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SYSTEMATIC REVIEW

Developing Cognitive Skills Through Active Learning: A Systematic Review of Health Care Professions

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Objective: To systematically review current literature to determine whether active learning is more successful than passive learning at producing cognitive skills in health care professions students.

Data Sources: An electronic search was conducted in 4 databases: EBSCO-CINAHL, EBSCO-Sport Discus, Educational Resources Information Center, and PubMed. Search terms included: millennial AND health education, active learning AND knowledge retention, flipped classroom AND learning outcomes, problem based learning AND learning outcomes, problem based learning AND student confidence, active learning AND critical thinking, higher order thinking AND active learning.

Study Selection: We included studies if they were published in English between 2007 and 2017 and evaluated outcomes of an active learning intervention. Studies of nonhealth care disciplines, practicing health care practitioners, or studies that did not address the primary research questions were excluded.

Data Extraction: Study design, health care discipline, intervention used, assessment measures, outcome(s) measures, main results, and conclusions were extracted from each article, as appropriate.

Data Synthesis: Articles were categorized based on capacity to answer 1 or both of the research questions. Conclusions were summarized according to the learning technique used and its effectiveness in regard to studied learning outcome. Out of 85 studies on lower-order cognition, 61 (72%) indicated active learning techniques were effective at achieving improved recall, understanding, and/or application of course material. Of 69 studies on higher-order cognition, 58 (84%) supported active learning over passive instruction for improving students' confidence in or performance of analytical, evaluative, and creative skills.

Conclusions: Active learning produces gains to both lower- and higher-order cognition at levels equal to, and more often, greater than the use of passive learning methods. Despite this evidence, we believe more high-quality, well-designed prospective studies using validated assessment measures are needed to endorse the value of these methods in producing cognitive skills.

Key Words: Problem-based learning, team-based learning, flipped classroom, critical thinking

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KEY POINTS

- Active learning techniques can be used as successful methods for improving students' knowledge, understanding, and application of information delivered in the didactic setting.
- Instructors should consider pairing low-risk, high-impact activities such as pause for discussion or demonstration, purposeful questioning, think-pair-share, and clicker quizzes with lecture to promote lower-order cognition in traditional learners.
- For more advanced learners, critical thinking and problem-solving abilities can be promoted by instructors through the use of more complex active learning techniques such as concept mapping, jigsaw discussion, role playing, simulation, cross-talk, and peer review in place of lecture instruction.

INTRODUCTION

Advancements in society, media, technology, and communication have made it more important than ever for health care professions educators to understand their audience and develop instructional methods as well as delivery styles that will produce effective learning outcomes for the new generation of students.[1] In the traditional method of instruction, the professor is deemed a content matter expert whose primary responsibility is to passively transfer information to an unobtrusive group of students. Ordinarily transpiring through reading, lecturing, and notetaking, passive learning offers the student minimal opportunity for verbal interaction or reflective feedback. Although passive learning has served as the traditionally dominant teaching method in United States higher education, more recent paradigms argue that students need a more active process of acquiring knowledge.[2] Active learning is a broad term used to describe multiple methods of instruction focused on holding the student responsible for their own learning.[2] Numerous instructional techniques have been included under active learning pedagogy including but not limited to: game-based learning (GBL), problem-based learning (PBL), case-based learning (CBL), team-based learning (TBL), and the flipped classroom (FC) method.[3] All of these student-centered teaching methods embrace similar features such as independence of the student, a coaching role of the professor, and provision of knowledge regarded to as a tool versus an aim.[4] Moreover, all active methods share the recurring goal of fostering deep learning and understanding.[4]

A notable and extensive review of 59 studies was performed to determine the effectiveness of active learning on improving knowledge and skill in approximately 8000 health care professions students.[5] Beyond establishing active learning as a sufficient tool for improving learning outcomes, conclusions from this review suggest 3 potentially important findings: (1) active learning is most effective when learners are able to give input on the selection of learning resources, (2) advanced learners have the potential to benefit more from active learning than less advanced learners, and (3) the anticipated benefits of active learning may vary between health care professions disciplines.[5] While obtainment of sufficient knowledge and skill is undeniably necessary in the preparation of any health care professional, the Commission on Accreditation of Athletic Training Education has deemed the development of critical thinking skills as central to the delivery of high-quality patient care.[6] Unfortunately, notable reviews of literature deeming active learning as advantageous at stimulating the higher-order cognitive processes such as critical thinking, problem solving, and decision-making capabilities that are needed for smooth transition to practice, are far less common. Therefore, the overall purpose of this study is to systematically review and synthesize evidence associated with the effectiveness of active learning strategies on health care professions students' lower- and higher-order thinking skills. More specifically, this systematic review aims to address the following research questions: (1) Are active learning techniques more successful as compared to passive techniques at increasing lower-order cognition, as described by recall, understanding, and application of knowledge in health care professions students? (2) Are active learning methods more effective as compared to passive methods at improving higher-order cognition as measured by analyzing, evaluating, and creating in students of health care professions disciplines?

