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A Six-step Approach for Standardized Student Assessment in Medical Education

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

High quality assessment is an essential and integral part of any educational process; we cannot separate it from learning and teaching. To ensure the effectiveness of the assessment process, rigorous and continuous steps and observations must be followed. These multiple steps and observations are necessary to avoid or compensate for any flaws that may occur in the entire assessment process.

This study was conducted in Faculty of Medicine, King Abdulaziz University (FOM-KAU) in Jeddah, Saudi Arabia in the academic year 2010/2011. It aimed at improving the quality of student assessment in medical education through standardizing the student assessment system by following a unique six-step approach and faculty staff members training on applying these six step with proper documentation of the whole process using exam worksheet. The study was part of CMCL-FAIMER fellowship project of the author and was conducted in Musculoskeletal and Cardiovascular modules which offered to second and third year medical students, respectively, in the FOM-KAU.

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The results of this study showed significant increase in staff knowledge and skills regarding assessment after attending the comprehensive workshop on student assessment. Also, there was significant increase in staff satisfaction regarding trainer performance, program content, and program organization. The exam worksheet was fully completed in Musculoskeletal and Cardiovascular modules in the year of the study and faculty staff members in both modules became familiar with its components.

In conclusion, the six-step approach is one of the steps for improving the quality of student assessment in FOM-KAU through standardizing the assessment system and faculty development in the area of assessment. Over the few years after the study, there is marked improvement of assessment practices in FOM-KAU, which became in the focus of interest of both medical education department and the centre of teaching and learning development in KAU. This was manifested in the faculty development activities, moving towards electronic assessment, establishment of assessment unit and the international publications in the field of assessment. The six-step approach is now widely applied in Fakeeh College for Medical Sciences (FCMS) in its three educational programs, as a part of programmatic assessment through Assessment centre which recently established for central control of the whole assessment system in the college.

Keywords: Effective; student assessment; medical education.

1. INTRODUCTION

1.1 Study Background

"Assessment drives learning." This classic statement by George E. Miller (1919–1998) succinctly encapsulates the central role of assessment in any form of education. Assessment is an essential and integral part of any educational process; we cannot separate it from learning and teaching [1]. Assessment entails the systematic gathering of evidence to judge a student's demonstration of learning [2,3]. It plays a major role in the process of medical education, in the lives of medical students, and in society by certifying competent physicians who can care for the public. The very foundation of medical curricula is built around assessment milestones for students [4]. Assessment and evaluation often drive the curricula of medical schools, and students measure their progress through the curriculum by the examinations they have passed. Society has the right to know that physicians who graduate from medical schools and subsequent residency training programs are competent and can practice their profession in a compassionate and skillful manner. Assessment is of fundamental importance because it is central to public accountability [5].

1.2 Steps for Effective Student Assessment

Effective student assessment can only drive learning, but effective assessment will appropriately answer the question: "How well does the individual perform?" [6].

To ensure the effectiveness of the assessment process, rigorous and continuous steps and observations must be followed. These multiple steps and observations are necessary to avoid or compensate for any flaws that may occur in the entire assessment process [2,7]. The steps begin by identifying the purpose of the assessment, followed by the selection of the learning outcomes (LOs) to be assessed in specific exams, and then by designing the test blueprint, followed by selecting and writing test items aligned with the LOs. The final step is to evaluate the quality of the exam through item analysis to detect poorly performing or poorly developed test items and to ensure assessment quality through psychometric analysis [8].

1.2.1 Identifying the purpose of assessment

Regarding the purpose of assessment, we should distinguish between two types of assessment, formative and summative assessments, and properly use each to achieve educational impact and maximize the benefits of each one.

Formative assessment, which is called "assessment for learning," helps students to diagnose gaps in their competency, deviation between their present situation and their intended target, and their need to act in order to attain this target [9]. Formative assessment is a continuous process or guideline, not an official test, and it is intended to track learning throughout the teaching process. The quality of the teaching and the learning experiences are evaluated by formative assessment. Dependent

on this evaluation, the faculty staff members of medical schools can align their instructional materials and course LOs for learners to accomplish these desired LOs. Constructive feedback to learners and teachers is the key element of formative assessment [3]. Compared to formative assessment, the purpose of summative assessment, called "assessment of learning," is to determine an authentic pass/fail judgment regarding students. In addition, by summative assessment, we assure the community that our learners have met the minimum requirements to give medical diagnoses and manage patient care [10]. In conclusion, formative assessments augment learning, teaching, and feedback in order to enhance the LOs of a certain course. Summative assessments give legitimacy to student competencies.

