EFFECTIVE ASSESSMENT METHODS
IN INTEGRATED MODULAR LEARNING

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Abstract

Introduction. The aim of integrated modular education is to develop students' competencies in using acquired knowledge about the structure, function and biochemical properties of organs and systems when analyzing clinical cases.

Aim. To summarize the experience of implementing integrated assessment methods in modular training and evaluate their effectiveness.

Material and methods. Statistical processing of the results of the summer examination session of 380 students of the EP "General Medicine" and "Pediatrics" was carried out in the SPSS statistics 20.0 program. The normality of the characteristic in the sample was checked using the Kolmogorov-Smirnov test. The average value is presented as the arithmetic mean – M (Mean), indicating the 95% confidence interval (95% CI) and standard deviation (SD).

Results. The article analyzes teaching and assessment methods in integrated modular education, when the module includes different disciplines related to the learning outcomes, using the example of the integrated discipline "Skeletomuscular system in norm". The technology of integrated OSPE, first introduced by the authors, is described in detail, examples of the use of "active" and "passive" stations in the anatomy, histology, physiology, biophysics and biochemistry of the musculoskeletal system are given. The authors also gave a concept to the structured integrated oral exam first introduced by the authors, when the oral exam is structured by introducing stations in disciplines, taking into account the share of each discipline in the integrated module. Structuring is also carried out by determining the response time at each station. The experience of preparing exam cards for such an exam on the base of the clinical case is described, which allows the use of integrated knowledge in all disciplines included in the module. A thorough analysis of the results of passing both the practical part using OSPE technology and the oral integrated structured exam using the described methodology was carried out, as well as a comparative analysis with the previous academic year, when another assessment methods were used.

Conclusions. The work carried out to change the vector of assessment in the exam in favor of an integrated OSPE and an integrated oral structured exam has shown the effectiveness and efficiency of this approach.

Keywords: modular education, integrated disciplines, objective integrated structured practical examination (OSPE), structured oral examination, grade distribution curve (Bell Curve).

Резюме

ЭФФЕКТИВНЫЕ МЕТОДЫ ОЦЕНИВАНИЯ
В ИНТЕГРИРОВАННОМ МОДУЛЬНОМ ОБУЧЕНИИ

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Введение Интегрированное модульное обучение имеет своей целью сформировать у студентов компетенции по использованию полученных знаний о строении, функции и биохимических свойствах органов и систем при разборе клинических случаев.

Цель: обобщение опыта внедрения интегрированных методов оценки при модульном обучении и оценка их эффективности.

Материал и методы исследования. Проведена статистическая обработка результатов летней экзаменационной сессии 380 обучающихся ОП «Общая медицина» и «Педиатрия» в программе SPSS statistics 20.0. Проводилась проверка на нормальность признака в выборке с применением критерия Колмогорова-Смирнова. Среднее значение представлено среднеарифметическим – M (Mean), с указанием 95% доверительного интервала (95% ДИ) или стандартного отклонения (SD).

Результаты. В статье проводится анализ методов преподавания и оценки при модульном обучении, когда в модуль включены разные дисциплины, связанные конечными результатами обучения, на примере интегрированной дисциплины «Костно-мышечная система в норме». Подробно описана впервые внедренная авторами технология

проведения интегрированного ОСПЭ, приведены примеры использования «активных» и «пассивных станций» по анатомии, гистологии, физиологии, биофизике и биохимии костно-мышечной системы. Авторы дали понятие разработанному ими устному структурированному интегрированному экзамену, когда устный экзамен структурирован путем введения станций по дисциплинам с учетом доли каждой дисциплины в интегрированном модуле. Также структурирование проводится путем определения времени ответа на каждой станции. Описан опыт составления билетов устного экзамена на основе клинического случая, позволяющего использовать интегрированные знания по всем дисциплинам, входящим в модуль. Проведен анализ результатов сдачи практической части по технологии ОСПЭ и устного интегрированного структурированного экзамена по описанной методике, а также сравнительный анализ с прошлым учебным годом, когда использовались другие методы оценки.

Выводы Проведенная работа по смене вектора оценивания на экзамене в пользу интегрированного ОСПЭ и интегрированного устного структурированного экзамена показало эффективность и действенность данного подхода.

