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Educational Article

Translation of learning objectives in medical education using high-and low-fidelity simulation: Learners' perspectives

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الملخص

أهداف البحث: يتقن طلاب الطب الإجراءات والمهارات من خلال عدد من العناصر، بما في ذلك القدرة على فهم الأهداف التعليمية لمهام محددة. تبحث هذه الدراسة في عمليات تحديد أهداف التعلم التي حددها طلاب الطب، وما إذا كان اختيار المحاكاة الدقيقة يؤثر على هذه القدرة في دورات المهارات السريرية الأساسية وطب المسنين بجامعة لوبلن الطبية.

طرق البحث: قام ما مجموعه ١٢١ من طلاب الطب بتقييم مدى تنفيذ هدف التعلم في دورتين مع محاكاة ذات دقة عالية ومنخفضة. باستخدام استطلاع عبر الإنترنت ذي أسئلة مغلقة، بعد إرسال قائمة بأهداف التعلم المخصصة للدورات التدريبية إلى المشاركين. قام الباحثون أيضا بتقييم كيفية تقييم الدورات بشكل عام من حيث قيمتها الموضوعية والتطبيق العام.

النتائج: وجدنا أن الطلاب حددوا أهدافا تعليمية مضمنة في الدورات التدريبية وقاموا بتقييم كلا الدورتين بشكل إيجابي. ارتبطت آراء المشاركين الإيجابية بالقيمة الموضوعية العالية لكلا الصفين.

الاستنتاجات: قد يستفيد المعلمون ومنشئو الدورات التدريبية من ملاحظات الطلاب حول وضوح أهداف التعلم، التي يمكن أن تعزز نهج التعلم المعتمد على الطالب في المحاكاة الطبية. يمكن اعتبار هذا النهج بمثابة مدخل لاختيار المهام لتحسين تعلم الطلاب.

الكلمات المفتاحية: محاكاة عالية الدقة؛ أهداف التعلم؛ محاكاة الدقة المنخفضة؛ التعليم الطبي؛ طلاب الطب

Abstract

Objectives: The mastering of learnt procedures by medical students is triggered by numerous elements, including the ability to understand educational goals for specific tasks. In this study, the authors investigated the processes for identifying learning objectives set forth by medical students and the possibility of the chosen simulation fidelity influencing this ability in Basic Clinical Skills and Elderly Medicine courses at the Medical University of Lublin.

Methods: A total of 121 medical students assessed the extent to which learning objectives were implemented in two courses with high- and low-fidelity simulation. Using an online survey with closed-ended questions, a list of learning objectives assigned to the courses was sent to participants. The authors evaluated how the courses were generally assessed in terms of their substantive value and general applicability. The Spearman rank correlation (Spearman's rho), $\chi 2$, and descriptive statistics were used for investigating research problems.

Results: Students correctly identified established learning objectives embedded in the courses and positively assessed both courses. Participants' affirmative opinions were related to the high substantive value of both courses.

Conclusions: Teachers and course creators could benefit from students' feedback about the clarity of learning objectives. The application of some of their ideas would promote a student-centred approach in medical simulation. This approach could be considered input for task selection and optimisation of learning.

Keywords: High-fidelity simulation; Learning objective; Low-fidelity simulation; Medical education; Undergraduate medical students

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Introduction

Medical simulation enables educators to enhance and invigorate the teaching-learning process by utilising the pillars of andragogy; shaping the motivation to learn is a key objective.[1] Intrinsic motivation is the driving force behind adult learning; it is essential for accessing a learner's intrinsic drive, with the right thought-provoking training aimed at stimulating one's mind. Simulation provides clinical anchoring, even for simple procedural skills. Simulation also supports student-centred curricula based on, in particular, students' needs and expectations.[2]

Simulation training is task-oriented and contextualised.[3] Knowles et al., pointed to becoming involved as a crucial expectation among adult learners. Simulation promotes small group teaching and involves participants in active learning through the performance of tasks.[1] Besides actively participating in simulation training, students can reflect on their performance through feedback.[4]

