KRZYSZTOF NESTEROWICZ

(UNIWERSYTET JAGIELLOŃSKI)

RESEARCH ON THE EFFECTIVENESS OF TRANSFERRING SKILLS WITH THE USE OF E-LEARNING IN THE PRECISION OF BLOOD PRESSURE MEASUREMENT CONDUCTED BY PHARMACISTS

INTRODUCTION

Internet technologies have fundamentally altered the technological and economic landscapes so radically that it is now possible to make quantum leaps in the use of technology for learning. Yet there is also a danger. If we focus too much on the technology itself and not enough on how well it is used, we will continue to fall short. But if we neglect the power of the Internet, we will never get off the ground. In the end, successful Internet-enabled learning, or „e-learning", depends on building a strategy that optimizes the technology within an organizational culture that is ready and willing to use it.[1]

E-learning systems have become important tools in the process of continuing education of pharmacists and other healthcare specialists. In Poland the continuing education of graduated pharmacists is obligatory in order to keep their professional license valid.[2] Nowadays more than 70% of Polish professionally active pharmacists take part in courses carried out with the use of e-learning platforms. There are five available and independent from each other online systems offering such courses:

---

[1] M. J. Rosenberg, *E-learning: Strategies for Delivering Knowledge in the Digital Age*, McGraw-Hill Professional 2001, s. 16–17.

[2] J. Brandys, A. Mendyk et al., *An e-Learning System for Pharmacist Continuing Education, Pharmacy Education*, March 2006, 6 (1), s. 65–70.

- e-duk@cja as a common project of the Local Pharmaceutical Chamber and Faculty of Pharmacy Jagiellonian University Medical College in Krakow,
- farmacja.edu.pl created by educators from the Faculty of Pharmacy Warsaw Medical University,
- e-umed.lodz.pl provided by Medical University in Lodz,
- Platform of Modern Education of Polish Pharmaceutical Society,
- e-farmacja.net which is the social e-learning portal for pharmacists and pharmacy technicians run by Local Pharmaceutical Chamber in Krakow.

E-duk@cja is the largest system dedicated to pharmacy continuing education.[3] It was launched in February 2005. The aim of the e-duk@cja project is to develop a distance learning system for the life-long educational needs of pharmacists.[4] For today e-duk@cja has more than 14,000 active users, about 20 courses, nearly 60 credits to gain, ca. 600 independent users' visits daily and above 2 million hits of the website per year.[5]

The increasing popularity of e-learning as the way of continuing education requires investigation and evaluation of the quality and efficacy of this method of education. In the below study we focused on the transfer of skills with the use of distance learning methods.

Blood pressure measurement is the basis for the diagnosis, management, treatment, epidemiology and research of hypertension, and the decisions affecting these aspects of hypertension will be influenced, for better or worse, by the accuracy of measurement.[6]

THE AIM OF THE STUDY

No matter which measurement device is used, blood pressure will always be a variable haemodynamic phenomenon that is influenced by many factors, which include the circumstances of measurement itself, emotion, exercise, meals, tobacco, alcohol, temperature, respiration, bladder distension and pain; blood pressure is also influenced by age, race and diurnal variation, usually being lowest during sleep.[7] It is not always possible to modify these factors but we can

---

[3] e-dukacja.pl [homepage on the Internet], © e-dukacja.pl 2004–2012 centrum farmaceutycznych szkoleń online. Available at: http://www.e-dukacja.pl/ [11.10.2012].

[4] A. Mendyk, M. Polak et al., *System e-duk@cja wczoraj, dziś i jutro*, „Aptekarz Polski" January 2009, no. 29/7, s. 7–9.

[5] K. Nesterowicz, A. Mendyk et al., *E-Learning in Continuing Pharmaceutical Education in Poland*, „Bio-Algorithms and Med–Systems" Vol. 7, No. 13, 2011, s. 11–15.

[6] E. O'Brien et al., *Practice Guidelines of the European Society of Hypertension for Clinic, Ambulatory and Self Blood Pressure Measurement*, „Journal of Hypertension" 2005, 23, s. 697–701.

[7] Ibidem.

minimise their effect by taking them into account in reaching a decision as to the relevance or otherwise of a particular blood pressure measurement.[8] One needs to acquire special skills in order to measure blood pressure properly.