Ключевые слова: модульное образование, интегрированные дисциплины, объективный интегрированный структурированный практический экзамен (ОСПЭ), структурированный устный экзамен, кривая распределения оценок (Bell Curve).

Түйіндеме

БАҒАЛАУДЫҢ ТИІМДІ ӘДІСТЕРІ
БІРІКТІРІЛГЕН МОДУЛЬДІК ОҚЫТУДА

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Кіріспе Біріктірілген модульдік оқыту клиникалық жағдайларды талдау кезінде мүшелер мен жүйелердің құрылымы, қызметі және биохимиялық қасиеттері туралы алған білімдерін қолдануда студенттердің құзыреттіліктерін дамытуға бағытталған.

Зерттеудің мақсаты Бұл жұмыстың мақсаты модульдік оқытуда интеграцияланған бағалау әдістерін енгізу тәжірибесін жинақтау және олардың тиімділігін бағалау болып табылады.

Материалдық және зерттеу әдістері. SPSS statistics 20.0 бағдарламасында «Жалпы медицина» және «Педиатрия» БП 380 студентінің жазғы емтихан сессиясының нәтижелерін статистикалық өңдеу жүргізді. Үлгідегі сипаттаманың қалыптылығы Колмогоров-Смирнов сынағы арқылы тексерілді. Орташа мән 95% сенімділік интервалын (95% CI) немесе стандартты ауытқуды (SD) көрсете отырып, орташа арифметикалық – М (Орташа) ретінде берілген.

Нәтижелер. Мақалада «Қалыпты тірек-қозғалыс жүйесі» кіріктірілген пәнінің мысалында модуль оқудың соңғы нәтижелеріне қатысты әртүрлі пәндерді қамтитын модульдік оқытудағы оқыту және бағалау әдістеріне талдау жасайды. Авторлар алғаш рет енгізген интеграцияланған OSPE технологиясы егжей-тегжейлі сипатталған, тірек-қимыл аппаратының анатомиясында, гистологиясында, физиологиясында, биофизикасында және биохимиясында «белсенді» және «пассивті станцияларды» қолдану мысалдары келтірілген. Ауызша емтихан пәндер бойынша станцияларды енгізу арқылы, кіріктірілген модульдегі әрбір пәннің үлесін ескере отырып құрылымдалған кезде авторлар өздері әзірлеген ауызша құрылымдық интеграцияланған емтиханға тұжырымдама берді. Сондай-ақ құрылымдау әрбір станциядағы жауап беру уақытын анықтау арқылы жүзеге асырылады. Клиникалық жағдай негізінде ауызша емтихан билеттерін құрастыру тәжірибесі сипатталған, бұл модульге енгізілген барлық пәндер бойынша интеграцияланған білімді пайдалануға мүмкіндік береді. OSPE технологиясы бойынша практикалық бөлімді және сипатталған әдістемені пайдалана отырып, ауызша біріктірілген құрылымдық емтиханды тапсыру нәтижелеріне талдау, сондай-ақ басқа бағалау әдістері қолданылған өткен оқу жылымен салыстырмалы талдау жүргізілді.

Қорытынды Емтихандағы бағалау векторын біріктірілген OSPE және біріктірілген ауызша құрылымдық емтихан пайдасына өзгерту бойынша жүргізілген жұмыс осы тәсілдің тиімділігі мен тиімділігін көрсетті.

Түйінді сөздер: модульдік білім беру, кіріктірілген пәндер, объективті интеграцияланған құрылымдық практикалық емтихан (OSPE), құрылымдық ауызша емтихан, бағаларды бөлу қисығы (Bell Curve).

Introduction

The aim of the integrated modular training is to develop students' competencies to use acquired knowledge about the structure, function and biochemical properties of organs and systems when analyzing clinical cases.

