Assessing and Achieving Intended Learning Outcomes against the NQF

Case of CS Program at Jadara University

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Abstract

Achieving learning outcomes in the academic programs is an essential requirement for ensuring students are gained the required knowledge and skills that are comply with market needs. An efficient mechanism is required to check the extent of learning outcomes achievement and their impact on students. An efficient method is designed and applied on the academic programs at Jadara University with good performance and positive results that guide faculty members and managements on defining the weaknesses and strong improvements.

Keywords*: Learning outcomes, National Qualifications Framework, NQF, Quality*

1. Introduction

Universities have to develop and implement significant improvements for implementing and applying quality assurance requirements [12]. Accreditation and Quality Assurance Commission for Higher Education Institutions (AQACHEI)/ Jordan has developed its own National Qualifications Framework with the cooperation of GIZ/ Germany under Erasmus+ project. The General Idea to apply the NQF is to place each academic grade in its level. Jordan has defined 10 levels to cover all academic certificates.

AQACHEI has requested all academic institutes in Jordan to place its qualifications in their level and link them with the quality assurance indicators. Many institutes have conflicts on how to apply NQF and check the outcomes achievements on courses level and academic programs. This paper shows how courses and programs intended learning outcomes could be checked and achieved.

This paper shows a background in section 2, and the methodology is illustrated in section 3, section 4 shows the discussion and results where section 5 shows the

development and quality assurance center mentoring processes, the conclusion and future work is listed in section 6 and section 7 shows the used references.

2 Preliminary

The Accreditation and Quality Assurance Commission for Higher Education Institutions (AQACHEI) is the official authorized commission that is controlling Quality Assurance and Accreditation in all institutions in Jordan. Recently, AQACHEI has published a new update of the quality assurance manuals for all academic programs. Furthermore, made an agreement with Gesellschaft für Internationale Zusammenarbeit (GIZ) that published the Jordanian National Qualifications Framework (JNQF).

The JNQF is a hierarchical classification of all levels and types of qualifications and certificates associated with formal or informal education programs, as the national framework consists of 10 levels for each of the academic and professional tracks, so that, descriptors are defined for each level to define the Knowledge, Skills and Competencies that should be related to the qualification, and this enables ensuring a common quality of all qualifications and setting standards based on learning outcomes to develop educational programs that lead to qualifications that allow the ability to develop, evaluate and improve the quality of education in a number of contexts, and qualifications frameworks usually exist at the national, regional and international levels [1].

Therefore, the JNQF is based on the concept of learning outcomes, so that different educational institutions must establish their educational programs based on clear learning outcomes that are compatible with the descriptors of the level in which the qualifications resulting from these programs are to be placed, and this means that the process of controlling the quality of programs and their evaluation systems must be based on the evaluation of learning outcomes and not on the basis of assessing inputs such as teachers, curricula, and material capabilities in order to access student-centered education systems rather than the teacher [1].

Comparing the NQF in Jordan with other countries, we found that Jordan defined 10 levels and three descriptors which are Knowledge, Skills, and Competencies [1], in the meanwhile the Qualifications Framework for the Emirates depends on three descriptors also but the third descriptor is divided into three sub descriptors which are: Knowledge, Skills, and Aspects of Competencies (Autonomy and responsibility, Role in context, and Self-development) [2]. In the New Zealand Qualifications Framework they are similar: Knowledge, Skills, and Application of Knowledge and Skills [3].

In Scottish Credit and Qualifications Framework, 12 levels are defined with five descriptors which are: Knowledge and understanding, Practice, Generic cognitive skills, Communication, ICT, and numeracy skills, and Autonomy, Accountability, and working with others [4]. Furthermore, in the Bahrain National Qualifications

Framework they have five descriptors which are: Knowledge - Theoretical Understanding, Knowledge - Practical Application, Skills - Generic Problem Solving and Analytical Skills, Skills - Communication, ICT, and numeracy skills, and Competencies - Autonomy, Responsibility, and Context [5]. Table 1 summarizes the difference among the mentioned countries.