1.2.2 Identifying learning outcomes (LOs)

LOs are the measurable, specific, and observable results which are expected from any learning experience. Professional competence has been defined by Epstein and Hundred [4] as "the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individual and community being served." With the introduction of competency-based medical education (CBME), there is a now clear distinction between the terms "competence" ("able to do") and "performance" ("actually does"). According to Miller's pyramid model of clinical competence, the assessment of performance at the highest level is the "does," and competence assessment at the lower level is the "shows how." Typically, performance assessment offers a much more authentic view of a student's capability in an actual clinical context [11]. Effective assessment necessitates detection of measurable and observable outcomes or competencies. These could be in the form of tasks that lead to one or more competencies or an assessment of the whole competency, per se. Although it seems reasonable to work on that scheme, there have been concerns that obtaining individual competencies may not really lead to actual or acceptable performance. A student who is competent in physical examinations, history taking, and treatment planning may still not be able to effectively manage a patient's care [12]. Therefore, assessment must be developed in alignment with these LOs with the aim of measuring the degree to which they are or are not achieved by the end of a student's learning experience.

1.2.3 Designing test blueprint

Exam validity is an essential component that ensures assessment quality. It is a prerequisite of every assessment and implies that students have accomplished the minimal degree of performance specified in the LOs. Basically, the type of validity related to measurements of academic accomplishment is content validity [13]. Assessment content is valid whenever it is in alignment with the LOs and learning experiences, and the congruence of these elements of education can be enhanced by the use of an assessment blueprint [14,15]. Although the main purpose of the test blueprint is to validate assessment content, a well-developed blueprint can also have other roles, such as directing the choice of learning experiences. "Course blueprint" might, for that reason, be a more suitable descriptor of this instrument [16].

1.2.4 Selecting assessment method

There are a variety of assessment methods, all of which have intrinsic strengths and weaknesses; therefore, the use of multiple and different assessment methods can compensate somewhat for the weakness of any one method. The use of this approach aims at fulfilling the five criteria described by van der Vleuten for the effectiveness of assessment methods: validity, reliability, acceptability to faculty and learners, impact on learning process and future practice, and cost [17].

1.2.5 Item analysis

The analysis of assessment items provides valuable information regarding the scores which students get on their tests. Student scores could be misleading if inaccuracies are linked to them. Bad quality assessment questions could produce an incorrect score. If questions are improperly assigned or the answer is mistaken by the test writer, if items have more than one best answer, or if items are too difficult for a group of students, we will obtain an incorrect mark. These kinds of items, usually called "flawed/underperforming rogue items," need to be readjusted before students' scores are released. Two basic statistical methods are frequently utilized to recognize flawed items: the item difficulty and the item discrimination indexes. The proportion of

students who get the question right is called the item difficulty index, while the ability of an item to discriminate between high achieving and low achieving students refers to the discrimination index. The higher the discrimination index of any item reflects more positively on its higher quality [3].

1.3 Aim of the Study

To our knowledge, and based on our online literature searches, there is no practical framework or model that follows sequential and systematic steps in implementing student assessment processes in medical education. It is very important to use an assessment model that will help to close the assessment loop and to use the assessment results to improve the entire medical education learning process. The data that is collected throughout the continuous assessment cycle can identify the actions that will enhance students' learning after implementing those actions and then cycling back to collect assessment data for continuous improvement.

This study aimed at improving the quality of students' assessment by standardising the student assessment system through a unique six-step approach and faculty staff members trained to apply these six steps with proper documentation of the whole process using an exam worksheet.

2. METHODS

This study was conducted at the Faculty of Medicine, King Abdulaziz University (FOM-KAU) in Jeddah, Saudi Arabia in the academic year 2010/2011. FOM-KAU started its new curriculum in the academic year 2006/2007. The curriculum could be considered a hybrid one that emphasises vertical, horizontal and spiral integration with the introduction of new courses like patient safety, early clinical experiences and communication skills, medical ethics, professionalism and special study modules and electives. In addition, a great emphasis was directed towards student assessment to ensure the achievement of new program LOs.

This study is part of the CMCL-FAIMER innovative curricular project of the author as a partial fulfillment of his fellowship program. The project takes two directions. The first one is toward enhancing all assessment procedures through a unique six-step approach that includes an exam worksheet which was designed to be completed by the involved modules and cover the above-mentioned six steps. The second direction is toward faculty development to master all the principles of effective assessment. This was accomplished through a series of comprehensive training courses.

