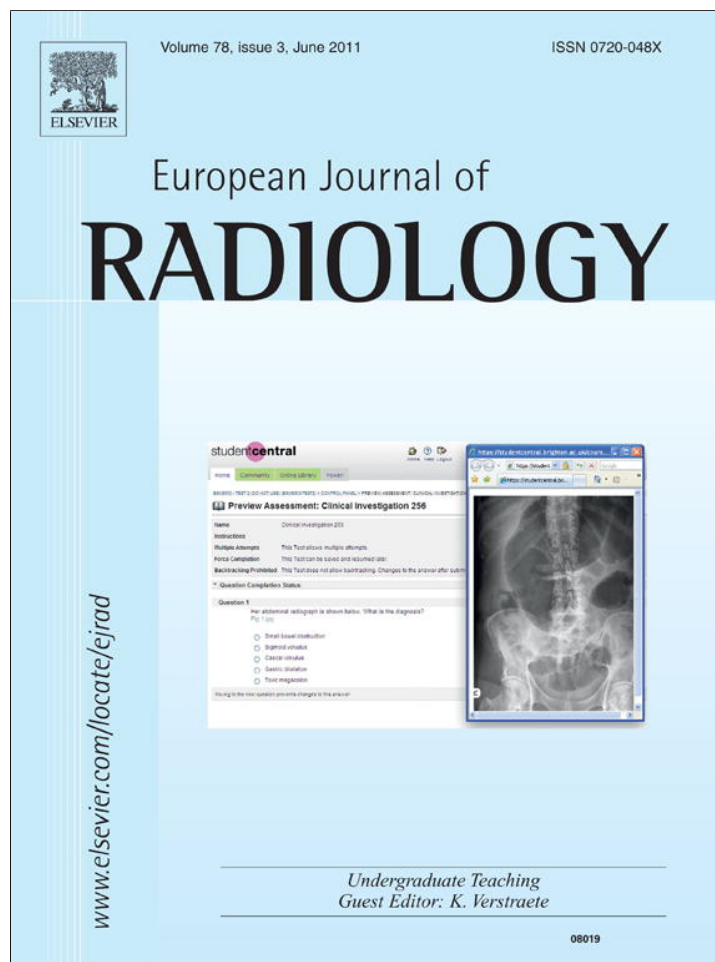


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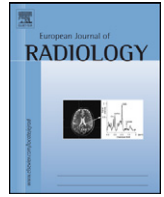
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## Radiological clerkships as a critical curriculum component in radiology education

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## ABSTRACT

**Objective:** The aim of this research was to explore the perceived value of clinical clerkships in the radiology curriculum as well as the impact of radiology clerkship on students' beliefs about the profession of radiology as a whole and as a career.

**Methods:** This study is a sequel to a previous survey in which student perceptions about radiology curriculum components were investigated. The present study focuses on a further analysis of a subsection in this study, based on 14 statements about radiology clerkship and two statements about radiology as a career.

**Results:** Perceived usefulness of the aspects of radiology clerkship as "radiology examination", "skills development" and "diagnosis focus" were awarded the highest scores. The predict value of the subscale "radiology examination" on the level of performance was very high (adjusted  $R^2 = 0.19$ ,  $p < .001$ ).

**Conclusion:** Students expressed highly favorable evaluation of clerkship as a learning environment to learn to order and to interpret imaging studies as well as an unique possibility to attend various radiological examinations and to access to specific radiology software systems, as well as to get a better view on radiology and to improve image interpretation skills. This positive attitude towards clerkship is closely tied to students' beliefs about the profession of radiology as a whole. These aspects of dedicated radiology clerkship are crucial for effective and high-quality education as well as for the choice of radiology as a career.

