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## ORIGINAL ARTICLE

### Evaluating the Application of the curriculum Elements with an Approach to Professional Competency (Case study: radiology residency curriculum of Mashhad University of Medical Sciences)

**Background:** Competency-based program is one of the effective approaches that has attracted the policy makers' attention in the process of medical education and promotion of its quality. Regarding the important role of this approach, this research aims to evaluate the professional competency-based curriculum of radiology residents at Mashhad University of Medical Sciences.

**Methods:** This research is a descriptive-survey study investigating the opinions of radiology residents and professors. The participants were 90 radiology residents and 16 board members who were selected by census. The research tool was a researcher-made questionnaire including 35 items classified in 9 categories. The questionnaire was used after evaluating its reliability and validity. All the items were reliable regarding the Cronbach's alpha coefficient of 0.7. Data analysis was done by descriptive and inferential statistics (one-sample t-test and independent t-test).

**Results:** According to the radiology residents' and professors' viewpoints, all the nine elements of the residency program (goals, contents, learning-teaching strategies, Learning activities, materials, education time, education space, grouping, and evaluation) are above the medium level and there is no difference between the residents' and professors' viewpoints.

**Conclusions:** Investigating the competency approach, the elements of the curriculum, and the competency-based education of residency program can be effective in promotion of clinical performance. According to the results of this study, the studied radiology residency program corresponds to Klein's nine elements.

**Keywords:** residency program, curriculum, competency

تقييم تطبيق عناصر المنهج مع نهج للكفاءة المهنية (دراسة حالة: منهج الإقامة الإشعاعية بجامعة مشهد للعلوم الطبية)

الخلفية: يعد البرنامج القائم على الكفاءة أحد الأساليب الفعالة التي جذبت انتباه المخططين في عملية التعليم الطبي وتعزيز جودته. فيما يتعلق بالدور المهم لهذا النهج، يهدف هذا البحث إلى تقييم المناهج المهنية القائمة على الكفاءة في تخصص الأشعة في جامعة مشهد للعلوم الطبية.

المنهج: هذا البحث عبارة عن دراسة استقصائية وصفية تبحث في آراء المقيمين والأساتذة في قسم الأشعة. كان المشاركون ٩٠ مقيماً في قسم الأشعة و ١٦ عضواً في مجلس الإدارة تم اختيارهم عن طريق التعداد. كانت أداة البحث عبارة عن استبانة من إعداد الباحث تضمنت ٣٥ فقرة مصنفة في ٩ فئات. تم استخدام الاستبانة بعد تقييم مصداقيته وصحته. كانت جميع العناصر موثوقة فيما يتعلق بمعامل كرونباخ ألفا البالغ ٠.٧. تم إجراء تحليل البيانات عن طريق الإحصاء الوصفي والاستنتاجي (اختبار t لعينة واحدة واختبار t المستقل).

النتائج: وفقاً لوجهات نظر المقيمين في قسم الأشعة والأساتذة، فإن جميع العناصر التسعة لبرنامج الإقامة (الأهداف، والمحتويات، واستراتيجيات التعلم والتعليم، وأنشطة التعلم، والمواد، ووقت التعليم، ومساحة التعليم، والتجميع، والتقييم) أعلى من المتوسط. المستوى ولا يوجد فرق بين رأي السكان والأساتذة. الخلاصة: يمكن أن يكون التحقيق في نهج الكفاءة وعناصر المنهج والتعليم القائم على الكفاءة لبرنامج الإقامة فعالاً في تعزيز الأداء السري. وفقاً لنتائج هذه الدراسة، يتوافق برنامج الإقامة الشعاعية المدروس مع عناصر كلاين التسعة. الكلمات المفتاحية: برنامج الإقامة، المنهج، الكفاءة

### ارزیابی کاربرد عناصر برنامه آموزشی با رویکرد مبتنی بر شایستگی حرفه‌ای (مورد مطالعه: دوره دستیاری رادیولوژی دانشگاه علوم پزشکی مشهد)

**زمینه و هدف:** یکی از رویکردهای اثربخشی که در فرایند آموزش پزشکی و ارتقای کیفیت آن مورد توجه برنامه‌ریزان قرار گرفته، رویکرد برنامه مبتنی بر شایستگی است. با توجه به اهمیت این رویکرد، هدف پژوهش حاضر ارزیابی برنامه آموزشی مبتنی بر شایستگی حرفه‌ای دوره دستیاری رادیولوژی دانشگاه علوم پزشکی مشهد می‌باشد.