METHODS

This systematic review was completed in accordance with the guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.[7] For the purposes of this systematic review, lower-order cognition was defined by the bottom 3 tiers of Bloom's revised taxonomy: remembering, understanding, and applying. Higher-order cognition was established by the top 3 tiers: analyzing, evaluating, and creating.

Data Sources and Searches

A comprehensive, electronic search of 4 individual databases (CINAHL, SPORTDiscus, Educational Resources Information Center [ERIC], and PubMed) was performed. Boolean terms and phrases included millennial AND health education, active learning AND knowledge retention, flipped classroom AND learning outcomes, problem-based learning AND learning outcomes, problem based learning AND student confidence, active learning AND critical thinking, higher order thinking AND active learning (Table). Searches were expanded to apply related words and search within the full text of the article. Additional searches of the references list for relevant articles were also performed by hand. All searches were conducted from January 1, 2007, through December 2017.

Table. Search Terms, Databases, and Number of Articles Identified

Search Terms	CINAHL	SPORTDiscus	ERIC	PubMed	Total
Millennial AND health education	66	104	11	32	213
Active learning AND knowledge retention	96	22	14	85	217
Flipped classroom AND learning outcomes	7	10	21	23	61
Problem based learning AND learning outcomes	45	85	69	0	199
Problem based learning AND student confidence	95	27	12	160	294
Active learning AND critical thinking	12	249	253	237	751
Higher order thinking AND active learning	20	14	116	30	180
Total	341	511	496	567	1915

Study Selection

Peer-review articles were included in this review if they were published in English, between 2007 and 2017, and investigated the effectiveness of any active instructional technique on learning in students of any health care profession discipline. Editorials, commentaries, abstracts and studies of nonscientific or nonhealth care-related educational disciplines were excluded. Additionally, research studies that did not address the primary questions of interest were omitted from inclusion in this review.

Following the elimination of duplicate articles from the search results, a 2 step process was used to identify appropriate articles for inclusion in this review. The first author (N.A.H.) performed the initial screenings of article titles and abstracts, after which a meeting between authors was held to obtain consensus on inclusion criteria. Full-text review of articles was then performed by both authors (N.A.H., C.W.B.) followed by a meeting resulting in consensus to further restrict study inclusion criteria. Articles that did not meet study criteria were excluded.

Data Extraction and Quality Assessment

We classified articles according to their research question of interest. The study design, learning technique, learning outcome(s), assessment measure(s), population, main results, and conclusions were extracted from each article and entered on a standard data-collection form. For articles including multiple outcomes of interest, extraction was limited to only the outcomes suitable to address the research questions of interest. The first author (N.A.H.) performed initial quality assessments for studies included in this review using the 2014 Joanna Briggs Institute levels of evidence approach (http://joannabriggs.org) after which a meeting between authors was held to obtain consensus on level of evidence assignments.

Data Synthesis and Analysis

The authors critically analyzed included studies to evaluate participants, learning technique, learning outcome, and results. The results were then formulated using a qualitative synthesis of study findings. Articles were categorized into 2 groups based on their ability to answer the research questions: success with lower-order cognition or effectiveness with higher-order cognition. Studies with outcomes addressing both questions of interest were included in both groups. Unfortunately, a meta-analysis was not possible at this time since data were unable to be assembled due to the heterogeneity of the populations, learning techniques, learning outcomes, and results.

RESULTS

Results of Search

Our initial literature search resulted in a total of 1915 potential articles. After removing 1519 duplicate articles found across the 4 databases, the remaining 396 articles were screened for inclusion by title and abstract. After reviewing the title and abstract of each study, an additional 210 articles met the exclusion criteria or failed to supply content relevant to the research questions addressed within our systematic review. Therefore, 185 articles remained for full-text evaluation and data extraction (Figure).