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### 1. Introduction

In an earlier study, a detailed picture was developed about the perceived impact of components of an innovate radiology curriculum at Ghent University (e.g., e-learning, radiology case based learning, radiology online assessment). Research consistently emphasizes that the way students experience and perceive an educational innovation mediates the attainment of learning outcomes that result from their innovative learning environment [1–4]. In the context of clerkships, such student perceptions seem to be particularly important. It has e.g., been found that satisfaction with the residency experience was associated with factors that enhance learning [5]. In addition, positive experiences with clerkship can influence future career decisions [6]. More recently, the potential impact of radiology clerkships in view of future radiology careers has been studied. Available evidence states that students consider their clerkship of importance to develop as a radiologist and in view of their future career choice [7–9].

The results of our earlier study pointed at a high student appreciation level in relation to radiology clerkships during their clinical training years. During a clinical training phase, students adopt rather an applied perspective of their knowledge and skills. This results in a strong appreciation of practice linked curriculum components (ref. Article: The Long-term Impact of the Radiological Curriculum Innovation in the Medical Doctors Training at Ghent University, submitted in EJR with following manuscript number: HI 411-10). Medical curricula seem to differ widely as to the place of and importance attached to radiology clerkships. In Europe [10], most medical education curricula clearly incorporate an opportunity to be involved in radiology clerkship. In US medical schools, radiology clerkships are rather presented as an elective and are to a lesser extent a mandatory [11,12] curriculum component of the medical training during the clinical years. The literature also recommends that radiology clerkship or practical activities are to be introduced rather early in the clinical curriculum [13]. Early contact with the radiology professional setting is expected to give opportunities to encounter inspiring role models [14]. This is hypothesized to have an impact on opting for radiology as a career perspective; especially in female students [13].

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In this study we investigate the perceived educational impact of radiology clerkship during a clinical training period on student knowledge and skills acquisition and development of attitudes towards radiology and the radiology career.

## 2. Description of the required clinical radiology clerkship at Ghent University

The structure of radiology curriculum and the way the radiology is taught at Ghent University was described in detail in a previous study. Fig. 1 reflects the place of radiology clerkships throughout the curriculum, with a focus on the clinical training years.

In the present study we center on the perceived impact of the compulsory radiology clerkship for 6<sup>th</sup> year students. These students stay at a radiology department for 1 week and have to carry out specific tasks during this period. The related learning objectives and the internship schedule are clearly defined and information about it is available via the educational e-learning platform of the university. During the first internship day, students are given practical information and are introduced to the learning objectives that have to be attained. Next, students have to fill out an online prior knowledge test. This test – consisting of 42 items – covers the mastery of radiology anatomy, different radiology techniques, radiology of diseases and radioprotection. A variety of question formats are implemented: multiple choice questions, drop down menu questions and “click on the structure” questions. Students receive automated immediate feedback to identify their knowledge gaps. The tests build on the radiology curriculum that was part of the 2<sup>nd</sup> to 5<sup>th</sup> year curriculum (radiology anatomy, pathology, interpretation, radiation protection and appropriate use of radiology techniques). The prior knowledge state test highlights the need to refresh the radiology knowledge base. As to the latter, students have access to syllabi and reference books, and e-learning exercises. The latter vary in difficulty and are an efficient means to upgrade their knowledge base.

During the next days of their internship, students carry out a selected number and type of radiological examinations (radiographic examinations, computed tomography (CT), magnetic resonance imaging (MRI), positron-emission tomography (PET-CT), ultrasound, etc.). They participate in routine clinical practice. They attend clinical radiology conferences and multidisciplinary team meetings. They apply recommendations about appropriate use of radiology equipment. Other learning objectives urge the interns to improve their interpretation skills of radiological images, to work with web-based PACS (Picture Archiving and Communication System) and to work with CDs containing image data from different hospitals resulting from different software packages to manage radiology images (AGFA, KODAK, E-FILM, ETIAM, TELEMIS). At the end of the clerkship all students submit an evaluation form that helps them to reflect on the radiology tests, their experiences, and what they have learned during the clerkship. Students also fill out an online final radiology test, consisting of 54 questions.