Table 1: The Descriptors in different countries

Country	NQF descriptors
Jordan	1. Knowledge 2. Skills 3. Competencies
UAE	1. Knowledge, 2. Skills 3. Aspects of Competencies (Autonomy and responsibility, Role in context, and Self-development)
New Zealand	1. Knowledge, 2. Skills, 3. Application of Knowledge and Skills
Scotland	1. Knowledge and understanding 2. Practice 3. Generic cognitive skills 4. Communication, ICT, and numeracy skills 5. Autonomy, Accountability, and working with others
Bahrain	1. Knowledge - Theoretical Understanding 2. Knowledge - Practical Application 3. Skills - Generic Problem Solving and Analytical Skills 4. Skills - Communication, ICT, and numeracy skills 5. Competencies - Autonomy, Responsibility, and Context

Jadara University is a private university that was established on 2004 and started teaching postgraduate programs in 2006 and 14 bachelor programs were opened in 2008. Now, it has seven faculties with 34 bachelor programs and 12 master programs. Programs specifications were written based on programs objectives not outcomes.

Learning outcomes are significant to the new requirements for both Program Intended Learning Outcomes (PILOs) and Course Intended Learning Outcomes (CILOs) [10]. Learning outcomes can be described as statements of the knowledge, skills and abilities (competencies) individual students should possess and can demonstrate upon completion of a learning experience or sequence of learning experiences [6].

3. Methodology

According to the JNQF, PILOs should be assessed against the JNQF descriptors, where the descriptors have to be satisfied. Therefore, PILOs should be classified into three dimensions that are Knowledge, Skills, and Competencies. The JNQF allows institutes to include sub descriptors if needed for more clarifications [1].

Graduates have to achieve their PILOs in order to qualify them and satisfy the program aims and gain the needed knowledge, skills, and competencies to get a career that suites their ambitions. The challenges can be summarized in the following points:

− Applying JNQF requirements.
− Converting form objectives to outcomes.
− Writing PILOs for all programs in accordance to the aims of their programs.
− Linking the PILOs with the JNQF descriptors.
− Writing CILOs for all courses to achieve the PILOs.
− Mapping the CILOs to their related PILOs in accordance to JNQF descriptors.
− Preparing assessed work (Questions) to satisfy the CILOs.
− Assessing the extent to which CILOs and PILOs are achieved.
− Training the faculty staff on quality assurance requirements and changing teaching culture.

Figure 1 shows the new methodology that is employed to assess the PILOs and CILOs achievements.
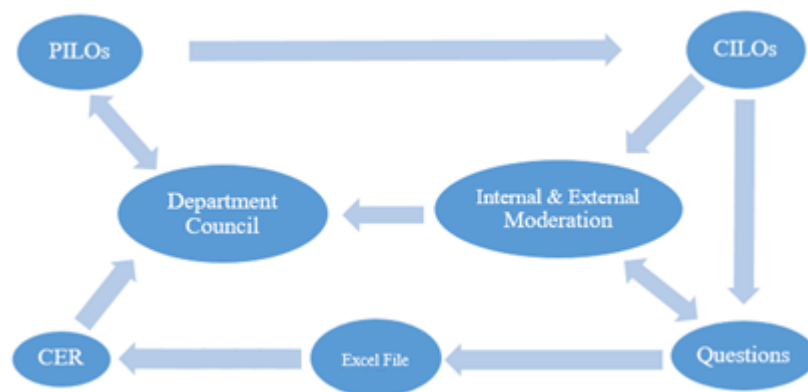

Fig. 1: Methodology for assessing PILOs and CILOs achievements

The processes of reviewing and reformulating the PILOs are required to go through a number of procedures, including the benchmarking processes, the advisory board, and stakeholders to enrich the review process.

