended solely on the average equation. On the contrary, the suggested method and Wahab's method depended on the weight average equation. However, there is a clear difference between the two methods: Whereas Wahab's method used total credit hours for the course, the suggested method assumed that each CLO requires the same time, so course credit hours were divided equally among the number of course CLOs (Table 3).

As shown in Table 6, there was a clear variation between the three methods used in PO assessment and the general outcome-based exam. The results revealed that the suggested method had the lowest variation (9%), but this percentage is still high and might be attributed to the fact that the general outcome-based exam was conducted after three months of summer vacation. Many studies have been conducted to explain the effect of summer vacation on learning outcomes [26-27].

Despite the clear significant difference between the suggested method and the other two methods, as confirmed by the root mean square error, there was a high positive correlation between the three methods, as confirmed by the correlation test. This might be attributed to the calculation of the three methods, which was based on the average [28].

5 Conclusion and Future Work

The PO evaluation procedure is an integral component of the education process. In this study, various variables were integrated to reflect students' actual achievement. This will help to improve the educational quality process during SWOT analysis. The statistical analysis revealed a clear variation in the achievement of POs between the suggested method and the other two methods. The suggested method is closer to the actual achievement of POs than the other two methods, as confirmed by the root mean square error, which proved that it is sensitive to the number of CLOs. Fulfilling the requirements of today's educational quality systems are not an easy task, therefore the simplification of procedures for faculty members can foster high performance, which is beneficial for the education process. For more improvements on the suggested method, the author recommends adding some extra factors in the equation, such as the student's GPA (grade point average). This will be treated in the next article.

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7 References

[1] Brown, P. (1990). The 'Third Wave': education and the ideology of parentocracy. British Journal of Sociology of Education, 11, 65-86. https://doi.org/10.1080/0142569900110105

[2] Sohel-Uz-Zaman, A. S. M., & Anjalin, U. (2016). Implementing total quality management in education: Compatibility and challenges. Open Journal of Social Sciences, 4, 207-217 . https://doi.org/10.4236/jss.2016.411017

[3] Mansour, N., & Al-Shamrani, S. (2015). Science education in the Arab Gulf States: Visions, sociocultural contexts and challenges. (Rotterdam: Sense Publishers)

[4] Hoy, C., Bayne-Jardine, C., & Wood, M. (2000). Improving quality in education. (London: Falmer Press)

[5] UNESCO, UNICEF, WHO, The World Bank (2000). Focusing Resources on Effective School Health: A FRESH Start to Enhancing the Quality and Equity to Enhancing the Quality and Equity of Education.
[6] Abdeljaber, H. A. M., & Ahmad, S. (2017). Program outcomes assessment method for multi-academic accreditation bodies: Computer science program as a case study. International Journal of Emerging Technologies in Learning (iJET), 12, 23-35 . https://doi.org/10.3991/ijet.v12i05.6410
[7] Donnelly, K. (2007). Australia's adoption of outcomes based education: A critique. Issues in Educational Research, 17, 183-206.
[8] Stephanie, M. A. (2007). Education service delivery: The disastrous case of outcomes-based qualifications frameworks. Progress in Development Studies, 7, 65-78. https://doi.org/10.1177/146499340600700106
[9] McPeake, J. A. (2007). The principalship: A study of the principal's time on task from 1960 to the twenty-first century. Unpublished doctoral dissertation, Marshall University, Huntington, West Virginia.
[10] Kolmos, A., Hadgraft, R. G., & Holgaard, J. E. (2016). Response strategies for curriculum change in engineering. International Journal of Technology and Design Education, 26, 391-411 .https://doi.org/10.1007/s10798-015-9319-y
[11] Adam, S. (2004). Using learning outcomes: A consideration of the nature, role, application and implications for European education of employing "Learning Outcomes" at the local, national and international levels. United Kingdom Bologna Seminar, 1-2 July 2004, Heriot-Watt University (Edinburgh Conference Centre), Edinburgh.
[12] European Commission. (2005). ECTS users' guide: European credit transfer and accumulation system and the diploma supplement. (Brussels: European Commission)
[13] Smith, L., & Abouammoh, A. (2013). Challenges and opportunities for higher education in Saudi Arabia: An exploratory focus group. (Dordrecht: Springer) 167-179. https://doi.org/10.1007/978-94-007-6321-0_16
[14] Calderon, O. (2013). Direct and indirect measures of learning outcomes in an MSW program: What do we actually measure? Journal of Social Work Education, 49, 408-419 . https://doi.org/10.1080/10437797.2013.796767
[15] Price, B. A., & Randall, C. H. (2008). Assessing learning outcomes in quantitative courses: Using embedded questions for direct assessment. Journal of Education for Business, 83, 288-294 .https://doi.org/10.3200/joeb.83.5.288-294
[16] Nichols, J. O., & Nichols, K. W. (2005). A road map for improvement of student learning and support services through assessment. (New York: Agathon Press)
[17] Allen, M. J. (2007). Assessing academic programs in higher education. (New York: John Wiley & Sons)
[18] Biney, P. O., & Bryant, M. R. (2005, June). A novel strategy for the direct assessment and improvement of engineering programs developed and implemented by Prairie View A&M University. (Paper presented at 2005 Annual Conference, Portland, Oregon)
[19] Memon, Q. A., & Harb, A. (2009). Developing electrical engineering education program assessment process at UAE University. Australasian Journal of Engineering Education, 15, 155-164. https://doi.org/10.1080/22054952.2009.11464033
[20] Turkmen, N., Khaled, A. R. A., al-Raghbi, O. M., Zaki, G., Siddique, M., Gari, A., & Bokhary, A. (2010, December). A procedure to assess engineering courses based on program outcomes. (Paper presented at Proceedings of the 7th Saudi Engineering Conference (SEC&), Riyadh, Saudi Arabia)
[21] Wahab, H. F. A., Ayob, A., Zaki, W. M. D. W., Hussain, H., Hussain, A., & Mokri, S. S. (2011). Program outcomes measurement and assessment processes. Procedia Social and Behavioral Sciences, 18, 49-55 .https://doi.org/10.1016/j.sbspro.2011.05.008