To enhance the characteristics of low- and high- fidelity simulation, we need to choose learning objectives (LOs) that enable the delivery of valuable training. Keating described simulation as implementing procedural knowledge in the form of algorithms, techniques, methods, and criteria for applicable medical problems. Therefore, training should focus on measurable LOs.[5] Additionally, the LOs of relevant training should be adjusted to participants' levels so as not to cause frustration or boredom.[6] The literature subdivides LOs into knowledge, skills (procedural or technical), and behaviours or teamwork. The combination of these three types of objectives constitutes a well-structured training programme.[7]

Choosing the modality should follow formulating LOs. High-fidelity simulation is appropriate in complex clinical cases and it enables teamwork, whereas low-fidelity simulation is advantageous for acquiring procedural and technical skills. Higher fidelity does not always equate to enriched learning; sometimes; it can result in overload or distraction.[8]

Purpose of the study

The intended LOs in the student-centred approach should be identifiable; therefore, in our study, we have analysed learners' perspectives on the translation of LOs through low- and high-fidelity simulation in undergraduate medical education.

Materials and Methods

General background of research

The study involved fourth-year medical students at the Medical University of Lublin (MUL) in the undergraduate medical programme (a six-year curriculum). Those surveyed were recruited from students participating in the Elderly Medicine course. The student sample consisted of 152 fourth-year medical students. Participants had previously completed the simulation-based course, Basic Clinical Skills, during their second year; this course is embedded in the formal curriculum. The modules in year 4 are built on the LOs from the year 2 module. Both courses use the medical simulation technique, Study participants were taught in the newly developed teaching facility, the Centre for Medical Simulation (CMS), at MUL.

The study was conducted in July 2018 using computer-assisted web interviewing (CAWI). The questionnaire was delivered electronically with Google tools.

Research sample

One hundred fifty-two medical students participated in two simulation-based courses: Basic Clinical Skills (BCS) for low-fidelity simulation and Elderly Medicine (EM) for high-fidelity simulation. These medical students were invited to join our study and share their perceptions concerning the clarity of intended LOs. Research was voluntary and anonymous. The post-course assessment was intended to ensure objectivity in their observations; students reflected on what they remembered after completing the courses.

Courses

Basic Clinical Skills (BCS) was a low-fidelity (LF) simulation course taught with task trainers (i.e. 15 teaching hours over a period of five weeks). Students took the course during the fourth semester of their studies. Each teaching block (or session) lasted for just over 2 h (135 min) and was held once per week. Five blocks were included based on the five procedures taught during the laboratories (Appendix 1). Seven tutors were included in the BCS teaching faculty—one per each group of five students during a teaching session.

Elderly Medicine (EM) was a high-fidelity (HF) course, taking place mostly in the simulation rooms of the CMS and mirroring required clinical environment characteristics (Emergency Room, Internal Diseases Department) with HF simulators or simulated patients. Further, EM included 30 teaching hours of training spread over 10 sessions (135 min per session) held once per week. Seven tutors were part of the EM teaching faculty—one per each group of five students for a simulation scenario session.

One session was an introductory seminar held at the beginning of the course, and one was a communications workshop related to diagnostics and the treatment of elderly patients (Appendix 2). The remaining eight sessions implemented HF scenarios. Medical students commenced training during the seventh semester of their studies.

Appendix 2 LOs of the EM course including the original numbers taken from the bill regulating the content of medical studies following the Bologna regulation (EHEA).[9]

Instrument and procedures

The survey administered in this study consisted of an opinion questionnaire with 14 closed-ended questions and a tool assessing the socio-demographic status of the respondents (four questions). Three educationalists, two Doctors of Medicine, and a biostatistician, as experts in the field, reviewed the survey for its relevance and validity. The reliability of the instrument expressed as the alpha coefficient was 0.88, demonstrating adequate reliability.