3.1 PILOs

The PILOs should be generic and well differentiated in respect to JNQF descriptors. In this paper, a case study is conducted on the Computer Science (CS) Program at Jadara University. The PILOs in CS are revised and updated as Table 2 shows through a set of procedures and yielded more generic (9) outcomes instead of (16), which are classified into three dimensions and numbered using the first letter from their descriptor to differentiate them as in the following:

− Knowledge: with 4 outcomes that are K1, K2, K3, and K4.

− Skills: with 3 outcomes that are S1, S2, and S3.
− Competencies: with 2 outcomes that are C1 and C2.

All PILOs are differentiated, separated, no intersection, and became more generic according to external reviewer report and the CS advisory board report. In addition, the PILOs are modified according to the curriculum policy and its procedure and satisfied the aims of the CS program.

Table 2: PILOs for CS Program

Program Intended Learning Outcomes
Knowledge
K1) Demonstrate critical knowledge and understanding of the concepts, principles of computing, methodologies, and available tools for software development.
K2) Recognize and have detailed knowledge of professional ethics and social responsibilities of the practices of computer professional
K3) Design algorithms and diagrams using design tools, write code, and implement computer program using industry standard programming languages.
K4) Use and test computer based systems in terms of general quality attributes
Skills
S1) Analyze, synthesize information, and identify solutions in different contexts through applying suitable algorithms, structures, diagrams, research, and other appropriate methods.
S2) Evaluate, assess, demonstrate insight, interpretation and creativity to complex situations, and propose design solutions for computer-based systems.
S3) Communicate effectively as an individual, in teams and in multi-disciplinary settings together with the capacity to undertake lifelong learning.
Competencies
C1) Demonstrate the ability to work individually and take the responsibility of self-learning and decision-making.
C2) Demonstrate the ability to communicate findings to peers, senior colleagues and general audiences through formal methods.

3.2 CILOs

The CILOs for each course have been written to achieve the PILOs, since the PILOs are updated, therefore, it has brought about a change in CILOs. A comprehensive review has been carried out of the CILOs and their links to the PILOs. In writing the CILOs, the graduates attributes are considered that are identified by the ACM/IEEE [7], the courses are reviewed, revised, benchmarked, and updated accordingly.

The review also took into account the progress of students from one level to another by considering the level and prerequisites of each course and clarifying the overall coherence of the sequence and complexity of the courses through a tree that shows the linking of the courses and their integration across the different levels [1].

The course descriptions form has been modified and became rich with several sections to show a full specifications for each course. Each course description is written clearly after considering the benchmarking report, ACM/IEEE, and PILOs, where the course descriptions shows that each course has covered a specific topic.

For instance, Figure 2, shows the description for the Structured Programming course.

1. Course Description

This course will qualify students to gain programming skills where it introduces computer programming methods and emphasis in problem solving on the fundamentals of structured design using the principles of top down problem solving strategy. The topics include: an introduction to computer programming, problem solving steps, program design modeling using pseudocode, algorithms, and flowcharts, and also structured programming methods, constructs, and implementation using C++ programming language.

Fig. 2: A short description of a course

In writing the CILOs, Bloom's action verbs are considered carefully [8][9][11], which has been well explored within the CS area. The CILOs are linked to the PILOs, for instance, the first column in Table 3 shows the CILOs for the Databases course and the second column shows the linked PILO. The course may cover several knowledge areas where it has several CILOs that each CILO covers a specific PILO. This to assure that all CILOs are differentiated within the same course and mapped well to its PILOs. The CILOs are classified into three dimensions as well and numbered using small "a" letter followed by a sequence number for Knowledge, "b" for Skills, and "c" for Competencies.

Table 3: The CILOs for a course

Course Intended Learning Outcomes (CILOs)	
Knowledge	**PILOs**
a1. Describe database concepts, architecture, environment, models and characteristics.	K1
a2. Design database tables using relational algebra, ERD, and normalization based on user requirements.	K4
a3. Implement DDL, DML using SQL effectively.	K4
Skills	
b1. Analyze user requirements to design the database model.	S1
Competence	
c1. Work effectively taking both individual and collective responsibility to carry database tasks.	C1

Following the CILOs is the course structure which it represents the course topics distribution on CILOs, credit hours, and other information. The CILOs are not equal in size, do not have a uniform mapping to curriculum hours, and have an associated type of knowledge and topics. Table 4 shows the course structure for the first three weeks as an instance, where each week has 4 hours are required to be given to students; 2 theoretical and 2 tutorial/lab hours. The CILOs are distributed across topics to ensure that they are achieved.