An objective structured practical examination (OSPE) is the most effective tool for assessment of knowledge of practical anatomy when basic knowledge is integrated with clinical anatomy issues [7, 9]. Among medical universities in Kazakhstan, OSPE on basic disciplines was first introduced at the Department of Anatomy of Semey Medical University in the 2009-2010 academic year after a detailed comprehensive analysis of student performance in order to find optimal methods for forming and mastering of general and special competencies of graduates. The experience of conducting assessment using this methodology has already shown its effectiveness [6,2,4]. However, improving the education system leads to use new technologies for teaching and assessment student achievements. Thus, widely used integrated approaches to teaching between basic, basic and clinical disciplines, "horizontal" and "vertical" integration [3,9] have led to integrated assessment in all disciplines included in a module or committee.

Purpose of the study. The purpose of this work is to summarize the experience of implementing integrated assessment methods in modular training and evaluate their effectiveness. The article describes the technology of intermediate control of integrated modular disciplines developed by the authors and introduced into the educational process, consisting of an OSPE and an integrated structured oral examination.

Material and research methods. Statistical processing of the results of the summer examination session of 380 students of the EP "General Medicine" and "Pediatrics" was carried out in the SPSS statistics 20.0 program. When analyzing quantitative data, a test was carried out for the normality of the characteristic in the sample with a visual assessment and the use of the Kolmogorov-Smirnov test. In the case of a normal distribution of a characteristic, the mean value is presented as the arithmetic mean - M (Mean), indicating the 95% confidence interval (95% CI) or standard deviation (SD). To compare the average values of the summer examination sessions of 2021-2022 and 2022-2023 academic years, the Student's t-test for independent samples with a normal distribution was used.

The article presents the experience of creating a training and assessment system based on a modular integrated approach on the example of the "Musculoskeletal system in norm" committee. The final results of training in the musculoskeletal system are the ability of students to explain the structure and physiological properties of bones and their connections at the level of the morphofunctional unit of bone tissue and at the level of the whole organism in normal conditions and in the analysis of clinical cases.

The first stage is drawing up a plan of the integrated discipline. When drawing up the plan, the director of the committee involves teachers of clinical disciplines, who determine the necessary topics of the committee in all disciplines. Thus, when developing the thematic plan "Musculoskeletal system in norm" traumatologists, neuropathologists, dermatologists, and rheumatologists took part. The integrated course plan is included in the general schedule by the course coordinator. This ensures a sequential study of topics to better understand joint biomechanics and the mechanisms of muscle contraction.

The criteria for current and intermediate assessment of the discipline are prescribed in the Syllabus, where the ratio of formative (current) and summative assessment are indicated, as well as the share of each discipline in the final assessment of the committee. For "Musculoskeletal system in norm", the percentage of assessment for each discipline has been introduced into the LMS, the frequency rate of formative assessments within each module has been determined, as well as the proportion of formative test. Students can see grades for each discipline and the share of each discipline in the final grade. Summative control includes two stages - an integrated practical examination (OSPE) and an integrated oral examination.

A **formative** assessment of students during the study of the discipline is carried out through an interactive discussion in practical classes using modern methodological approaches, such as TBL (team-based learning), CBL (case-based learning), mastering practical skills, demonstrating physiological and biochemical experiments, study of macro- and microscopic preparations, use of MCQ of different cognitive levels. At the end of each module, a case study is used by PBL (Problem-Based Learning). To do this, teachers of clinical disciplines provide a set of clinical cases that allow students to determine the place of the studied basic disciplines in the system of integrated medical knowledge. Determining the patient's problems helps to analyze the structural properties and topography of organs through a specific clinical case, aims 1st-2nd year students to apply the acquired knowledge in the future practice and develops clinical thinking.

When conducting formative testing, an analysis of test tasks is carried out, the committee director has an opportunity to analyze all submitted tasks in disciplines according to the following criteria - academic performance, complexity and discrimination. It is recommended to redesign test items with a low discrimination index. Also, the presented analytical tables help to determine the correct use of distractors for each test task.

To assess practical skills, the most appropriate method is the **Objective Structured Practical Exam** (OSPE), introduced by our department in 2009. This method is considered by many authors as the most effective tool for assessing the practical aspects of anatomical knowledge in a system where basic knowledge is integrated with the clinical or functional part of anatomy. In addition to testing cognitive and psychomotor skills, the OSPE helps to assess observation, analysis and interpretation abilities. The exam can be structured by determining the number of stations and the timing of the stations. During the OSPE, various elements are assessed, and each element takes part in the integrated assessment. The methodology for conducting OSPE is described in detail by the authors in previous works [2,4].

