Assessment of the students’ achievement of learning outcomes of radiological sciences program, Najran University experiment

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GSC Biological and Pharmaceutical Sciences, 2021, 14(01), 129–136

Publication history: Received on 10 January 2021; revised on 17 January 2021; accepted on 19 January 2021

Article DOI: https://doi.org/10.30574/gscbps.2021.14.1.0020

Abstract

The present study was conducted to evaluate the achievement of undergraduate radiological sciences students of PLOs by the applied method in Radiological sciences, Najran University. The assessment of the program learning outcomes in department of radiological sciences, Najran University was conducted by direct and indirect methods and analysis the results of students’ achievement. The study was applied on 21 graduating students, batch of academic year 2019-2020 by applying Najran University model. Direct measurement was applied by linking of each PLO to exams questions on quizzes, midterm exams, final exams, project work and presentation. Indirect method was implemented based on surveys; exist, alumni and employers’ surveys.

Najran University model is able to measure the achievement of PLOs and it supported by an indirect assessment method. The radiological sciences program highlights on the student outcomes for the graduate for continuous quality of the curriculum and teaching and learning process in future.

Keywords: Program Learning Outcomes; Direct and indirect methods; Assessment; students’ achievement; Radiological sciences.

1. Introduction

Higher education institutions have acknowledged the importance of assessing student learning outcomes. The results of these assessments can be used in developing methods for ensuring positive learning outcomes [1].

Outcomes based education (OBE) is as an educational process which is based on achievement the outcomes for individual student learning [2]. It involves revising of the curriculum and assessment methods to reflect the achievement of high order learning [3]. All curriculum and teaching decisions are made based on how best to facilitate the desired final outcome [4]-[5]. The unambiguous outcome is used to plan the curriculum, monitor its implementation, evaluate it and assess student’s achievement (6). In outcomes-based education, the learning system should align the teaching methods and the assessment, and CLOs are achieved [7]-[9].

Assessment is one or more processes that identify, collect, and prepare data to examine the achievement of program outcomes and its educational objectives [10].

Student learning outcomes assessment is conducted by colleges and universities at the undergraduate and graduate levels for academic departments to determine whether programs cover the material stated in their learning goals, whether students are learning the material, and the impact on student retention, graduation, post-graduation outcomes,
and institutional accreditation, with the aim of providing faculty with data that can be used to help programs evolve or improve [11].

The calculating of PLOs is conducting by using direct and indirect assessment methods, and using these collected results as a catalyst for change and improvements, such as revising curricula and courses structures, improving the learning activities and enhancing the faculty teaching competence.

The aim of the present study is focusing on the model of assessment the student’s achievement of PLOs radiological sciences program at Najran University.

The assessment is a process of collect data to evaluate the attainment of PLOs. Different types of assessment are used to measure PLOs and CLOs as direct and indirect methods [12]-[15]. A novel method evaluates the attainment level for course outcomes as well as program outcomes could be proposed by Sudheer et al [16]. The result of PLOs measurements is used to promote the quality of the teaching and learning processes in the program.

The courses are mapped to PLOs by examining individual learning outcomes of each course. The students’ achievement of CLOs of each course are assessed. Every PLO is evaluated individually based on data collected from courses’ exams results, faculty, students, alumni, internship, and employers to measure its performance level [14],[17]. Based on recent proposed suggestion, the study on the impact of different assessment methods for radiological sciences students at Najran University are required in order to ensure the quality of students’ achievement and their evaluation feedback [18].

2. Methodology

Program of radiological sciences one of the undergraduate programs in applied medical sciences college at Najran University, the program provides B.Sc. degree in radiological sciences, which requires the completion of 142 credit hours. There are (11) LOs of the specified program, they cover the three different domains (knowledge, skills and competence).

Learning outcomes statements of the radiological sciences program are arranged in the Table 1.

