Res Dev Med Educ, 2021, 10, 10
doi: 10.34172/rdme.2021.010
https://rdme.tbzmed.ac.ir

Original Research

Active Learning and Competency Preconditioning Strengthen Osteopathic Medical Student Performance, Physician Attributes, and Competency Assessments

Vivek R Joshi[1*], Michael J Younger[1], Bhargavi Joshi[2]

[1]Department of Biomedical Sciences Kentucky College of Osteopathic Medicine Pikeville, KY. USA
[2]Department of Basic Sciences LAU University, USA

Article info

Article History:
Received: 28 Apr. 2021
Accepted: 26 May 2021
epublished: 3 July 2021

Keywords:
Active learning
Competency-based curriculum
Team-based learning
Competencies
Professionalism
Medical knowledge
Osteopathic principles & practices

Abstract

Background: Medical education has been reliant on didactic lectures, which are predominantly teacher-centered learning. Competency-based education was introduced in North America and with this came a paradigm shift in how schools conceptualize curricula and measure learning outcomes. This modern approach started a change away from traditional lecture-based and teacher-centered curricula to a more student-centric approach using various tools. Competency-based education is widely regarded as an outcome-based approach to design, implement and evaluate the curriculum using widely accepted competencies. Authorities recommend seven core competencies which have various indicators to address student performance. The main purpose of this research is to utilize active learning tools to enhance this approach and then assess competencies in the first year of medical school to improve academic outcomes as well as exposing students to competency domains on which they will be assessed and to ultimately create a complete physician.

Methods: The study was conducted at a medical school during the first semester of medical school and included 145 students. Various active learning tools, such as modified case-based learning, quizzes, and case discussions, were used to assess competency in a biochemistry and genetics course, and these were compared to questions based on concepts delivered by the traditional lecture method.

Results: Student performance on high-stakes examinations after active learning sessions on content and concepts had statistically higher average percentages on the second, third and fourth examinations. The average Diff (p) for the second, third, and fourth examination to the questions being considered for the study were (Diff p= 0.84, 0.83, and 0.92) with a positive moderate correlation for the second examination (r= 0.535) and strong positive correlation for the third and fourth examination (r=0.745 and r=0.856) for their final biochemistry grades.

Conclusion: The study shows some positive and significant results that active learning methods are a useful and meaningful way to deliver a curriculum for a competency-based education system, and may be better suited than traditional lectures for providing content and assessing competencies which are necessary to become a complete physician.

Introduction

Lecture-based curricula continue to be largely utilized in medical education around the world. However, with the paradigm shifts in medical education and advancements in information technology, we have been obliged to modify the way we deliver medical education to current generations of students, including millennials and Generation Z[1]. Historically, medical education has been oriented toward didactic lectures which are predominantly teacher-centered learning. Many scholars believe that this strategy has limited scope for critical thinking and promotes passive learning while encouraging adult students to rely on preexisting knowledge to build more information. Based on Edgar Dale's "Cone of Learning" model, which incorporates several theories related to instructional design and learning processes, one can conceptualize how people learn and retain knowledge[2]. With information from this model and empirical data from various articles, research shows that after two weeks most students tend to recollect only ten percent of what they read or heard in comparison to approximately ninety percent of what they are involved in doing[3]. This is the basis of "experiential

***Corresponding author:** Vivek R Joshi, Email: vivekjoshi@upike.edu

learning" or "active learning"[4]. Active learning mostly encompasses a variety of educational methods intended to facilitate student involvement in the learning process in comparison to the lecture-based approach to medical education[5,6]. Many researchers have used various types of innovative teaching and learning methods to promote active learning environments and to obtain feedback regarding curricular content and improvement[7].

Active learning methods such as problem-based learning, audience response system, and social media usage (podcasting, Twitter, and Facebook) have been shown to improve student participation and attention, increase classroom attendance, reinforce key concepts and content, and become a medium for communication between student and teacher. This in turn improves instruction and enhances learning performance and retention of the presented material[8,9,10]. Many subject-specific curricula remain focused and dedicated to delivering content detail with less importance placed on the development of student competence and confidence in their field of study. Essentially, this overburdens students with factual, dis-integrated knowledge that is compartmentalized, and lacks holistic intellectual relevance which in turn inhibits acceptance by the present generations of students. This does not help students become confident and self-reliant in situations they may encounter later in training or as a physician, thus rendering them less effective[11]. This discord between how information is provided and how information and knowledge are utilized has led to further modification and modernization of approaches utilized for content delivery and outcome assessment. To overcome these deficiencies, educators and leaders worked collaboratively and collectively to identify an effective, innovative approach, which we now know as competency-based medical education.