Table 4: Course structure for a course

Course structure					
Week	**Hours**	**CILOs**	**Topics**	**Teaching & Learning Methods**	**Assessment Methods**

1	4	a1	File based systems vs Database Management Systems and historical roots of DBS.	Lecture	Formative Assignment
2	4	a1, a2, a3	Database systems concepts, architecture, Users and Database Administration and Tuning.	Lecture	Assignment
3	4	a3, b1	Data Modeling.	Lecture, discussion	Discussion, Quiz
…	…	…	• …	…	…

The links among courses in the curriculum through a mapping matrix showing the relationship of each CILO with the related PILOs as Table 5 shows.

Table 5: Mapping CILOs into PILOs

Course Name	PILOs /CILOs	K1	K2	K3	K4	S1	S2	S3	C1	C2
Discrete Mathematics	a1	√								
	b1					√				
	b2						√			
	c1								√	
Communication Skills	a1	√								
	a2		√							
	b1					√				
	b2						√			
	c1								√	
Structured Programming	a1	√								
	a2		√							
	b1					√				
	b2							√		
	c1								√	
Computer Ethics & Social Responsibility	a1	√								
	a2				√					
	c1								√	
	c2									√

The mapping matrix shows which CILOs satisfy specific PILOs, and it ensures that CILOs are well differentiated within the same course and well mapped to the PILOs. The program team believes that by giving descriptive CILOs, it facilitates interpretation of what outcomes mean in the context of a particular course.

3.3 Achievement of ILOs

The mapping matrix is one critical component of ensuring that students achieve the PILOs. The matrix demonstrates that each PILO is mapped to one or more CILOs which form the compulsory courses that constitute the program as a whole.

Furthermore, each CILO for any course is assessed. The suitability of the assessment instrument for measuring the CILO is verified both internally and externally. Thus, by definition if a student successfully completes all assessments for all courses he/she has demonstrated achievement of the full set of PILOs.

The University also recognizes that in terms of assurance of learning it is important to measure the extent to which PILOs for any program have been achieved. To accomplish this, a new methodology has been designed and implemented to involve recording the percentage of the overall marks awarded to each student for each CILO. The spreadsheet provides valuable information for the Program Coordinator and the Program Team as it gives an indication of student performance in each of the PILOs which the course is designed to assess. When the results for each course are aggregated across the entire program the Program Coordinator and Program Team can conduct a comparative analysis of the extent to which PILOs are being achieved. Such an analysis may identify a need to enhance the support provided to students in order to achieve particular PILOs.

Thus, at the end of each semester an Excel file is created to show the achievement of CILOs based on student scores in each learning outcome. Then by using an aggregating formula the intended learning outcomes will be considered is achieved or not and transferred to another excel file. The Excel file embeds the mapping matrix that link the PILOs with CILOs and thus provides an accurate reflection of the extent to which the PILOs have been met.

This new methodology was sent to an external quality assurance expert to assure its validity determine the achievement of the PILOs and his positive feedback confirmed to the Development and Quality Assurance Centre (DQAC) in the university that the methodology was a robust, valid and an accurate tool for measuring overall attainment of PILOs. Thus, it is now integrated into University quality assurance mechanisms as a methodology which is adopted by all programs. Internal and external moderation forms have been modified to ensure that the criteria used in evaluation of assessments provide specific confirmation that the assessment is valid and reliable and addresses the measurement of the CILOs and thus in turn satisfy one or more of the PILOs.

