REVIEW

The Use of Self-Study in Health Professional Higher Education and Medical Education - A Mixed-Method Systematic Review

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Abstract

Purpose: **Health profession education and medical education should implement primarily active learning units in the curriculum. Self-study/guided self-study is such a tool that promotes active learning, a method that involves students in their learning process. The implementation of active learning is intended to develop or consolidate practical skills (hands-on). This mixed-method systematic review evaluated the of self-study/guided self-study in the university landscape for health professions education and medical education. Another goal was to foster awareness of the method self-study/guided self-study.**

Method: **A systematic literature search in CINAHL, Embase, ERIC, PubMed and Web of Science was performed. Additionally, a manual search was conducted. This article included qualitative, quantitative, or mixed-method study designs. Included articles were appraised using the JBI Critical Appraisal Tool for qualitative and quantitative research. Abductive thematic analysis was used to synthesize evidence. Random-effects meta-analysis was performed to determine the effects of self-study that develop or consolidate practical skills (hands-on) in health professional or medical students compared to traditional teaching.**

Results: **Fifteen articles were included totaling 3949 students volunteering in the studies. Critical appraisal of the studies ranged from average to good. Seven studies reported the use of individual self-study. The overall weighted effect favored self-study compared to traditional teaching (SDM 0.30, 95%CI: 0.13−0.48, $p = 0.003$).**

Discussion: **The synthesized findings suggested that self-study/guided self-study was used as individual self-study. Self-study/guided self-study could develop or consolidate practical skill (hands-on) in health professional and medical students. The self-study/guided self-study should be structured in such a way that individual learning, dyad and group learning are possible.**

Keywords: Graduate education, Self-study, Self-directed learning, Independent learning, Self -education

1. Introduction

Teichmann [1] defined self-study as the amount of students' workload which is spent for the independent development and appropriation of study content, such as preparation and follow-up of teaching content, reading, chores, exam preparation and thesis writing. The Cambridge English Dictionary explained self-study as the way of learning about a subject that involves studying alone at home, rather than in a classroom with a university lecturer. The accentuation as it appears in the term "self-study" seems to be a key concept in the higher education process to emphasize the self and the associated aspects such as independence, personal responsibility and self-activity [2].

In higher education settings, Landwehr and Mueller [2] and Rogan [3] distinguished three forms of self-study. The first form is free self-study, where students set their goals and specific topics and

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content and develop them voluntarily according to their own interests. The second type is individual self-study. Topics from lectures are worked on in greater depth by students, without learning and work orders from teachers. The third form is guided self-study, in which the teacher initiates the framework and the tasks (e.g. cases). During processing of the tasks, the students are supported by the university lecturers (or tutors). The results are discussed and checked by the university lecturers (or tutors).

Economical burdens and personal fears from educators may act as barriers against the adoption of self-study, for educational purposes in health professional settings. As the COVID-19 pandemic challenges education systems worldwide, the self-study approach moves into unintended focus. Many governments all over the world decided to close educational institutions in an attempt to contain the spreading of the disease. Whilst such action may be sound from an epidemiologic perspective, students could not attend face-to-face activities [4]. Lecturers of educational institutions have adopted education through various online platforms and were compelled to adopt a system for which they were not prepared for [5]. During the COVID-19 lockdown and the severe restrictions on teaching on-campus, the question arose how practical skills can be taught and learned by students. Prior to COVID-19 lockdown, the opinion hold, that teaching practical skills was only possible with physical interaction between the (university) lecturers and the students. However, studies showed that practical skills in health profession students can be taught by using video-based approaches or virtual activities [6–11]. During the COVID-19 lockdown, many countries allowed educational institutions to teach practical content (e.g. in the field of nursing, physiotherapy, medicine) on site in small groups (e.g. maximum five students). In this case, guided self-study may offer favorable opportunities for learning and can be applied as a didactic method, allowing health professional students to acquire the abilities and competencies needed for professional practice.

In health profession education it is not explicitly described when and how learners develop practical skills (e.g. blood sampling, palpation of anatomical landmarks) and competences [12]. One approach can be that learners have the ability to improve these skills by themselves [13]. The COVID-19 pandemic provides an opportunity to rethink teaching and learning methods in higher education settings. This article should represent to how commonly self-study/guided self-study was used in the higher education landscape of health professional education and medical education. Another aim was to foster awareness of the method of self-study/guided self-study as a didactic method which will then be used to develop or consolidate practical skills (hands-on) in the university landscape for health professions students and medicine students.

The research question were:

1. What is known about the use of self-study/guided self-study in health professional education and medical education curricula?
2. What is the appropriateness of self-study/guided self-study for promoting practical skills (hands-on) in health professional education and medical education?

2. Methods

2.1. Study design

To answer the research questions, a mixed-methods systematic review [14] was performed that includes the method of a comprehensive, systematic literature search which may reduce cognitive biases.

2.2. Synthesis methodology

This current study included types of studies that are mixed. Hence, the types of findings to be synthesized are mixed. Furthermore, two modes of analysis theory building and theory testing were utilized [14].