**روش:** این مطالعه، از نوع توصیفی-پیمایشی است که طی آن به بررسی نظر اساتید و دستیاران رادیولوژی پرداخته شده است. مشارکت کنندگان شامل ٩٠ نفر از دستیاران رادیولوژی و ١٦ نفر از اعضای هیئت علمی رادیولوژی بودند که به روش سرشماری انتخاب شدند. ابزار پژوهش، پرسشنامه محقق ساخته‌ای که شامل ٣٥ سوال با ٩ مولفه بود که پس از تایید روایی و پایایی مورد استفاده قرار گرفت. کلیه مولفه‌ها از پایایی مناسب برخوردار بودند چرا که شاخص آلفای کرونباخ، از ٠/٧ بیشتر می‌باشد. جهت تجزیه و تحلیل داده‌ها از آمار توصیفی و آماری استنباطی (آزمون t تک نمونه‌ای و آزمون t دو گروه مستقل) استفاده شده است.

**یافته‌ها:** از نظر اساتید و دستیاران رادیولوژی، همه عناصر نه گانه برنامه آموزشی دوره دستیاری (شامل اهداف، محتوا، راهبردهای یاددهی-یادگیری، مواد و منابع آموزشی، روش-های تدریس، زمان آموزش، فضای آموزش، گروه بندی و ارزشیابی) بالاتر از سطح متوسط می‌باشد و همچنین تفاوت دیدگاهی بین نظرات اساتید و دستیاران رادیولوژی وجود ندارد.

**نتیجه‌گیری:** بررسی و شناسایی رویکرد شایستگی، عناصر برنامه آموزشی و برنامه مبتنی بر شایستگی در آموزش دستیاران، می‌تواند در ارتقاء عملکرد بالینی موثر باشد و با توجه به نتایج این مطالعه، برنامه مورد بررسی دستیاران رادیولوژی با عناصر نه گانه کلاين همخوانی دارد.

**واژه های کلیدی:** دوره دستیاری، برنامه آموزشی، شایستگی

### پيشه روانه شايستگي پر مبني تعليمي عناصر كا استعمال، مشهد يونيورسيتي آف ميديكل ساينسس مين راديالوجي ثيارنمنت مين ايك تحقيقات

**بيك گراوند:** ميديكل تعليم كے معيار كو بڑھانے كے لئے نصاب بنانے والے انتھك كوشش كرے ہیں اور نہ ميديكل طلباء كی شايستگي پر مبني نصاب بنارے ہیں۔ اس اپروچ كی اہميت كے پيش نظر اس تحقيقات كا هدف پيشه روانه شايستگي پر مبني تعليمي نصاب كی جانچ كرنا ہے۔ یہ تحقيق مشهد يونيورسيتي آف ميديكل ساينسس مين راديالوجي ثيارنمنت مين راديالوجي ريزيڈنٹس كی سطح پر انجام دی گئی ہے۔

**روش:** یہ ایک عارضی تحقیق ہے اس میں اساتذہ اور ریدیالوجی کے ریزیڈنٹس کے نظریات کا جائزہ لیا گیا ہے اس میں نوے ٩٠ افراد نے شرکت کی تھی جس میں سولہ افراد ریدیالوجی ثيارنمنت كی اكيڈميك كونسل كے ركن تھے۔ تحقیق میں شرکت کرنے والوں كو نو موضوعات كے ذیل میں پینتیس سوالات ڈالے گئے تھے۔ یہ ایک علمی اور تحقیقاتی سوالنامہ تھا۔ ڈیٹا كا تجزیہ کرنے كے لغے ٹی ٹسٹ اور دو طرفہ ٹی ٹسٹ سے استفادہ کیا گیا۔