This study was developed to answer the following questions:

1- Is there standardized assessment system for Musculoskeletal and Cardiovascular modules?
2- Are faculty staff members in Musculoskeletal and Cardiovascular modules well trained to develop high quality assessment in their modules?

The research design is a quasi-experimental design (post- program–only with a nonequivalent control group design) as illustrated:

	Exposure to New Design	**Measurement After**
Treatment Courses (Courses Musculoskeletal and Cardiovascular modules)	**X_1**	**0_1**

Regarding staff participation in the training course, they were subjected to a pretest and a posttest, and the research design is a quasi-experimental, pre-program/post-program design as illustrated:

	Pretest	**Exposure to Training Course**	**Posttest**
Staff in Department (Courses X & Y)	**0_1**	**X**	**0_2**

This project was implemented in Musculoskeletal and Cardiovascular module which offered to second and third year medical students, respectively, in the FOM-KAU during the first phase of the new curriculum in the 2010–2011 academic year. This six-step approach to achieve the project's objectives was applied for all written exam conducted in the courses, at this time only type A MCQs were used in mid and final exams:

1. Identifying the purpose of the test.
2. Identifying the learning outcomes.
3. Analyzing the course contents.
4. Designing a test blueprint (table of specifications) using a designed computer program.
5. Constructing test items according to the test blueprint and applying the test.
6. Evaluation of test items using item analysis for functioning and non-functioning items and estimating assessment reliability.

Staff training for writing LOs, designing a test blueprint, writing MCQs, and interpretation of item analysis was done through a series of three Student Assessment faculty development training courses organized at the center of education development in King Abdulaziz University. Two of the courses were offered to female staff, and one was offered to male staff. A total of 58 staff members participated in the courses (44 females, 14 males). All Musculoskeletal and Cardiovascular modules committee members attended these courses, in addition to these courses, specialized hand on workshops were organized to help committee members to implement the six-step approach in their modules and to fill the exam worksheet.

A structured course evaluation questionnaire was given to participants on the last day of the course, the questionnaire containing a mixture of open- and close-ended questions.

