Physiology and Pharmacology 28 (2024) 36-42
Experimental Research Article

A self-report survey on the relationship between memory retention of physiology and clinical reasoning ability in medical students: a need for vertical integration

Seyed Ali Mard[1], Sanaz Taherpour[2], Kambiz Ahmadi Angali[3], Narjes Zaeemzadeh[4*]

1. Medical Basic Sciences Research Institute, Persian's Gulf Physiology Research Center, Department of Physiology, School of Medicine, Ahvaz Jundishapour University of Medical Sciences, Ahvaz, Iran
2. School of Medicine, Medical Educational and Development Center (EDC), Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
3. Department of Epidemiology and statistics, School of Hygiene, Medical Educational and Development Center (EDC), Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
4. Department of Phamacology, Medical Educational and Development Center (EDC), Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

ABSTRACT

Introduction: A lack of integration between basic sciences, including physiology, and clinical practice is a problem in medical education that may interfere with clinical reasoning. In this study, we evaluated the attitude of medical students of Ahvaz Jundishapur University of Medical Sciences toward this issue.

Methods: A total of 273 clinically active medical students participated in the study, comprising 117 externs, 53 interns, and 103 residents. Externs and interns are medical students with indirect and direct exposure to real patients, respectively, while residents are medical doctors pursuing specialization. The questionnaire included two questions focused on "memory retention of physiology" and "clinical application of physiology."

Results: The percentage of students who reported having a little/fair amount of physiology content in their memory was significantly higher than those who claimed to have much/very much physiology knowledge in their memory: 90.6% (106) versus 9.4% (11) in externs, 84.9% (45) versus 15.1% (8) in interns, and 84.46% (87) versus 15.53% (16) in residents ($P<0.001$). Additionally, there was a significant increase in the number of students who stated that the loss of physiology knowledge interferes with their clinical reasoning compared to those who did not have such an idea: 81.2% (95) versus 18.8% (22) in externs, 77.36% (41) versus 22.64% (12) in interns, and 78.64% (81) versus 21.36% (22) in residents ($P<0.001$).

Conclusion: Clinically active medical students at Ahvaz Jundishapur University of Medical Sciences recognize the importance of physiology for enhancing clinical performance. They acknowledge that difficulties in remembering this knowledge can have adverse effects on the future practice of doctors.

Keywords:
Physiology
Medical education
Clinical reasoning
Knowledge loss

* Corresponding author: Narjes Zaeemzadeh, zaeemzadehn@gmail.com
Received 27 March 2023; Revised from 19 June 2023; Accepted 20 June 2023

Citation: Mard S.A, Taherpour S, Ahmadi Angali K, Zaeemzadeh N. A self-report survey on the relationship between memory retention of physiology and clinical reasoning ability in medical students: a need for vertical integration. Physiology and Pharmacology 2024; 28: 36-42. http://dx.doi.org/10.61186/phypha.28.1.36

Introduction

Medical education aims to train professional physicians capable of improving public and private health levels in different nations (Augustine Egwu et al., 2011). Traditional methods of medical education often lack integration between basic and clinical sciences, requiring medical students to build their clinical knowledge upon a foundation of basic understanding (Zaeemzadeh et al., 2019). The fact is that basic science knowledge is not an inert corpus of facts that does not interact with clinical knowledge. A good understanding of basic sciences significantly influences long-term diagnostic success (Woods et al., 2006).

Among the basic sciences, physiology is considered one of the most fundamental courses essential for comprehending clinical problems (Gupta et al., 2014). Since the nineteenth century, onward, the era of Virchow, Bernard, and Starling, medical practice was based on physiologic principles. Each clinical problem needs a comprehensive search for clues that lead to a correct diagnosis. The task is to bold pertinent clues and avoid distracting ones (separating wheat from chaff). Being able to think about physiological basis of clinical materials, provides a roadmap that helps passengers reach the right diagnostic destination (Tobin 2019). Dr. Hall, one of the authors of the famous physiology textbook "Guyton and Hall Textbook of Medical Physiology", asserts that graduating medical students believe physiology is highly relevant and essential to their clinical training (Adi and Alturkmani 2013). Some clinicians, especially those in anesthesiology, intensive care, internal medicine, neurology, cardiology, and nephrology, routinely apply physiology concepts in their daily practice (Woods et al., 2006). In an effort to promote physiology education, countries like Malaysia hold annual teaching competitions for physiology and pharmacology, offering special awards to winners (Roy et al., 2017).

