International Journal of Science Education
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tsed20

Scientific Skills as Core Competences in Medical Education: What do medical students think?

Laura Ribeiro[ab], Milton Severo[c], Margarida Pereira[d] & Maria Amélia Ferreira[d]

[a] Department of Medical Education and Simulation, Department of Biochemistry, Faculty of Medicine, University of Porto, Porto, Portugal

[b] Instituto de Investigação e Inovação em Saúde (I3S), Universidade do Porto, Porto, Portugal

[c] Department of Medical Education and Simulation, Department of Clinical Epidemiology, Predictive Medicine and Public Health, Faculty of Medicine, University of Porto, Porto, Portugal

[d] Department of Medical Education and Simulation, Faculty of Medicine, University of Porto, Portugal, Porto, Portugal

Published online: 30 Jun 2015.

To cite this article: Laura Ribeiro, Milton Severo, Margarida Pereira & Maria Amélia Ferreira (2015): Scientific Skills as Core Competences in Medical Education: What do medical students think?, International Journal of Science Education, DOI: 10.1080/09500693.2015.1054919

To link to this article: http://dx.doi.org/10.1080/09500693.2015.1054919

International Journal of Science Education, 2015
http://dx.doi.org/10.1080/09500693.2015.1054919

Scientific Skills as Core Competences in Medical Education: What do medical students think?

Laura Ribeiro[a,b*], Milton Severo[c], Margarida Pereira[d] and Maria Amélia Ferreira[d]

[a]*Department of Medical Education and Simulation, Department of Biochemistry, Faculty of Medicine, University of Porto, Porto, Portugal;* [b]*Instituto de Investigação e Inovação em Saúde (I3S), Universidade do Porto, Porto, Portugal;* [c]*Department of Medical Education and Simulation, Department of Clinical Epidemiology, Predictive Medicine and Public Health, Faculty of Medicine, University of Porto, Porto, Portugal;* [d]*Department of Medical Education and Simulation, Faculty of Medicine, University of Porto, Portugal, Porto, Portugal*

Background: Scientific excellence is one of the most fundamental underpinnings of medical education and its relevance is unquestionable. To be involved in research activities enhances students' critical thinking and problem-solving capacities, which are mandatory competences for new achievements in patient care and consequently to the improvement of clinical practice. *Purposes:* This work aimed to study the relevance given by Portuguese medical students to a core of scientific skills, and their judgment about their own ability to execute those skills. *Methods:* A cross-sectional study was conducted on students attending the first, fourth and sixth years of medical course in the same period. An assessment istrument, exploring the importance given by Portuguese medical students to scientific skills in high school, to clinical practice and to their own ability to execute them, was designed, adapted and applied specifically to this study. *Results:* Students' perceptions were associated with gender, academic year, previous participation in research activities, positive and negative attitudes toward science, research integration into the curriculum and motivation to undertake research. The viewpoint of medical students about the relevance of scientific skills overall, and the ability to execute them, was independently associated with motivation to be enrolled in research. *Conclusions:* These findings have meaningful implications in medical education regarding the inclusion of a structural research program in the medical curriculum. Students should be aware that clinical practice would greatly benefit from

The research was conducted by the author, "Laura Ribeiro" at affiliation "a".

*Corresponding author. Department of Medical Education and Simulation, Department of Biochemistry, Faculty of Medicine, University of Porto, Portugal, Al. Prof. Hernâni Monteiro, 4200 - 319 Porto, Portugal. Emails: lribeiro@med.up.pt, lauratribeiro@gmail.com

the enrollment in research activities. By developing a solid scientific literacy future physicians will be able to apply new knowledge in patient care.