Table 1 PLOs statements

| PLOs  | Statement                                                                 |
|-------|----------------------------------------------------------------------------|
| PLO1  | Explain the concepts of basic principles of medical sciences, physics and the associated applications. |
| PLO2  | Describe the methods of different medical imaging procedures.              |
| PLO3  | Practice basics and medical sciences applications and imaging procedures in medical laboratories with the optimal patient care and protection. |
| PLO4  | Operate effectively and safely the different medical imaging modalities.    |
| PLO5  | Evaluate the medical images of different modalities and differentiate between the normal and abnormal appearance. |
| PLO6  | Manage the operation of different medical imaging modalities effectively and accurately. |
| PLO7  | Acquire an interpretable high-quality image utilizing different imaging modalities. |
| PLO8  | Carry out the optimal imaging examinations dependent on the assessment of patient conditions and safety requirements with ethical and legal manners. |
| PLO9  | Demonstrate basics management and research skills.                         |
| PLO10 | Communicate effectively with patient, colleagues and other health professionals. |
| PLO11 | Demonstrate teamwork and inter-professional collaboration.                 |

The direct methods to assess the students’ achievement of LOs of the radiological sciences program are tabulated in the Table 2.
Table 2 Direct assessment methods per each PLO

| Assessment methods          | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 |
|-----------------------------|------|------|------|------|------|------|------|------|------|-------|-------|
| Midterm written exam        | ✓    |      |      |      |      |      |      |      |      |       |       |
| Final written exam          | ✓    | ✓    |      |      |      |      |      |      |      |       |       |
| Quizzes                     | ✓    | ✓    |      |      |      |      |      |      |      |       |       |
| Assignments                 | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    |      |      |       |       |
| Midterm practical exam      | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    |      |      |       |       |
| Final practical exam        | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    |      |      |       |       |
| Log book                    | ✓    | ✓    | ✓    |      |      |      |      |      |      |       |       |
| Performance evaluation      | ✓    | ✓    | ✓    |      |      |      |      |      |      |       |       |
| Project work                | ✓    | ✓    | ✓    |      |      |      |      |      |      |       |       |
| Presentation                |      |      |      |      |      |      |      |      |      |       | ✓     |

PLOs courses map with their relative weights are prepared due to the key faculty staff assessment and designed in Excel sheet as shown in Table 3.

Table 3 PLOs and courses map with relative weights

| Course / PLOs               | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 |
|-----------------------------|------|------|------|------|------|------|------|------|------|-------|-------|
| Physiology                  | 14%  |      |      |      |      |      |      |      |      |       | 5%    |
| Histology                   | 14%  | 3%   |      |      |      |      |      |      |      |       | 5%    |
| Anatomy                     | 14%  |      |      |      |      |      |      |      |      |       | 5%    |
| Pathology                   | 16%  | 4%   |      |      |      |      |      |      |      |       | 5%    |
| Radiation Physics           | 14%  |      |      |      |      |      |      |      |      |       | 5%    |
| G. Investigations           | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 11%   |
| Patient Care                | 4%   | 3%   |      |      |      |      |      |      |      |       | 8%    |
| Ultrasound Physics          | 4%   | 4%   |      |      |      |      |      |      |      |       | 5%    |
| Rad. Protection             | 14%  |      |      |      |      |      |      |      |      |       | 5%    |
| Practical Tr. (1)           | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 11%   |
| S. Investigations           | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 5%    |
| Cross S. Anatomy            | 14%  |      | 6%   |      |      |      |      |      |      |       | 8%    |
| Nuclear M. Physics          | 4%   | 4%   |      |      |      |      |      |      |      |       | 8%    |
| US. Technique               | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 5%    |
| Fluoroscopy                 | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 5%    |
| Advanced Tech.              | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 5%    |
| Practical Tr. (2)           | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 11%   |
| CT                          | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 8%    |
| Practical Tr. (3)           | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 8%    |
| Practical Tr. (4)           | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 8%    |
| Adv. Equipment              | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 8%    |
| Emergency                   | 4%   | 4%   | 6%   |      |      |      |      |      |      |       | 8%    |
| Nuclear Medicine            | 4%   | 4%   |      |      |      |      |      |      |      |       | 8%    |
| Film Reading                | 4%   |      | 7%   |      |      |      |      |      |      |       | 7%    |
| Practical Tr. (5)           | 4%   | 4%   | 7%   |      |      |      |      |      |      |       | 11%   |
| Practical Tr. (6)           | 4%   | 4%   | 7%   |      |      |      |      |      |      |       | 11%   |
| MRI                         | 6%   | 4%   | 7%   |      |      |      |      |      |      |       | 7%    |
| Practical Tr. (7)           | 6%   | 4%   | 7%   |      |      |      |      |      |      |       | 12%   |
| Radiotherapy                | 6%   | 4%   |      |      |      |      |      |      |      |       | 10%   |
| Project Work                | 6%   |      | 8%   |      |      |      |      |      |      |       | 10%   |

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Firstly, the obtained students’ marks for each CO assessment are entered in the designed Excel sheet model. Radiation physics course is presented as an example, where its CO1 and CO2 were assessed by midterm written exam out of 20 marks. And the distribution of the exam marks for CO1 and CO2 of Radiation physics course is 8 and 12 marks respectively.