Vertical integration, involving the use of basic science concepts in assessing and managing patients in clinical scenarios, allows medical students to integrate their basic knowledge, including physiology, into clinical judgment (Li et al., 2014). Early clinical exposure (ECE) has been shown to enhance understanding of physiology topics, aiding better retention of the subject matter (Sathishkumar et al., 2007). Abraham suggests that emphasizing clinical concepts while teaching physiology can develop critical thinking skills in medical students (Abraham et al., 2004). The curriculum should ideally be guided by clinically-relevant medical content rather than pure disciplines traditionally titled anatomy, biochemistry, genetics, immunology, microbiology, pathology, pharmacology, physiology, and public health sciences (Pangaro 2010). Various innovative methods, such as problem-based learning (PBL) (Abraham et al., 2008), self-directed learning (SDL) (Abraham et al., 2011; Gade and Chari 2013; Pai et al., 2014), lectures based on problem (LBP) (Alaagib et al., 2019),construction of physical models(Rezende-Filho et al., 2014), concept maps(González et al., 2008), mathematical models (Abram et al., 2007), structured interactive sessions (SIS) (Rehan et al., 2016), and Puzzle-based teaching (Stetzik et al., 2015) have been proposed to improve medical physiology education.

In Iran, medical education encompasses four levels: basic sciences (five semesters, studying anatomy, physiology, embryology, genetics, and other basic sciences), physiopathology (two semesters, studying pharmacology, pathology, and theoretical courses of all internal medicine branches), externship (five semesters, observation and indirect exposure to patients in clinical sectors), and internship (three semesters, direct exposure to patients in clinical sectors). After graduation from medicine medical doctors (M.D.), can enter the "residency" programs for being specialized in a specific field of medicine (internal medicine, obstetrics, pediatrics, etc.). The trainees in externship, internship, and residency are called extern, intern, and resident respectively.

The idea of vertical integration (educating basic and clinical parts of each organ simultaneously) has been a controversial topic among medical education leaders in Iran and is being implemented in a few universities. However, Ahvaz Jundishapur University of Medical Sciences (AJUMS) has not adopted this approach, and the traditional lecturing method is still prevalent in teaching physiology. To assess medical students' opinions about the memory retention of physiology and the impact of its loss on clinical diagnosis and treatment power, we conducted a study involving three clinically active levels of education: externs, interns, and residents at AJUMS.

Material and Methods

This short survey was conducted on medical students at AJUMS from 2015-to 2018 and approved by

the Ethical Committee of this university (IR.AJUMS.REC.1394.114). All participants had completed the first two levels of medical education in Iran, encompassing basic sciences and physiopathology, and had transitioned to the clinical sectors. Initially, the sample size comprised 393 medical students, including 118 externs, 61 interns, and 214 residents. The data were analyzed in 2019.

The study utilized an anonymous questionnaire comprising two multiple-choice questions (MCQ) that also included inquiries about participants' age and current level of education. The questions were as follows:

How much has physiology knowledge remained in your memory?

A little fair much very much

Can the loss of physiology knowledge interfere with your clinical reasoning?

Yes Fair No

To ensure the validity of the questionnaire, the questions were reviewed and verified by seven university lecturers in physiology, comprising 2 full professors, 1 associate professor, 2 assistant professors, and 2 Ph.D. candidates in physiology. The reliability of the questionnaire was further confirmed through a small pilot study with a sample size proportionate to the main study. The collected data were categorized based on the Likert scale, and the reliability was confirmed using the Cronbach's alpha coefficient.

Statistical analysis

SPSS 23 statistical software was used to analyze the data. To compare percentages, the Chi-square test was employed. Data are expressed as mean. $P<0.05$ is considered significant.

Results

Out of the 393 medical students who initially participated, data from 273 students (117 externs, 53 interns, and 103 residents) aged between 22-33 years were analyzed. One hundred twenty questionnaires were not returned for various reasons.