Keywords: *Medical education; Undergraduate research; Scientific skills*

Introduction

Scientific education is an essential foundation for excellence in medicine practice, as stated by Flexner, more than 100 years ago (Flexner, 1910) and adopted by many medical schools worldwide throughout the time (Cooke, Irby, Sullivan, & Ludmerer, 2006; Fleming, 2011). Several studies reported that students involved in research activities improve relevant scientific skills, such as the development of research design/protocols, use of statistics methods, writing ability and the application of research approaches to clinical practice (Case-Smith, Holland, & Bishop, 2011; Frei, Stamm, & Buddeberg-Fischer, 2010; Solomon, Tom, Pichert, Wasserman, & Powers, 2003). Furthermore, research activities enhance students' critical thinking and problem-solving capacities, which are mandatory competences for new achievements in patient care and consequently to the improvement of clinical practice (Agha & Howell, 2005; Greenhalgh, 2003; Remes, Helenius, & Sinisaari, 2000). Evidence demonstrates that the understanding and practice of evidence-based medicine generate better physicians (van Eyk et al., 2010; Hunskaar et al., 2009); therefore students should be encouraged to participate in research activities, facing science as a process, instead of as a simple collection of facts (Houlden, Raja, Collier, Clark, & Waugh, 2004).

In Portugal, since the implementation of the Bologna Process (Cumming, 2000) in 2007 the integration of students in scientific research has become a priority. The Medical Course of the Faculty of Medicine of University of Porto (FMUP) was reformulated into an Integrated Master Course in Medicine, organized in two complementary cycles of three years each: the first corresponding to a degree in basic health sciences, and the second cycle comprising two years of clinical learning and one year of professional clinical clerkship. The mandatory final outcome is the production of a master thesis.

Evidence suggests that students' confidence in their own research skills is associated with research interests, positive outcome expectations and higher academic performance (Bieschke, 2000; Unrau & Beck, 2004). By acquiring specific scientific skills, students also become more competitive relatively to their future careers. This can constitute an interesting advantage considering the current concern in Portugal about the possibility of medical unemployment (Santana, 2013). Indeed, the high number of students entering Portuguese medical schools, exceeding in the near future the demand of the Portuguese population, may lead to under-employment, unemployment and emigration (Santana, 2013).

Considering the need to train professionals of excellence, medical educators should be able to develop strategies to help future physicians to achieve their full potential by training them with a strong scientific foundation. Research from our group has been

investigating the perceptions of medical students about different types of competencies as well as the implications of this subject in medical education (Barbosa et al., 2011; Loureiro, Severo, Bettencourt, & Ferreira, 2011a; 2011b).

This work aimed to study the self-perceptions of Portuguese medical students about the relevance attributed to a core of scientific skills as well as their own ability to execute them.

Methods

The participants of this cross-sectional study were medical students enrolled in the Master Degree Course in Medicine from FMUP, Portugal. The study included the freshman students (first year), those who concluded the first cycle of studies (beginning of the fourth year) and students who completed the entire medical course (end of the sixth year) in the same academic year. Among the 796 eligible medical students, 611 (76.8%) participated in this study. From these 611 participants, 251 (41.1%) were attending the first year, 148 (24.2%) were attending the fourth year and 212 (34.7%) were attending the sixth year of the medical course.

Participants completed a self-administered and anonymous questionnaire entitled 'Importance of Scientific Skills for Clinical Practice' (ISS4CP) comprising 11 items corresponding to the following scientific skills: writing, oral and visual communication, literature searching, the use of information technologies, English proficiency, data analysis, team work, problem-solving, time management and improving learning. For each skill, five items were assessed: the skill's importance during high school; the skill's importance for high school assessment; the skill's importance for clinical practice; the skill's personal importance and finally own ability to execute that skill. All items followed a Likert scale ranging from 1 (very important) to 4 (unimportant). The questionnaire also inquired about gender, type of school attended at secondary level (public or private) and participation in research activities before or during the medical course. Twenty-eight questions of the ISS4CP, questioning medical students about knowledge and attitudes about science and research, were included and adapted from a previous study (Vodopivec et al., 2002).