A thematic synthesis approach was followed for qualitative studies in Synthesis 1. The intended output of this approach is to generate analytic themes that offer a new interpretation that is beyond results offered by primary articles [15]. In synthesis 2, post-data of quantitative studies were pooled in the form of a meta-analysis to determine the impact of self-study/guided self-study whether practical skills could be learned. Finally, we integrated the two types of results by using Synthesis 1 to interrogate Synthesis 2, resulting in Synthesis 3.

We followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement, predominantly the study design, eligibility criteria, method of study search, synthesis and analysis, were specified to enhance transparency in reporting the synthesis of the mixed-method research.

2.3. Data sources and literature search

This study employed a preplanned sensitive search strategy that used the SPIDER tool [16] to assist the research question and the eligibility

criteria for this systematic literature search. Sample (S): undergraduate physiotherapy students, health-professional students, medical students; Phenomenon of interest (PI) = self-study, self-regulated learning, self-directed learning, self-determined learning, workload; Design (D) = no self-study, traditional classroom; Evaluation (E) = practical skills (hands-on: these included techniques that need to be learned for examining the patient (e.g. joints range of motion, muscle strength) and there are techniques that need to be learned for treating patient) and research type (R) = qualitative, quantitative and mixed methods studies. The combination was (S AND PI) AND (D AND E) AND R.

The systematic literature search was conducted to illustrate the global application of self-study or guided self-study in the academic setting of health-professions education. The following databases were searched: CINAHL, Embase, ERIC, PubMed and Web of Science. Additionally, a search was performed in the reference lists of the surveyed studies and in Google Scholar.

2.4. Eligibility criteria

We established specific inclusion and exclusion criteria to identify each study and to make them more specific to the research questions of our interest. Table 1 lists the inclusion and exclusion criteria.

2.5. Critical appraisal of methods

The quality of the included qualitative articles was evaluated during the synthesis using the Joanna Briggs Institute (JBI) Critical Appraisal Tools. After completion of the synthesis, a sensitive analysis was performed. In this process, studies of lower quality were excluded to reduce influence [17].

2.6. Extraction of study characteristics

At first, title and abstract were screened, and duplicates removed by one reviewer (SR) [18]. Afterwards the included articles were read, and their quality was appraised by two reviewers (SR & JT) independently. Data extraction was conducted using a spreadsheet by the same two reviewers (SR & JT) independently. Any disagreement between the reviewers was solved by consensus.

Extracted study characteristics were: first author's name, study population, country of origin, study design, description of intervention, quantitative data about changes in learners' knowledge or consolidation or developing practical skills (hands-on) and three self-study methods highlighted by Landwehr and Muller [2] as self-study and guided self-study.

2.7. Synthesis

The first step was to synthesize qualitative studies of intervention that described the use of self-study/guided self-study in health professional and medical education curricula. Furthermore, a synthesis of qualitative studies about the impact of self-study/guided self-study aimed at increasing knowledge gained in practical skills in health professional education and medical education. We have conducted a line-by-line coding of the text and afterwards we have grouped the initial codes and collapsed codes. The second step was to synthesize post-interventional data from quantitative studies to determine the effects of self-study/guided self-study compared to traditional methods on practical skills. The third step carried out an abductive thematic analysis by Thomas and Harden [19]. The findings of the articles were read and coded. This included appraising quantitative data by forming narrative interpretations of the quantitative findings with codes. The next step was deductively organizing and

Table 1. Inclusion and exclusion criteria.

Inclusion criteria	
Topic:	Studies which have used guided self-study in medical, health-profession and pharmacy higher education teaching
Populations	Physiotherapy students, nurse students, health professional students, medical students
Language	English, German
Study type	Qualitative and quantitative research
Publication type	Peer reviewed journals
Time frame	2000–2022
Exclusion criteria	
Topic	Traditional teaching methods and higher education courses that are not medical, health-professional or pharmacy related
Publication type	Books, editorials, commentaries, narrative reviews, conference abstracts

summarizing the coding under methods of self-study and workload of self-study.

2.8. Statistical analysis

Meta-analysis was performed using the Review Manager 5.3 (2014 Version 5.3, Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration). Standardized mean differences (SMDs) for post-intervention values were used and forest plots were generated to compare effect sizes across the higher education studies. The effect sizes in each intervention group were synthesized in the forest plot with a fixed-effects model. The I^2-test represented the consistency between higher education articles. The Cochrane handbook for systematic review suggest for $I^2 < 40\%$ a low risk of heterogeneity, between 40% and 75% ed a moderate risk of heterogeneity, and >75% indicates a high risk of heterogeneity. A sensitivity analysis was conducted by excluding the non-RCT studies to evaluate the robustness of the overall weighted mean effect size against differences in study design.