The aim of the study was to compare the effectiveness of an e-course to a stationary course provided for pharmacists based on the transfer of skills related to the proper measurement of blood pressure by mechanical sphygmomanometer with aneroid manometer and stethoscope.

METHODS

The course "Right Monitoring of Blood Pressure for Pharmacists" was provided as an e-learning course for pharmacy students and pharmacists from the investigated group and as a stationary course for attendees from the control group.

The investigated group consisted of pharmacy students and pharmacists trained by e-learning course provided on the platform VBoard and the control group consisted of pharmacy students and pharmacists taught in a stationary way. The participation in the research was voluntary and assignment to both groups was randomized. The access to the investigated group was open for pharmacy students and pharmacists registered on the e-learning platform VBoard. The stationary and e-learning course took place in February 2009. Participants from the control group were trained how to measure blood pressure by physician. There was a lecture prepared for attendees from the investigated and control group and 8 minutes-long schooling movie. Participants from both groups needed to pass the preliminary test. There were 10 questions in the test and one needed to answer correct on at least 6, which was 60% of positive answers, to be included in the course and research.[9]

There were 5 pharmacy students and pharmacists in the investigated group and 6 pharmacy students and pharmacists in the control one who completed the course and measurements. Women were the majority in the investigated group: 4 women out of 5 attendees (80%) and in the control one 3 women out of 6 participants (50%).
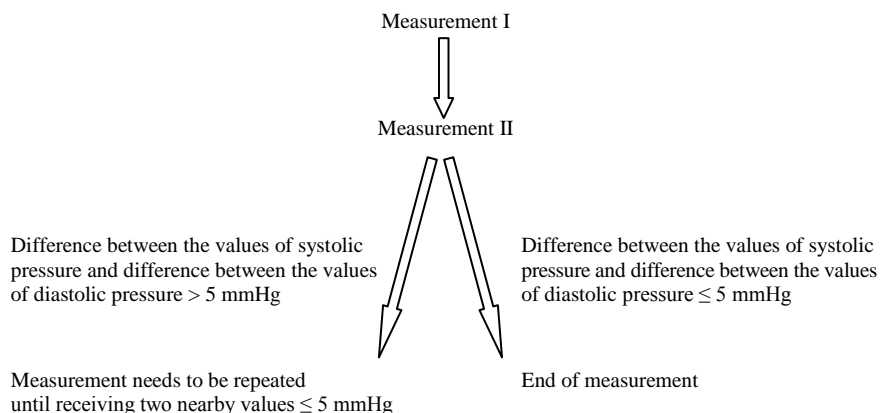
The material of both courses was the same in principles and the difference lied in the communication channel. Each participant who completed the course successfully worked later with one patient who was coming each Tuesday and Thursday in the period of four weeks to check his/her blood pressure. Each measurement was done twice at one meeting and the difference between the values of systolic pressure by two measurements following one after another could not be higher than 5 mmHg, otherwise the measurement needed to be

---

[8] E. O'Brien, J. Petrie et al, *Blood Pressure Measurement: Recommendations of the British Hypertension Society*, 3rd ed., British Medical Journal Publishing Group, London 1997.

[9] VBoard [homepage on the Internet], VBoard Copyright © 2004–2012. Available at: http://papaver.farmacja.cm-uj.krakow.pl/vboard/ [11.10.2012].

repeated until the difference between two of them was lower or equal 5 mmHg. The same condition was kept also for the diastolic pressure (Fig. 1). This allowed to monitor the precision of measurements done by attendees from both groups and compare it to each other. The results of measurements were written down in the special form which was prepared in advance.

Figure 1. The procedure of right measurement of blood pressure

Measurement I

Measurement II

Difference between the values of systolic pressure and difference between the values of diastolic pressure > 5 mmHg

Difference between the values of systolic pressure and difference between the values of diastolic pressure ≤ 5 mmHg

Measurement needs to be repeated until receiving two nearby values ≤ 5 mmHg

End of measurement

Reference: author's.

All attendees were supposed to follow guidelines of the European Society of Hypertension for clinic, ambulatory and self blood pressure measurement described below:[10]

Attitude of observer

Before taking the blood pressure, the observer should be in a comfortable and relaxed position, and should not rush the procedure, otherwise the cuff may be deflated too rapidly, resulting in underestimation of systolic and overestimation of diastolic pressures.