With the introduction of integrated modular training, there was a need to conduct an integrated OSPE in all disciplines of committee, which was also first developed and conducted on the basis of the Department of Anatomy in 2020 on committee "The musculoskeletal system in norm". The integrated OSPE was conducted at 14 stations

so that the entire group (13-14 students) could complete the assessment at the same time. The director of the committee developed a blueprint of the OSPE, which included all the main sections of the integrated discipline, and also identified "active" (procedure stations) and "passive" (response stations) stations and disciplines responsible for

assessment at each station. The number of stations for each discipline is determined by the discipline's share in the total academic hours of the committee.

An example of a blueprint for integrated OSPE is presented in Table 1.

Table 1.

Blueprint (plan) of the objective structured practical examination (OSPE) on the committee "Musculoskeletal system in norm".

№ of station	Topics, goals and competencies	Discipline	Bone, cartilage and muscle tissue	Skin, skin derivatives	Bones, joints muscles of the trunk	Bones, joints muscles of the upper limb	Bones, joints muscles of the lower limb	Head and neck
1	Skeleton, bones	Anatomy			1	1	1	1
2	Bones – a clinical case of "Response stations"	Anatomy				1	1	
3	Anatomical preparations	Anatomy			1	1	1	
4	Anatomical preparations	Anatomy			1	1	1	
5	Anatomical models	Anatomy			1	1	1	1
6	X-ray images	Anatomy				1	1	
7	Anatomical table "Anatomage"	Anatomy					1	
8	Histopreparations (microscope)	Histology	1	1				
9	Micrography (monitor)	Histology	1	1				
10	CT/MRI, ultrasound, etc.- images (monitor)	Biophysics					1	
11	"Response stations" situation task	Biochemistry	1					
12	"Response stations" situation task	Physiology	1					
13	"Procedure stations" Observed stations - Dynamometry	Physiology				1		
14	Calculation of Dynamometry indicators by formulas	Physiology				1		

The technique has been tested on this committee and is being successfully applied. Each station takes 1,5 minutes. To evaluate the results, a checklist has been developed, in which students fill in answers as they go through the stations, and then the examiners assign points for each answer there. At all stations there are teachers on duty who monitor the correct completion of the checklist by students. The presence of teachers of the committee disciplines is necessary in case of questions arising on the discipline

station, to ensure the continuity of the OSPE (Fig. 1). Teachers on duty, except of the examiners of "active" stations, do not participate in the assessment and do not come close to students at the stations, but only conduct observations. Each station is scored from 1 to 10 points, the score for each station is entered into a checklist in the LMS "Keyps". So, students can see the grades for each answer and evaluate their achievements in each committee discipline.

Figure 1. The objective structured practical examination (OSPE) on the committee "Musculoskeletal system in norm".

At anatomy stations, not only three-dimensional anatomical models and preparations are used, but also sections presented on the anatomical table "Anatomage", X-ray images, as well as images of visual investigation methods. This is due to the rapid development of computer diagnostic methods and the need to determine anatomical structures not only on X-ray, but also on ultrasound images, computed tomography (CT), and magnetic resonance imaging (MRI). Previously, during practical classes, such images are considered while discussing of clinical cases, and the goal is not to identify pathological syndromes, but anatomical structures.

The experience of the Department of Anatomy demonstrates that it is possible to use tasks of a higher cognitive level in OSPE, not only simple recognition of anatomical structures, but for the application of knowledge of basic disciplines when analyzing clinical cases. The solution to such situations at OSPE is to find and mark the damaged organ, part of an organ or anatomical structure (topical diagnostics).

Histology skills include the ability to work with a microscope, identify structural elements in histological preparations, as well as in micrographs. An example of an "active" station is the measurement of the force of contraction of muscles by the dynamometry method. The practical skill developed in class is demonstrated at the OSPE to the examiner, who evaluates the performance according to the checklist. At stations in biophysics and biochemistry, students are offered solutions to situational problems presented on the monitor.