The individual student’s achievement score per CO1 and CO2 according to the student performance result in the written midterm exam are entered in the designed Excel sheet model as shown in Table 4 (a).

**Table 4 (a) Students marks in each CO**

| Sn. | Name      | Total/20 | CO1 | CO2 |
|-----|-----------|----------|-----|-----|
| 1   | student 1 | 12       | 5   | 7   |
| 2   | student 2 | 12       | 4   | 8   |
| 3   | student 3 | 17       | 6.2 | 10.8|
| 4   | student 4 | 18       | 6   | 12  |
| 5   | student 5 | 13       | 4   | 9   |
| 6   | student 6 | 11       | 5   | 6   |
| 7   | student 7 | 14       | 6   | 8   |
| 8   | student 8 | 12       | 6   | 6   |
| 9   | student 9 | 16       | 6   | 10  |
| 10  | student 10| 10       | 5   | 5   |
| 11  | student 11| 18       | 8   | 10  |
| 12  | student 12| 16       | 5   | 11  |
| 13  | student 13| 14       | 4   | 10  |
| 14  | student 14| 15       | 6   | 9   |
| 15  | student 15| 17       | 8   | 9   |

Secondly, the mark of the individual student per each CO is converted into percentage, where the percentages of CO1 and CO2 of Radiation physics course for the written midterm exam are divided to 40% and 60% respectively as shown in Table 4 (b).

**Table 4 (b) Students score percentage in each CO**

| Sn. | Name      | %   | CO1 | CO2 |
|-----|-----------|-----|-----|-----|
| 1   | student 1 | 60  | 62.5| 58  |
| 2   | student 2 | 60  | 50  | 67  |
| 3   | student 3 | 85  | 77.5| 90  |
| 4   | student 4 | 90  | 75  | 100 |
| 5   | student 5 | 65  | 50  | 75  |
| 6   | student 6 | 55  | 62.5| 50  |
| 7   | student 7 | 70  | 75  | 67  |
| 8   | student 8 | 60  | 75  | 50  |
| 9   | student 9 | 80  | 75  | 83  |
| 10  | student 10| 50  | 62.5| 42  |
| 11  | student 11| 90  | 100 | 83  |
| 12  | student 12| 80  | 62.5| 92  |
| 13  | student 13| 70  | 50  | 83  |
| 14  | student 14| 75  | 75  | 75  |
| 15  | student 15| 85  | 100 | 75  |
An overall assessment report of COs is extracted from the designed Excel sheet, where the total number of the students who completed the course and also the percentage of the students achieved the target per each CO are obtained in Excel format as shown in Table 5.

**Table 5** Model of extracted data report from designed Excel sheet for each course

| COs Results | Knowledge | Skills | Competence |
|-------------|-----------|--------|------------|
|             | CO1       | CO2    | CO3        | CO4 | CO5 | CO6 |
| Total no. of students completed the course | | | | | |
| Percentage of students achieved the target | | | | | |

Finally, the result of assessment of each PLO is obtained by collected the assessment of COs for the related courses with the PLO. Where 100% of the students are expected to achieve ≥ 70%.

In other hand, the indirect assessment methods of PLOs were carried out based on of surveys include exit survey, alumni survey and employers’ surveys. Questionnaires were designed based on 5-point Likert scale, and the collected results from these questionnaires were analyzed. The cycle of indirect assessment methods is annually, and their KPIs equal 80 % are shown in Table 6.

**Table 6** Indirect assessment methods cycle.

| Indirect assessment methods | Frequency | Target |
|----------------------------|-----------|--------|
| Exit survey                | Annually  | 80 %   |
| Alumni survey              | Annually  | 80 %   |
| Employers surveys          | Annually  | 80 %   |

The obtained results of the direct and indirect assessment methods of PLOs are compared and analyzed.