Attitude of patient

Patients should be encouraged to relax and be advised that neither they nor the observer should talk to each other for the few minutes before and during the blood pressure measurement.

---

[10] E. O'Brien et al., *Practice Guidelines…*, op. cit., s. 697–701.

Posture of subject

Blood pressure should be measured with the individual sitting with back support, legs uncrossed and the arm supported at heart level.

The cuff and bladder

If a blood pressure measuring device is dependent on cuff occlusion of the arm, it will be prone to the inaccuracy induced by miscuffing, whereby a cuff contains a bladder that is either too long or too short relative to arm circumference (Table 1). A review of the literature on the century-old controversy relating to the error that may be introduced to blood pressure measurement by using a cuff with a bladder of inappropriate dimensions for the arm for which it is intended has shown that miscuffing is a serious source of error.[11]

Table 1. Recommended bladder dimensions for adults

British Hypertension Society	
Standard cuff	Bladder 12 × 26 cm for the majority of adult arms
Large cuff	Bladder 12 × 40 cm for obese arms
Small cuff	Bladder 12 × 18 cm for lean adult arms and children
American Heart Association	
Small adult cuff	Bladder 10 × 24 cm for arm circumference 22–26 cm
Adult cuff	Bladder 13 × 30 cm for arm circumference 27–34 cm
Large adult cuff	Bladder 16 × 38 cm for arm circumference 35–44 cm
Adult thigh cuff	Bladder 20 × 42 cm for arm circumference 45–52 cm

Reference: E. O'Brien et al., *Practice Guidelines of the European Society of Hypertension for Clinic, Ambulatory and Self Blood Pressure Measurement*, "Journal of Hypertension" 2005, 23, s. 697–701.

---

[11] Idem, *A Century of Confusion: Which Bladder for Accurate Blood Pressure Measurement?*, "Journal of Human Hypertension" 1996, 10, s. 565–572.

Observer error

Observer error, which can greatly affect the accuracy of measurement, may be the result of systematic error, terminal digit preference or observer prejudice or bias.

Aneroid sphygmomanometers

The aneroid manometer is not generally accurate. An inflation/deflation system, an occluding bladder encased in a cuff, and auscultation using a stethoscope are features common to this device, any of which may introduce error. Aneroid sphygmomanometers register pressure through a bellows and lever system, which may become inaccurate with everyday use, usually leading to false low readings.[12]

Performing auscultatory measurement:[13]

- The observer should ensure that the manometer is no more than 1 metre away so that the scale can be read easily, that the bladder dimensions are accurate, and that, if the bladder does not completely encircle the arm, its centre is over the brachial artery.
- The stethoscope should be placed gently over the brachial artery at the point of maximal pulsation; the cuff should then be inflated rapidly to about 30 mmHg above the palpated systolic pressure and deflated at a rate of 2–3 mmHg per second.
- Systolic blood pressure is the first appearance of faint, repetitive, clear tapping sounds that gradually increase in intensity.
- Diastolic blood pressure is at the point of disappearance of sounds or the first mmHg value at which the sounds are no longer audible (phase V); when sounds persist down to zero, muffling of sounds (phase IV) should be recorded for diastolic pressure.

RESULTS

11 pharmacy students and pharmacists from both groups passed the preliminary online test on the platform VBoard[14] with the score of at least 60% correct answers, took part in the course and completed the measurement phase.

---

[12] Idem, *Practice Guidelines…*, op. cit., s. 697–701.

[13] Ibidem.

[14] VBoard [homepage on the Internet], VBoard Copyright © 2004–2012. Available at: http://papaver.farmacja.cm-uj.krakow.pl/vboard/ [11.10.2012].

Investigated group

Each from 5 pharmacy students and pharmacists did the measurement of blood pressure following the instructions presented at the course before for his/her assigned patient. The measurement needed to be repeated 6 times in the group because the nearby values of systolic pressure or nearby values of diastolic pressure were bigger than 5 mmHg (see Fig. 1).

Control group

Also here the conditions were the same like for the investigated group. There were 6 pharmacy students and pharmacists. The measurement needed to be repeated 7 times because of the difference between nearby values of systolic or diastolic pressure bigger than 5 mmHg.