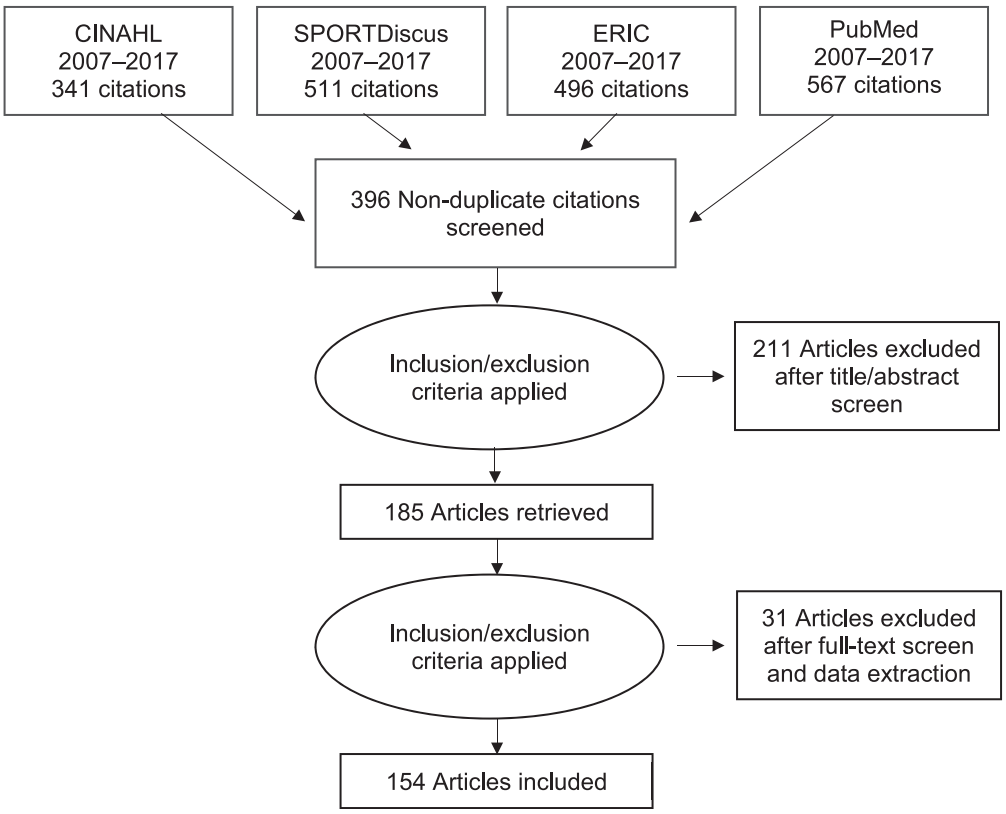
An additional 31 articles were excluded during the data extraction process: 1 study included secondary school students, 7 studies did not include students of a health-related discipline, 4 studies included practicing health care professionals, 7 studies described active learning techniques without measuring learning outcomes, 1 study focused solely on clinical education and practice, 8 studies did not directly evaluate the instructional method, and 4 studies evaluated outcomes not related to didactic instruction or didactic outcomes not included in our systematic review. A total 154 articles remained wherefrom data were extracted and synthesized in the results. This consisted of 85 studies addressing lower-order thinking and 69 studies focused on higher-order cognitive skills.

Lower-Order Cognition

Our review aimed to investigate the effect of active learning on lower-order cognitive tasks such as the ability to remember, understand, and apply knowledge learned in the didactic setting. Of the 154 studies included in our review, 85 studies (55%) addressed changes in lower-order cognition following participation in 1 or more active learning techniques. Of these 85 studies, 61 (72%) indicated improvement in lower-order cognition as a result of an active learning intervention.

Game-Based Learning. Nine studies[8–16] were available to investigate the effect of GBL on lower-order cognition. Five of the 9 studies (56%) provided support for the use of GBL for enhancing knowledge. For example, Aljezawi and Albashtawy[8] investigated knowledge acquisition and performance in nursing students participating in passive and GBL methods. While both groups were successful at attaining knowledge gains, the GBL group showed significantly greater knowledge

Figure. Search strategy and study selection process. Abbreviation: ERIC, Educational Resources Information Center.



acquisition both at initial posttest and 10 weeks following the intervention.[8] Furthermore, Tivener and Hetzler[9] found that, while athletic training students in both passive and audience response system groups showed statistically significant increases in knowledge, students in the "clicker" group demonstrated higher knowledge acquisition as compared to those in the passive learning environment.

Correspondingly, 3 of 9 studies (33%) suggested that GBL produced similar gains in lower-order thinking as compared to passive learning methods. For instance, Blakely et al[15] performed a systematic review of 16 studies concluding both passive and gaming instruction increase student knowledge; however, neither technique can be deemed more helpful to students than another. In contrast, 1 of the 9 studies on GBL (11%) revealed this active learning method to be less successful than passive lecture at increasing lower-order cognition in students of health care-related professions. Rondon et al[16] found that speech-language and hearing students (N = 29) in the passive learning conditions performed better at short- and long-term intervals when compared to students learning via GBL methods.

Problem-Based Learning. Seventeen studies[17–33] were available to describe the effectiveness of PBL on increasing student knowledge. Ten of the 17 studies (59%) were in support of PBL for improving lower-order cognition in health care professions students. Tsou et al[17] found that PBL was successful at preparing medical students (N = 236) for license examination and at improving students' self-perceived knowledge and understanding of basic medical sciences. Likewise, Ho et al[18] found that speech-language pathology student performance on PBL tutorials was correlated with overall scores on clinical evaluations and standardized competency assessments. Of significant relevance, support for PBL was found in a systematic review and meta-analysis by Galvao et al.[19] In a collection of 5 studies, authors found that students participating in PBL had higher midterm and final exam scores than those partaking in passive instructional methods.[19]

In addition to the 10 studies recommending PBL over passive learning, an additional 7 studies (41%) rated PBL to be similar in effectiveness to passive learning techniques for increasing lower-order cognition. For example, Takkunen et al[26] found PBL had no effect on exam scores as compared to the passive approach. However, it should be noted, PBL tutors perceived a greater benefit of active learning in lower performing students.[26] Overall, 100% of studies researching PBL indicated increases in knowledge equal or greater to passive learning practices.