### 3. Results and discussion

The assessment of the students’ achievement of PLOs were applied on the radiological sciences graduating students’ batch of 2019-2020 (21 students). The results of the achievement of PLOs by using the direct methods for every student are shown in Table 7.

**Table 7** Individual student achievement of PLOs

| Student ID | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| ID1        | 74   | 73   | 77   | 79   | 84   | 75   | 79   | 76   | 75   | 79    | 81    |
| ID2        | 73   | 70   | 77.5 | 78   | 79   | 74   | 75   | 71.5 | 73   | 77.5  | 81    |
| ID3        | 78   | 71   | 77   | 77   | 80   | 77   | 77   | 74.5 | 75   | 73.5  | 80    |
| ID4        | 71   | 70   | 75   | 76   | 77.5 | 74   | 76   | 77.5 | 73.5 | 74    | 80.5  |
| ID5        | 72   | 72   | 77   | 79   | 80   | 80   | 77   | 73   | 73   | 78    | 81.5  |
| ID6        | 70   | 72   | 77   | 78   | 77   | 68.5*| 78   | 71   | 73   | 72.5  | 81    |
| ID7        | 73   | 75   | 75   | 75   | 74   | 84   | 78   | 68.5*| 78   | 70.5  | 78    |
| ID8        | 72   | 73   | 72   | 71.5 | 70.5 | 83   | 77   | 70.5 | 77.5 | 73    | 77    |
| ID9        | 70   | 74   | 73.5 | 74   | 72   | 80   | 77.5 | 71.5 | 77   | 74    | 76    |
The above Table shows that, PLOs (by the direct methods of assessment) achieved the target value (70 %), where PLOs rated between (70.6 %) and (77.6 %). PLO11 achieved the highest value compared to the other PLOs, where it rated (77.6 %). While PLO1 achieved the lowest value, where it recorded (70.6 %).

The comparison between the results of PLOs assessment by direct and indirect methods are displayed in Figure 1.

![Figure 1](image_url)

**Figure 1** Comparison between the results of PLOs achievement by direct and indirect methods

It is clear from the above Figure, all PLOs achievement by indirect methods recorded higher values than that by direct methods. The collected results by surveys (the indirect method) displayed that, the students give a feedback within rate 3.87 and 4.23 out of 5; (77.4 % and 84.6 %).

Also, the measurements of PLOs by the indirect methods showed that, they achieved the target benchmark (80%) except PLO1 and PLO8, where they rated (79.4%) and (77.4%) respectively.

PLO11 recorded the highest value of students’ achievement by using the indirect methods, where it rated (84.6 %). While PLO8 rated the lowest value of student’s achievement (77.4%) by indirect method.
4. Conclusion

Overall, direct and indirect assessment methods carried out to assess the PLOs of radiological sciences graduating students, have been successfully implemented. Results show that the indirect assessment methods rated higher values than the direct assessment for all PLOs.

PLO11 (Demonstrate teamwork and inter-professional collaboration) recorded similar achievement approach by using the both assessment methods, where it achieved the highest values compared to the other PLOs.

The difference between the mean value of the students’ achievement of PLOs by using the indirect and direct assessment methods equals 3.8%.

According to the obtained results, continuous quality improvement was suggested and carried out. Course report and annual program report are prepared, including the achievement of students’ learning outcomes in radiological sciences program at Najran University. Finally, these reports contain feedback and recommendations from the courses coordinators to improve the student’s achievement for next semester.

In general, the applied method is able to measure the achievement of PLOs and it supported by an indirect assessment method. The radiological sciences program highlights on the student outcomes for the graduate for continuous quality of the curriculum and teaching and learning process in future.

Compliance with ethical standards

Acknowledgments

The authors would like to express their gratitude to the Ministry of Education and the Deanship of Scientific Research, Najran University, Kingdom of Saudi Arabia for their financial and technical support.

Disclosure of conflict of interest

Author hereby state that there is no conflict of interest.

Statement of ethical approval

After approval of the research proposal by the deanship of scientific research, it was reviewed by Najran University ethical review panel. A formal approval to carry out the study was obtained from the Dean of Applied Medical Sciences College to conduct the study after an explanation of its objectives. Informed consent was taken from each student. All data was confidential and used for the research purpose only.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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