Altogether in both groups took place 233 measurements during the period of four weeks. The difference in the precision of measurement between both groups was analyzed by t-Student Test.[15] The computer programme Statistica provided by Statsoft© was used for analysis of results.[16]

The received p-value is 0.9376 and is higher from the chosen statistical significance level 0.05. Therefore we cannot exclude the hypothesis H_0. Basing on chosen probes and chosen statistical significance level the difference in the precision of the measurement between both groups was not observed.[17]

CONCLUSION

There was not statistically significant difference in precision of blood pressure measurement between the investigated and control group. The purpose of both courses was to transfer and check skills related to the proper measurement of blood pressure with the auscultatory device. Participants schooled by e-learning and stationary course showed the same level of preparation in measuring blood pressure of their patients.

DISCUSSION

With few exceptions, hundreds of media comparison studies have shown no differences in learning (Clark, 1994; Dillon, Gabbard, 1998). A metaanalysis by Bernard et al. (2004) integrating research studies that compared learning from

---

[15] J. O'Connor, J. Robertson et al., *Student's t-Test, MacTutor History of Mathematics Archive*, University of St Andrews. [Online]. Available at: http://www-history.mcs.st-andrews.ac.uk/Biographies/Gosset.html [11.10.2012].

[16] Statsoft® [homepage on the Internet], © Statsoft Polska 1995–2012. Available at: http://www.statsoft.pl/ [11.10.2012].

[17] M. Sobczyk, *Statystyka. Podstawy teoretyczne, przykłady – zadania*, UMCS, May 1998.

electronic distance education to learning from traditional classroom instruction indicates no practical differences in learning between face-to-face and electronic distance learning. A review of online learning by Tallent-Runnels, Thomas, Lan, Cooper, Ahern, Shaw and Liu (2006) concurs:[18] "Overwhelming evidence has shown that learning in an online environment can be as effective as that in traditional classrooms. Second, students' learning in the online environment is affected by the quality of online instruction. Not surprisingly, students in well-designed and well-implemented online courses learned significantly more and more effectively than those in online courses where teaching and learning activities were not carefully planned and where the delivery and accessibility were impeded by technology problems."

Two reviews have investigated learning styles with special focus on health science education. Romanelli stresses the lack of a conceptual framework for both learning style theory and measurement and conclude that faculty members should make concentrated efforts to teach in a multi style fashion.[19] Cook concludes that further research in web-based learning could clarify the feasibility and effectiveness of assessing and adapting to learning.[20] Others have criticized the use of learning styles as predictors of learning preferences with the argument that there are more important factors involved in the learning process. Some work has been done since Cooks review was published, but there are only a few papers relevant for medical web-based education.[21]

The main finding of this study is the proof of comparable effectiveness in transferring skills by e-learning and stationary methods. It was verified with the focus on precision of measurements in both groups for the period of four weeks.

---

[18] C. Ruth Clark, E. Richard Mayer, *e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*, John Wiley & Sons, 2011, s. 20.

[19] F. Romanelli, E. Bird, M. Ryan, *Learning styles: a review of theory, application, and best practices*, "American Journal of Pharmacy Education", February 2009, 19, 73 (1), s. 9.

[20] D. A. Cook, *Learning and cognitive styles in web-based learning: theory, evidence, and application*, "Academic Medicine: Journal of the Association of American Medical Colleges" March 2005, 80 (3), s. 266–278.

[21] D. A. Cook, W.G. Thompson, K.G. Thomas, M.R. Thomas, *Lack of interaction between sensing-intuitive learning styles and problem-first versus information-first instruction: a randomized crossover trial*, "Advances in Health Sciences Education: Theory and Practice" March 2009, 14 (1), s. 79–90, epub 2007 Nov 24; D. A. Cook, W. G. Thompson, K. G. Thomas, M. R. Thomas, V. S. Pankratz, *Impact of self-assessment questions and learning styles in Web-based learning: a randomized, controlled, crossover trial*, "Academic Medicine: Journal of the Association of American Medical Colleges" March 2006, 81 (3), s. 231–238; J. A. McNulty, B. Espiritu, M. Halsey, M. Mendez, *Personality preference influences medical student use of specific computer-aided instruction (CAI)*, "BMC Medical Education" 2006, 6, s. 7; T. Brown et al., *Are learning style preferences of health science students predictive of their attitudes towards e-learning?*, "Australasian Journal of Educational Technology" 2009, 25 (4), s. 524–543.

It was proven statistically that there were not significant differences between the investigated and control group.