Flipped Classroom. Eight studies[34–41] considered the effects of the FC intervention on students' attainment of lower-order cognition. Four of the 8 studies (50%) indicated successful knowledge production with FC instruction. Koo et al[34] discovered that FC design was more successful at improving overall final grades as compared to passive techniques.[34] Similarly, Gillispie[35] found that the FC method was successful at increasing scores on both multiple-choice exams and objective structured clinical examinations. Gross et al[36] used the FC format to measure knowledge in students across 3 exams. As compared to passive methods, FC resulted in a significant improvement in exam scores.[36] Moreover, the positive effects of FC were greater in female students as well as students with lower grade point averages.[36]

Three of the 8 studies (38%) found the active method to be of similar or equal success to the passive approach. In a study of 82 medical students, Hsu et al[37] found no statistically significant difference in exam performance between students learning in FC and passive conditions. In contrast to these results, 1 study (11%) found poor results for flipping the classroom. Murray et al[41] found FC did not significantly improve doctor of physical therapy student performance on knowledge, comprehension, or application aspects of lower-level cognition. Furthermore, the findings suggested students' prior academic performance might have had a significantly larger impact on knowledge retention in all performance areas than the teaching pedagogy used in the didactic setting.[41]

Team-Based Learning. Eight studies[42–49] deliberated the value of TBL on student knowledge. All 8 studies (100%) deemed TBL as a successful practice for increasing lower-order cognition. Echeto et al[42] researched the effects of both passive learning and TBL on senior-year dental students. Students receiving the TBL intervention scored higher on examinations, mean course scores, and final passing grades as compared to students learning through the passive method.[42] Likewise, Kalra et al[43] found that 72% of medical students who learned with a jigsaw version of small-group TBL perceived better understanding of course material. Furthermore, Wong and Driscoll[44] compared the active learning techniques of independent study and jigsaw on performance of physical therapy students. Outcomes revealed significantly higher performance on course content quizzes after the jigsaw activity as compared to students who performed independent study.[44] It should also be noted 2 of the 8 studies demonstrated TBL to be successful at increasing short-term knowledge retention; however, no difference was seen between team-based and passive learning at the long-term interval.[46,48]

Case-Based Learning. Five studies[50–54] inspected the connection between CBL and lower-order cognition in health care professions students. All 5 studies (100%) agreed on CBL as a successful method of improving student knowledge. A cross-sectional study by Ciraj et al[50] investigated CBL in medical students, concluding that mean exams scores were higher in the CBL student group as compared to the non-CBL group. In addition, CBL was perceived by students and faculty to improve learning, retention, and understanding of course content.[50] Furthermore, Speicher et al[51] performed a review aimed at providing athletic training educators a rationale for implementing CBL. Authors found students who engaged in a form of CBL using multiple-case examination and cueing were more apt to recall their learning and use it when faced with novel cases in the clinical environment.[51]

Simulation. Eight studies[55–62] contained in this review aimed at analyzing the effects of simulation learning on health care professions students' lower-order cognitive skills. All 8 studies (100%) reinforced the use of simulation as an instructional method for increasing knowledge in students. Tivener and Gloe[55] sought to determine through a mixed-methods study whether athletic training students gain knowledge from participation in high-fidelity simulation. Study results suggest that high-fidelity simulation is an effective instructional technique for increasing knowledge and improving skills in professional-level athletic training students.[55] In further support of simulation, Aqel and Ahmad[56] designed an experimental pretest/posttest study to examine the effectiveness of both a lecture and low-fidelity simulation intervention against a lecture and high-fidelity simulation intervention. While knowledge and skill was increased across both groups, nursing students in the high-fidelity simulation group showed greater improvements in knowledge and skill as compared to their low-fidelity simulation counterparts.[56] Furthermore, study results concluded both groups did not retain knowledge 12 weeks after training; a significant difference in favor of the high-fidelity simulation was found for better long-term retention of skills.[56]

One randomized control trial comparing simulation-based teaching to passive instruction was located. In this study, Salem[57] discovered students in the simulation group did not demonstrate significant advantages in knowledge retention, although they did exhibit significantly greater skill performance and efficiency. Likewise, Shin et al[58] used a descriptive, cross-sectional, and comparative design to investigate the effect of passive methods versus a combination of active methods including high-fidelity simulation on competency and performance in nursing students. The study rated both competency and performance as significantly higher in the active learning group as compared to the passive learning group.[58]

Other Techniques. An additional 31 studies[63–93] using unique or combined techniques addressed lower-order cognition resulting from active learning pedagogies. Twenty-three of these 31 studies (74%) were in support of the use of active learning to increase knowledge in health care professions students. For example, Gingerich et al[63] used a within-subjects design to assess the effectiveness of write-to-learn activities. Authors found write-to-learn assignments to be beneficial in raising exam scores for psychology students both immediately and 8.5 weeks after the educational intervention.[63]