## 3. Research objectives

In view of this study, the following research objectives have been stated:

1. To describe – according to the students – the perceived value of the radiology clerkship during clinical training years.  
To determine the perceived impact of the dedicated radiology clerkship experience on radiology knowledge acquisition.
2. To explore the perceived impact of radiology clerkship on students ideas about radiology as a profession and radiology as a future career choice.

## 4. Research design

### 4.1. Participants

Students, enrolled for the MD training in 2008 (years 2–7) at Ghent University, were asked to complete a questionnaire about their perceptions in relation to the undergraduate radiology curriculum components. The design, content and structure of the Evaluation Radiology Teaching Concept Scale (ERTeCS) were extensively discussed in a previous article. The ERTeCS was filled out anonymously, and after obtaining informed consent. The questionnaire was accompanied by a letter giving background information about the objectives of the study. Participation was voluntary and students were informed that neither participation nor non-participation would affect their grades. Ethical approval was granted by the Human Investigation Ethical Committee of the Ghent University Hospital. In the present study, only the data from 6<sup>th</sup> and 7<sup>th</sup> year students are used, and only part of the ERTeCS research instrument, as will be explained below. Since we focus on radiology clerkships, we also center on the group of students who have experienced the 6<sup>th</sup> year radiology clerkship. At the time of the ERTeCS administration only 99 students (all 7<sup>th</sup> year students, and only part of 6<sup>th</sup> year students) did already participate in this clerkship.

## 5. Research instruments

### 5.1. Validity and reliability of the Radiology Teaching Concept Scale (ERTeCS)

Since we focus in the present study on radiology clerkship, only a subpart of the ERTeCS is used in the context of this research report. The original subscale about the radiology internship consisted of 18 items. Data from the research sample were split up in an exploratory subsample and a confirmatory subsample. An initial exploratory factor analysis – building on the exploratory subsample data – was helpful to eliminate items with weak factor loading. This resulted in a final 14-item scale, consisting of five subscales (Table 1). Standardized sum scores were calculated for each subscale related to a particular latent internship related variable (minimum 1–maximum 5). In the next step, a confirmatory factor analysis was carried out, based on the factor structure develop on the base of the data from the confirmatory subsample. The analysis resulted in satisfactory goodness-of-fit indices:  $\chi^2=97.017$ ,  $p<.001$ ;  $CMIN/DF=1.76$  ( $<5$  indicates adequate fit);  $CFI=.957$ ;  $GFI=.915$  ( $\geq 0.90$  indicates adequate fit);  $RMSEA=.073$  ( $<0.08$  indicates an adequate fit). Lastly, reliability coefficients were calculated (Table 1). The Cronbach's  $\alpha$  values range from 0.68 to 0.96, indicating acceptable to very good reliability levels, reflecting an acceptable to strong internal consistency.

The five subscales reflect five foci upon the nature and value of the radiology internship experience: (1) radiology diagnosis focus, (2) skills development focus, (3) interdisciplinary focus, (4) radiology examination focus, and (5) clerkship setting focus. The related items in Table 1 illustrate concretely the particular core fo each subscale.

### 5.2. Radiology as a profession and radiology as a career option

Two specific ERTeCS items focused on profession/career related issues. Statements such as “I think that radiology has a future as a profession” and “I am interested in radiology as a career choice” were additionally analyzed to explore the orientation towards