After the integrated OSPE, an analysis of the results was made. The average score was 71,9. Out of 380 students who passed the practical exam, 35 (9,2%) had "excellent" marks, 132 students (34,7%) received "good", 123 (32,4%) "satisfactory", 52 students (13,7%) received a grade below 60% (also "satisfactory") and 38 students (10,0%) did not complete the proposed tasks. These results show that the proportion of students who passed the exam with "excellent" marks and students who did not pass the exam corresponds to the normal distribution of student grades. After this, a detailed analysis of the students' answers was carried out in order to identify the most difficult and easiest questions.

The methodology for conducting an **oral integrated structured exam** was proposed by the coordinator of the 1st year in the specialties "General Medicine" and "Pediatrics", Associate Professor S.K. Kozhanova and discussed at a meeting of the Committee of Educational Programs.

The main difficulty in preparing for the oral integrated structured examination was the preparation of clinical cases covering the main issues in all disciplines. After the exams questions were provided by teachers of all disciplines, the director of the committee compiled questions in relation to clinical cases, designed for the level of competence of 1st-2nd year students.

For example, a clinical case related to the damage of the shoulder joint (dislocation, fracture, stretching or muscle damage). Anatomy questions concern the structure of the joint, the bones which form the joint and the muscles that act on the joint. Questions on histology refer to the condition of bone tissue leading to increased fragility and activation of bone cells involved in osteogenesis. Physiology questions concern the physiological properties of a muscle acting on a joint. Thus, a comprehensive survey is carried out on the normal structure of the joint, muscles acting on it, as well as possible disorders of the musculoskeletal system in the proposed clinical case.

Before the exam, students use blueprint in all disciplines they had studied by committee. During the exam, students had time to prepare for the answer and then they answered questions at 4 stations - 2 on anatomy, 1 on histology and 1 on the physiology of the musculoskeletal system. At each station, the students had 3 minutes for answers and, at a signal, moved to the next station. So, students were assessed at 4 stations by four examiners, who immediately entered the marks on the answer sheet. In addition, an independent examiner was present at the exam. This approach ensures the objectivity of the assessment, as the final grade consists of average of 4 marks from examiners who evaluate them independently. All marks are filled into checklist in the LMS, thus students can see and evaluate the correctness of their answers for each discipline of the committee.

The experience of organization an oral examination shows that formation of specific questions at 4 stations helps structuring the oral examination, optimize and calculate the total exam time. With the right compiling the questions, two to three minutes is enough to answer for a question at the station. Thus, each student has the opportunity to demonstrate knowledge of the disciplines of committee within 12 minutes.

The average oral response score in the 2022-23 academic year was 74,5. In Anatomy, it was 72,3 when answering the questions of the 1st station, and 75,0 when answering the questions of the 2nd station. For histology, the average mark was 79.3, and for physiology, 71,4. The data indicates a correct compiling of questions in the exam cards. Based on the results of the oral exam, the director of the committee analyzes the grades for each ticket in order to identify the most difficult and easiest questions. Subsequently, these questions were either rephrased that allows the answer to be answered within 2-3 minutes, or replaced be another question.

Thus, answers to all stages of the formative and summative assessment are subject to analysis by the director of the committee. Feedback of students and teachers participating in the assessment was conducted for each stage. Due to the fact that the oral integrated structured exam was introduced for the first time at our university, the questionnaire for teachers included questions such as:

- indicate the most objective form of assessment in the exam by your opinion;

- did you like the oral format of the exam using integrated cases;

- how objective do you think the assessment is in the oral exam;

- is there enough time for students to prepare and answer questions?

By analysis of teachers' feedback all examiners consider that the oral form of the second stage of summative assessment is the most objective. Also, all the examiners said that two minutes are enough to answer the

station's questions. This method of examination puts all students in the same conditions, and, in contrast to the traditional previously used form of an oral examination, the proposed structured form of the exam permits to assess a large number of students within a definite time. Formulating specific questions related to the clinical case helps reduces response time at each station.