As illustrated in figure 1, when asked about the retention of physiology topics:

42.74% of externs (n=50), 50.94% of interns (n=27), and 47.57% of residents (n=49) answered "A little"

47.86% of externs (n=56), 33.96% of interns (n=18), and 36.89% of residents (n=38) answered "Fair"

7.69% of externs (n=9), 13.21% of interns (n=7), and

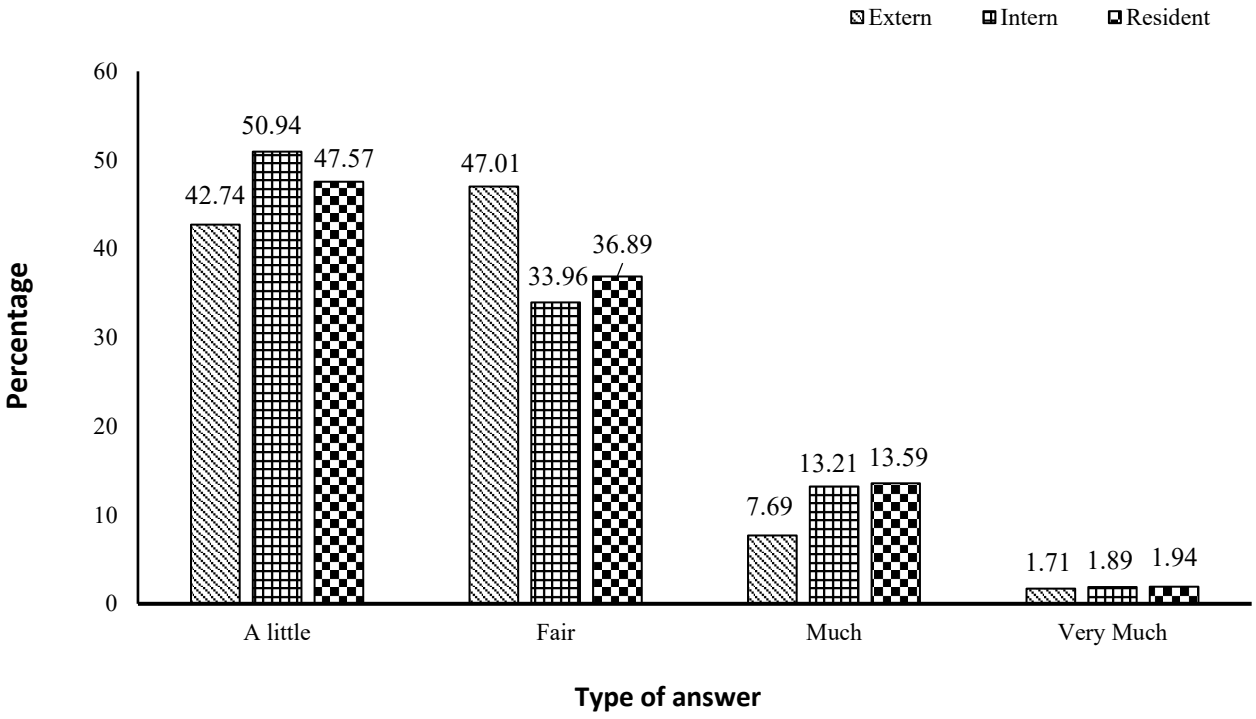

FIGURE 1. The percentage of participants' responses to the question "How much has Physiology knowledge been remained in your memory?" is presented as mean. Externs and interns are medical students with indirect and direct exposure to real patients, respectively, and residents are medical doctors studying for specialization.