The competency-based medical education was introduced in North America at the start of the 21st century, and with this came a shift in how schools conceptualize their curricula and measure learning outcomes. Competency-based education is widely regarded as an outcome-based approach to designing, implementing and evaluating a curriculum using widely accepted competencies. One widely accepted competency framework in medical education is provided by the ACGME Outcomes project. In 2007, the American Association of Colleges of Osteopathic Medicine (AACOM) created a workgroup to look at core competencies for osteopathic medical students [11]. The primary focus of this workgroup was to help osteopathic medical schools define and integrate the osteopathic core competencies into their curriculums. The main idea behind this workgroup was to create a set of performance indicators that would be common to all students studying osteopathic medicine, although schools were also allowed to develop additional performance indicators depending on their mission or focus. AACOM recommends seven core competencies within which are various indicators that address student performance[12]. The seven AACOM core competencies are Osteopathic Principles and Practices, Medical Knowledge, Patient Care, Interpersonal and Communication Skills, Professionalism, Practice-Based Learning, and Improvement and Systems-Based Practice. If these competencies are practiced properly, they ensure the achievement of professional competency and not merely recall of medical information and retention of knowledge [12,13].

Much research is being conducted on the importance of attaining core competencies and achieving milestones for a curriculum to be deemed successful in every way. Modern-day medical education is now viewed as a curriculum driven by an outcome-based approach to design, implement, assess, and evaluate using an organized framework of competencies and milestones [14].

Various methods are at the disposal of educators to not only help train competent physicians but also improve outcomes in high-stakes examinations, which include but are not limited to flipped classrooms, gamification, podcasting, Twitter, Facebook, problem-based or case-based learning, and integrated modular curricula [15, 16,17]. Therefore, these tools, both in class and on social media (out of class), need to be used creatively and effectively to improve student participation and their academic outcomes.

The main purpose of this current study is to examine different active learning tools and their effect on enhancing and assessing the AACOM core competencies in a biochemistry and genetics course during the first year of medical school. This should ultimately lead to a better academic outcome and will help create a knowledgeable physician who satisfies all the competencies as required by the medical school and the licensure authority [18,19]. The main focus of this study is to ascertain how core osteopathic competencies such as medical knowledge, professionalism, practice-based learning and improvement, and interpersonal and communication skills can be assessed and utilized in basic sciences courses such as biochemistry, which will encourage and motivate faculty and educational department in various schools to include competency assessment in the initial formative years of a medical student[20,21]. This study may also provide a basis for using active learning tools to enhance curriculum based on observation, and medical content management in real time and with efficiency.

Materials and Methods

Participants

This study was carried out at the Kentucky College of Osteopathic Medicine, Pikeville, Kentucky, during the Fall {YEAR} term with first-year medical students, when students participate in biochemistry & genetics, gross anatomy, histology, and cell biology, osteopathic patient care, and osteopathic manipulative medicine courses. This study included all first-year students enrolled in

the Fall term. There were no exclusion criteria as every student admitted into the osteopathic medical school is part of this observational and analytical study. Class population demographics were acceptably diverse, with approximately 30% of the students from the Kentucky and the rest of the students from 28 other states in the United States. Every student was expected to attend lecture classes and active learning sessions, which were offered in form of team-based cased discussions, formative quizzes, and take-home quizzes.

Study Protocol:

The students were given access to Canvas, a university-wide learning management system that provides access to online lecture materials, accessory reading resources, and lecture capture videos. This study used used a team-based learning (TBL) module, quizzes, and case discussions. For the sessions, the students were advised to come prepared and all the relevant content and information were made available on Canvas. For active learning sessions, the students were randomly assigned to groups by assigning every student a number and then running these numbers through web-based software to divide them into random groups. Every student was notified of their group number in advance. On the day of the sessions, before the team-based session, the students participated in an individual readiness assessment test (*iRAT)* and then participated as a team to answer the same questions as part of the team readiness assessment test (*tRAT)*. The students were asked to select one member to act as the group leader and group liaison (to moderate the discussions), one member to act as a scribe (to make notes for references), and one member to act as peer grader (to grade the team members on their participation, communication, respect towards other members and preparation for sessions). A grading rubric was provided to the grader and the faculty observer. The duties for participants based on their roles were specified to all students in advance. There were four sessions in all, and every group contained 10-12 students who rotated roles during different sessions as well as a faculty observer. These sessions were used to assess professionalism, medical knowledge, practice-based learning and improvement, and interpersonal and communication skills. It was the responsibility of the members with specific roles to encourage and involve the other members in their group and to help assess the group members fairly. The students were expected to participate in a small group setting, collaborate with their colleagues, and learn in a self-directed session which was facilitated by the faculty member and the student leader of the group. The students were provided with the objectives for the sessions and were responsible to come prepared for the sessions. Resources at their disposal included textbooks, journal articles, and web-based information. The first active learning session was used to create an overview and path to go forward over the semester. During this session, the students first answered a set of cases individually and then as a team. During the group discussions, students were encouraged to provide evidence for the solution or answers for the cases. Answers chosen and marked by the group were expected to be accepted by everyone based on scientific reasoning and not through guessing.