For students, the survey questions included similar questions regarding the format of the examination and the time for prepare and answer. But students also had the opportunity to answer questions related to each discipline of the committee, for example:

- whether there were any unfamiliar questions on the exam that that were not in the materials you passed;

- indicate the disciplines of the committee for which you received sufficient preparation for the exam;

- indicate the disciplines of the committee for which you received insufficient preparation for the exam;

- which discipline of the committee did you have the most difficulty studying?

- which discipline did you enjoy studying the most?

According to the students' comments, the greatest difficulties were caused by the studying Anatomy in the committee "The musculoskeletal system in norm", however, the study of Anatomy in this committee students liked the most.

The results of the summer examination were analyzed by constructing a grade distribution curve (Bell Curve), the main element of statistical analysis of teaching and grading, which is based on the principle of ranking grades, according to which "excellent" (A, A-) and "good" (B+, B, B-) grades can be received by no more than 35% of all students in this group, and "unsatisfactory" (F, FX) grade – by no less than 10%. At the same time, at least 55% of all students receive grades C+, C, C-, D+, D. The main essence of Bell Curve is an analysis of the

variety of use by teachers of the entire range of grades, in accordance with the outcome of the discipline [5,1].

The diagram of the normal distribution of student grades in the integrated discipline "Musculoskeletal system in norm" is shown below (Figure 2).
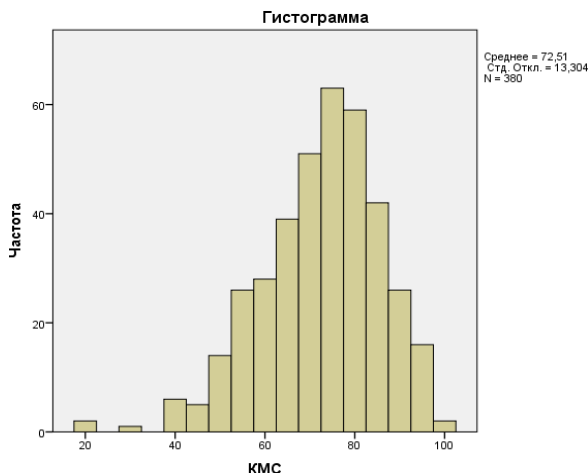

Figure 2. The curve of the distribution of student grades in the integrated discipline "Musculoskeletal system in norm" (Bell Curve).

The average value of academic performance of the committee was 72,5. Out of 380 students in the specialty "General Medicine", 35 (9,2%) passed the exam with an "excellent" grade, 132 students (34,7%) received "good" marks, 175 (46,1%) students passed the exam with a "satisfactory" grade, and 38 (10%) test takers did not pass the threshold level.

Comparative statistical analysis data for the specialty "General Medicine" and "Pediatrics" are shown in Table 2.

Table 2.

Statistical analysis data based on the results of the examination in the integrated discipline "Musculoskeletal system in norm".

Disciplines of the 1st year "General medicine" "Pediatrics"	Median	Average	95% confidence interval for the average	Standard deviation	The criterion of normality-Kolmogorov-Smirnova
Musculoskeletal system in norm, "General medicine"	74,00	72,51	71,17-73,85	13,304	0,212
Musculoskeletal system in norm, "Pediatrics"	82,00	80,10	76,89-83,31	10,046	0,200

In the specialty of "Pediatrics", the grades received by students also were within the normal distribution curve of grades, however, the number of students in this specialty is much smaller (35), and the selection score for this specialty is higher. The average score at the end of the session was 80,1, and there were no students who had not mastered the program in the discipline.

A comparative analysis with the previous academic year showed that the average grade in the integrated discipline "Musculoskeletal system in norm" in the 2022-23 academic year was 72,5%, while in the 2021-22 academic year it was 68,6%, the difference significant (p<0.05). This is due to the fact that during the examination students received low scores when passing the test summative exam (68,5), which was conducted before the introduction of the oral structured exam. The OSPE score did not differ significantly

and was 71,9 in the 2022-23 academic year, and 72,5 in the 2021-22 academic year.

Conclusion.

So, the work carried out to change the vector of assessment in the exam in favor of OSPE and an integrated oral structured exam has shown the effectiveness and efficiency of this approach. The experience of conducting oral exams in the 1st course permits to recommend this form of exam for the 2nd course students in the current academic year.

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