After completing BCS and EM, participants received a questionnaire containing a list of LOs. The characteristics of BCS had four primary LOs assigned to them; EM had eight. Participants who completed both courses were to assess the degree to which LOs were completed for the BCS and EM courses using a five-point Likert scale. The scale was as follows: 5 *Strongly agree*, 4 *Agree*, 3 *Neither agree nor disagree*, 2 *Disagree*, 1 *Strongly disagree*. Lower scores would indicate the lack of implementation concerning previously assigned educational goals. The LOs were based on current regulations regarding medical education in Poland.[10]

As the last part of the study, participants could provide their general opinions of both courses (EM and BCS) and their substantive value for a future profession, also using a five-point Likert scale. In summary, the questionnaire included 14 questions with 12 LOs to be assessed by the surveyed medical students described in Appendix 1 and Appendix 2 and two questions for course assessment.

The questionnaire included a separate sheet (online screen) prepared for the respondents' socio-demographic data. The open-ended questions included socio-demographic characteristics of the participants, such as gender, year of study, age, and place of residence.

Data analysis

The computer software Statistica version 10 was used for database and statistical analyses. The authors have presented results as percentages and numbers. P-values < 0.05 were considered significant. The Shapiro—Wilk test assessed conformity with a normal distribution. The χ^2 test was used to analyse the relationships between the examined qualitative variables. The Spearman rank correlation (Spearman's rho) was helpful in an investigation of the relationships between usefulness (substantive content) and the general assessment of the labs.

Results

Participants' characteristics

Of the 152 questionnaires distributed, 121 were collected; of those, 96 (63%) were fully complete. The link to the questionnaire was sent to students via their university email accounts. Participants had four days to complete the survey. A reminder was also sent to the students concerning the questionnaire and extending the time to complete it by four more days.

Table 1: Respondents' assessments of the Basic Clinical Skills (BCS) course.

Assessment of a course	Gender				Age				Place of residence			
	Male		Female		20—23		24 and more		Urban areas		Rural areas	
	n	%	n	%	n	%	n	%	n	%	n	%
Low assessment BCS	6	6	4	4	4	4	6	6	8	8	2	2
Average BCS	2	2	0	0	0	0	2	2	2	2	0	0
High assessment BCS	38	40	46	48	26	27	58	61	68	71	16	17
Total	46	48	50	52	30	31	66	69	78	81	18	19
χ2	3.00				1.27				0.48			
df	2				2				2			
p	0.223				0.530				0.788			

*p < 0.05; χ2- chi2 test; p — a level of significance χ2; df- the degrees of freedom.
Division: 1—2 - Low assessment, 3 - Average, 4—5 - High assessment.

Table 2: Respondents' assessments of the Elderly Medicine (EM) course.

Assessment of a course	Gender				Age				Place of residence			
	Male		Female		20—23		24 and more		Urban areas		Rural areas	
	n	%	n	%	n	%	n	%	n	%	n	%
Low assessment EM	8	8	2	2	6	6	4	4	10	10	0	0
Average (EM)	2	2	8	8	0	0	10	11	8	8	2	2
High assessment EM	36	38	40	42	24	25	52	54	60	63	16	17
Total	46	48	50	52	30	31	66	69	78	81	18	19
χ2	7.26				8.40				2.58			
df	2				2				2			
p	**0.027***				**0.015***				0.275			