To each item a score was calculated by computing the average of responses. High scores represent lower levels of attributed importance/ability to execute. Principal Components Analysis (PCA) with oblimin rotation was used to identify the underlying constructs (factors) of the questionnaire about the importance of scientific skills. Cronbach's alpha was used to assess the reliability of the questionnaire through internal consistency.

Two independent sample *t*-test and analysis of variance were used to compare scores of factors according to gender, academic year, type of school attended at secondary education level and previous participation in research projects. The Pearson correlation and the multiple linear regression model were used to explore associations between the underlying constructs and gender, academic year, participation in research activities, attitudes, integration into the curriculum and motivation toward scientific research.

All statistics analyses were performed with the R 2.12.1. The significance level was set at 0.05. The ethical principles of this research followed the guidelines approved by the Ethics Committee of FMUP/Centro Hospitalar São João.

Results

Almost 65% of the participants were female. In total, 72.3% attended public schools in the secondary education level and more than 75% did not participate in research projects before or during the medical course.

Regarding the questionnaires' constructs, PCA identified three factors that explained 38% of the total variance: factor 1: 'perceived importance of the scientific skills to high school'; factor 2: 'perceived importance of the scientific skills to clinical practice' and factor 3: 'own ability to perform the skills'. Moderate to strong associations were identified between items 1 and 2 resulting in factor 1, between items 3 and 4 generating factor 2 and item 5 corresponds singly to factor 3 (Table 1). Factor 1 explained 18% of the variance (Cronbach's alpha = 0.939), factor 2 explained 12% of the variance (Cronbach's alpha = 0.890) and factor 3 explained 8% of the variance (Cronbach's alpha = 0.828).

The mean scores were 1.76, 1.49 and 1.54 for factor 1, factor 2 and factor 3, respectively. Compared with men, women gave lower scores to both factors 1 and 2, and significant differences were observed between scores for all factors according to academic years (Figure 1). Students, who had undertaken research, before or during the medical course, gave lower scores to both factors 2 and 3 compared with students who did not. Significant differences were not found between scores for all factors according to the attendance of public or private secondary schools (Figure 1).

Negative attitudes toward science showed an inverse association with all factors, while positive attitudes showed a positive association (Table 2). Integration of research activities into the curriculum and motivation to perform research presented a significant association with both factors 2 and 3 (Table 2).

After adjustment to all the variables, motivation to perform research maintained a significant association with the three factors (Table 3).

Discussion

In undergraduate education, the engagement of young students in research activities is the earliest form of encouragement for the development of skills such as literature searching, English proficiency, data analysis, team work, problem-solving, communication skills, time management and improving learning (Houlden et al., 2004; Reinders, Kropmans, & Cohen-Schotanus, 2005; Solomon et al., 2003). Considering that medicine is a science-based profession, the enrollment of medical undergraduate students in research is an effective strategy to help future physicians to achieve their full academic potential (Houlden et al., 2004; Reinders et al., 2005).

This study suggests that medical students' self-perception of scientific skills' relevance to both secondary schooling level and clinical practice, as well as their own ability to execute them, differs according to gender and academic year. Women

Table 1. PCA with oblimin rotation of the questionnaire items related to each scientific skill