**نتیجے:** ریدیالوجی کے اساتذہ اور ریزیڈنٹس ریدیالوجی تعليمي نصاب كے تمام نو موضوعات، اهداف، مضامين تدریسی، تعليمي استراتیجی، پڑھائی كرنا اور سیکھنا، گروه بندی اور جائزہ لینے میں اوسط سطح سے بہتر تھے اور اساتذہ اور ریزیڈنٹس كے مابین نظریات میں كوئی اختلاف نہیں دیکھا گیا۔

**سفرارش:** اس تحقیق سے پتہ چلتا ہے كہ شايستگي پر مبني نظام تعليم سے ان كی كلينيكل صلاحیتوں میں اضافہ ہوتا ہے۔ اس تحقیق كے نتائج سے معلوم ہوتا ہے كہ ریدیالوجي ريزيڈنٹس كا نصاب تعليم مذکورہ بالا نو موضوعات كو كور كرنا ہے۔

**کلیدی الفاظ:** ریدیالوجی، تعليم، شايستگي، موضوعات

## INTRODUCTION

Nowadays, competency of health experts has become an important element in their education and most of the faculties, universities, specialized associations, monitoring institutions, and professional health organizations provide formal programs for education of such specialists (1). In past, expert development was traditionally defined as a designed preparation program in organizations (2). Nevertheless, although expert development has been linked with planned programs, specialists recently participate in both formal and informal development programs for promotion of their knowledge and skills (3). Expert development refers to all the specialists' activities aiming to improve their knowledge, skills, and behaviors as teachers, leaders, managers, and researchers in both personal and group environments. In this regard, expert development can provide the individuals with the necessary knowledge and skills of teaching and learning, designing educational programs, learner assessment, program evaluation, leadership, management, and research. Also, it can strengthen or change the attitudes to different aspects of the people's roles and responsibilities in this area (4). On the other hand, competency-based education is significantly important in medical education and it aims to increase the graduates' skills and abilities in their professional roles (5). It should be also noted that competency approach is one of the approaches that has been paid attention to link between the social needs and the graduates' learned material and to cope with the challenge of promotion and development of clinical performance (6). Koenen et al. (2015) have defined competency as an integrated set of skills, attitudes, and knowledge that are effective in some aspects of their professional performance and growth (7). The ultimate goal of specialized medical education is to provide a resident with the necessary knowledge, attitudes, practical skills, and competencies that are necessary for a specialist (8). Competency-based medical education is an approach to designing and evaluating an educational program by using an organized structure of competencies, and it can finally provide the condition of better caring for patients (9). As all the stages of professional development lead to promotion of the doctors' skills, knowledge, and attitudes, promotion of medical education in residency program is an ideal scenario for improvement of quality and safety in patients (10). Since competency-based education is increasingly used all over the medical education systems, the majority of the recent debates about designing and with at least one year of employment history.

development of competency-based program has been only focused on residency programs (9). In this approach, the curriculum is designed based on the competencies and it includes the necessary knowledge and skills regarding the competency criteria (11). According to Everwijn et al. (1993), competency-based program includes three major goals: 1. Learning the materials, 2. Promotion of specialized and general competencies, and 3. Promotion of learning capacity (12). Professional development activities should provide a way of achieving the above-mentioned goals and consequently, development of clinical skills, professional