*p < 0.05; χ2- chi2 test; p — a level of significance χ2; df- the degrees of freedom.
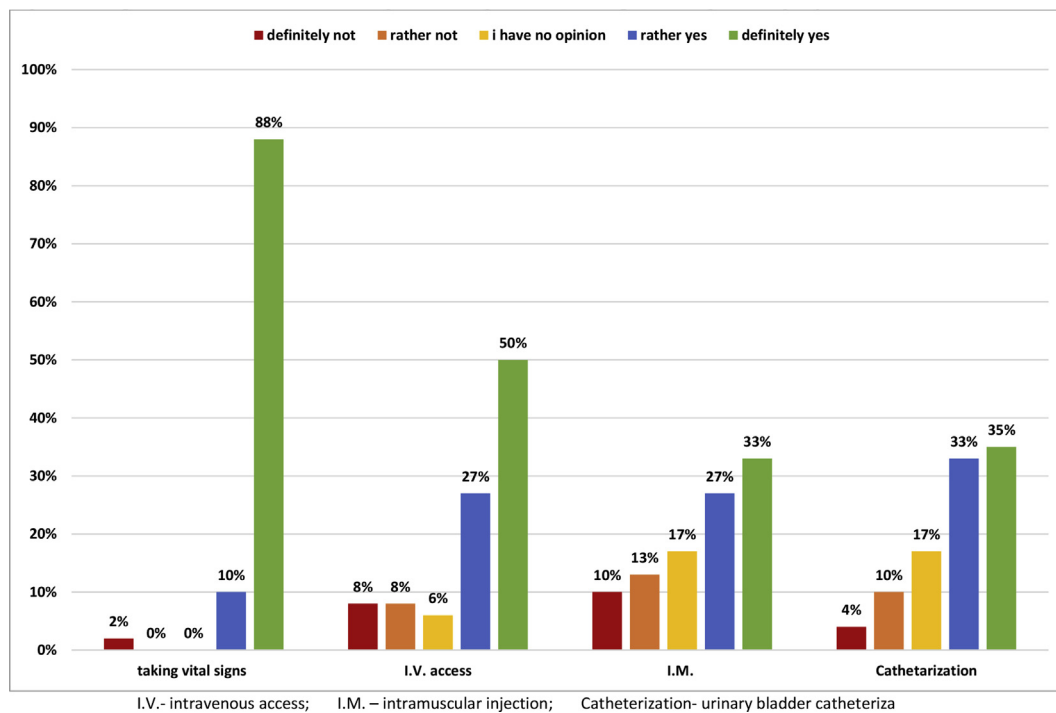Division: 1—2 - Low assessment, 3 - Average, 4—5 - High assessment.
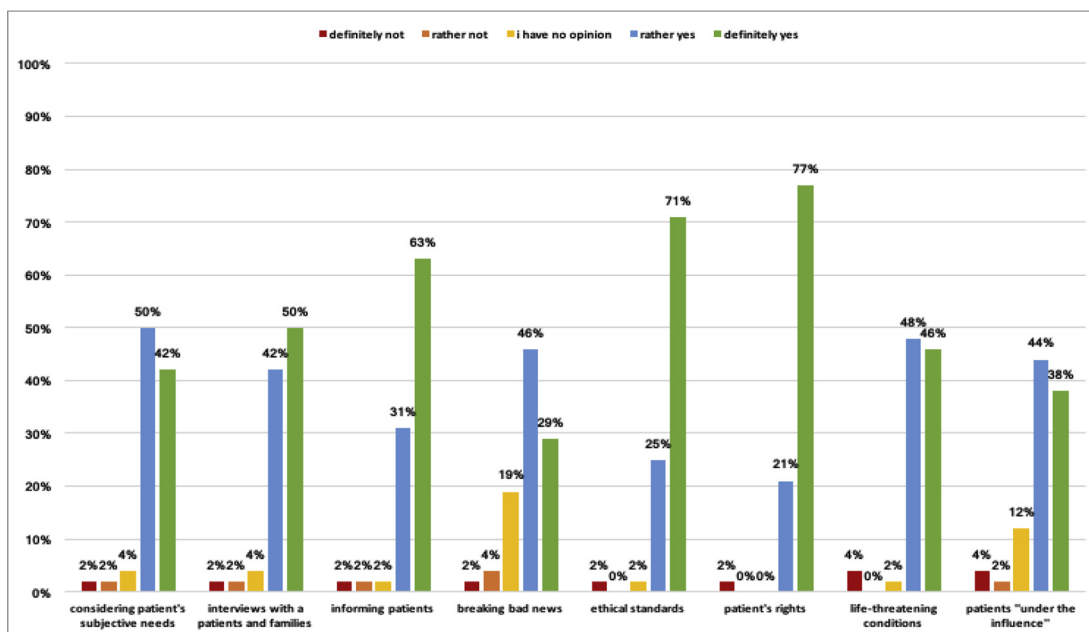
Figure 1: Respondents' levels of understanding concerning the degree of implementation of learning objectives (LOs) for the Elderly Medicine (EM) course.