However, 7 of 31 studies (23%) on lower-order cognition also found mixed results with active learning or outcomes similar to passive methods. For example, Waltz et al[64] performed a review of 22 studies. While 15 studies reported positive results, 7 studies were unable to support the effectiveness of active learning methods.[64] Studies included within this review lacked consistent definitions of active learning and commonly failed to provide estimate measures for reliability and validity, leading authors to conclude insufficient evidence is available to recommend the use of active learning methods over traditional in nursing professions education.[64] Only 1 study (3%) by Mahler et al[65] found poor effects for active learning on improving knowledge. When the use of self-directed learning was compared to both lecture and traditional workshop formats for medical students, authors found individual test scores from self-directed learning were significantly lower than both passive lecture and workshop formats.[65]

Of the 61 studies in support of active learning, 68.9% (n = 42/61) were deemed moderate-level evidence or higher. Furthermore, an additional 21 studies (25%) suggested active learning techniques were equally successful as passive lecture at facilitating lower-order thinking. Of these 21 studies, 81% were considered moderate-level evidence or higher. Despite the potency of these results, 3 (3.5%) studies still remained in support of passive learning methods over active learning techniques. After exhaustive review of literature, we recom-

mend that health care professions educators use active learning techniques over passive learning techniques to stimulate the production of students' lower-order cognition in the didactic setting. (Grade A recommendation)

Higher-Order Cognition

Higher-order cognitive tasks such as analyzing, evaluating, and creating underlie the skills such as critical thinking and problem solving necessary for employability and successful transition to clinical practice. A total of 69 studies addressed these characteristics in health care professions students. Of the 69 studies included, 84% (N = 58/69) of the studies supported the use of active learning techniques for improving these higher-order skills.

Problem-Based Learning. Thirty-six studies[17,19,22,24,26,27,31–33,90,93–118] were located in reference to PBL and higher-order cognition. Out of the 36 studies, 30 studies (83%) were in support of using PBL to improve higher-order cognition. Jones et al[93] aimed to determine whether the use of PBL would promote higher levels of critical thinking in nursing students as compared to passive teaching approaches. Students in the PBL group had more pronounced increases in critical thinking and communication levels.[93] Students within this group also rated PBL as instrumental to their motivation to seek additional information regarding the course concepts.[93] Furthermore, in a PBL study by Baker[94] music therapy students indicated improved confidence and reported feeling substantially more competent in making clinical decisions. In further support, the systematic review by Nkosi and Thupayagale-Tshweneagae[95] confirmed that PBL boosted self-esteem, confidence, scholarship, and the analysis component of critical thinking in nursing students.

Mala-Maung et al[96] reported similar results in medical students, finding that the use of PBL correlated to improvements in problem solving, critical thinking, and decision making. Moreover, Baker et al[97] performed a study using the Learning Skills Profile to determine the effects of a PBL curriculum on job-related skills. Problem-based learning was responsible for producing increases in all 12 elements of the Learning Skills Profile.[97] Statistically significant increases occurred on 8 personal learning skills: leadership, help, sense making, information gathering, theory, quantitative, action, and initiative.[97] Additionally, 6 job skills showed significant improvements: help, sense making, information gathering, information analysis, theory, and technology.[97] Also, Richmond et al[98] compared passive learning to small- and large-group PBL to determine which instructional method would best promote higher-level thinking. Study results found that, when students received active learning instruction, they scored significantly better on higher-level test questions as compared to students who received traditional passive instruction.[98]

In addition to the 30 studies in support of PBL over passive methods, 5 studies (14%) showed mixed results or deemed PBL to be of similar effectiveness to passive learning for generating higher-order learning skills. For example, Coker[115] used the Self-Assessment of Clinical Reflection and Reasoning as well as the California Critical Thinking Skills Test to evaluate the clinical reasoning and critical thinking skills of occupational therapy students. While students increased their overall scores, statistically significant improvements occurred only in evaluation, inductive, and deductive reasoning, while no changes were made in the scores for inference and analysis areas.[115] Also, Hur and Kim[33] found that medical students learning by PBL achieved better participation and problem-solving skills, but results were mixed between passive and PBL students for teamwork.

Moreover, a review by Kowalczyk[116] aimed to identify teaching methods demonstrating positive effects on radiologic sciences students' critical thinking skills. Thirteen studies investigated critical thinking skills in PBL curriculum.[116] However, only 6 of these 13 studies were able to demonstrate significant differences in critical thinking scores.[116] Furthermore, the authors were unable to provide evidence assessing the effectiveness of other active learning techniques such as collaborative learning and concept mapping. Overall, Kowalczyk[116] was unable to support the use of active learning for enhancing radiological sciences students' critical thinking skills.

On the other hand, 1 study (3%) identified PBL to be unsuccessful at marking changes in higher-order thinking. Pardamean[117] measured critical thinking in dental students using the Health Science Reasoning Test (HSRT), finding that students showed no significant continuous or incremental improvement in their overall critical thinking skills scores achievement during their PBL dental education.