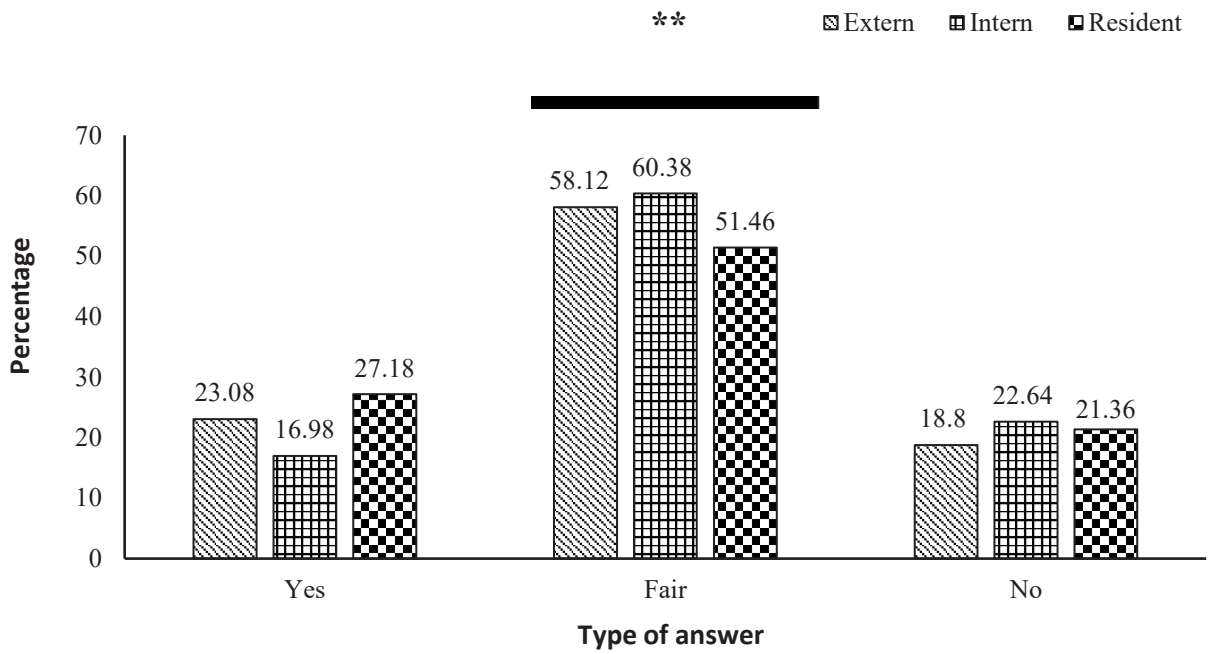

FIGURE 2. The response to the question: "Have knowledge loss of Physiology ever caused a problem in your clinical reasoning?" ***P*<0.01 significant increase versus "Yes"/"No." The data are expressed as mean. Externs and interns are medical students with indirect and direct exposure to real patients, respectively, while residents are medical doctors studying for specialization.

13.59% of residents (n=14) answered 'Much'

1.71% of externs (n=2), 1.89% of interns (n=1), and 1.94% of residents (n=2) answered "Very Much"

There is a significant difference among the answers (a little, fair, much, and very much) of externs, interns, and residents ($P<0.001$).

As shown in figure 2, to the question "Can physiology knowledge loss make a problem for your clinical reasoning?"

23.08% of externs (n=27), 16.98% of interns (n=9), and 27.18% of residents (n=28) answered "Yes"

58.12% of externs (n=68), 60.38% of interns (n=32), and 51.46% of residents (n=53) answered "Fair"

18.8% of externs (n=22), 22.64% of interns (n=12), and 21.36% of residents (n=22) answered "No".

The "Fair" answer was significantly higher than "Yes" and "No" answers among the externs, interns, and residents ($P<0.001$).

Discussion

In-depth education in medicine and meaningful approaches to training qualified medical professionals are vital for medical students to acquire the ability to deal with real practical scenarios and compete in the international environment (Li et al., 2015).

In this study, we aimed to assess the attitudes of medical students at three levels of education, including externs, interns, and residents (all clinically active trainees), regarding two major domains: 1) the amount of memory retention of physiology, and 2) its correlation with clinical reasoning ability.

Regarding the question about the amount of physiology knowledge retention, the percentage of students who stated they had a little/fair amount of physiology content in their memory was significantly higher than those who claimed to have much/very much physiology knowledge in their memory. Custers confirms these results, mentioning that in medical education, approximately two-thirds to three-fourths of knowledge will be retained after passing one year (Custers 2010). Physiology is among the topics that experience the least knowledge loss among basic sciences(Custers 2010). However, many students might lack confidence in their memory when a few years have passed since acquiring basic knowledge (Conway et al., 1991). Among the students who declared the retention "much" and "very much," the amount of retention was higher in residents compared to the interns and higher in interns compared to the externs (Although not statistically significant). This information aligns with our previous study on pharmacology knowl-

edge loss, indicating that longer-lasting clinical practice leads to better retention of basic knowledge (Zaeemzadeh et al., 2016).

The number of students who believed that physiology knowledge loss interferes with their clinical reasoning and practice was significantly higher than those who did not consider physiology knowledge loss a problem. This was predictable as physiology, following anatomy, is the most crucial discipline necessary for reliable clinical practice (Gupta et al., 2014). The current findings are consistent with Pangaro's result, which state that although the differential diagnosis of clinical problems can be memorized as part of illness facts, understanding pathophysiologic mechanisms of different diseases helps medical students remember the material much more easily afterward. The teacher has to guide the students to unify the surface features of illness (symptoms, signs, and laboratory findings) with underlying mechanisms (Pangaro 2010). The teacher's performance, pedagogical competence, intelligence, and self-efficacy will dramatically affect pupils' functioning and motivation to learn (Anggraeni 2014; Lumbantobing 2020). University professors need to simplify the pathophysiologic mechanisms of various diseases for students in a way that they fully comprehend the relevance between pathophysiology and the clinical features of an illness. Providing complicated clinical cases may distract students from grasping the essential mechanisms underneath (Pangaro 2010).