From the analysis of these 96 questionnaires, it was found that most participants were males (n = 50); further, 81% were fourth-year students living in urban areas. Tables 1 and 2 present the comparison of socio-demographic traits based on responses to the questionnaire and low, average, and high course assessments for both courses.

Learning objectives assessment

Learning objectives (LOs) were shortened and combined for the statistical analysis. According to the results of the survey, participants' opinions concerning achievement levels for the provided LOs were high in the case of both HF and

Figure 2: Respondents' levels of understanding concerning the degree of implementation of learning objectives (LOs) for the Basic Clinical Skills (BCS) course.

LF courses. Four out of eight LOs received a majority of 5s (on the Likert scale 1−5) from participants taking the EM course (Figure 1). The LO, 'considering a patient's subjective needs', received the most 4s on the Likert scale (50%). Comparably, the LO 'dealing with an elderly patient "under the influence" of alcohol or other substances' obtained mostly 4s (44%), a few 3s (12%), and 2s (4%). Just a few 1s and 2s appeared for all LOs provided, with their levels oscillating between 0 and 4% (see Figure 1).

With regard to BCS LOs, the majority earned 5s from the respondents. However, opinions varied noticeably with regard to urinary bladder catheterisation and intramuscular injection procedures. Furthermore, we were struck by responses regarding the peripheral vein cannulation procedure: 8% were scores of 1 (Figure 2). Table 2 presents the data.

Course assessments

The gender of participants and the EM LO 'patients' subjective needs and expectations' (p = 0.000) were positively correlated. Similarly, the gender of those surveyed positively influenced the assessment concerning the urinary bladder catheterisation procedure (p = 0.010) in the LF course.

The general evaluation positively correlated with the gender and age of respondents in the EM course (Table 2). The data confirmed the lack of a relationship between BCS assessments and participants' socio-demographic characteristics (Appendix 2).

The recognisable and substantive content of the provided LO influenced evaluations of BCS and EM courses. Regarding the HF course, the Spearman rank R statistic was 0.810, suggesting a strong correlation between the usefulness of the knowledge taught and the course assessment. The LF course was characterised by the Spearman rank correlation 0.668, suggesting a high correlation.

Discussion

The educational LO assessment provided a view on participants' understanding of the purpose of the laboratories in both types of simulation training, HF and LF. Gandomkar and Sandars and Gandomkar et al. referred to it as students' metacognitive self-monitoring, ensuring that students are aware of the intended learning outcomes and their level of mastering those outcomes at the end of the course (leading to self-regulated learning).[11,12] Self-regulated learning empowers clinical judgment and prepares students for future clinical practice.[12,13] Alwahab et al. confirmed the value of clinical reasoning in medical curricula in their research.[14]

Perceptions of study participants were highly congruent with intended LOs for both EM and BCS courses. Collected data confirmed that the students noticed and attended to prominent educational goals in both courses. Furthermore, the data confirmed that this finding was associated with students' expectations regarding the intended LOs (substantive content influencing a positive perception of the course). The finding is similar to that of Lyons−Warren et al. in their research, whereby they proposed introducing the means for students to voice intended learning goals and describe that which could influence their satisfaction with the training provided.[15] Moreover, Larsen et al. elaborated about the prerequisite for successful collaborations between teachers and students: both of them must engage with the intended learning goals.[16]