Scientific skills and corresponding items	Factors		
	1[a]	2[b]	3[c]
Writing communication			
1. Importance during high school	**0.40**	0.21	−0.07
2. Importance for assessment at high school	**0.33**	0.27	−0.10
3. Importance for clinical practice	0.05	**0.46**	0.02
4. Personal importance of this skill for you	0.07	**0.47**	−0.02
5. How do you score your ability to execute it?	−0.02	0.10	**0.58**
Oral communication			
1. Importance during high school	**0.57**	0.13	−0.09
2. Importance for assessment at high school	**0.61**	0.11	−0.11
3. Importance for clinical practice	−0.02	**0.60**	−0.06
4. Personal importance of this skill for you	−0.01	**0.62**	−0.05
5. How do you score your ability to execute it?	−0.14	0.11	**0.57**
Visual communication			
1. Importance during high school	**0.52**	0.09	0.01
2. Importance for assessment at high school	**0.59**	0.11	0.02
3. Importance for clinical practice	0.17	**0.35**	0.10
4. Personal importance of this skill for you	0.18	**0.36**	0.09
5. How do you score your ability to execute it?	−0.02	−0.01	**0.62**
Literature searching			
1. Importance during high school	**0.71**	0.01	0.00
2. Importance for assessment at high school	**0.73**	0.04	0.01
3. Importance for clinical practice	0.02	**0.60**	0.00
4. Personal importance of this skill for you	0.07	**0.54**	0.11
5. How do you score your ability to execute it?	0.13	−0.10	**0.66**
Information technologies			
1. Importance during high school	**0.67**	0.06	0.10
2. Importance for assessment at high school	**0.69**	0.07	0.12
3. Importance for clinical practice	0.13	**0.45**	0.13
4. Personal importance of this skill for you	0.11	**0.43**	0.28
5. How do you score your ability to execute it?	0.09	−0.08	**0.65**
English proficiency			
1. Importance during high school	**0.78**	−0.26	0.01
2. Importance for assessment at high school	**0.81**	−0.20	0.02
3. Importance for clinical practice	0.01	**0.50**	−0.06
4. Personal importance of this skill for you	0.12	**0.40**	0.06
5. How do you score your ability to execute it?	0.22	−0.18	**0.43**
Data analysis			
1. Importance during high school	**0.75**	0.01	0.10
2. Importance for assessment at high school	**0.71**	0.05	0.12
3. Importance for clinical practice	0.12	**0.49**	0.15
4. Personal importance of this skill for you	0.08	**0.42**	0.29
5. How do you score your ability to execute it?	−0.01	−0.03	**0.68**

(*Continued*)

Table 1. Continued

Scientific skills and corresponding items	Factors 1[a]	2[b]	3[c]
Team work			
1. Importance during high school	**0.64**	0.09	−0.12
2. Importance for assessment at high school	**0.62**	0.13	−0.09
3. Importance for clinical practice	0.04	**0.50**	−0.04
4. Personal importance of this skill for you	0.00	**0.51**	0.11
5. How do you score your ability to execute it?	0.02	0.09	**0.54**
Problem-solving			
1. Importance during high school	**0.64**	0.13	−0.06
2. Importance for assessment at high school	**0.68**	0.06	−0.05
3. Importance for clinical practice	0.00	**0.64**	−0.06
4. Personal importance of this skill for you	0.06	**0.58**	0.03
5. How do you score your ability to execute it?	−0.02	0.05	**0.68**
Time management/self-organization			
1. Importance during high school	**0.65**	−0.01	−0.09
2. Importance for assessment at high school	**0.64**	0.04	−0.05
3. Importance for clinical practice	0.04	**0.63**	−0.09
4. Personal importance of this skill for you	−0.03	**0.52**	−0.06
5. How do you score your ability to execute it?	−0.01	0.03	**0.47**
Improving learning			
1. Importance during high school	**0.67**	0.03	0.03
2. Importance for assessment at high school	**0.69**	0.02	0.03
3. Importance for clinical practice	0.01	**0.61**	0.07
4. Personal importance of this skill for you	0.00	**0.57**	0.08
5. How do you score your ability to execute it?	−0.09	0.12	**0.65**
Correlations			
Factor 2	0.38		
Factor 3	0.21	0.22	

[a]1: 'Perceived importance of the scientific skills to high school'.

[b]2: 'Perceived importance of the scientific skills to clinical practice'.