As seen, the majority of clinically active students experience both "physiology knowledge loss" and a "defect in clinical practice," confirming our theory about the relationship between these two factors. Therefore, an idea that can combine primary education with clinical practice can be invaluable. This is the same vertical integration that can promote medical education in AJUMS. As Woods suggests, basic science plays a central role in developing clinical expertise and provides a meaningful context for learning, enhancing the memory of clinical material, which will undoubtedly improve the diagnostic accuracy (Woods et al., 2006). In fact, the curriculum should meet the needs and desires of individual students, offering more flexibility and allowing for more interdisciplinary practice. Students entering specific sectors such as surgery, pediatrics, internal medicine, and gynecology should have the opportunity to review modules from related basic sciences like anatomy and physiology during clinical practice (Pangaro 2010).

Conclusion

Senior medical students at AJUMS, who have entered clinical practice, and residents, acknowledged that physiology is one of the essential syllabuses needed for better clinical performance among basic sciences. This issue serves as a powerful motivator for vertical integration at AJUMS, which combines the education of theoretical courses of internal medicine, physiology, and pharmacology with clinical courses of internal medicine all together. Although this vertical integration was supposed to follow horizontal integration in basic sciences, which has been in use for more than six years, it is currently halted due to institutional and technical barriers.

Acknowledgments

The authors express their gratitude to the Vice Chancellery of Research of Jundishapur University of Medical Sciences, Ahvaz, Iran, for providing financial support for this project. This paper is derived from the thesis work of Sanaz Taherpour, a medical student (Grant NO. U-94079).

Conflict of interest

The authors declare no financial or non-financial competing interests.

References

Abraham R R, Fisher M, Kamath A, Izzati T A, Nabila S, Atikah N N. Exploring first-year undergraduate medical students' self-directed learning readiness to physiology. Adv Physiol Educ 2011; 35: 393-5. https://doi.org/10.1152/advan.00011.2011

Abraham R R, Upadhya S, Torke S, Ramnarayan K. Clinically oriented physiology teaching: strategy for developing critical-thinking skills in undergraduate medical students. Adv Physiol Educ 2004; 28: 102-4. https://doi.org/10.1152/advan.00001.2004

Abraham R R, Vinod P, Kamath M G, Asha K, Ramnarayan K. Learning approaches of undergraduate medical students to physiology in a non-PBL- and partially PBL-oriented curriculum. Adv Physiol Educ 2008; 32: 35-7. https://doi.org/10.1152/advan.00063.2007

Abram S R, Hodnett B L, Summers R L, Coleman T G, Hester R L. Quantitative Circulatory Physiology: an integrative mathematical model of human physiology for medical ed-

ucation. Advances in Physiology Education 2007; 31: 202-210. https://doi.org/10.1152/advan.00114.2006

Adi A H, Alturkmani H J. Physiologically lucky: the role of medical physiology in modern medical education. Perspectives on medical education 2013; 2: 99-103. https://doi.org/10.1007/S40037-013-0044-5

Alaagib N A, Musa O A, Saeed A M. Comparison of the effectiveness of lectures based on problems and traditional lectures in physiology teaching in Sudan. BMC Med Educ 2019; 19: 365. https://doi.org/10.1186/s12909-019-1799-0

Anggraeni R D. Increasing lecturer competence as the quality assurance of lecturer performance. Management Studies 2014; 2: 309-329.

Augustine Egwu O, Dimkpa U, Ogbonnaya Orji J, Ogbannaya Njoku C, Ogbonnia Eni E, Besong E. Medical students - self-assessed confidence level before a major physiology examination: affective factors in a nigerian medical school. Acta Inform Med 2011; 19: 153-7. https://doi.org/10.5455/aim.2011.19.153-157

Conway M A, Cohen G, Stanhope N. On the very long-term retention of knowledge acquired through formal education: Twelve years of cognitive psychology. Journal of Experimental Psychology: General 1991; 120: 395. https://doi.org/10.1037/0096-3445.120.4.395

Custers E. Long-term retention of basic science knowledge: a review study. Adv Health Sci Educ Theory Pract 2010; 15: 109-128. https://doi.org/10.1007/s10459-008-9101-y