development, and knowledge promotion (13). Ryan (2011) has introduced the elements of competency-based program including the overall competencies based on the purpose, special achievements and competencies in terms of the measurable and observable goals, teaching, and evaluation (14). Lenburg et al. (2009) has introduced the elements of competency-based program including the learning achievements or goals, teaching-learning strategies, and evaluation (15). Dilmor et al. (2011) have defined these elements as the philosophy, goals, standards, education, and evaluation (16). Zeller et al. (2016) have defined these elements as the applied and practical knowledge in the purpose dimension, teacher-learner collaboration in content dimension, multipurpose scales in measurement tools dimension, evolutional and procedural evaluation in time dimension, and criterion-based and time-varying tests in evaluation standards dimension (17). There is no agreement among the experts about the program elements and the number of elements ranges between one and nine. Klein's classification is the most common concept of the program elements and it introduces nine elements including the goals, content, teaching-learning strategies, grouping, materials and resources, learning activities, space, time, and evaluation (18). One of the primary goals of medical faculties is educating competent graduates. So, promotion of professional competencies is one of the prerequisites of educational programs; because it helps people to cope with different environment. Many formal statements and reports have explicitly emphasized the importance of the doctors' preparation to achieve fundamental competencies. Medical faculties of Brown and Indiana Universities and the executive council of the World Federation of Medical Education have declared the students' competency as a criterion of accreditation of medical faculties (19). Studies suggest that the higher is the correspondence between the elements of a program, the higher the possibility of executing the program will be. So, each of these elements should be studied to become optimal. Studying the program elements is a useful step toward promotion of the doctors' professional competencies and also one of the main prerequisites of competency promotion and program evaluation. So, this research aims to evaluate the elements of radiology residency curriculum to promote these competencies.

## METHODS

This research is a descriptive-survey study that has investigated two groups as the research population. The first group includes all the radiology residents of the first, second, third, and fourth years (90 people) and the second group includes the radiology professors (16 people) who were selected by census. The research tool is a researcher-made questionnaire including 35 items and 9 components that were extracted by content analysis of the specialized curriculum of radiology. The components were determined based on Klein's nine elements including the goals, content, teaching-learning strategies, grouping, materials and resources, learning activities, space, time, and evaluation. The elements were set in terms of Likert's scale. The subjects filled an informed consent letter and they received some

explanations about the research goals. The validity of the questionnaire was evaluated by the experts' viewpoints and its reliability was calculated by Cronbach's alpha coefficient. Table 1 presents the Cronbach's alpha coefficient for each component of the questionnaire.

## RESULTS

The findings included testing the reliability of the research components. The results showed that all the components of the program are reliable regarding the Cronbach's alpha coefficient (above 0.7).

Components (elements)	Cronbach's alpha coefficient
Goals	701.0
Content	785.0
Teaching-learning strategies	720.0
Materials and references	840.0
Learning activities	739.0
Education time	839.0
Education space	780.0
Grouping	757.0
Evaluation	717.0

In the following, one-sample t-test was used for investigating the role of the components of radiology residency program. Table 2 presents the results of one-sample t-test for the role of the nine elements of the radiology curriculum.

According to Table 2, since the calculated t-value is higher than the critical level (1.96) at  $\alpha=0.05$ , the assumption of no significant difference between the sample means and the population means (3) is rejected in all tests (at the confidence level of 95%). So, according to the radiology residents' and professors' viewpoints, all the nine elements of the studied program are above the medium level. Meanwhile, t-test was used for comparing the mean of their

opinions about the residency program. Levene's test was first used to check the variance equality. In this test, the null hypothesis is the equality of all variances. After using the Levene's test, t statistic was used to check the equality of means between the two studied populations. This test requires the existence of a quantitative variable and a stratified variable. The quantitative variable is the same as the dependent variable that is compared between the two populations. However, the stratified variable is the independent variable that makes the populations distinct. As the results of this test showed the different means of the two populations in terms of the independent variable, it can be concluded that the independent variable affects the dependent variable. Regarding the upper bound and lower bound values presented in the table, we can specify the population that has a higher mean in terms of the dependent variable. So, if the upper bound and lower bound values are both positive, it shows that the first group has a higher mean, and if the upper bound and lower bound are both negative, the second group has a higher mean. If the upper bound is positive and the lower bound is negative, the difference between the means of the two groups is not significant. In the following, the means of the residents' (1) and professors' (2) opinions about the main variables are compared. Studies showed that there is no difference between the means of the answers reported by the residents and professors.