3. Results

3.1. Search results

The systematic literature research yielded 1076 articles. After deletion of 289 duplicates and screening the titles and abstracts, a further 775 studies were excluded. Altogether, 91 texts were read, from which 15 articles with 3949 participants across the studies were included in the final analysis. These studies were categorized into medicine [18,20–28], nursing [29], osteopathic medicine [30], pharmacy [31] and physiotherapy [32–34]. Two studies were designed as qualitative studies (n = 2; 13%) [21,28], three as cohort studies (n = 3; 20%) [26,31,32], five as randomized controlled trial (n = 5; 33%) [18,20,25,30] and five studies as non-randomized controlled trial (n = 5; 33%) [23,24,29,33,34]. The flow chart gives an overview of the selection process (Fig. 1).

3.2. Critical appraisal results

Overall, the outcomes of the critical appraisal were average to good, with appropriate methods to answer the research questions. It could be shown that the qualitative (Appendix Table 1) studies had a higher overall quality when compared to cohort studies (Appendix Table 2), randomized (Appendix Table 3) and non-randomized trials (Appendix Table 4). Randomized controlled trial included in this study generally failed to completely allocate study participants to treatment groups, blind the assessors and measure outcomes in a reliable way.

3.3. Study characteristics

Table 2 represents study characteristics. Included articles were conducted in seven countries: Canada [33], Germany [20,24,27], Portugal [28], The Netherlands [21,34], Singapore [25], Thailand [18,23] and USA [26,29–32]. Nine articles were published after 2016 [18,20,23–26,28,30,33]. The other three articles were published 2002 [32], 2005 [29], and 2012 [21].

3.4. Findings of the synthesis of qualitative studies

"Medical students appear to be spending 9.8 h/week in self-study in clinical training" stated Barbosa et al. [28] in their study. Furthermore, Barbosa et al. [28] postulated that "time devoted to self-study in clinical training is related to the curriculum and student characteristics". Duvivier et al. [21] described that "Students reported an average of 17 h (SD 6.3) per week for self-directed study and 3.4 h (SD 2.2) for clinical skills practice outside timetabled training sessions. Thus, 20% of time for self-study was devoted to skills. Students in Year 3 reported a significantly lower number of hours for clinical skills than their first-year peers (2.9 vs. 3.5 h).

3.5. Findings of the synthesis of the quantitative studies

This study analyzed the effect of self-study on change in knowledge and skills versus traditional teaching based on a set of six articles, involving four randomized controlled trials [20,23,30,32,35], one cohort trial [34] and one non-randomized trial [23]. Fig. 2 shows the forest plot of this the meta-analysis. The overall weighted mean effect size favored self-study as compared to traditional teaching (SDM = 0.30, 95%CI: 0.13–0.48, p = 0.003). A sensitivity analysis was conducted by excluding the non-RCT studies.

(Fig. 3) Based on the results of the four randomized controlled trials represents a weighted mean effect sizes of SMD = -0.54 (95CI: −1.71 − 0.63) was found, favoring traditional teaching but the difference was statistically not significant (p = 0.37).

3.6. Findings of the narrative synthesis

Table 3 depicts the results categorized into three groups, self-study, methodology self-study and learning and their subgroups.