Simulations have been described as valuable in terms of their educational impact. Nevertheless, the educational outcomes of HF and LF simulations remain debateable.[17] In our research, we also addressed the impact of a chosen fidelity on students' understanding of intended learning outcomes and course assessments as an important factor for increasing our knowledge in this area. The procedural skills in BCS and clinical scenarios in EM seemed to be challenging and at a level appropriate for our sample of medical students, as they touched upon all enumerated LOs.[18,19]

Our classes were implemented according to research by Beaubien and Baker, as the authors strongly recommended avoidance of by students of premature expositions regarding HF during the 'earliest stages of skill acquisition'.[21] Our results confirmed the legitimacy of this approach, as second-year students identified LOs of the LF course, whereas after two more years of further education they were ready to tackle HF training and identify its purpose (EM).[22]

Research by Adams et al. supported the belief that HF was of no significant benefit to the newer student; they even concluded that HF simulation was redundant for new students.[23] We were directed by a similar belief when implementing LF simulation for second-year students. Munshi et al.[17] have presented a similar view, emphasising that novice students can transfer skills at a high level when using a simple simulator. At more advanced levels, simulation reality mirrors complex tasks at higher speeds.[24] Correspondingly, our second-year students acquired procedural skills taught with LF simulation, whereas fourth-year students encountered HF simulation. Both of these modalities provided apparent LOs uncovered by participants in laboratory activities. Therefore, each fidelity is best utilised only when aligned with educational goals (LOs) which emphasise its use within a programme.

Novice students have only freshly entered the medical world; therefore, pace and non-technical skills are limited within their training.[17,21,25] More non-technical skills are acquired with further educational training.[26] This order of teaching modalities is compatible with the Recommendations for Clinical Skills Curricula for Undergraduate Medical Education by the Association of American Medical Colleges.[26]

Interestingly, LF simulation has been proven to surpass traditional classroom didactics in the teaching of medical procedures.[27] Numerous research studies have provided evidence for the usefulness of LF simulation in teaching procedural skills, including laparoscopic procedures,[28,29] lumbar puncture,[30] vascular surgery,[31] suturing,[33] basic clinical skills,[23,24] and emergency procedures.[37] Therefore, our choice of the modality used accedes to sound evidence.

A similar body of evidence applies to teaching complex tasks and non-technical skills with HF simulation.[38] Both modalities of the simulation method were successful in achieving an intended LO from the students' perspective. Educating students on 'learning objectives' may lead to

shaping their expectations and attitudes towards the learning process and inspiring a willingness to contribute to it.

Limitations

The sample of participants recruited for our research included students at MUL in Poland; they might differ from medical students at other educational institutions in respect to their curriculum programme and their simulation experience. Additionally, the focus of this study was students' understanding of LOs embedded in two courses included in the medical curriculum, so it could also be beneficial to conduct a survey concerning other major courses in order to develop greater knowledge on the topic transfer of learning objectives. Furthermore, the degree of understanding and experience among students in the use of simulation technology might have been investigated with other more objective measures, such as assessment outcomes.

Conclusions

Overall, these medical students uncovered LOs embedded in both courses. On the whole, respondents were positive regarding the substantial value of the training in both simulation modalities. Value could be increased, however, by providing more feedback in terms of students' outcomes concerning the intended LOs.

The use of patient LF and HF simulation in medical education is an exciting and valuable method, which appears to benefit students as a preparation for 'real-life' settings, as well as for reinforcing the established LOs in medical curricula.

Recommendations

We should continue research on the reception of LOs throughout the medical curriculum to amplify student-centredness of implemented courses. Such research should address the diverse learning needs, interests, and aspirations of individual learners, as well as groups of learners, and we should implement objective measures as assessment outcomes.

Source of funding

Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

Ethical approval was obtained from the institutional review board before collecting data. A signed consent form was obtained from each participant before he/she completed the questionnaire.