## DISCUSSION

According to the results of this research, the radiology residents and professors reported that all the nine elements of the curriculum (goals, contents, learning-teaching strategies, materials, education time, education space, grouping, and evaluation) are above the medium level and there is no difference between the residents' and professors' viewpoints. The results showed that the goals of the radiology residency program of the Health Ministry are based on the students' knowledge, skill, and attitudes, and the proportion of the goals to the social needs. Meanwhile, the content of the program is based on the updated scientific theories and findings. The content of the radiology residency

Content	Sig	The mean difference	T statistic	Confidence level=95%	
				Lower bound	Upper bound
Goals	0.013	0.17	2.564	0.0367	0.2966
Content	0.002	0.18	-2.141	-0.1608	0.1396
Teaching-learning strategies	0.012	0.22	2.604	0.0516	0.3928
Learning activities	0.006	-0.27	-2.843	-0.4650	-0.0810
Materials	0.005	0.33	2.901	0.1037	0.5630
Grouping	0.000	-0.80	-9.023	-0.9824	-0.6261
Place	0.000	-0.54	-5.238	-0.7530	-0.3370
Time	0.000	-0.54	-6.258	-0.7191	-0.3709
Evaluation	0.000	-0.47	-5.053	-0.6572	-0.2846

**Table 3. Independent t-test for comparing the opinions of residents and professors about the role of the nine elements of the residency curriculum**

Components	Number	Mean	SD	Levene's test , variance equality			t-test, comparison of means				Significant difference
				F	sig	variance	t	sig	Upper bound	Lower bound	
Goals	90	3.16	0.53	0.460	0.500	Equal	-0.110	0.912	-0.38	0.34	No
	15	3.18	0.43								
Content	90	2.93	0.61	2.568	0.114	Equal	-1.829	0.072	-0.77	0.03	No
	15	3.30	0.42								
Teaching-learning strategies	90	3.19	0.71	1.799	0.185	Equal	-0.904	0.370	-0.68	0.26	No
	15	3.40	0.41								
Learning activities	90	2.66	0.79	3.402	0.070	Equal	-1.617	0.111	-0.94	0.10	No
	15	3.08	0.53								
Materials	90	3.34	0.98	3.666	0.060	Equal	0.125	0.901	-0.59	0.67	No
	15	3.30	0.46								
Grouping	90	2.16	0.74	1.163	0.285	Equal	-0.995	0.324	-0.73	0.25	No
	15	2.40	0.52								
Place	90	2.40	0.85	1.102	0.298	Unequal	-1.308	0.196	-0.94	0.20	No
	15	2.77	0.65								
Time	90	2.41	0.73	4.413	0.040	Equal	-1.227	0.225	-0.62	0.04	No
	15	2.70	0.40								
Evaluation	90	2.52	0.79	3.871	0.054	Equal	-0.328	0.744	-0.60	0.43	No

program has been designed for acquisition of the necessary competencies and skills. This content includes the general and specialized competencies that provide the opportunity for active teaching methods. Learning activities provide the opportunity of knowledge development. The teaching methods specified in this program are based on problem and modeling. Also, the education facilities and radiology technologies and also, the professors' ability to use these technologies are some of the main factors related to the element of materials and resources. The education time and its proportionality to the content is one of the most important factors effective in learning. Learning space and facilities are the factors related the education space. The volume of scientific resources and radiology references is consistent with the time allocated to upgrade and OSCE tests and evolutonal assessment is done every month in addition to the final test. Since the nine elements of this program were determined based on the students' condition, they are consistent with the results reported by Darzi et al. (2019) who concluded each of the nine elements matches with the learners' conditions and the experts' viewpoints (20). Residency education has many challenges in specifying the competencies; however, it should emphasize the competency promotion. As we are moving toward the development of competencies in medical education, our first effort may be to identify the general and specialized

competencies. Also, program assessment is significantly effective in the success of the program and so, health service provision requires the professional abilities of all the members of clinical teams. One of the limitations of this study was the brief review of the residents' opinions. So, generalization of the results may be challenging. However, continuous evaluation of professional development programs can be effective in promotion of knowledge, attitudes, and general and specialized competencies.

#### Ethical considerations

Ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc. have been completely observed by the authors. The ethics committee of Semnan University approved this research, ethics code IR.SEMUMS.REC.1398.244.

#### ACKNOWLEDGEMENT

The authors express their gratitude and appreciation to the radiology professors and residents of Mashhad University of Medical Sciences. This article is part of the PhD thesis of thesis number25982.

**Financial Support:** This research received no financial support.

**Conflict of Interest:** None to be declared.

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