The study is innovative in the way that it focuses on evaluating the effectiveness of e-learning in transferring skills. In the available literature there are many evidences of studies conducted on pharmacy continuing education related with the transfer of knowledge and only a few focused on transferring skills and later verifying obtained ones by participants. Therefore there is the need to conduct further researches on that matter.

Among some studies there is one focused on transferring skills by e-learning. The research was conducted in 2007 at the Capella University by Janet C. Craig where the efficacy of e-learning course in providing chosen skills was proved as successful.[22]

Traditionally, all the training classes have been taught in a face-to-face classroom. Within recent years, most organizations have acquired informational technology for business purposes. Now, the question arises, will the use of this technology for training effectively and efficiently enable employees to transfer the skills they are taught to the workplace?[23]

Larger for-profit industries, especially those with a multi-national workforce that have moved their orientation and new hire training online seem to have been successful. Some have established in-house e-learning universities to deliver a large portion of their training. Well known companies such as The Home Depot, BMW of North America, The Hartford, and Black and Decker Corporation have very successfully implemented e-learning and regard it as a change initiative that has the potential to impact business results.[24]

ABSTRACT

E-learning is widespread among pharmacists who take part in the continuing education courses. The fast development of e-learning platforms which provide educational courses has been noted. There is a need of standardization and validation of distance learning courses, especially as they have started to be recognized and accredited by continuing pharmacy education centres, pharmaceutical societies, chambers or other institutions which supervise the continuing education process.

The study is focused on exploring the transfer of skills related to the proper measurement of blood pressure by mechanical sphygmomanometer with aneroid manometer and stethoscope. The transfer of skills takes place in the research by two learning methods: e-learning and stationary course. Their effectiveness is compared to each other.

---

[22] J. C. Craig, E^2*: Efficient and Effective e-Learning*, A Dissertation Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy, Capella University, October 2007.
[23] Ibidem.
[24] Ibidem.

The received p-value from the analysis of the precision of measurement in both groups is 0.9376. It is higher from the established statistical significance level 0.05. Therefore the hypothesis H_0 is not excluded. The verified hypothesis H_0 assumes that the difference between analyzed parameters from both samples is null:[25]

$$H_0 : \Theta_1 = \Theta_2$$

There is not observed any difference in precision of measuring blood pressure between both groups with established statistical significance level 0.05. E-learning shows to be an effective tool not only in transferring knowledge but also in obtaining special skills needed for pharmacists in their daily work.

STRESZCZENIE

E-learning jest szeroko rozpowszechniony wśród farmaceutów, którzy biorą udział w szkoleniach ciągłych. Zauważalny jest szybki rozwój platform e-learningowych, które oferują kursy edukacyjne. Zachodzi potrzeba standaryzacji i walidacji kursów nauczania zdalnego, szczególnie od kiedy zaczęły być uznawane i akredytowane przed centra edukacji farmaceutycznej, towarzystwa farmaceutyczne, izby i inne instytucje, które nadzorują proces szkoleń ciągłych.

Badanie jest skoncentrowane na ocenie przekazywania umiejętności związanych z właściwym pomiarem ciśnienia krwi przez ciśnieniomierz mechaniczny z powietrznym mankietem i stetoskopem. Przekazywanie wiedzy zachodzi w badaniu dwoma metodami nauczania: w ramach e-learningu i kursu stacjonarnego. Efektywność tych metod jest porównywana ze sobą.

Otrzymana wartość p z analizy precyzji pomiaru w obu grupach wynosi 0,9376. Jest to wyższa wartość od przyjętego poziomu istotności statystycznej równego 0,05. Nie obserwuje się różnicy w precyzji pomiaru ciśnienia krwi między obiema grupami przy przyjętej wartości poziomu istotności statystycznej 0,05. Nie ma powodu do odrzucenia hipotezy H_0. Weryfikowana hipoteza H_0 zakłada, że różnica między analizowanymi parametrami z obu prób wynosi zero:[26]

$$H_0 : \Theta_1 = \Theta_2$$

E-learning okazuje się skutecznym narzędziem nie tylko do przekazywania wiedzy, ale również do uzyskiwania specjalnych umiejętności przez farmaceutów w ich codziennej pracy.