Radiology Clinical Clerkships at Ghent University					
Year	5	6	7		
Type	Required structured- guided	Required	Elective		
Duration	half day	5 days (one week)	<table border="1"> <tr> <td>12 weeks for the potential Radiology Residency candidates</td> <td>3-6-9 weeks for future non- radiology specialists</td> </tr> </table>	12 weeks for the potential Radiology Residency candidates	3-6-9 weeks for future non- radiology specialists
12 weeks for the potential Radiology Residency candidates	3-6-9 weeks for future non- radiology specialists				
Tasks	Observational tasks	Active tasks	Active tasks		
Objectives	<ol style="list-style-type: none"> <li>To demonstrate the working of radiology department (the equipment, patient flow, image flow, reporting, administrative and logistic work)</li> <li>To learn to work with radiological CD's from different hospitals containing imaging studies</li> <li>To learn to work with web-based PACS and solve radiological cases</li> <li>To solve electronic teaching files/cases</li> </ol>	<ol style="list-style-type: none"> <li>To follow a selected number and type of radiological examinations (Conventional radiography, CT, MRI, ultrasound, etc.)</li> <li>To improve the interpretations skills of radiological images</li> <li>To learn to work with web-based PACS (case-based learning) and on CD's</li> <li>To participate in routine clinical practice in the department</li> <li>To learn "what to order and when" (recommendations for appropriate use of radiology)</li> <li>To attend clinico-radiological conferences and multidisciplinary team meetings</li> </ol>	<ol style="list-style-type: none"> <li>To obtain a high level of radiology images interpretation</li> <li>To learn to make a prescription according to Guidelines for appropriate use of radiology</li> <li>To make different radiology cases</li> </ol>		

Fig. 1. Clinical radiology clerkships at Ghent University.

Table 1  
Statements representing attitude towards clinical radiology clerkship.

Statements <sup>a</sup>	$\alpha^b$	Mean	SD <sup>b</sup>	t-Test	Effect size
Radiology clerkship (14 items, N = 99)	0.88	3.23	0.91		
<b>Subscale: diagnosis focus</b>	0.85	3.52	0.86	**	0.59
1 I improved my knowledge of radiology during the clerkship		3.36	1.18		
2 My skills for interpretation of radiological images improved during the clerkship		3.20	1.17		
<b>Subscale: skills development focus</b>	0.81	3.61	0.83	**	0.72
3 During the clerkship I learned to work with radiological CD's with imaging studies from the various hospitals		3.61	1.11		
4 I am able to work independently with radiological CD's with imaging studies from the various hospitals		3.39	1.10		
5 During the clerkship I learned to work with web-based PACS system		3.46	1.17		
6 I am able to work independently with web-based PACS system		3.44	1.19		
<b>Subscale: interdisciplinary focus</b>	0.96	3.25	0.97	***	0.27
7 I believe taking part in multidisciplinary staff meetings during the radiology clerkship offers added value to the clerkship		3.96	1.53		
8 I found my participation in multidisciplinary staff meetings during the radiology clerkship informative and fascinating		4.03	1.58		
<b>Subscale: radiology examination focus</b>	0.79	3.89	0.54	**	1.19
9 During the radiology clerkship I was able to attend various radiological examinations		3.97	1.21		
10 I am able to solve the clinical questions posed during radiological examinations		3.43	1.08		
11 During the clerkship I learned to correctly prescribe a radiological examination		3.16	1.29		
12 I am able to correctly prescribe a radiological examination independently		3.54	1.06		
<b>Subscale: clerkship setting focus</b>	0.68	3.23	0.91	**	0.25
13 There is sufficient variation in the tasks the student have to perform during the clerkship		3.51	1.32		
14 I believe the supervision by docent and radiologists was optimal during clerkship		3.05	1.27		

Comparing the benchmark score (=3): \*effect size based on Cohen's d: small effect (>.20); medium effect (>.50); large effect (>.80); \*\*p < .001; \*\*\*p < .05.

<sup>a</sup> The items are scored from "totally disagree" (1) to "totally agree" (5).

<sup>b</sup> N = number of respondents, SD = standard deviation,  $\alpha$  = Cronbach's alpha.

the radiology profession and radiology as a career choice. Students scored these items on a five point Likert-scale ranging from “strongly disagree” to “strongly agree”.