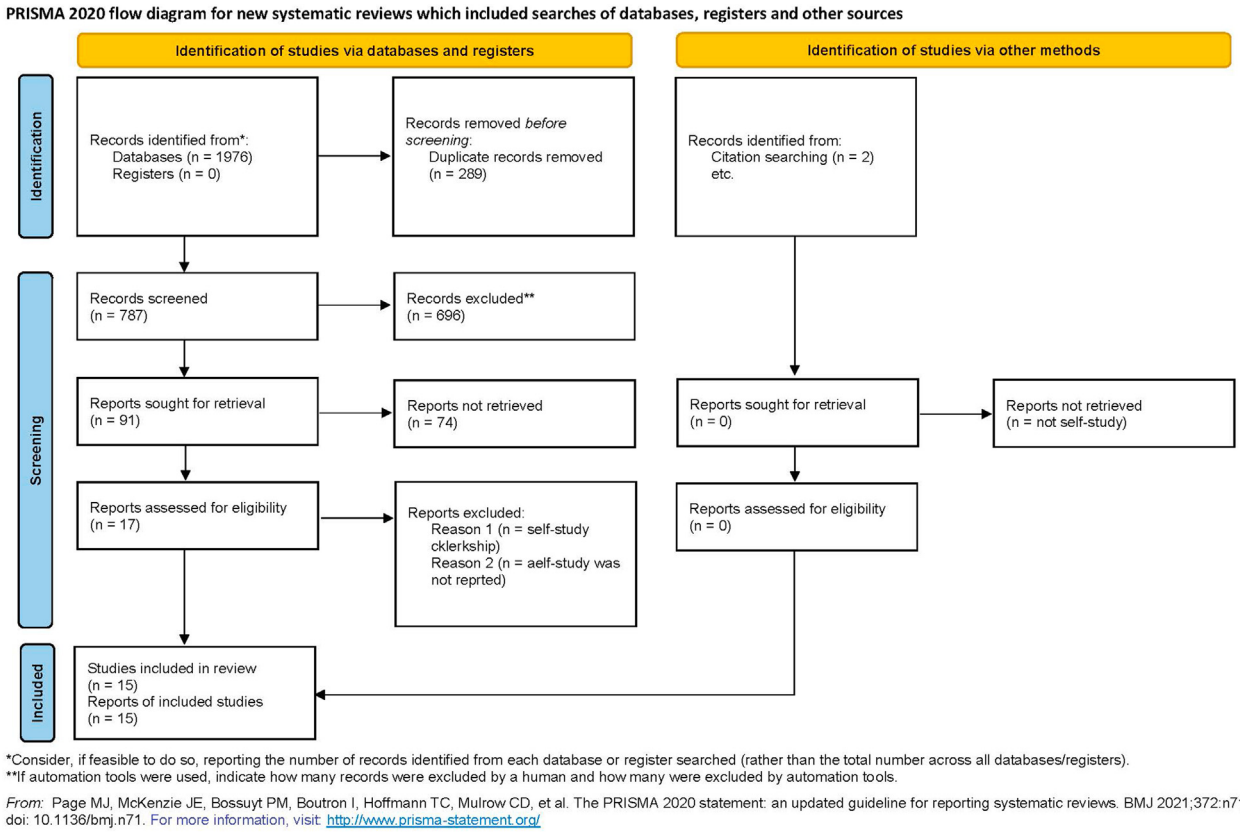

Fig. 1. Flow chart of this study.

The first column self-study presents articles that described the method of self-study or the workload of self-study. The first subgroup in the column represents articles that described the used method individual self-study [18,20,23,24,26–30,32]. The second subgroup depicts the workload of self-study.

The second column presents the methodology of the self-study that was used in the studies. The first subgroup in the second column indicates the study that used monitoring [24,28,33]. The second subgroup shows a qualitative assessments method [21]. The third subgroup represented the comparison method, in which self-study was compared against other intervention [18,20,23,26,27,29–31,33].

The third column represented the topic of learning. The first group in this column depicts the learning gain of self-study in students [18,20,23,24,27,29–33]. The second subgroup represent the time that was spent to learning practical skills [21]. The third subgroup represents the way in which learning can be influenced [24,25,28,30,33].

4. Discussion

In this current review, evidence has been identified, screened and synthesized to provide a comprehensive understanding of aspects of self-study that can be used to develop and consolidate practical skills (hands-on techniques) in higher education settings in the area of health profession degree courses and in medical education settings. The findings based on this set of studies demonstrated that self-study has the potential to foster practical skills in health profession students and medical students. Furthermore, self-study should be implemented in health profession and medical education curricula. These findings may have practical implications. Lecturers and persons responsible for the educational curricula should be aware of the advantages of self-study and should schedule self-study in the timetable of their curricula.

This study, including a total of 3949 students was time limited (from the year 2000 on). The observed poor quality of evidence in this study may be described by the complexity of undertaking research in the setting of higher education, along with the lack of an international agreement on definition and roles in the curriculum. The included articles were from seven different countries and three continents. Therefore, their results were not limited to a particular region or higher education

Table 2. Study characteristics of the included studies with full descriptive intervention information and results.

Author (Year)	Participants (Country) Sample size (n) Study type	Description of intervention	Key findings
Barbosa et al. [28] (2017)	Medical students (Portugal) n = 1220 Qualitative study	Students in clinical years completed a questionnaire to evaluate each clerkship. Questionnaire about time devoted to self-study per week outside the hospital for learning purposes	Self-study hours per week: least amount of time spent for Bioethics was 5.1 h per week (SD 5.0); greatest amount of time spent for Medicine rotation was 19.2 h (SD 12.4) h per week. Average of 9.8 (95% CI: 9.0–12.0) h per week in each clerkship Self-study hours allocated in curriculum? Defined as ECTS*27*SH and were scaled by subtracting the mean of allocated study hours.
Braun et al. [20] (2021)	Medical students (Germany) n = 25 IG = 13 CG = 12 Randomized controlled trial	IG: reading textbook about pulmonary function testing interpretation CG: 40 Powerpoint slides about bronchodilation studies, metacholine provocation, DLCO, and Krogh Index as well as respiratory muscular strength, tutorial videos about spirometry and body plethysmography and supportive information, including 1) a handout with a written explanation for all abbreviations, 2) a handout with the typical respiratory graphs, and 3) a flow chart with a procedural algorithm	Small knowledge gain of 12% and skills gain of 8% in IG, mean gains of the CG were 24% for knowledge and 40% for skills.
Bukowski [32] (2002)	Physiotherapy students (USA) n = 55 Cohort study	Second year students (n = 17) completed a self-study, computerized non-cadaver anatomy course. This group worked independently for the remainder of their 15-week course. Third year students (n = 20) attended weekly lectures and completed a self-study computerized non-cadaver anatomy course. First year students (n = 18) completed a cadaver anatomy course. This included weekly lectures & dissection laboratories for 15 weeks.	The results of this study determined that computerized self-study techniques may be a viable alternative to traditional cadaver laboratory and instruction in human gross anatomy courses.
Duvivier et al. [21] (2012)	Medical students (Netherlands) n = 52 Qualitative study	Six focus group interviews were carried out from years one to three. Interviews were recorded, transcribed and analyzed using quantitative methods.	Students devote 20% of self-study time to skill training with year one medical students. They practice significantly more than year three medical students.
Feeg et al. [29] (2005)	Nursing students (USA) n = 125 IG = 61 CG = 64 Non-Randomized trial	IG: Students received a CD-ROM. The CD-ROM helped nursing students learn information about Health Insurance Portability and Accountability (HIPAA). This CD integrated text and sound with a self-paced viewing of screens to hold learners' interest and allow for repetition to improve understanding. CG: no CD	Significant difference between the IG and CG in the 20-item, multiple-choice test in the pre-test (t = 1.95, p = 0.05).
Junhasavasdikul et al. [18] (2017)	Medical students (Thailand) n = 93 Randomized controlled trial	IG 1: "cartoon-style" handout on the topic basics of intercostal chest drain system: one and two-bottle IC. Participants had two weeks to study the material individually, whenever it suited them. IG 2: "traditional-style" handout on the topic basics of intercostal chest drain system: one and two-bottle IC. Participants had two weeks to study the material individually, whenever it suited them.	IG 1 achieved a score 13.8% higher than the IG 2 (p = 0.018)