[c]3: 'Own ability to perform skills'.

attributed greater importance to the use of such skills in both high school and clinical practice compared to men. In addition, they felt as competent as men to execute those skills, despite other authors reporting that female medical students tend to underestimate their abilities, while males tend to overestimate them (Minter, Gruppen, Napolitano, & Gauger, 2005), even when female students objectively achieve higher grades (Blanch, Hall, Roter, & Frankel, 2008).

Comparison between academic years showed that students attending the first year of medical course attributed the lowest importance to scientific skills for high schooling level. The temporal proximity and the weaker academic requirements associated with secondary education are possible reasons for these perceptions. Students attending the fourth year gave the lowest importance to scientific skills for clinical practice and

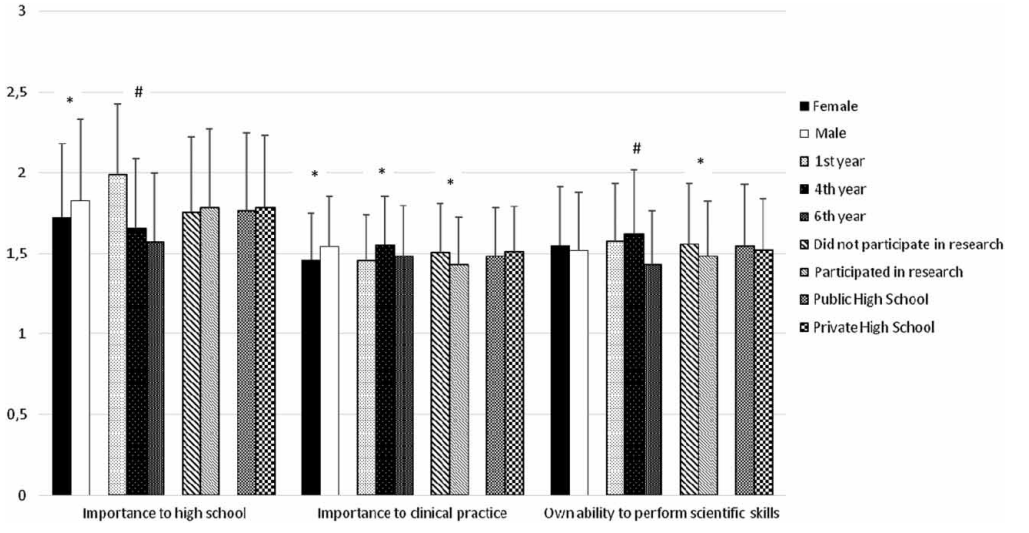

Figure 1. Scores of scientific skills' perceived importance and of own ability to perform them, according to gender, academic year, participation in research activities and type of high school $^{*}p < 0.05$ within categories of gender, academic year and participation in research. $\#p < 0.001$ within categories of academic year.

Table 2. Association between the importance attributed to scientific skills with attitudes, curriculum and motivation toward research

	Importance to high school *r* (95%CI)	Importance to clinical practice *r* (95%CI)	Own ability to perform scientific skills *r* (95%CI)
Positive attitudes	0.202 (0.123;0.278)	0.268 (0.191;0.342)	0.104 (0.023;0.183)
Negative attitudes	−0.081 (−0.162;0.000)	−0.173 (−0.252; −0.093)	−1.115 (−0.195;−0.033)
Integration of research into the curriculum	0.074 (−0.007;0.154)	0.290 (0.213;0.363)	0.122 (0.042;0.202)
Motivation to perform research	0.043 (−0.037;0.123)	0.277 (0.200;0.350)	0.185 (0.106;0.262)

Note: CI, confidence interval.

mentioned the lowest capacity to execute them, comparing to the other studied years. This was probably the most surprising and concerning finding of our study as it shows that students' interest in research decreases after the basic cycle of studies.