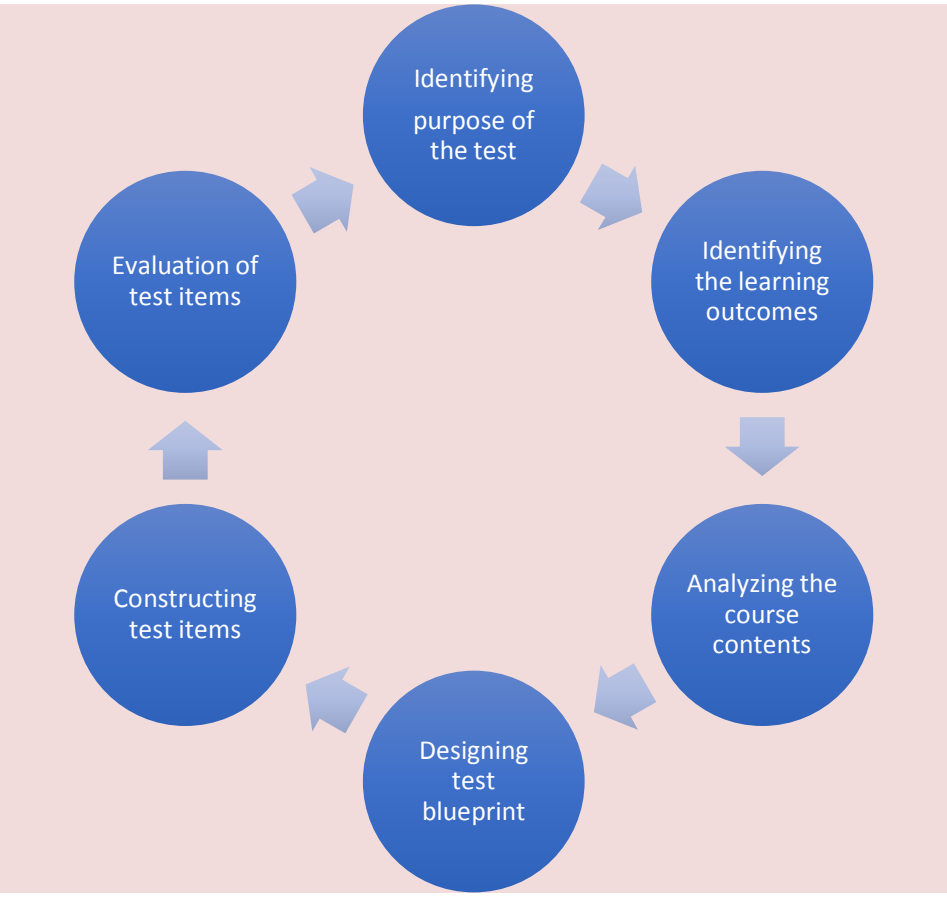

Fig. 1. Six-step approach for standardizing student assessment

It was divided into three sections as follows: the first section focused on trainer evaluation, the second section focused on program content, and the third section focused on the course. Returned questionnaires were checked to identify any omissions or ambiguities in the responses. Open questions were analyzed thematically. A five-point, Likert-type scale was used in the questionnaires, with strongly disagree coded 1 and strongly agree coded 5. The statistical analysis of the results was carried out according to conventional standard statistical procedures using computed statistical analysis with SPSS version 16.0 for Microsoft Windows 7 software (SPSS, Inc., Chicago, IL, USA). The percentage of satisfaction was calculated and represented in this study as it is more meaningful. The questionnaire was validated by having three medical education experts review it for any ambiguity and its fitness to the purpose for which it was designed. Also, the questionnaire was piloted by giving it to ten Faculty members to check also for any ambiguity that needed correcting and clarity of language.

For all groups, a pretest-posttest format was applied. The test questions were related to important assessment terminology, LOs, types of test items, and the concepts of validity and reliability. The pretests and posttests were marked manually, and the SPSS was used to obtain frequencies with the calculation of percentage of knowledge improvement for participants.

To implement and document the six-step approach, an exam worksheet was designed, which included the six steps for standardizing the assessment system in FOM-KAU. The six-page exam worksheet includes, on its first page, data related to the exam, such as the course, year, and the number and types of questions. The second page is a checklist for evaluating the quality of the concerned course LOs; the third page contains the test blueprint for the exam and the standardized criteria for the interpretation of item analysis data; and the fourth and fifth pages are a checklist for evaluating the quality of the MCQs. The exam worksheet was distributed through the Office of the Vice Dean for Basic Medical Sciences. Medical Education Department staff members followed and supported the basic science departments in completing and applying the exam worksheet in their concerned courses.

2.1 Ethical Consideration and Approval

Study was conducted according to the Ethical consideration of CMCL-FAIMER guidelines. An approval to conduct this project was taken from the Dean and Vice Dean of College of Medicine, King Abdulaziz University, Saudi Arabia which is an essential component of author's application for the fellowship program. At the time of conducting this study, there was no obligation to take ethical approval for medical education researches in FOM-KAU.

3. RESULTS

3.1 Training Courses

Table 1 illustrated the percentage improvement of assessment knowledge in group 1 of faculty staff members, the average percentage of improvement in all items is 43.3%. The highest improvement was in the knowledge about Bloom's taxonomy which was 83.4% and the lowest was in Faculty staff members about the types of test items, it was 29.2%.

Table 2 illustrated the percentage improvement of assessment knowledge in group 2 of faculty staff members, the average percentage of improvement in all items is 57%. The highest improvement was in the knowledge about Bloom's taxonomy which was 100% and the lowest was in Faculty staff members' knowledge about characters of learning objectives, it was 26.7%.

Table 1. Percentage improvement of assessment knowledge in Group 1

Question	Pretest (%)	Posttest (%)	Percentage of improvement
Assessment Terminology	20.8	50	29.2
Bloom's Taxonomy	8.3	91.7	83.4
Characters of Learning Objectives	41.7	75	33.3
Validity and Reliability	29.2	70.8	41.6
Types of Test Items	33.3	62.5	29.2
Average	**26.7**	**70**	**43.3**

Table 2. Percentage improvement of assessment knowledge in Group 2

Question	Pretest (%)	Posttest (%)	Percentage of improvement
Assessment Terminology	13.3	60	46.7
Bloom's Taxonomy	0	100	100
Characters of Learning Objectives	13.3	40	26.7
Validity and Reliability	13.3	93.3	80
Types of Test Items	26.7	86.7	60
Average	**19**	**76**	**57**

Table 3. Results of course evaluation by trainee (Percentage of satisfaction)