### 5.3. Radiology knowledge test scores

A particular part of the ERTeCS consisted of ten knowledge questions regarding to general radiology knowledge.

## 6. Procedure

As stated above, only the ERTeCS data from 6<sup>th</sup> and 7<sup>th</sup> year students – enrolled for the MD curriculum – were used in the present study ( $n = 194$ ). Students enrolled in the 6<sup>th</sup> year and the 7<sup>th</sup> year of medical training were included in a secondary analysis (Fig. 2). The ERTeCS data subset included the scores for the general radiology prior knowledge test, and the items in relation to student ideas about radiology as a profession and radiology as a career option.

To obtain a performance measure related to radiology, scores from the ERTeCS prior knowledge state test were used.

## 7. Statistical analyses

Statistical analyses were carried with AMOS (structural equation modeling software – version 6.0) and SPSS (version 15, Statistical Package for the Social Sciences, SPSS; Chicago, IL, USA). The quantitative analysis initially builds on descriptive statistics, after checking for accuracy of data entry, missing values and outliers. Inferential statistics were applied to compare group means: one-sample  $t$ -test was used to compare student perception scores with a benchmark score and an independent samples  $t$ -test was used to compare students performance on prior knowledge test for groups students that were involved or not involved in a radiology clerkship. Analysis of variance (ANOVA) and regression analysis were used to study the predictive power of the perception measures on student performance, and their ideas about radiology as a professions and radiology as a career choice.

## 8. Results

### 8.1. Response rate

As can be derived from Fig. 2, the number of students (year 6 and 7) filling in the ERTeCS questionnaire was 194. At that specific moment, only about half of the students ( $n = 99$ ) had already been involved in a radiology clerkship and could react to items in relation to the radiology clerkship. But, all students ( $n = 194$ ) solved the ERTeCS general radiology prior knowledge test, and replied to the items in relation to the radiology profession and radiology as a career option.

### 8.2. Perceived value of the clerkship

The standardized scores for each subscale are presented in Table 1. When we adopt a benchmark score of  $>3$ , we can conclude that the average subscale scores reflect a positive perceived value in relation to the five foci of the radiology clerkship. Fig. 3 shows in a more graphical way how the appreciation levels for the different foci in the radiology clerkship are high. When testing the mean subscale scores with the benchmark (benchmark score = 3), consistent statistical analysis results are obtained for three clerkship foci: *radiological examination* (mean 3.89, SD 0.54,  $p < .001$ , high effect size: Cohen's  $d = 1.19$ ), *skills development* (mean 3.61, SD 0.83,  $p < .001$ , medium effect size: Cohen's  $d = 0.72$ ) and *diagnosis focus* (mean 3.52, SD 0.86,  $p < .001$ , medium effect size: Cohen's

$d = 0.59$ ). In relation to two internship foci, the analysis results are marginally significantly different: *interdisciplinary focus* (mean 3.25, SD 0.86,  $p < .05$ , small effect size: Cohen's  $d = 0.27$ ) and *clerkship setting* (mean 3.23, SD 0.91,  $p < .05$ , small effect size: Cohen's  $d = 0.25$ ).

### 8.3. The impact of the radiology clerkship on radiology knowledge acquisition

All students ( $n = 194$ ) solved the ERTeCS general radiology prior knowledge test. The results of an independent samples  $t$ -test show significant differences between the score of students involved in a radiology clerkship ( $n = 99$ ) and the score of students not involved in a radiology clerkship ( $n = 95$ ): mean [SD], 746.5 [SD = 157.7] vs 648.5 [SD = 171.3];  $p < .001$ .