The reasons that might explain these results and the unfulfilled expectation feelings during this first cycle are the dissociation between basic and clinical sciences, curriculum overload (Alam, 2011) and consequently the fear of not having good marks (Ward, 2011) and, most of all, the absence of engaging in meaningful research work (Hren et al., 2004), despite the awareness of the importance of scientific skills (Hunter, Laursen, & Seymour, 2007).

Table 3. Multiple linear regression model of association between perceived importance of scientific skills with gender, academic year, participation and attitudes toward research activities

	Importance to high school β (p-value)[a]	Importance to clinical practice β (p-value)[a]	Own ability to perform scientific skills β (p-value)[a]
Gender			
Female	1	1	1
Male	0.088 (0.018)	0.077 (0.002)	−0.036 (0.254)
Academic year			
First year	1	1	1
Fourth year	−0.428 (<0.001)	0.040 (0.203)	0.000 (0.991)
Sixth year	−0.507 (<0.001)	−0.025 (0.391)	−0.205 (<0.001)
Participation in research activities			
No	1	1	1
Yes	0.028 (0.496)	−0.031 (0.257)	−0.061 (0.087)
Positive attitudes	0.163 (0.004)	0.170 (<0.001)	0.028 (0.557)
Negative attitudes	0.044 (0.438)	−0.026 (0.493)	−0.046 (0.337)
Integration of research into the curriculum	0.237 (<0.001)	0.119 (0.002)	0.071 (0.153)
Motivation to perform research	0.013 (0.015)	0.014 (<0.001)	0.018 (<0.001)

[a]Linear regression coefficients adjusted for all the variables on the table.

These findings also raise concerns for those who believe that less self-confidence and underestimation of ability could reduce academic performance (Ferguson, James, & Madeley, 2002). First year students and students at the end of the medical course showed higher levels of self-perceived capacity to execute the studied skills compared with those attending the fourth year. Given the high grades needed to be admitted to the medical course, it was not surprising to observe that freshman students were highly confident in their abilities. On the other hand, as mentioned by some authors (Laidlaw, Aiton, Struthers, & Guild, 2012) as they progress in the course, in case of not having clear role models in science, at an early stage they will give priority to other components, excluding research as an academic component. Nonetheless, medical educators are responsible for ensuring that students receive a high-quality education complying with their expectations and full potential. Medical students need to be aware that research skills and competences are very important to the routine clinical practice, and not just useful to the physician-scientists involved in full-time research (Laidlaw et al., 2012).

Perceptions of medical students about the importance of scientific skills to clinical practice and about their own ability to execute them were also significantly related to previous participation in research activities, both positive and negative attitudes toward science, research integration into the curriculum and motivation to perform research. After adjusting for potential confounders, we verified that motivation

maintained a significant relationship with the importance attributed to scientific skills for clinical practice and with the self-perceived ability to perform those skills. Thus, medical educators are responsible for revealing research opportunities in the curriculum and conveying the importance of biomedical research to clinical practice. In addition, others reported that medical students would like to be more involved in research and indicate research as a useful alternative to electives (Aslam, Shakir, & Qayyum, 2005). In this line, medical schools should provide research opportunities, stimulate students to publish research articles before graduation and encourage them to pursue a scientific career (Reinders et al., 2005).

This study has the inherent limitations of any cross-sectional study. Thereafter, a follow-up study of these students' cohorts could provide relevant information for the design of an educational research program. The study is based on the self-perception of students, which may also be a limitation. Nevertheless, self-perceived competence is seen as one of the components of self-efficacy (Solomon et al., 2003), and hence its evaluation may constitute an indicator of medical students' motivation to maintain and improve specific skills. An increasing body of evidence demonstrates that properly gathered student perceptions about several issues of their education can be used as valid foundations for extracting evaluative conclusions concerning the quality of medical education (Bandura, 1993; Lizzio, Wilson, & Simons, 2002; Scicluna et al., 2012).