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Table 2. (continued)

Author (Year)	Participants (Country) Sample size (n) Study type	Description of intervention	Key findings
Kewcharoen et al. [23] (2019)	Medical students (Thailand) n = 80 IG (fourth year): 20 IG (fifth year): 20 CG (fourth year): 20 CG (fifth year): 20 Non-Randomized controlled trial	For both groups: teaching was performed five weekly study sessions. IG: separately study of different topics of electrocardiogram on their own. CG: Different topics of electrocardiogram interpretation were assigned to tutors for teaching.	Pre-test to post-test: mean post-test score was significantly higher than the mean pre-test score in all groups A significant difference ($t_{(38)}$ = 3,91, <0.001) in mean post-test score between the fourth year CG group (17.7, SD 3.4) and the fourth year IC group (13.3, SD 3.8) was determined. A significant difference ($t_{(38)}$ = 4.70, <0.001) in mean post-test score between the fourth year CG group (9.8, SD 3.3) and the fourth year IC group (4.6, SD 3.7) was determined.
Kühl et al. [24] (2019)	Medical students (Germany) n = 192 IG 1: 76 IG 2: 78 CG: 42 Non-Randomized controlled trial	IG 1: start with an on-site phase after information e-mail 0 (students received instructions and a working sheet for self-study phase 1. Students prepare alone in self-study phase 1. Self-study phase 1 was characterized by watching videos and dealing with comprehension questions as provided in the study material. Self-study phase 2 was similar to self-study phase 1. IG 2: start with an on-site phase after information e-mail 0 (students received instructions and a working sheet for self-study phase 1. Students prepare in learning dyads in self-study phase 1. Self-study phase 1 was characterized by watching videos and dealing with comprehension questions as provided in the study material. Self-study phase 2 was similar to self-study phase 1. CG: An information e-mail was send in which were told that students' should watch three videos until on-site phase 1. during self-study phase 2, students should watch two videos. They were neither instructed to form learning dyads, nor did they receive any comprehension questions.	Significant higher acquisition of knowledge (conceptual knowledge: multiple-choice question and conditional knowledge: problem-solving question) in IG 2 compared to IG 1 and CG (p < 0.0001).
Montpetit-Tourangeau et al. [33] (2017)	Physiotherapy students (Canada) n = 61 Non-Randomized controlled trial	All students participated in a five-month pre-test phase, a 130-min guided learning phase, and a four-week self-study phase. At the start a pre-test was carried out (baseline). After each phase a post-test was performed: assess, near transfer, problem solving and conceptual knowing. After the pre-test phase, students were categorized as novice or advanced learners. They were then randomly assigned to either the concept map completion condition group or concept map study condition group. Concept map completion condition group: this group worked with an incomplete map. This map presented only concepts in boxes with rounded edges without presenting the links explaining the relationships between the concepts. The presented concepts were the main concepts of the decision-making processes. Concept map study condition group: this group worked with a visual diagram of the decision-making process.	No main learning condition effects were determined.