### 8.4. Students perceptions about the usefulness of clerkship and learning performance

As stated in the introduction, there is empirical evidence that – positive – student perceptions play a mediating role in attaining higher performance levels in the context of a curriculum innovation or an innovative learning environment. To test this assumption in the context of the radiology clerkships, a stepwise multiple linear regression was carried out in which the average perception radiology clerkship score was entered to predict the general radiology knowledge test score. The overall radiology clerkship perception scores seem to explain 12% of the variance in the test score (adjusted  $R^2 = 0.12$ ,  $p < .001$ ). When we enter separately the five internship subscale perception scores in the regression analysis, the picture changes. The subscale *Radiological examination* seems to be single significant predictor in the equation and explains up to 19% of the variance in the radiology test score (adjusted  $R^2 = 0.19$ ,  $p < .001$ ). This can be considered as a high proportion in explained variance. The other four clerkship subscale scores do not seem to contribute in a significant way to the equation.

### 8.5. Students perceptions about the radiology clerkship and choosing radiology as a profession or as a career choice

The results present a clear picture about the students' perceptions towards radiology as a profession and career. Most of our 6<sup>th</sup> and 7<sup>th</sup> year students (84.5%) believe that radiology has a future as a profession and 10.3% are interested in radiology as a future career. Previous research originating from students enrolled in US medical schools, reported average percentages of 7.4% [15] to 8% [16] of students considering radiology as a career choice.

It is important to repeat that – at the time of the ERTeCS questionnaire administration – about half of the 6<sup>th</sup> year students were already involved in a radiology clerkship (99/194). This helps to compare student perceptions of students involved/not involved in a radiology clerkship. Students with radiology clerkship experience adopt a more positive orientation towards radiology as a profession (ANOVA between subjects  $F = 7.47$ ,  $p < .01$ , *Partial Eta Squared* .008). But, this difference – though significant – is not large. This can be explained by referring to the medical curriculum structure of Ghent University. Students are exposed to radiology from years 2 to 7 of their training. This implies already early contact with radiology in preclinical years (ex-cathedra radiology lessons, radiology e-learning exercises, etc. This makes radiology a visible [17] component of the Ghent University integrated medical curriculum and explains partly the positive perceptions [18] about the radiology profession. Nevertheless, the particular radiology clerkship experience in the 6<sup>th</sup> year seems to affect students' opinion about radiology as a profession.

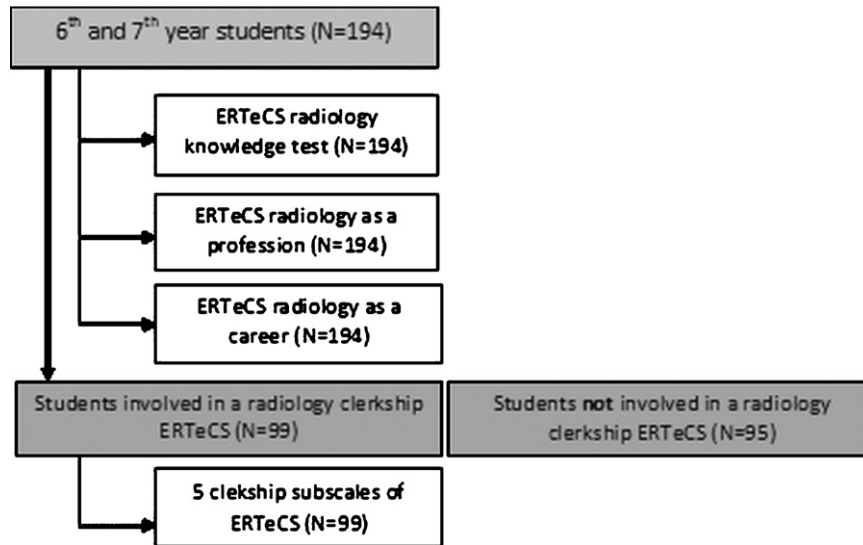


Fig. 2. Student samples and participation details.