It addition it should be noted that student achievement of the PILOs are also tested indirectly through a variety of questionnaires which are used to incorporate the views of a variety of stakeholders. Thus, for example, employer surveys are important in confirming that students have attained the relevant PILOs.

4. Discussion and Results

The new methodology can be described as following:

− The PILOs were considered when the CILOs were re-written for each course and this was clearly matched with program specifications and the courses' descriptions too.

- The PILOs are represented by capital letters (K, S, C) to refer to Knowledge, Skills, and Competencies respectively, each letter has sub-specific skill where we assigned them as K1, K2, K3, and K4 to cover A, and so on for other PILOs. Courses' learning outcomes were written in accordance to the PILOs and represented by small letters as a1, a2, a3, or, a4 to cover the capital K's sub-specification. Subsequently, when all sub-specifications (K1, K2, …) are covered, this means that specific outcome (K) is covered which represents Knowledge in the JNQF.
- In the mapping of CILOs and PILOs, each CILO is linked to its referred PILO, and this is illustrated in the heads (Top and Left) of Table 5.
- The mapping and the link between PILOs and CILOs as shown in Table 5, where each PILO is achieved when gathering its related CILOs as Table 6 shows. From the links between the two tables it is clear that each PILO is achieved. To close the loop, exams' questions are prepared in accordance of the CILOs of each course, where marks for CILOs are stated beside questions.

Table 6: CILOs to their PILO Achievements

Course Name	PILOs/ CILOs	K1	K2	K3	K4	S1	S2	S3	C1	C2
Discrete Mathematics	a1	87.7								
	b1					77				
	b2						94			
	c1								91	
Communication Skills	a1	89								
	a2		88							
	b1					66				
	b2						88.2			
	c1								93	
Structured Programming	a1	66.5								
	a2		78							
	b1					65				
	b2							77.3		
	c1								71.7	
Computer Ethics & Social Responsibility	a1	67								
	a2				89.4					
	c1								90	
	c2									85

- Questions in all assessed work satisfy each learning outcome, marks and some statistics are calculated to ensure CILOs are achieved and satisfied. Questions' marks for each CILO are collected in the Excel file where each course outcome includes its marks and is gathered and assigned to its related PILO. The marks under each CILOs for the Midterm, Coursework, and Final for each student are gathered under their related PILOs, and at the bottom of the PILOs the status is shown. Furthermore, the Excel file is used to aggregate the course grades and

assign the course grade to each related PILO, this to make sure that we achieved the CILOs and linked them with their PILOs.

− The Course Evaluation Report (CER) is used to show the course status, where it represents a conclusion of the students statistics, distribution of grades with statistical chart, alignment and exams, grades, alignment of CILOs with assessment schedules, and achievement of stated CILOs. The CER is discussed in the CS departments' councils to approve the grades before sending them to the college council.

− The PILOs are first determined, and then the CILOs are written for each course depending on its related PILO. Specifically, questions for midterm and final exams were written with respect to course CILOs and sent for moderation with the course description that includes its CILOs, the moderator has to fill up the moderation form that has a section about CILOs assessment, which is stated in the moderation form and this gives good indications that exam questions assessed the right CILOs. All exams' marks for a course are collected and the conclusion is stored in a file that shows the CILOs and PILOs achievements. The CER summarizes the results information about a course then it is forwarded to the department council to be discussed and approved.

− The instructor collects his students work and grades, then the program coordinator reviews them in a process which is called post moderation, the coordinator has to fill up the post moderation form.

− The annual external reviewer has reviewed students work, final year projects, internship reports, assessment methods, achievements of the CILOs and PILOs as well the external examiner, but the last one has focused on all students work and achieving CILOs and PILOs.