Gade S, Chari S. Case-based learning in endocrine physiology: an approach toward self-directed learning and the development of soft skills in medical students. Adv Physiol Educ 2013; 37: 356-60. https://doi.org/10.1152/advan.00076.2012

González H L, Palencia A P, Umaña L A, Galindo L, Villafrade M L A. Mediated learning experience and concept maps: a pedagogical tool for achieving meaningful learning in medical physiology students. Advances in physiology education 2008; 32: 312-316. https://doi.org/10.1152/advan.00021.2007

Gupta S, Gupta A K, Verma M, Kaur H, Kaur A, Singh K. The attitudes and perceptions of medical students towards basic science subjects during their clinical years: A cross-sectional survey. International Journal of Applied and Basic Medical Research 2014; 4: 16. https://doi.org/10.4103/2229-516X.125675

Li A S, Berger K I, Schwartz D R, Slater W R, Goldfarb D S. Facilitating the transition from physiology to hospital wards through an interdisciplinary case study of septic shock. BMC medical education 2014; 14: 1-8. https://doi.org/10.1186/1472-6920-14-78

Li Y-Y, Li K, Yao H, Xu X-J, Cai Q-L. Reform in teaching preclinical pathophysiology. Advances in physiology education 2015; 39: 254-258. https://doi.org/10.1152/advan.00165.2014

Lumbantobing P A. The contribution of lecturer pedagogical competence, intellectual intelligence and self-efficacy of student learning motivation. Budapest International Research and Critics in Linguistics and Education (BirLE) Journal 2020; 3: 564-573. https://doi.org/10.33258/birle.v3i1.852

Pai K M, Rao K R, Punja D, Kamath A. The effectiveness of self-directed learning (SDL) for teaching physiology to first-year medical students. Australas Med J 2014; 7: 448-53. https://doi.org/10.4066/AMJ.2014.2211

Pangaro L. The role and value of the basic sciences in medical education: The perspective of clinical education-students' progress from understanding to action. J Int Assoc Med Sci Educ 2010; 20: 307-13.

Rehan R, Ahmed K, Khan H, Rehman R. A way forward for teaching and learning of Physiology: Students' perception of the effectiveness of teaching methodologies. Pakistan journal of medical sciences 2016; 32: 1468. https://doi.org/10.12669/pjms.326.10120

Rezende-Filho F M, da Fonseca L J, Nunes-Souza V, Guedes Gda S, Rabelo L A. A student-centered approach for developing active learning: the construction of physical models as a teaching tool in medical physiology. BMC Med Educ 2014; 14: 189. https://doi.org/10.1186/1472-6920-14-189

Roy B, Goh N, Malik R H. Medical education system in Malaysia maintaining a gold standard - an extraordinary example from the Malaysian Society of Pharmacology and Physiology. Nepal J Epidemiol 2017; 7: 697-698. https://doi.org/10.3126/nje.v7i3.19008

Sathishkumar S, Thomas N, Tharion E, Neelakantan N, Vyas R. Attitude of medical students towards early clinical exposure in learning endocrine physiology. BMC Medical Education 2007; 7: 30. https://doi.org/10.1186/1472-6920-7-30

Stetzik L, Deeter A, Parker J, Yukech C. Puzzle-based versus traditional lecture: comparing the effects of pedagogy on academic performance in an undergraduate human anatomy and physiology II lab. BMC medical education 2015; 15: 107. https://doi.org/10.1186/s12909-015-0390-6

Tobin M J. Why physiology is critical to the practice of medicine: a 40-year personal perspective. Clinics in Chest Medicine 2019; 40: 243-257. https://doi.org/10.1016/j.

ccm.2019.02.012

Woods N N, Neville A J, Levinson A J, Howey E H, Oczkowski W J, Norman G R. The value of basic science in clinical diagnosis. Academic Medicine 2006; 81: S124-S127. https://doi.org/10.1097/00001888-200610001-00031

Zaeemzadeh N, Mard S, Khosravi M, Lajmirnia M, Sedighi A. Pharmacological knowledge loss among medical students in Ahvaz Jundishapur University of Medical sciences. South East Asian J Med Educ 2016; 10: 60. https://doi.org/10.4038/seajme.v10i2.29

Zaeemzadeh N, Taherpour S, Behzadian N, Mard S A. Evaluation of physiology knowledge loss in medical students of Ahvaz Jundishapur University of Medical Sciences. Adv Med Educ Pract 2019; 10: 157-162. https://doi.org/10.2147/AMEP.S189029