The main objective of the first session was to analyze and observe the importance of these sessions in the long-term retention of the core concepts learned and their significance in the assessment of the content. The students' participation and involvement were measured using an internally developed assessment form for small group sessions and it was the responsibility of the grader to be fair and honest during this assessment. This form was also compared with the faculty observer's assessment to ensure fairness of grading.

Four of AACOM's Osteopathic Core Competencies were used for the assessment: Medical knowledge, Professionalism, Interpersonal and communication skills, and Practice-based learning and improvement. These four competencies were the focus of assessment during this study. Student participation, preparation for the session, behavior towards colleagues and session, communication with others, involvement, and demeanor during discussions were all used to assess these competencies.

Following the sessions, students were then reassessed on the core concepts addressed in the active learning module during their high-stakes examinations. The students at our medical college take four high-stakes examinations each semester following a four- or five-week period of learning medical concepts and content. The assessment for medical knowledge competency was conducted by asking multiple-choice questions based on the concept addressed in the active learning sessions and tagging these questions for outcome measurement.

Results

All 145 students enrolled in the biochemistry class were osteopathic medical students. The students were evenly divided by sex, with 51% being females and 49% being males (Table 1). The age of the learner group ranged from 20 to 40 years, and all had a similar educational background and GPA close to the mean GPA for the class upon entering the school. No exclusions weremade while performing the tasks or during the analysis of the results of the study.

In all, 40 cases were used for this study. The cases were developed by the faculty with certain concepts horizontally integrated with other subjects taught in Fall semester for the active learning module. These were grouped into six broad categories based on general concepts addressed

Table 1. Student population demographics

Sex	Count	Percent
Male	70	48
Female	75	52

in the didactic lectures: general biochemistry, synthetic and degradative metabolism, nutritional biochemistry, disorders, biotechnology, and genetics. The concepts which were assessed during the active learning were then reassessed during the block examinations in the form of clinical vignettes and tagged with the competencies to be assessed and analyzed following the examinations.

The statistics for the study were compiled at the end of the academic year and analyzed for any significance according to Pearson's correlation using SPSS data analysis software. This method was utilized to assess the impact of using the modified TBL technique on students' acquisition and retention of medical knowledge and then to measure the outcome based on their performance in the high-stakes examinations. This method was used to address the competency domain involving medical knowledge. Typically, students take four high-stakes examinations in a semester. For this research, the concepts delivered through the active learning method were embedded into the examinations and those questions were monitored for their performance. Every examination had approximately seven to eight questions from the core concepts and objectives addressed during the TBL session. Other competencies such as professionalism, communication and interpersonal skills, and practice-based learning and improvement were assessed during the active learning sessions. As described earlier, the scribe from the group was given the task of assessing the students for their participation, involvement, communication skills, and professionalism.

The results of the study correlated well with the hypothesis of the study and the desired outcome. Student performance on the high-stakes examinations after the active learning session on the content and concepts had a statistically higher average percent point in the second, third and fourth examinations. The average discrimination index for the questions which were tagged to the medical knowledge competency (tagged questions) was Diff (p) as 0.75 with a weak positive correlation (r=0.390) for their final grades in the biochemistry course. The results of the analysis after the first session were better; the average Diff (p) for the second, third, and fourth examination to the questions being considered for the study were (Diff (p)= 0.84, 0.83, and 0.92) with a positive moderate correlation for the second examination (r= 0.535) and strong positive correlations for third and fourth examinations (r=0.745 and r=0.856) with their final biochemistry grades (Table 2). The statistical analysis of the student performance in various assessment sessions correlated well with their final grades in biochemistry (r=0.844).

The mean average discrimination indices for all other questions (untagged questions) on the respective examinations were comparable to those of the questions being considered for assessing the competency. The Diff (p) for the rest of the questions in the various examinations was 0.794, 0.780, 0.813, and 0.867, respectively (Table 3).