Authors contributions

KN was responsible for conceptualisation, methodology, formal analysis, investigation, and writing the original manuscript draft. KT was responsible for conceptualisation, supervision, and resources. KT and KN were responsible for data interpretation, literature review. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jtumed.2019.10.006.

References

1. Knowles MS, Malcolm S, Holton EF, Swanson RA. The adult learner: the definitive classic in adult education and human resource development. Routledge 2014; vol. 387: 402.
2. Shanks D, Wong RY, Roberts JM, Nair P, Ma IW. Use of simulator-based medical procedural curriculum: the learner's perspectives. BMC Med Educ 2010 Dec 8; 10(1): 77.
3. Kim JG, Kim W, Kang GH, Jang YS, Choi HY, Kim H, et al. Pre-hospital i-gel blind intubation for trauma: a simulation study. Clin Exp Emerg Med 2018 Mar 30; 5(1): 29−34.
4. Jones RW. Learning and teaching in small groups: characteristics, benefits, problems and approaches. Anaesth Intensive Care 2007 Aug 22; 35(4): 587−592.
5. Keating SB. The classic components of the curriculum: developing a curriculum plan. In: Keating SB, DeBoor S, editors. Curriculum development and evaluation in nursing education. Fourth. New York, NY: Springer Publishing Company; 2019. pp. 150−158.
6. Khan K, Pattison T, Sherwood M. Simulation in medical education. Med Teach 2011 Jan 23; 33(1): 1−3.
7. Chatterjee D, Corral J. How to write well-defined learning objectives. J Educ Perioper Med JEPM 2017; 19(4): E610.
8. Haji FA, Cheung JJH, Woods N, Regehr G, de Ribaupierre S, Dubrowski A. Thrive or overload? The effect of task complexity on novices' simulation-based learning. Med Educ 2016 Sep; 50(9): 955−968.
9. European higher education area and Bologna process [internet]; 1999 [cited 2019 Jul 30]. Available from: http://ehea.info/page-how-does-the-bologna-process-work.
10. Department of Health. The Bill of Polish Health Ministry on education standards in case of medical students. [Rozporządzenie Ministra Nauki i Szkolnictwa Wyższego z dnia 9 maja 2012 r. w sprawie standardów kształcenia dla kierunków studiów: lekarskiego, lekarsko-dentystycznego, farmacji, pielęgniarstwa i położnictwa] [Internet]. Bill; 2012 [cited 2019 Jul 30]. p. 89. Available from: http://prawo.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20120000631.
11. Gandomkar R, Sandars J. Unravelling the challenge of using student learning goals in clinical education. Med Educ 2017 Jul 1; 51(7): 676−677.
12. Gandomkar R, Mirzazadeh A, Jalili M, Yazdani K, Fata L, Sandars J. Self-regulated learning processes of medical students during an academic learning task. Med Educ 2016 Oct 1; 50(10): 1065−1074.
13. Lasater K. High-fidelity simulation and the development of clinical judgment: students' experiences. J Nurs Educ 2007; 46(6): 269.
14. Alwahab A, Abdulqader S, Nugud A, Nugud S, Cyprian F, Shaikh AA, et al. Team-based learning in an undergraduate

pathology curriculum and its effects on student performance. **J Taibah Univ Med Sci 2018**; 13(5): 496.

15. Lyons-Warren AM, Kirby JP, Larsen DP. Student views on the role of self-regulated learning in a surgery clerkship. **J Surg Res 2016 Dec**; 206(2): 273−279.

16. Larsen DP, Wesevich A, Lichtenfeld J, Artino AR, Brydges R, Varpio L. Tying knots: an activity theory analysis of student learning goals in clinical education. **Med Educ 2017 Jul 1**; 51(7): 687−698.

17. Munshi F, Lababidi H, Alyousef S. Low- versus high-fidelity simulations in teaching and assessing clinical skills. **J Taibah Univ Med Sci 2015 Mar 1**; 10(1): 12−15.