Conclusion

The importance given by Portuguese medical students to scientific skills for clinical practice and the way they perceived own ability to execute them were associated with gender, academic year, previous participation in research activities, both positive and negative attitudes toward science, research integration into the curriculum, and were independently and strongly associated with the motivation to undertake research.

Along the medical course, students should be aware that clinical practice would greatly benefit from enrollment in research activities. Early exposure to research activities would generate scientifically literate clinicians, and better prepared professionals, able to develop their professional paths on behalf of populations' health. These findings have important implications in medical education, as they underline the need for motivating students through the implementation of an integrated research program in medical curriculum, providing them a solid scientific foundation for the excellence of clinical practice.

Acknowledgements

Authors thank the students of FMUP who enrolled in this study by completing the questionnaire and Joana Mendes for helping in manuscript writing.

Disclosure statement

The authors declare having neither competing and financial interest nor benefit arose from the direct application of this research.

Funding

This work was supported by the European Regional Development Fund (ERDF); COMPETE (Operational Programme 'Thematic Factors of Competitiveness) and Fundação para a Ciência e a Tecnologia, Portugal (FCT) [grant number EXPL/IVC-PEC/1302/2013].

ORCID

Laura Ribeiro http://orcid.org/0000-0002-9613-0672
Milton Severo http://orcid.org/0000-0002-5787-4871
Margarida Pereira http://orcid.org/0000-0001-5980-604X
Maria Amélia Ferreira http://orcid.org/0000-0001-6789-3796

References

Agha, R., & Howell, S. (2005). Intercalated BSc degrees—why do students do them? *The Clinical Teacher*, *2*(2), 72–76.

Alam, A. (2011). How do medical students in their clinical years perceive basic sciences courses at King Saud University? *Annals of Saudi Medicine*, *31*(1), 58–61.

Aslam, F., Shakir, M., & Qayyum, M. A. (2005). Why medical students are crucial to the future of research in South Asia. *PLoS Medicine*, *2*(11), e322.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, *28*(2), 117–148.

Barbosa, J., Severo, M., Fresta, M., Ismail, M., Ferreira, M. A., & Barros, H. (2011). How students perceive medical competences: A cross-cultural study between the medical course in Portugal and African Portuguese speaking countries. *BMC Medical Education*, *11*(1), 24.

Bieschke, K. J. (2000). Factor structure of the research outcome expectations scale. *Journal of Career Assessment*, *8*(3), 303–313.

Blanch, D. C., Hall, J. A., Roter, D. L., & Frankel, R. M. (2008). Medical student gender and issues of confidence. *Patient Education and Counseling*, *72*(3), 374–381.

Case-Smith, J., Holland, T., & Bishop, B. (2011). Effectiveness of an integrated handwriting program for first-grade students: A pilot study. *American Journal of Occupational Therapy*, *65*(6), 670–678.

Cooke, M., Irby, D. M., Sullivan, W., & Ludmerer, K. M. (2006). American medical education 100 years after the Flexner report. *New England Journal of Medicine*, *355*(13), 1339–1344.

Cumming, A. (2000). The Bologna process, medical education and integrated learning. *Medical Teacher*, *32*(4), 316–318.

van Eyk, H. J., Hooiveld, M. H., Van Leeuwen, T. N., Van der Wurff, B. L., De Craen, A. J., Dekker, F. W., & Education, N. V.-S. I. G. o. S. (2010). Scientific output of Dutch medical students. *Medical Teacher*, *32*(3), 231–235.

Ferguson, E., James, D., & Madeley, L. (2002). Factors associated with success in medical school: Systematic review of the literature. *British Medical Journal*, *324*(7343), 952–957.

Fleming, K. A. (2011). Flexner at 100: A brief view from Oxford. *Perspectives in Biology and Medicine*, *54*(1), 24–29.

Flexner, A. (1910). *Medical education in the United States and Canada: A report to the Carnegie Foundation for the Advancement of Teaching*. New York, NY: Carnegie Foundation for the Advancement of Teaching.