Peine et al. [27] (2016)	Medical Students (Germany) n = 244 Group 1: n = 61 Group 2: n = 55 Group 3: n = 52 Group 4: n = 54 Randomized controlled trial	Group 1: online course, based on Moodle web-based learning, that included 35 pages in three chapters (elearning) Group 2: non-guided self-instruction, students were divided into groups of 13–15 and assigned to individual rooms. Students received a copy of the subject catalogue with the formulated learning objectives and had to follow the subject-catalogue. Students were free to choose which method they would use to learn the subject matter: books, guidelines and internet access. All groups were supervised by a tutor to ensure a calm learning environment (self-study) Group 3: followed teacher-centered instructions (TCI) Group 4: followed seminars of four groups of 13–15 students (seminars)	Significant differences were determined between: group 1 and group 2 ($p < 0.05$), group 1 and group 3 ($p < 0.01$), group 1 and group 4 ($p < 0.001$), and group 2 and group 3 ($p < 0.05$).
Rotgans & Cleland [25] (2020)	Medical Students (Singapore) n = 120 Randomized controlled trial	For all students: video-recorded lecture (30-min) about of the function of protein synthesis in memory consolidation and reconsolidation. IG 1: listen video and self-explanation IG 2: listen video and dyadic explanation CG 1: listen video once CG 2: listen video twice	Significantly higher acquisition of learning and retention ($F = 5.67$, Wilks $\Lambda = 0.94$, $P = 0.019$, $\eta 2 = 0.05$) in IG 1 and IG 2 compared to CG 1 and CG 2. IG 2 results suggest more effective than IG 1 ($F = 3.70$, Wilks $\Lambda = 0.83$, $P = 0.002$, $\eta 2 = 0.09$)
Thomson & Lowrie [26] (2017)	Medical students (USA) n = 1170 2012: n = 156 2013: n = 171 2014: n = 174 2015: n = 167 2016: n = 170 2017: n = 164 2018: n = 168 Cohort study	The histology laboratory sessions underwent a transition from a teaching (contact hours) module to a self-study module. Students in 2012 and 2013 received histology in traditional way, in-person lectures followed by laboratories; total 31 laboratory sessions for 51 contact hours. Students in 2014 received hybrid instruction in histology; traditional laboratories and a block of five laboratories that were delivered as self-study modules; total 43.25 h. Students in 2015 and 2016 started with self-study. A few introductory laboratory sessions were kept as in-person sessions. Total contact hours were 6.25 h.	United States Medical Licensing Examination® (USMLE®) Step 1 Examination. No significant change in performance in the in-house examination ($F(2,506) = 0.676$, $p = 0.51$). Significant improvement in overall practical examination grade average was associated with the self-study modules ($F(6, 1164) = 10.213$, $p = < 0.01$). Student feedback regarding the self-study module was positive.
Thomson et al. [30] (2017)	Osteopathic medical students (USA) n = 29 Randomized controlled trial	IG: Web-based self-study group (STMM). The STMM conducted a self-study. CG: Mnemonic-use method group (MUM). The MUM followed a radiologist who applied the mnemonic method.	Learning and interpretation of chest radiograph (CXR). Examination of 20 patient cases. A case had six different entities to check. A total of 120 points were possible. The MUM group significantly improved their score versus the STMM group ($p = 0.001$).

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Table 2. (continued)

Author (Year)	Participants (Country) Sample size (n) Study type	Description of intervention	Key findings
Trinckley et al. [31] (2017)	Pharmacy students USA) n = 310 Cohort study	IG: second year pharmacy students: Phase 1: Two-week self-study phase. Students prepared an 18-page WHO patient safety document. In addition, in a prior class lecture, students were instructed to watch a 20-min video from the WHO. The patient safety educational methods implemented included a self-study and active application of root cause analysis (RCA) skills in Phase 2. The RCA activities were twofold and included in-class activities (Phase 2) followed by an experiential activity conducted during their Introductory Pharmacy Practice Experiential CG: third-year pharmacy students: had no formal patient safety education	Compared to third year pharmacy students, second year students demonstrated more patient safety ($p = 0.0092$).
Van Lankfeld et al. [34] (2019)	Physiotherapy students n = 173 (Netherlands) IG: n = 35 CG: n = 138 Non-Randomized controlled study	IG: Self-directed learning conditions – minimum competence outcomes of the learning program and the related assessments were pre-defined. Students identified their learning need and developed learning activities based on their learning need and self-drive. Teacher guided students during this process as coach. CG: students followed TCI	No difference between knowledge and performance for both groups.

program, which resulted in heterogeneity in study objectives, results, and interpretation.

Regarding the research question “what is known about the use of self-study/guided self-study in health professional education and medical education curriculum?” it can be stated that individual self-study method was used in seven out of 15 higher education studies. In individual self-study, the teacher defines the tasks and the students themselves decide on the place, time and scope of the learning [2,3]. The tasks refer to the current learning content of the curriculum [2]. Moreover, self-study includes the amount of students' workload spent on the independent development and acquisition of curricular content. In particular, Landwehr and Müller [2] described self-study in detail on the basis of three characteristics: 1. The external structure of the academic course can be determined by the students themselves within the framework of defined guidelines 2. The detailed structure of the process of the learning process and working process is essentially determined by the students themselves. 3. The presence of university lecturers is possible, but not an essential element for this type of study course.

None of the included studies defined the term self-study. Since the beginning of the Bologna Process in the year 1999, self-study was formally given priority alongside the required time of face-to-face study in bachelor's/master's degree programs. However, it should be noted that self-study was already carried out in advance of the Bologna reform. The Latin word “studere” means ‘to make an effort’ or ‘to strive for’. According to Kless [36] the concept of self-study can be described as pleonasm, since the concept of self is redundant and indicates that students are ‘engaged’ or ‘strive for something themselves’.