A stepwise linear regression, with the five radiology clerkship subscale scores as predictors for the dependent variable student's opinion about radiology as a profession, shows interesting results. Only one clerkship subscale score seems to contribute in a significant way to the equation: The "Clerkship setting" focus explain 15% of the variance in responses to the question about radiology as a profession (adjusted  $R^2=0.15$ ,  $p<.001$ ). This high proportion can be explained by the large variation in tasks that student have to carry out during their radiology clerkship and the provision of sufficient supervision by expert radiologist during the clerkship. This is in line with the research findings that stress the importance of student exposure to role models [14]. The other clerkship subscale

scores did not contribute significantly to student attitudes about radiology as a profession.

Secondly, we center on the tendency of students to opt for radiology as a future career choice. Not surprisingly, students who were already involved in a radiology clerkship showed less interest in radiology as a personal future career choice (mean score 1.4 versus 1.7, ANOVA between subjects  $F=22.28$ ,  $p<.001$ , *Partial Eta squared* .02). It is likely that students who are enrolled in a clerkship during their 6<sup>th</sup> and nearly final year of their medical training, will already have an established idea about their future professional orientation and especially about their future specialization. This interpretation is also supported by Shepherd et al. stressing the

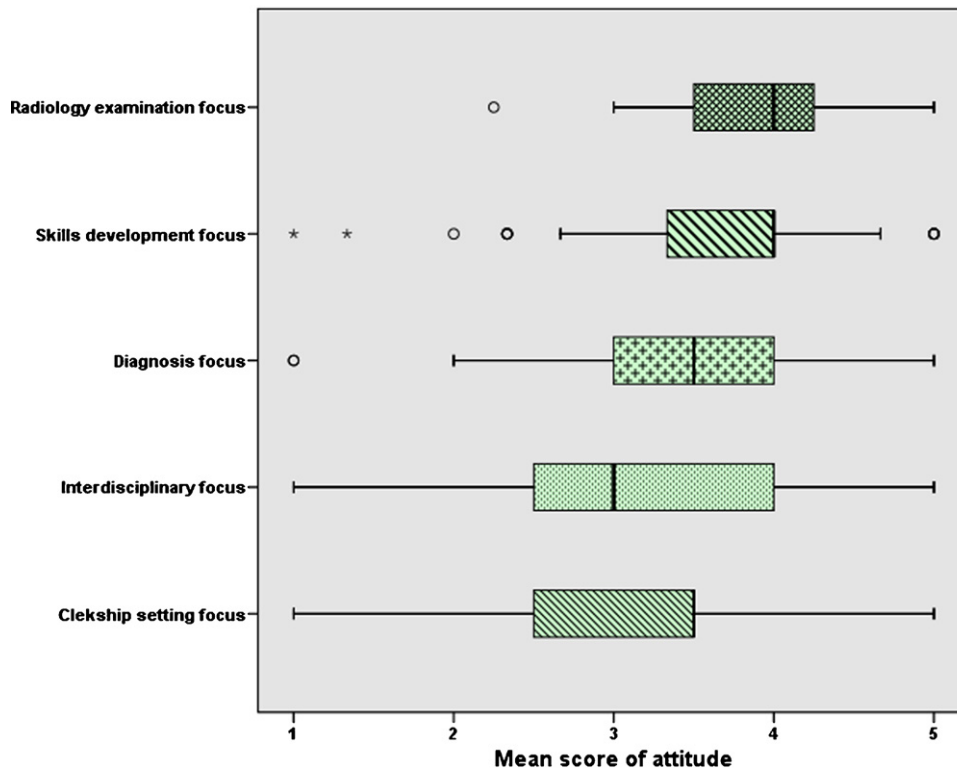


Fig. 3. Perceived usefulness of different aspects of the radiology clerkship.

importance of radiology electives in view of opting or not opting for a specialization in radiology [9]. Ambivalent students who are yet not sure about their future career choice can benefit from the 6<sup>th</sup> year clerkship and be considered as a “target group” increase the attractiveness of a radiology career choice. A stepwise linear regression with the five clerkship subscale scores as predictors shows that the subscale “*Diagnosis focus*” significantly explains 11% of the variance in opting for radiology as a career choice (adjusted  $R^2 = 0.11$ ,  $p < .001$ ). This is in line with other research findings. Developing an adequate level of radiology knowledge, clinical thinking, and interpretation skills of radiological images are in line with perceived needs of students [19–21] in view of a prospective career choice. Other clerkship subscales did not contribute significantly to the proportion of explained variance in the dependent variable.