REFERENCES

1   Zieliński R., *Siedem wykładów wprowadzających do statystyki matematycznej*, Warszawa 2004. [Online]. Available at: http://www.impan.gov.pl/~rziel/7ALL.pdf [07.12.2012].
2   Rosenberg M. J., *E-learning: Strategies for Delivering Knowledge in the Digital Age*, McGraw-Hill Professional, 2001, s. 16–17.

---

[25] R. Zieliński, *Siedem wykładów wprowadzających do statystyki matematycznej*, Warszawa 2004. [Online]. Available at: http://www.impan.gov.pl/~rziel/7ALL.pdf [07.12.2012].
[26] Ibidem.

3   Brandys J., Mendyk A. et al., *An e-Learning System for Pharmacist Continuing Education in Poland, Pharmacy Education*, March 2006, 6 (1), s. 65–70.

4   e-dukacja.pl [homepage on the Internet], © e-dukacja.pl 2004–2012 centrum farmaceutycznych szkoleń on-line. Available from: http://www.e-dukacja.pl/ [11.10.2012].

5   Mendyk A., Polak M. et al., *System e-duk@cja wczoraj, dziś i jutro*, „Aptekarz Polski" January 2009, no. 29/7, s. 7–9.

6   Nesterowicz K., Mendyk A. et al., *E-Learning in Continuing Pharmaceutical Education in Poland*, "Bio-Algorithms and Med–Systems" Vol. 7, No. 13, 2011, s. 11–15.

7   O'Brien E. et al., *Practice Guidelines of the European Society of Hypertension for Clinic, Ambulatory and Self Blood Pressure Measurement*, "Journal of Hypertension" 2005, 23, s. 697–701.

8   O'Brien E., Petrie J. et al, *Blood Pressure Measurement: Recommendations of the British Hypertension Society*, 3rd ed., British Medical Journal Publishing Group, London 1997.

9   VBoard [homepage on the Internet], VBoard Copyright © 2004–2012. Available at: http://papaver.farmacja.cm-uj.krakow.pl/vboard/ [11.10.2012].

10 O'Brien E., *A Century of Confusion: Which Bladder for Accurate Blood Pressure Measurement?*, "Journal of Human Hypertension" 1996, 10, s. 565–572.

11 O'Connor J., Robertson J. et al., *Student's t-Test, MacTutor History of Mathematics Archive*, University of St Andrews. [Online]. Available at: http://www-history.mcs.st-andrews.ac.uk/Biographies/Gosset.html [11.10.2012].

12 Statsoft® [homepage on the Internet], © Statsoft Polska 1995–2012. Available from: http://www.statsoft.pl/ [11.10.2012].

13 Sobczyk M., *Statystyka. Podstawy teoretyczne, przykłady – zadania*, UMCS, May 1998.

14 Clark C. Ruth, Mayer E. Richard, *e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*, John Wiley & Sons, 2011, s. 20.

15 Romanelli F., Bird E., Ryan M., *Learning styles: a review of theory, application, and best practices*, "American Journal of Pharmacy Education", February 2009, 19, 73 (1), s. 9.

16 Cook D. A., *Learning and cognitive styles in web-based learning: theory, evidence, and application*, "Academic Medicine: Journal of the Association of American Medical Colleges" March 2005, 80 (3), s. 266–278.

17 Cook D. A., Thompson W.G., Thomas K.G., Thomas M.R., *Lack of interaction between sensing-intuitive learning styles and problem-first versus information-first instruction: a randomized crossover trial*, "Advances in Health Sciences Education: Theory and Practice" March 2009, 14 (1), s. 79–90, epub 2007 Nov 24.

18 Cook D. A., Thompson W. G., Thomas K. G., Thomas M. R., Pankratz V. S., *Impact of self-assessment questions and learning styles in Web-based learning: a randomized, controlled, crossover trial*, "Academic Medicine: Journal of the Association of American Medical Colleges" March 2006, 81 (3), s. 231–238.

19 McNulty J. A., Espiritu B., Halsey M., Mendez M., *Personality preference influences medical student use of specific computer-aided instruction (CAI)*, "BMC Medical Education" 2006, 6, s. 7.

20 Brown T. et al., *Are learning style preferences of health science students predictive of their attitudes towards e-learning?*, "Australasian Journal of Educational Technology" 2009, 25 (4), s. 524–543.

21 Craig J.C., *E^2: Efficient and Effective e-Learning*, A Dissertation Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy, Capella University, October 2007.