The second research question was “what is the appropriateness of self-study/guided self-study for promoting practical skills (hands-on) in health professional education and medical education?” The meta-analysis based on this limited set of studies showed that self-study has the potential to consolidate and enhance practical skills (hands-on) as compared to traditional teaching ($SDM = 0.30$, 95% CI: 0.13–0.48). The methods that should be used for self-study are instruction during the self-study phase, individual self-explanation, and dyadic explanation. These findings are helpful, because learning occur in self-study phases and not during teaching in classrooms. Gramache [37] postulated that university students may lack an understanding of what exactly learning at the university level involves. Learning at the university should allow

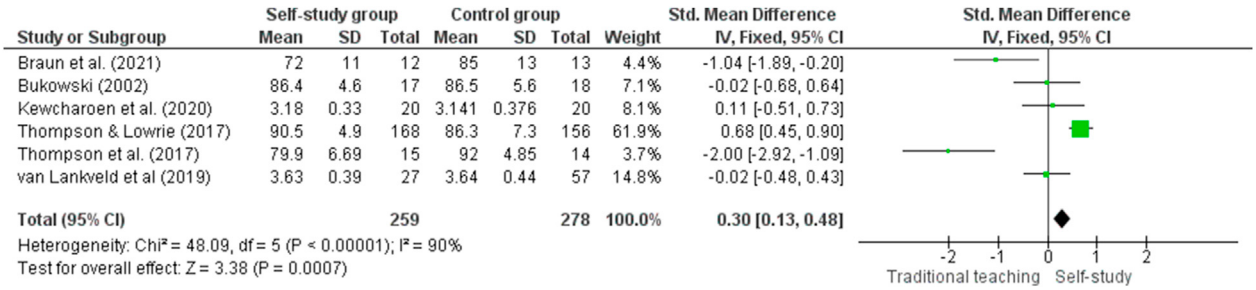

Fig. 2. Forest plot showing effects between self-study and traditional teaching.

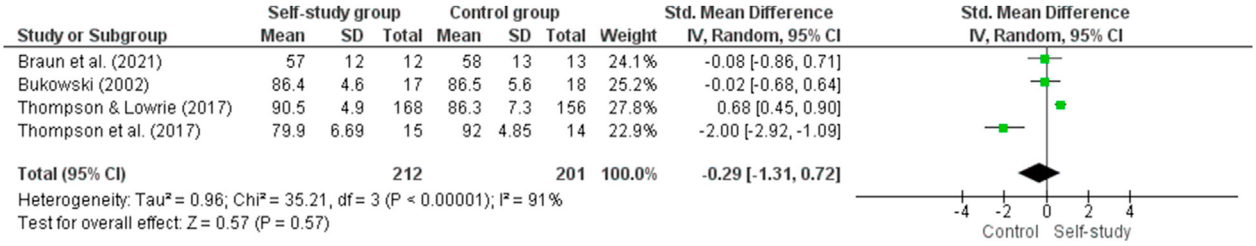

Fig. 3. Forest plot of sensitive analysis showing effects between self-study and traditional teaching.

Table 3. Overview of the categorized groups.

Self-study	Methodology self-study	Learning
Using individual self-study	Monitoring self-study	Changes in knowledge gain and practical skills
Feeg et al. [29]	Barbosa et al. [28]	Braun et al. [34]
Bukowski [32]	Kühl et al. [42]	Bukowski [32]
Braun et al. [34]	Montpetit-Tourangeau et al. [43]	Feeg et al. [29]
Junhasavasdikul et al. [18]		Junhasavasdikul et al. [18]
Kewcharoen et al. [37]		Kewcharoen et al. [37]
Kühl et al. [42]		Kühl et al. [42]
Thomson & Lowrie [35]		Montpetit-Tourangeau et al. [43]
Thomson et al. [30]		Thomson et al. [30]
Peine et al. [27]		Trinkley et al. [31]
Trinkley et al. [31]		Peine et al. [27]
Van Lankfeld et al. [34]		Van Lankfeld et al. [34]
	Interview about self-study	Students spend time to practice hands-on skills
	Duvivier et al. [21]	Duvivier et al. [21]
Students' workload for learning	Comparison intervention between self-study and teaching methods	Influence learning strategy
Barbosa et al. [28]	Braun et al. [34]	Barbosa et al. [28]
	Feeg et al. [29]	Kühl et al. [42]
	Junhasavasdikul et al. [18]	Montpetit-Tourangeau et al. [43]
	Kewcharoen et al. [37]	Rotgans & Cleland [39]
	Montpetit-Tourangeau et al. [43]	Thomson et al. [30]
	Thomson & Lowrie [35]	
	Trinkley et al. [31]	
	Thomson et al. [30]	
	Peine et al. [27]	
	Van Lankfeld et al. [34]	

students to easily adapt to the university environment, determine their academic goals, and develop their academic and individual skills. Throughout the learning process, the majority of students need learning assistance in order to be successful within the educational system and beyond [38]. Professional support that includes comprehensive strategies enabling students to be successful in their studies should be provided by universities [39]. Therefore, self-study/guided self-study should be structured in the timetable in such a way that both individual learning and dyad or group learning are possible. Guidance during the working phase should be ensured by a university lecturer (or a tutor). Self-study/guided self-study should be designed to allow for a combination of individual learning, group learning, and dyad, if possible. This learning arrangement combined with a guiding should be designed in such a way that the students are motivated and able to act autonomously, at least in certain areas. Jones and Kember [40] described that physiotherapy students' propensity towards a deep self-learning approach if university replace traditional instruction with self-learning packages in their curricula.