Item/Group	Group 1 (Male)	Group 2 (Female)	Group 3 (Female)
Trainer Evaluation	90.9 ± 3.7	90.8 ± 1.4	84.7 ± 7.7
Topic and Content Evaluation	92.1 ± 3.59	91.5 ± 1	87 ± 6.4
Course Organization	96.2 ± 1.7	90.2 ± 11.4	90 ± 9.3

Table 4. Implementing a six-step approach in musculoskeletal and cardiovascular modules

	Steps	Musculoskeletal	Cardiovascular
1.	Identifying the purpose of the test.	√	√
2.	Identifying the learning outcomes.	√	√
3.	Analyzing the course contents.	√	√
4.	Designing test blueprint (table of specifications) using a designed computer program.	√	√
5.	Constructing test items according to the test blueprint and applying the test.	√	√
6.	Evaluation of test items using item analysis for functioning and non-functioning items and estimating assessment reliability.	√	√

Table 3 illustrated the results of course evaluation by trainee, in the three courses, the satisfaction for the three components: trainer evaluation, topic and content evaluation and course organization is over 90% in the first and second group and range between 84.7 and 90% in the third group, that reflects high satisfaction among participants.

Table 4 illustrates the implementation of the six-step approach in the musculoskeletal and cardiovascular modules. All six steps were fully implemented, purpose of assessment was identified, all LOs were reviewed, course content was analyzed, test blueprint was designed using pre-designed software, test items were revised, and, finally, item analysis was implemented and interpreted.

4. DISCUSSION

The aim of this study was to improve the quality of students' assessment through standardizing the student assessment system following a unique six-step approach and faculty staff members training on applying these six step with proper documentation of the whole process. Faculty development in the area of assessment was conducted in the form of three training courses that covered all components of the exam worksheet in a practical manner. There was a marked increase in staff knowledge and skills regarding assessment after attending the comprehensive workshop on student assessment. Also, there was marked increase in staff satisfaction regarding trainer performance, program content, and program organization. The exam worksheet was applied in two courses in the FOM-KAU.

The first component of the exam worksheet included general information about the exam, and emphasis was on including the type of assessment, formative or summative, and item types for written assessment. Also, in the training course, there was an emphasis on the importance of formative assessment, especially in view of the shift to CBME in many medical

schools the world over. There is an increased awareness of formative assessment to ensure that students get regular, high-quality feedback to direct their progression towards the achievement of the required competencies [18,19]. With respect to those students lacking specific knowledge fields, skills, or attitudes, formative assessment could offer a "very early warning system" to direct a remedial response. For the few students who never attain the minimal level of competence needed for engagement in medical practice, early recognition will provide an earlier exit from medical education. On the other end of the spectrum, more qualified students can be given regular, formative assessments which allow their instruction to be concentrated more efficiently, therefore, making it more likely that their development would be faster and more efficient, to the maximum benefit of society, patients, and the students themselves [19].

The second step of this study model is identifying the LOs to be assessed in the exam. It is of great importance that the assessment be based on the LOs of the particular courses, which themselves are based on national standards [3]. Recently, some medical educationists claimed that LOs should go further than the classic domains and incorporate a wide variety of capabilities, such as those included in the competency frameworks of the Accreditation Council for Graduate Medical Education (ACGME) Core Competencies [20], the CanMEDS Roles [21], or the Good Medical Practice (General Medical Council 2013) [22]. Moreover, Kogan and Holmboe (2013) [23] suggested broadening assessment to include competencies, such as communication skills, patient safety, teamwork, and community care. This point of view is based on the concept that, traditionally, assessment has focused on LOs, such as the acquisition of knowledge or the demonstration of specific competencies in controlled settings, but with the shift to CBME, there has been a move toward work-based assessment with more emphasis on formative assessment. Thus, our concept should also move toward assessments that take into account the influence of students' competence on the quality of care offered to the individual [23]. For this reason, medical education will certainly require acceptance of a continual quality improvement process to ensure that advancement in learning leads not only to enhanced student outcomes, but also to much improved patient services. The last mentioned is the most significant target.