The outcomes of the other competencies during the active learning session were all satisfactory. The professional competency assessed by their presence and participation during the session had an average of 100%.

The domain involving interpersonal and communication skills had a mean average of 78% (Diff (p)= 0.78) and the practice-based learning and improvement domain had a mean average of 81% (Diff (p)=0.81). Both values are in the satisfactory range.

Discussion

This article reports on the study performed to assess the utilization of ACGME competencies in the first year of osteopathic medical students in a biochemistry course. In general, competencies are assessed during the clerkship or clinical years but are seldom assessed in basic sciences courses. During the active learning sessions, the students were completely engaged in the task at hand, discussed different challenges, and arrived at their conclusions after a thorough debate. Medical students tend to be competitive, but this activity fostered group relationships. The results of this study indicate that the active learning sessions have a favorable effect on students' academic outcomes. There was a clear indication that this method improved academic outcomes for certain concepts and along the way helped foster an important competency domain, medical knowledge. Though the results showed positive outcomes for knowledge acquired through active learning sessions, these results were not drastically different from knowledge acquired through conventional learning and teaching methods. One reason for similar results obtained by two different methods of learning may

Table 2. Mean percentages for student group for medical knowledge competency

Examination	Diff(p) Competency tagged	"r" value	Diff(p) Untagged question
Block I	0.75	0.390	0.794
Block II	0.84	0.535	0.780
Block III	0.83	0.745	0.813
Block IV	0.92	0.856	0.867

Competency tagged: questions tested based on concepts delivered using active learning sessions. Untagged: questions tested based on concepts delivered using conventional delivery (lecture).

Table 3. Results for professionalism, interpersonal skills and communication, practice-based learning and improvement domains

Competency domain	Diff(p)
Professionalism	1.0
Interpersonal skills and communication	0.78
Practice-based learning and improvement	0.81

The domain involving interpersonal and communication skills had a mean average of 78% (Diff (p)= 0.78) and the practice-based learning and improvement domain had a mean average of 81% (Diff (p)=0.81). Both values are in the satisfactory range.

be explained by different methods of learning on the part of the learner group or differences in strategies used for learning. However, the analysis of other determinants in the competency domain was favorable based on the participation and assessment by facilitators and group scribe.

To discuss the study further, one aspect must be kept in mind if a college intends to use the competency assessment through active learning sessions in a traditional curriculum: it is vital to have designated and reserved times for these active learning sessions. These sessions can be used to facilitate the required competency development. It must be acknowledged that these sessions are extremely effective in low-participating and shy learners' gain in the necessary confidence and platform to channel and put forth their opinion in a collegial and open environment [20, 21]. The earlier the students are exposed to such sessions, the better. In the medical curriculum, knowledge plays an integral role in expertise development. Based on the data, we found no negative impact of utilizing active learning sessions in the acquisition of medical knowledge. It is expected that students who participated in these active learning sessions may be better prepared in clinical practice due to early exposure and assessment of different competency domains [22,23].

Another aspect of utilizing active learning sessions was to expose students to other competency domains on which they will eventually be assessed, such as professionalism, interpersonal and communication skills, and practice-based learning and improvement during their pre-clerkship and clinical years. However, with the changes in curricula and basic science courses following a more clinical approach, it is also a positive indicator to use the various assessment domains in medical biochemistry courses.

Conclusion

To conclude, this study indicates that active learning methods are a useful way to deliver curriculum for a competency-based education system, and some positive and significant data have emerged which support the use of these active learning methods in providing and assessing most of the competencies, although perhaps not all of them. Further study is indicated to see how such a student learner cohort performs on the assessed competency domains during the clinical years in medical school.

Ethical approval

This study is exempt from IRB ethical committee approval.

Competing interest

There was no conflict of interest for this research.

Authors' contributions

Idea/Concept: The idea from the article was developed by Vivek R Joshi, Design: The design for the study was developed by Michael Younger, Data Collection/Processing: Vivek R Joshi was involved with collecting the data and processing it. Analysis/Interpretation: The data were analyzed and interpreted by Michael Younger, Literature Review: The articles and literature required for article were written by Bhargavi Joshi, Drafting/Writing: The article was drafted by Vivek R Joshi, Critical Review: The critical and language editing was performed by Michael Younger & Bhargavi Joshi

Acknowledgments

None declared by the authors.

Financial Disclosure

None declared by the authors.