[22] Zlatkin-Troitschanskaia, O., Toepper, M., Pant, H. A., Lautenbach, C., & Kuhn, C. (Eds.). (2018). Assessment of learning outcomes in higher education: Cross-national comparisons and perspectives. (Wiesbaden: Springer). https://doi.org/10.1007/978-3-319-74338-7
[23] Jover, J. M. N., & Ramírez, J. A. M. (2018). Academic performance, class attendance and seating location of university students in practical lectures. Journal of Technology and Science Education, 8, 337-345. https://doi.org/10.3926/jotse.353
[24] Credé, M., Roch, S. G., & Kieszczynka, U. M. (2010). Class attendance in college: A meta-analytic review of the relationship of class attendance with grades and student characteristics. Review of Educational Research, 80, 272-295 .https://doi.org/10.3102/0034654310362998
[25] Subramaniam, B. S., Hande, S., & Komattil, R. (2013). Attendance and achievement in medicine: Investigating the impact of attendance policies on academic performance of medical students. Annals of Medical and Health Sciences Research, 3, 202-205 .https://doi.org/10.4103/2141-9248.113662
[26] Cooper, H., Nye, B., Charlton, K., Lindsay, J., & Greathouse, S. (1996). The effects of summer vacation on achievement test scores: A narrative and meta-analytic review. Review of Educational Research, 66, 227-268 .https://doi.org/10.3102/00346543066003227
[27] Paechter, M., Luttenberger, S., Macher, D., Berding, F., Papousek, I., Weiss, E. M., & Fink, A. (2015). The effects of nine-week summer vacation: Losses in mathematics and gains in reading. Eurasia Journal of Mathematics, Science & Technology Education, 11, 1339-1413. https://doi.org/10.12973/eurasia.2015.1397a
[28] Hu, S. P. (2010, June). Simple mean, weighted mean, or geometric mean? (Paper presented at 2010 ISPA/SCEA International Professional Development and Training Workshop, San Diego, California)

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10 Appendix 1

10.1 Part A: Program outcomes

Domain	Code	Program outcome statements
Knowledge	1.1	Ability to select and apply knowledge of mathematics, science, and engineering to problems that require the application of principles and applied procedures or methodologies
	1.2	Ability to identify appropriate technology to provide solutions for issues related to medical equipment technology in societal and global context
Cognitive Skills	2.1	Ability to explain design problems, components, or processes needed for medical equipment technology
	2.2	Ability to choose appropriate technology and provide solutions to improve performance of existing medical devices
	2.3	Ability to identify, analyze, and solve technical problems in the broadly-defined medical equipment technology field
Interpersonal Skills & Responsibility	3.1	Ability to effectively study any case related to technological issues in medical devices and demonstrate it to peers and teachers
	3.2	Ability to effectively act as a member or leader on any technical team to discuss current technological issues in medical devices
	3.3	Ability to promote ethical principles and moral values for conducting experiments, developing and testing medical devices, or carrying out processes
Communication, Information Technology, Numerical skills	4.1	Ability to demonstrate and formulate written, oral, and graphical communication in both technical and non-technical environments
Psychomotor skills	5.1	Ability to use standard tests and measurements, evaluate biomedical experiments, calibrate medical devices, analyze data sets and apply international standards of medical equipment to improve overall healthcare processes

10.2 Part B: Program outcomes

Question bank flowchart

Question bank example

Course name		Electrical circuits	MET 243	
Units	Lecture objectives	MCQ	CLO	PO
Voltage and current	Become familiar with the factors that affect the terminal voltage of a battery	Definition of voltage: Work per charge Current per charge Resistance per charge	1.2.1	1.2

	and how long a battery will remain effective.	Voltage per charge		
		A potential difference or volt is always measured between: One point Two points Three points Four points	1.2.1	
		The unit of voltage measurement is: Volt Joules Ohm Amber	1.2.1	
		What is the potential drop across a 6 Ohm resistor if the current through it is 2.5 A? 10 A 15 V 15 F 12 A	1.2.1	
		The unit of current measurement is: Joules Ohm Amber Farad	1.2.1	
		500mA can be converted to read as: 500 V 0.5 A 5 A 0.05 mV	1.2.1	