5. Monitoring of DQAC

A series of measures have been adopted that achieve the desired objective through multiple approaches to having a homogeneous structure that effectively supports the implementation and monitoring processes. Figure 3 depicts a generic model of DQAC monitoring for assessments.
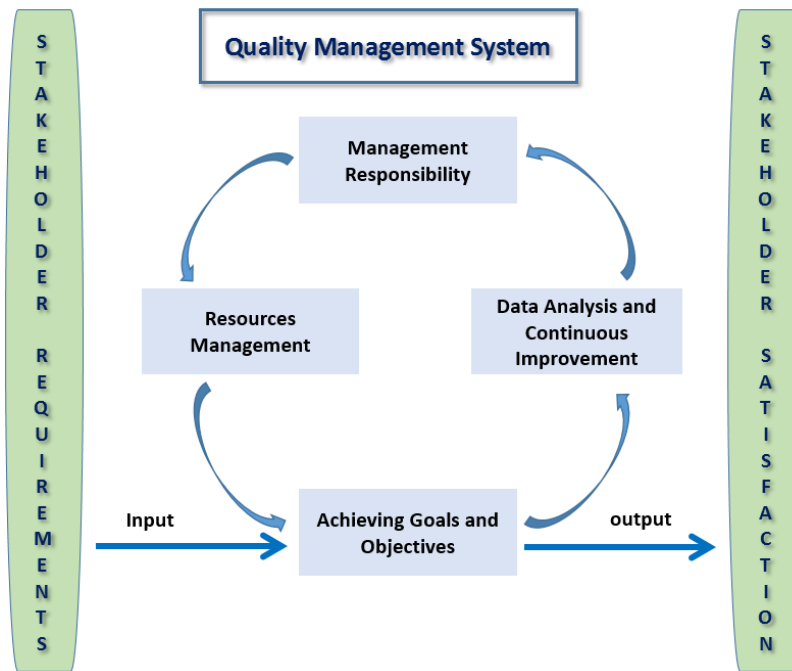
Fig. 3: DQAC System Process

In this vein, DQAC overviews the following:

− Holding periodic regular meetings to discuss issues related to the implementation of policies and procedures, and discussion of views for continuous improvement.

− Follow-up and evaluation of internal audits on the specifications of the courses at the beginning of each semester. These include the formulation of the outputs to be measurable, along with the means of teaching, learning and evaluation, and providing the programs with feedback through the program coordinators.

− Follow-up and evaluation of the performance of the internal moderators in terms of sufficient awareness of the process and seriousness in dealing with observations and overall accountability, as well as their follow-up to observations made by the teachers of the courses. Direct feedback should be provided at several levels, including the individual through the quality unit manager to faculty members on one hand and to the internal moderators, on the other hand, at the level of the program coordinators, in addition to presenting a summary of the monitoring operations to the responsible.

− Follow-up and evaluation of the process of nomination and selection of external moderators by the relevant departments according to the university regulations, including fairness, accuracy and appropriate methods of evaluating the students' work, and then evaluate their performance through the indicators besides the concerned department.

- Review post-moderation audits and the effectiveness of these audits, including verification of the absence of plagiarism in the work submitted by students. The DQAC represented by its director, followed up and emphasized the importance of these procedures and the strict implementation of these processes, which generated continuous responses and improvement from one semester to the next.
- Support, coordination and follow-up of the external review of programs through a proper selection of external reviewers, taking into account the diversity of the institutions where reviewers come from and ensuring that they have a distinguished academic background in various fields of specialization in computer science.
- The quality unit has followed up and requested the academic departments and program coordinators to discuss the reports received and determine the necessary procedures in their regard, and then follow up their application.
- The quality unit monitored and followed up the effectiveness of student evaluation policies and procedures by reviewing various samples of student assessed work during the semester and providing faculty with feedback on the implementation of teaching, learning and evaluation policies.

6. Conclusion and future work

A new intended learning outcomes assessing method is proposed and implemented in order to assess the CILOs achievements and their impact on the achievement of PILOs on the academic programs at Jadara University. This method facilitates the learning outcomes assessment, shows where the improvement is required, and eases the process of checking the learning outcomes achievements for the program and students.

More work can be done on developing an electronic system that stores all PILOs with their CILOs for all programs and courses as a future work. The system will keep records for students and programs over the years.

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