Simulation. Six studies[55,58,61,119–121] examined the effects of simulation learning on higher-order thinking. Of these 6 studies, 5 (83%) identified simulation to be beneficial in promoting higher-order thinking in students. Allaire[119] used the HSRT to measure the critical thinking skills in dental hygiene students using virtual patient simulation. While the simulation learning did not demonstrate a significant gain in HSRT scores between passive and active learning groups, students learning with virtual patient simulation perceived simulation as successful for promoting critical thinking, problem solving, and confidence in the clinical setting.[119] Shin et al[58] also found high-fidelity simulation, in combination with case studies, standardized patients, and reflection activities, to be more successful as compared to passive learning at improving critical thinking and human understanding. Likewise, Kaddoura[120] reported recent nursing graduates viewed simulation as successful at improving self-perceived critical thinking and confidence. Moreover, Ohtake et al[121] found that physical therapy students perceived the simulation experience as valuable in reflecting upon previous knowledge and experience in addition to the integration of classroom knowledge to clinical practice.

In contrast to these findings, 1 study (17%) found simulation ineffective. Shinnick and Woo[61] found that human patient simulation produced no statistically significant gains in critical thinking as measured by the HSRT. However, of particular interest, the authors found that critical thinking scores and improvements were most associated with age, baseline knowledge, and self-efficacy.[61] Despite the presence of some negative results, the majority of studies included in this review support simulation as effective in improving higher-order thinking in health care professions students.

Case-Based Learning. Five studies[50,52,85,122,123] included in this review investigated CBL and higher-order cognition.

All 5 studies (100%) supported CBL for enhancing higher-order cognition. For example, Harman et al[122] examined nutrition students' perspectives of learning after completion of a CBL course. Active learning was found to produce higher cognitive learning as well as better problem solving and communication skills.[122] Students indicated these improvements aided in the development of interpersonal skills, leading to success in team building including constructive criticism and negotiating abilities.[122] Likewise, Yoo and Park[85] found CBL positively affected sophomore nursing students. Students in the CBL group improved in regard to communication skills, problem-solving ability, and learning motivation as compared to students learning through passive methods.[85] Moreover, medical students in a study by Ciraj et al[50] agreed that CBL promoted independent learning, communication, and analytical skills. Faculty of these students rated the improvement in clinical reasoning as the largest advantage pertaining to the CBL method.[50] Trujillo et al[52] also compared instructor-led and student-led CBL methods. While instructor-led CBL emerged more successful than student-led approaches, the authors expressed that active learning produced increases in doctor of pharmacy student confidence in critical thinking, problem solving, and decision-making abilities as well as the pursuit of lifetime learning.[52]

Other Techniques. A total of 22 other studies[3,9,41,45,49,68,70,74,81,85,87–89,116,124–131] using other combined active learning techniques addressed the effects of active instruction on higher-order cognition. Eighteen (82%) studies supported the use of active learning techniques for the promotion of higher-order cognitive skills necessary for successful transition to clinical practice. For example, 2 studies used service learning for evidence of success in health care professions students. Atler and Gavin[81] found service learning beneficial for developing interaction skills as well as increasing confidence in occupational therapy students, while Hebert and Hauf[126] found service-learning successful at improving civic responsibility and interpersonal skills as compared to passive learning.

Four of the 22 unique studies (18%) found mixed results regarding higher-order cognition and active learning techniques or found results similar to passive methods. For example, Morey[127] found no significant difference in critical thinking improvement between Web-based and passive instruction. Similarly, Murray et al[41] discovered FC did not significantly improve physical therapy students' performance on higher-order cognition question exams as compared to passive face-to-face methods. In summary, regardless of the specific technique, active learning appears to be equally if not more successful at producing higher-order thinking in health care professions students.

Of the 58 studies in support of active learning, 56.9% (n = 33/58) were deemed moderate-level evidence or higher. Furthermore, an additional 9 studies (15.5%) suggested active learning techniques were equally successful as traditional lecture at facilitating higher-order cognitive thinking. Of these 9 studies, 88.9% were considered moderate-level evidence or higher. Despite the potency of this literature, 2 (3.4%) studies still remained in support of traditional learning methods over active learning techniques. After comprehensive review of literature, we recommend that health care professions educators use active learning techniques over traditional instruction to stimulate the production of students' higher-order cognition in the didactic setting. (Grade A recommendation)

DISCUSSION

In this study, we aimed to systematically review the available literature for quantifiable evidence in support of active learning techniques over passive learning techniques for the production of lower- and higher-order cognitive skills. The main findings of this review indicate active learning is a successful method of improving students' knowledge, understanding, and application of information delivered in the didactic setting. Despite the immense variety of active learning techniques, some of the most common strategies used in health care professions education were identified to include GBL, PBL, TBL, and CBL as well as FC.