Frei, E., Stamm, M., & Buddeberg-Fischer, B. (2010). Mentoring programs for medical students–a review of the PubMed literature 2000–2008. *BMC Medical Education*, *10*(32), 32.

Greenhalgh, T. (2003). Doing an intercalated BSc can make you a better doctor. *Medical Education*, *37*, 760–761.

Houlden, R. L., Raja, J. B., Collier, C. P., Clark, A. F., & Waugh, J. M. (2004). Medical students' perceptions of an undergraduate research elective. *Medical Teacher*, *26*(7), 659–661.

Hren, D., Lukic, I. K., Marusic, A., Vodopivec, I., Vujaklija, A., Hrabak, M., & Marusic, M. (2004). Teaching research methodology in medical schools: Students' attitudes towards and knowledge about science. *Medical Education*, *38*, 81–86.

Hunskaar, S., Breivik, J., Siebke, M., Tommerås, K., Figenschau, K., & Hansen, J.-B. (2009). Evaluation of the medical students research programme in Norwegian medical schools. A survey of students and supervisors. *BMC Medical Education*, *9*, 43.

Hunter, A. B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education*, *91*(1), 36–74.

Laidlaw, A., Aiton, J., Struthers, J., & Guild, S. (2012). Developing research skills in medical students: AMEE Guide No. 69. *Medical Teacher*, *34*(9), 754–771.

Lizzio, A., Wilson, K., & Simons, R. (2002). University students' perceptions of the learning environment and academic outcomes; implications for theory and practice. *Studies in Higher Education*, *27*, 27–52.

Loureiro, E., Severo, M., Bettencourt, P., & Ferreira, M. A. (2011a). Third year medical students perceptions towards learning communication skills: Implications for medical education. *Patient Education and Counseling*, *85*(3), e265–e271.

Loureiro, E. M., Severo, M., Bettencourt, P., & Ferreira, M. A. (2011b). Attitudes and anxiety levels of medical students towards the acquisition of competencies in communication skills. *Patient Education and Counseling*, *85*(3), e272– e277.

Minter, R. M., Gruppen, L. D., Napolitano, K. S., & Gauger, P. G. (2005). Gender differences in the self-assessment of surgical residents. *The American Journal of Surgery*, *189*(6), 647–650.

Reinders, J. J., Kropmans, T. J., & Cohen-Schotanus, J. (2005). Extracurricular research experience of medical students and their scientific output after graduation. *Medical Education*, *39*(2), 237.

Remes, V., Helenius, I., & Sinisaari, I. (2000). Research and medical students. *Medical Teacher*, *22* (2), 164–167.

Santana, P. (2013). Estudo da demografia médica no Sistema Nacional de Saúde. *Revista da Ordem dos Médicos*, *43*, 50–52.

Scicluna, H. A., Grimm, M. C., O'Sullivan, A. J., Harris, P., Pilotto, L. S., Jones, P. D., & McNeil, H. P. (2012). Clinical capabilities of graduates of an outcomes-based integrated medical program. *BMC Medical Education*, *12*(23), 23.

Solomon, S. S., Tom, S. C., Pichert, J., Wasserman, D., & Powers, A. C. (2003). Impact of medical student research in the development of physician-scientists. *Journal of Investigative Medicine*, *51* (3), 149–156.

Unrau, Y., & Beck, A. (2004). Increasing research self-efficacy among students in professional academic programs. *Innovative Higher Education*, *28*, 187–204.

Vodopivec, I., Vujaklija, A., Hrabak, M., Lukic, I. K., Marusic, A., & Marusic, M. (2002). Knowledge about and attitude towards science of first year medical students. *Croatian Medical Journal*, *43*(1), 58–62.

Ward, P. J. (2011). First year medical students' approaches to study and their outcomes in a gross anatomy course. *Clinical Anatomy*, *24*(1), 120–127.