To ensure exam validity, assessment methods must be based on LOs, types of competencies to be assessed, or the level of desired performance. In this study, the exam worksheet includes only one type of assessment method with its checklist and MCQs. This is because the MCQ format was the most commonly used assessment method for written exams at the time of this study, and it could function as a pilot for version one of the exam worksheet. Different methods of assessment, the required level of performance, the information sought, the students' level in Miller's pyramid [6,24], and the institution's facilities can all affect the selection of the assessment method used. An assessment system must actively accumulate information, making use of both structured and unstructured means; it must value quantitative and qualitative information, and confirm that the rigor and richness of the data utilized align with the stakes of the judgment being generated [25,26]. A comprehensive assessment has used nonstandardized approaches if it needs to collect data that assists in making inferences regarding future real-world practice [17,27]. It should be remembered that all assessment approaches possess limitations; several approaches are required to compensate for the deficiencies of any one method [17]. In the same manner, applying a combination of qualitative and quantitative information could provide a better interpretation of student assessments. Traditionally, the emphasis has been on quantitative information that is only related to objectivity and reliability, but this ends up being at the expense of real-world validity. On the other hand, qualitative approaches to assessment are extensive, provided they include methods to develop the trustworthiness of the information; [28] therefore, work-based assessments that depend on qualitative data could be both desirable and defensible.

In the current study, the results of the pretest-posttest, staff satisfaction with trainer background, course contents, and course organization, and the application of the exam worksheet in the Basic Medical Sciences Department in FOM-KAU all signify the importance and effectiveness of faculty development training courses. It is necessary to offer regularly organized and scheduled courses to cover all required staff competencies and skills. In a study conducted Alamoudi et al. evaluating the effects of faculty development on MCQ item analysis, it was concluded that faculty development, especially when concentrated on

MCQ item analysis, may generate long-term systematic improvement in the knowledge, self-confidence, and behavior of faculty members. As such, promoting FDPs could support faculty members. Furthermore, faculty development also requires assistance from the departmental board and a follow-up strategy that is in place to ensure its efficiency [29].

Over the last six years following the study, there has been marked improvement in the assessment practices in FOM-KAU, which became in the focus of interest of both the medical education department and the centre of teaching and learning development in KAU. This manifested in the faculty development activities, moving towards electronic assessment, the establishment of assessment unit and the international publications in the field of assessment. The Medical Education Department at FOM-KAU played an important role in enhancing assessment in the college and conducting faculty development in the area of assessment. More than twenty training courses were conducted over the last six years in all areas of assessment. Faculty staff members in the medical education departments have their research published in prestigious medical education journals, which reflect their experiences and interest in this important area [29-31]. A project for using student portfolios for learning and assessment was conducted over four years and implemented in a paediatric course; it is now used in Rabigh Medical College, KAU and Um al Qura College of Medicine and recently in FCMS [32]. The establishment of an assessment and examination unit in FOM-KAU was one of the cornerstones in improving student assessment, and it now supervises all assessment and electronic examination activities in the college. At the university level, the year 2010 witnessed the first experience of applying the computer-based assessment (CBA) in KAU in two courses, followed by wide administration in all university programs [33]. Moreover, the centre of teaching and learning development took initiative to train the faculty staff members on assessment and developed a professional developmental diploma for new faculty members, including assessment as one of its integral components.

Finally, the six-step approach and the exam worksheet are now widely applied in Fakeeh College for Medical Sciences (FCMS) in its three educational programs, MBBS, Nursing and Medical Laboratory Sciences, as a part of programmatic assessment through the assessment centre that was recently established for central control of the whole assessment system in the college [34-37]. In FCMS, the six-step approach and the exam worksheet became an integral part of the internal verification process of student assessment through reviewing exam questions against the exam blueprint and course learning outcomes (CLOs), reviewing exam items against the standardised checklist and finally interpreting the item analysis report.

5. CONCLUSION

In conclusion, the six-step approach to standardise the assessment system in FOM-KAU was fully implemented in the Musculoskeletal and Cardiovascular module. The approach is one of the steps for improving the quality of student assessment in FOM-KAU through standardising the assessment system and faculty development in the area of assessment. Over the last few years following the study, there has been marked improvement in the assessment practices in FOM-KAU, which became in the focus of interest of both the Medical Education Department and the Centre of Teaching and Learning Development in KAU. This was manifested in the faculty development activities, moving towards electronic assessment, the establishment of assessment unit and the international publications in the field of assessment. The six-step approach is now widely implemented in FCMS in its three educational programs, as a part of programmatic assessment through the assessment centre, which recently established for central control of the whole assessment system in the college.

6. LIMITATIONS OF STUDY

The short-term duration (one academic year) and small number of courses (only two) included in the project make it difficult to properly evaluate its effects on improving the quality of student assessment and its net effects on evaluating the achievement of LOs. Furthermore, there is no sufficient data for comparing the six-step approach effects with the current approaches in other courses at FOM-KAU.

CONSENT

It is not applicable.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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