Game-based learning is a widely recognized approach based on the use of educational games for the attainment of learning objectives.[132–158] This learning technique is often used in conjunction with automated response systems or clickers. Research has indicated GBL simplifies the learning process, making learning more interesting, student centered, and effective.[158] Game-based learning also promotes the recall of prior knowledge because it requires students to use previously learned information in order to score points or essentially "win the game."[158] Moreover, it encourages participating students to test different hypotheses, receive immediate feedback, and learn from their actions.[158] Using the social dimension to engage all learners, research shows GBL is also a sufficient method of stimulating critical thinking and problem-solving skills.[158]

Flipping the classroom is an active learning technique gaining popularity for its use in conjunction with computer-assisted instruction techniques and hybrid course designs. In the FC model, students are responsible for reviewing didactic learning materials such as readings, PowerPoints, voiceover lectures, videos, or podcasts on their own prior to attending class.[3,35] During formal teaching time, the instructor facilitates student-driven discussion of material via hands-on activities that foster content application.[3,35] Engaging both students and instructors in the learning process, a successful FC has been shown to encourage both deep understanding of course material and the development of students into critical thinkers and complex problem solvers.[35,64]

Stemming from the principle of self-directed learning, PBL refers to an active and inductive instructional method focused on learning in small groups of 6 to 8 students.[5,159] In PBL, the teacher serves as a facilitator focused on aiding students as they work through problems to acquire knowledge.[5,159] The PBL process consists of 5 fundamental steps which include analysis of the problem, establishment of learning objectives, collection of information, summarizing, and reflection.[160] These steps influence students to take the initiative, with or without the help of others, in determining their own learning needs, formulating their learning goals, identifying the resources needed, selecting and applying the appropriate learning strategies, and evaluating learning outcomes.[5] Problem-based learning is frequently used in conjunction with TBL, CBL, and simulation techniques. All of these approaches have resulted in knowledge gains as well as increased

problem solving and critical thinking in health care professions students.[52,58,85,93,95–97,119,120,122,160]

Regardless of the technique used, active learning approaches have shown success in developing lower-order cognitive tasks to degrees equal to, or more commonly, greater than passive instruction.[8–15,17,18–40,42–64,66–72,74–92] Further exceeding lower-order cognition, active learning has been found to cultivate the higher-order skills of analyzing, evaluating, and creating, which are fundamental for effective clinical practice in the 21st century. Mastery of these skills is required for developing complex cognitive abilities such as critical thinking, problem solving, clinical reasoning, and decision making. Many have suggested participation in the active learning experience encourages students to develop strong work values such as confidence, self-efficacy, teamwork, and communication skills. These are the abilities that employers demand when hiring millennial graduates beginning their transition to the workforce. Primary findings of this review are in support of the use of active learning strategies to meet these demands. Active approaches revealed value in enriching higher-order cognition, with popular techniques such as PBL and simulation performing greater than passive learning delivered through lecture presentations. Improvements in students' higher-order thinking were measured through a variety methods, ranging from written reflections to interviews and validated self-report measures such as the California Critical Thinking Skills Test, HSRT, or the Kolb's Learning Styles Inventory. Based on this evidence, it is plausible to assume equipping future health care providers with the abilities to evaluate, analyze, and create will better prepare them not only to provide safe, timely, effective, efficient, equitable, and patient-centered care, but to embrace the increasingly complex health care system.

The theory of adult education acknowledges that adult learners display attributes of maturity, independence, self-direction, responsibility, and individuality.[162] Furthermore, learning in adults is related to their social roles and previous experiences.[162] In athletic training, entry to the profession at the professional master's degree (PM) level will result in an older and more mature student. Previous research determines that critical thinking is fostered more easily at the graduate level because these programs focus the curriculum solely on professional education, thus improving the professional preparation of athletic training students.[163] With an average age of 25, there is no surprise that advanced students of the PM level exhibit greater critical thinking skills.[164] Baeten et al[4] studied various factors encouraging the effectiveness of the active learning environment, concluding older students are also more likely to use and benefit from an active learning approach. Thus, we suggest that it may be more appropriate to implement active learning techniques that promote partnership between the student and the teacher at the PM level.[162]

Despite recent changes to curricular content standards, athletic training faculty may still be hesitant to pedagogical change. Common barriers associated with the implementation of active learning include trouble adequately covering course material in the available class time, increasing instructors' preparation time, difficulty using active learning techniques with large classes sizes, and/or a lack of needed training, materials, equipment, or resources.[165] Likewise, instructors may fear the gamble that students will not participate actively, learn sufficiently, or enjoy the experience.[165] Moreover, instructors may fear losing control of the classroom environment, self-confidence in their own instruction, or respect from peers when teaching with an unconventional fashion.[165]

As with any change, faculty transitioning to active learning approaches should use thoughtful strategies to mitigate potential risks. First, we suggest instructors give students clear instructions on how to participate in active learning and describe their expectations for the classroom learning experience.[166] Second, we believe it will be beneficial to create a suitable and respectful environment where students can learn, think, be assessed, and receive feedback.[166] Lastly, we advise that professors begin with the implementations of low-risk active instructional approaches.[166] Those who are currently using passive approaches may consider the use of a low-risk, high-impact alternative such as an interactive lecture. In contrast to traditional passive lecture, interactive lectures incorporate both brief segments of traditional lecture as well as explicit opportunities for interaction.[166] These interactive opportunities may include pauses for discussion or demonstration, purposefully questioning, think-pair-share activities, clicker quizzes, etc.[166] Starting slow and providing brief opportunities for interaction may allow professors to obtain the benefits of active learning while also creating excitement in the classroom. It is our opinion that this technique will protect the classroom environment while also allowing the benefits of active learning to translate into students' lower-order cognition.