References

1. Turner-McGrievy GM, Campbell MK, Tate DF, Truesdale KP, Bowling JM, Crosby L. Pounds off digitally study: a randomized podcasting weight-loss intervention. Am J Prev Med. 2009;37(4):263-9. doi: 10.1016/j.amepre.2009.06.010.
2. Wingfield SS, Black GS. Active versus passive course designs: the impact on student outcomes. J Educ Bus. 2005;81(2):119-23. doi: 10.3200/joeb.81.2.119-128.
3. Diamond RM. Designing and Improving Courses and Curricula in Higher Education. San Francisco: Jossey-Bass; 2008. p. 487.
4. Dale E. Audio-Visual Methods in Teaching. 3rd ed. New York: Dryden Press; 1969. p. 108.
5. Shutty MS, DeGood DE. Patient knowledge and beliefs about pain and its treatment. Rehabil Psychol. 1990;35(1):43-54. doi: 10.1037/h0079049.
6. Gottlieb BS. Predicting outcome in pain programs: a matter of cognition. Paper presented at: the American Psychological Association Annual Convention; 1986; Washington, DC.
7. Latessa R, Mouw D. Use of an audience response system to augment interactive learning. Fam Med. 2005;37(1):12-4.
8. Hinde K, Hunt A. Using the personal response systems to enhance student learning: Some evidence from teaching economics. In: Banks DA, ed. Audience Response Systems in Higher Education: Applications and Cases. Hershey, PA: IGI Global; 2006. p. 140-54. doi: 10.4018/978-1-59140-947-2.ch010.
9. Caldwell JE. Clickers in the large classroom: current research and best-practice tips. CBE Life Sci Educ. 2007;6(1):9-20. doi: 10.1187/cbe.06-12-0205.
10. Harden RM. The integration ladder: a tool for curriculum planning and evaluation. Med Educ. 2000;34(7):551-7. doi: 10.1046/j.1365-2923.2000.00697.x.
11. National Board of Osteopathic Medical Examiners (NBOME). Fundamental Osteopathic Medical Competencies: Guidelines for Osteopathic Medical Licensure and the Practice of Osteopathic Medicine. NBOME; 2009.
12. Frank JR. The CanMEDS 2005 physician competency framework. Better Standards. Better Physicians. Better Care. Ottawa: The Royal College of Physicians and Surgeons of Canada; 2005.
13. Accreditation Council for Graduate Medical Education (ACGME). Outcome Project. Chicago: ACGME; 2009.

14. Frank JR, Snell LS, Cate OT, Holmboe ES, Carraccio C, Swing SR, et al. Competency-based medical education: theory to practice. Med Teach. 2010;32(8):638-45. doi: 10.3109/0142159x.2010.501190.
15. Das S, Joshi VR, Alsalhanie KM, Nauhria S, Khan S, Surender V. Impact of formative assessment on the outcome of summative assessment – a feedback based cross sectional study conducted among basic science medical students enrolled in MD program. Asian J Med Sci. 2017;8(4):38-43. doi: 10.3126/ajms.v8i4.17161.
16. Rose SH, Long TR, Elliott BA, Brown MJ. A historical perspective on resident evaluation, the Accreditation Council for Graduate Medical Education Outcome Project and Accreditation Council for Graduate Medical Education duty hour requirement. Anesth Analg. 2009;109(1):190-3. doi: 10.1213/ane.0b013e3181a1653b.
17. Smith SR. AMEE guide No. 14: outcome-based education: part 2-planning, implementing and evaluating a competency-based curriculum. Med Teach. 1999;21(1):15-22. doi: 10.1080/01421599979978.
18. Lee AG. The new competencies and their impact on resident training in ophthalmology. Surv Ophthalmol. 2003;48(6):651-62. doi: 10.1016/j.survophthal.2003.08.009.
19. Van Hell EA, Kuks JB, Borleffs JC, Cohen-Schotanus J. Alternating skills training and clerkships to ease the transition from preclinical to clinical training. Med Teach. 2011;33(12):e689-96. doi: 10.3109/0142159x.2011.611837.
20. Wimmers PF, Schmidt HG, Splinter TA. Influence of clerkship experiences on clinical competence. Med Educ. 2006;40(5):450-8. doi: 10.1111/j.1365-2929.2006.02447.x.
21. Carraccio C, Wolfsthal SD, Englander R, Ferentz K, Martin C. Shifting paradigms: from Flexner to competencies. Acad Med. 2002;77(5):361-7. doi: 10.1097/00001888-200205000-00003.
22. Moon Yl. Education reform and competency-based education. Asia Pac Educ Rev. 2007;8(2):337-41. doi: 10.1007/bf03029267.
23. Murray TJ. Medical education and society. CMAJ. 1995;153(10):1433-6.