## 9. Discussion

The present study reemphasizes the importance of affective variables – such as student perceptions about the learning environment – as mediating variables [1,3,22] to attain clinical competences and learning. Since the department of radiology at Ghent University has been responsible for the design, development of an innovative, it was a logical step to evaluate the curriculum innovation and to build on the perceived educational impact of radiology clerkship as part of the quality control cycles in relation to the implementation of the innovative.

The results of our research are consistent with previous research underpinning the critical role of radiology clerkship in the clinical part of the medical undergraduate curriculum [9,11,12]. Our study shows that radiology clerkship for 6<sup>th</sup> year students (duration of medical training program in Belgium is 7 years) reinforce the learning process. Teaching and evaluation methods related to radiology clerkship have been broadly explored in the literature. The results of our study, are in line with the earlier findings about the usefulness and effectiveness of pre- and post-clerkship tests [23–25]. One of the important learning objectives of the clerkship is the improvement of the radiology knowledge base and the development of basic skills image interpretation [19,20]. The result of our study indicates that students perceive the clerkship as valuable for their knowledge development and skills improvement. This is even confirmed in the regression analysis when using the perceived value as a predictor for the knowledge test scores. This is in agreement with the literature that points at the impact of attitudes on students' performance [26]. Positive attitudes towards radiology clerkship components influence considerably knowledge test scores.

Our findings are consistent with results from previous research that acknowledges that students need radiology clerkships [8,11,20] to be well-prepared to multidisciplinary clinical practice and to order appropriate radiological examinations in relation to common/specific diseases. Also graduate students who do not consider a career as a radiologist are also expected to interpret radiologic images independently from the opinion and report of a radiologist's expert [8,9,21]. Our results show – in line with earlier findings – how radiology clerkships attract students to consider radiology as a career [27]. In addition, the clerkships induce a more positive perception of the radiologist profession; this is again in line with earlier research results [21,28]. The students ERTeCS scores also indicate that our students perceived radiology clerkship as a setting to learn to order and to interpret radiology images, as well as an unique possibility to attend radiology patient examinations, and to have access to the different radiology software systems used in clinical centers throughout the country. The latter can play very important role to enhance the appeal of the radiology profession.

Such experiences may especially influence students with still a neutral or ambivalent perceptions about radiology as a personal career option.

## 10. Limitations

A number of limitations have to be mentioned in relation to this study. First, at the moment of the questionnaire administration, only a part of 6<sup>th</sup> year students had already been involved in a radiology clerkship. This implies that the groups compared in this study were the result of a random assignment. This depended entirely on the scheduling for radiology clerkship of the faculty administration.

A second limitation is related to the predictive value of student perceptions about the radiology clerkship on radiology knowledge test results. Since only a proportion (11–15%) of the variance in test results could be linked to the clerkship perception scores, a large part of the proportion clearly depends on other variables and processes. Future research should center on a further refinement of the set of predictive variables and how the clerkship experience interacts with other predictor variables. In this context it is also of importance to stress the fact that student perceptions were entered as predictors. It looks promising to enter radiology clerkship scores as additional measures.

Lastly, we did not center on the changes in attitudes towards radiology due to the clerkship experience. Considering the fact that now a valid and reliable instrument is available to study student perceptions in relation to five clerkship foci, future studies could center on the specific impact of the clerkship experiences on changes in these affective variables.

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