In order to reach the uppermost levels of cognition, we believe that students must be doing things and thinking about doing things. This includes requiring students to construct knowledge through higher-order thinking and also promote metacognition, or students' ability to self-assess and self-regulate themselves as learners. For this advanced level of learning, it is recommended that instructors use more complex active instructional techniques such as PBL through concept mapping, jigsaw discussion, and inquiry learning, CBL though case studies, role playing, and simulated activities, as well as other high-level learning techniques such crosstalk, peer review, or student-generated test questions in place of lecture. Beyond the proposed benefits to students and employers, instructors may also be impressed to find use of these advanced learning activities may be an avenue for inclusive teaching.[167] Active learning has been shown to reach and build higher-order cognitive skills in a variety of students including first-generation college students and underrepresented minorities.[167] Therefore, the reach of active learning can help promote interconnections between classmates, improving the class climate by enhancing a sense of belonging and motivation for marginalized students and those with differing levels of previous academic preparation.[167]

LIMITATIONS

This study completed an exhaustive review of the current literature surrounding active learning in health care professions education; however, it is not without limitations. While the studies included in this review varied in terms of design, the larger concern is studies varied vastly in the learning outcome of interest, the operational definitions for the learning outcomes of interest, as well as in the method of

outcome assessment. This factor made it difficult to combine studies and determine the effectiveness of specific individual learning outcomes such as critical thinking or problem solving. Furthermore, due to the large variety of learning outcomes discovered regarding active learning, the risk of both performance and reporting bias cannot be ruled out. There remains a possibility that publications could have distorted findings, as randomized control trial and cohort studies with statistically significant results are more likely to be published. Furthermore, due to the large amount of learning outcomes present in health care education, it is possible that the outcomes selected for this systematic review were in fact in line with the most favorable findings, introducing the potential for outcome bias in this study. Unfortunately, we were unable to find any studies specifically investigating the effectiveness of the active learning experience on student transition to practice or performance in the workplace following graduation.

While we were able to include 154 studies in this systematic review, only 22 were considered high level evidence (ie, randomized controlled trials); of the remaining, 67 studies were deemed moderate level (ie, quasi-experimental), 38 were considered low level (ie, cohort with control or case control), and 27 were very low-level evidence (ie, cross-sectional). Educators should proceed with caution before applying findings of low- and very low-level studies to their instructional practice. Furthermore, the limited number of athletic training studies did not allow us to evaluate the effect of active learning specifically in athletic training education. This may significantly alter how much this information can be used for instructional design of athletic training courses.

FUTURE RESEARCH DIRECTIONS

In efforts to strengthen the body of research on learner-centered instruction, additional largescale studies using consistent designs are essential to evaluate the effectiveness of active learning techniques on higher-order cognitive skills. Moreover, future studies must incorporate consistent and well-established assessment techniques using reliable and validated instruments to measure the true outcomes of which the intervention is designed to target. When possible, these studies should seek to assess real-world outcomes such as critical thinking skills, problem solving, and clinical decision making. Studies using consistent designs and assessment tools focused on evaluating specific techniques and learning outcomes could serve as beneficial to promoting conventional health care professions educational programs to develop a more active and student-centered learning environment.

Future research also necessitates studies using newly certified graduates and employers to determine whether participation in the active learning experience contributes to improved outcomes related to transition to clinical practice and the health care workplace. Collection of this evidence may inspire educators of health care professions to review their current pedagogical methods. Additionally, it may assist in determining appropriate strategies for implementing learner-centered instruction and incorporating active learning into course materials and the didactic learning environment. By committing to the development of a more student-centered learning environment, educators can better prepare students for successful entry into the health care workforce.

CONCLUSIONS

This systematic review presents evidence regarding the use of student-centered learning techniques in health care professions education. Specifically, we concluded that active learning results in gains to both lower-order (Grade of Recommendation = A) and higher-order cognition (Grade of Recommendation = A) greater or equal to the use of passive instructional techniques. Despite the evidence supporting active learning, the need for large, high-quality and well-designed prospective studies are needed to evaluate the influence of the active learning experience on newly certified health care professionals' transition to clinical practice and performance in the workforce. Until research is concluded, educators should approach instructional design with the needs of the student and the demand of the workforce at the center of priority.

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