18. Dieckmann P, Gaba D, Rall M. Deepening the theoretical foundations of patient simulation as social practice. **Simul Healthc J Soc Simul Healthc 2007**; 2(3): 183−193.

19. Schaumberg A, Schröder T, Sander M. Emergency medical training through simulation : always the same for everyone? [Notfallmedizinische Ausbildung durch Simulation] **Anaesthesist 2017 Mar 20**; 66(3): 189−194.

21. Beaubien JM, Baker DP. The use of simulation for training teamwork skills in health care: how low can you go? **Qual Saf Health Care 2004 Oct**; 13(Suppl 1): i51−i56.

22. Sarmah P, Voss J, Ho A, Veneziano D, Somani B. Low vs. high fidelity. **Curr Opin Urol 2017 Jul**; 27(4): 316−322.

23. Adams AJ, Wasson EA, Admire JR, Pablo Gomez P, Babayeuski RA, Sako EY, et al. A comparison of teaching modalities and fidelity of simulation levels in teaching resuscitation scenarios. **J Surg Educ 2015 Sep**; 72(5): 778−785.

24. Maran NJ, Glavin RJ. Low- to high-fidelity simulation - a continuum of medical education? **Med Educ 2003 Nov**; 37(Suppl 1): 22−28.

25. Mills BW, Carter OB-J, Rudd CJ, Claxton LA, Ross NP, Strobel NA. Effects of low- versus high-fidelity simulations on the cognitive burden and performance of entry-level paramedicine students. **Simul Healthc J Soc Simul Healthc 2016 Feb**; 11(1): 10−18.

26. Aamc. Recommendations For Clinical Skills Curricula For Undergraduate Medical Education Recommendations for Preclerkship Clinical Skills Education for Undergraduate Medical Education Task Force on the Clinical Skills Education of Medical Students. https://store.aamc.org/downloadable/download/sample/sample_id/174/.

27. McGaghie WC, Issenberg SB, Cohen ER, Barsuk JH, Wayne DB. Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. **Acad Med 2011 Jun**; 86(6): 706−711.

28. Pugh D, Hamstra SJ, Wood TJ, Humphrey-Murto S, Touchie C, Yudkowsky R, et al. A procedural skills OSCE: assessing technical and non-technical skills of internal medicine residents. **Adv Health Sci Educ 2015 Mar 14**; 20(1): 85−100.

29. Kurashima Y, Feldman LS, Kaneva PA, Fried GM, Bergman S, Demyttenaere SV, et al. Simulation-based training improves the operative performance of totally extraperitoneal (TEP) laparoscopic inguinal hernia repair: a prospective randomized controlled trial. **Surg Endosc 2014 Mar 23**; 28(3): 783−788.

30. Mayne W, Jootun D, Young B, Marland G, Harris M, Lyttle CP. Enabling students to develop confidence in basic clinical skills. **Nurs Times 2004**; 100(24): 36−39.

31. Lee JT, Qiu M, Teshome M, Raghavan SS, Tedesco MM, Dalman RL. The utility of endovascular simulation to improve technical performance and stimulate continued interest of preclinical medical students in vascular surgery. **J Surg Educ 2009 Nov**; 66(6): 367−373.

33. Heskin L, Mansour E, Lane B, Kavanagh D, Dicker P, Ryan D, et al. The impact of a surgical boot camp on early acquisition of technical and nontechnical skills by novice surgical trainees. **Am J Surg 2015 Sep**; 210(3): 570−577.

37. Remes V, Sinisaari I, Harjula A, Helenius I. Emergency procedure skills of graduating medical doctors. **Med Teach 2003 Jan 3**; 25(2): 149−154.

38. Flynn FM, Sandaker K, Ballangrud R. Aiming for excellence − a simulation-based study on adapting and testing an instrument for developing non-technical skills in Norwegian student nurse anaesthetists. **Nurse Educ Pract 2017 Jan**; 22: 37−46.