Herren [41] proposed the didactic method of problem-based learning as a good method to prepare guided self-study sessions. During the problem-based learning method, students can define learning objectives and orders can be created so that the students can work individually or can work in groups. According to Landwehr and Mueller [2] the workload of a module should be offered as follows: 40% frontal teaching, 40% guided self-study and 20% individual study. This combination of learning methods enables self-study learning within a workload setting of 30 Credits. The design of guided self-study should be structured in such a way that a combination of individual learning, group learning, and accompaniment is possible.

4.1. Limitation of this study

A limitation is that we include only English language articles and German language articles. As a consequence, some relevant articles might have been missed. We have searched at the electronical databases CINAHL, Embase, ERIC, PubMed and Web of Science. These databases are relevant for this topic. However, there is a chance of lacking relevant articles because of not searching in other databases such as Cochrane or PsycINFO. These databases cover disciplines relevant to the health professional education and medical education topic.

5. Conclusion

The synthesis of 15 articles in this present study resulted that self-study/guided self-study is being applied in the higher education landscape of health professions education as well as in medical education. The individual self-study is used for this purpose. This present study determine that health professional students or medical students can consolidate or develop practical skills (hands-on) during self-study/guided self-study phase. Self-study/guided self-study should be structured in such a way that individual learning, dyad and group learning are possible. We recommended a distribution of curriculum workloads of 40% frontal teaching, 40% of individual self-study and 20% guided self-study by a lecturer/tutor/peer.

Ethical approval

No ethical approval is necessary for this type of study.

Author contributions

Conceptualization: Slavko Rogan, Jan Taeymans, Evert Zinzen; Writing – original draft: Slavko Rogan: Writing – reviewing & Editing: Jan Taeymans, Evert Zinzen.

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Conflict of interest

The authors declare that this paper was conducted in the absence of any financial relationships that could be construed as a potential conflict of interest.

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Appendix

Appendix Table 1. Quality appraisal qualitative studies.

	Barbosa et al. [34]	Duvivier et al. [36]	%
Is there congruity between the stated philosophical perspective and the research methodology?	Y	Y	100
Is there congruity between the research methodology and the research question or objectives?	Y	Y	100
Is there congruity between the research methodology and the methods used to collect data?	Y	Y	100
Is there congruity between the research methodology and the representation and analysis of data?	Y	Y	100
Is there congruity between the research methodology and the interpretation of results?	Y	Y	100
Are participants, and their voices, adequately represented?	Y	Y	100
Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	Y	Y	100
Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	N/A	N	6.3

Appendix Table 2. Quality appraisal cohort studies.

	Bukowski [32]	Thomson & Lowrie [26]	Trinckley et al. [31]	%
Were the two groups similar and recruited from the same population?	Y	Y	Y	100
Were the exposures measured similarly to assign people to both exposed and unexposed groups?	Y	N	Y	67
Was the exposure measured in a valid and reliable way?	N	Y	N	33
Were confounding factors identified?	N	N	N	0
Were strategies to deal with confounding factors stated?	N	N	N	0
Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Y	Y	Y	100
Were the outcomes measured in a valid and reliable way?	N	Y	N	33
Was the follow up time reported and sufficient to be long enough for outcomes to occur?	N	N	N	0
Was appropriate statistical analysis used?	Y	Y	Y	100

Appendix Table 3. Quality appraisal randomized controlled trials.

	Braun et al. [20]	Junhasavasdikul et al. [18]	Peine et al. [27]	Rotgans & Cleland [25]	Thomson et al. [30]	%
Was true randomization used for assignment of participants to treatment groups?	N	Y	Y	Y	Y	75
Was allocation to treatment groups concealed?	N	N	Y	N	N	20
Were treatment groups similar at the baseline?	Y	N/A	Y	Y	Y	88
Were participants blind to treatment assignment?	N	N	N	N	N	0
Were those delivering treatment blind to treatment assignment?	N	N	N	N	N	0
Were outcomes assessors blind to treatment assignment?	N	N	N	N	N	0
Were treatment groups treated identically other than the intervention of interest?	Y	Y	Y	Y	Y	100
Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	N/A	N	N	Y	N	10

(*continued on next page*)

Appendix Table 3. (continued)

	Braun et al. [20]	Junhasavasdikul et al. [18]	Peine et al. [27]	Rotgans & Cleland [25]	Thomson et al. [30]	%
Were participants analyzed in the groups to which they were randomized?	Y	Y	Y	Y	Y	100
Were outcomes measured in the same way for treatment groups?	Y	Y	Y	Y	Y	100
Were outcomes measured in a reliable way?	N	N	Y	N/A	N	30
Was appropriate statistical analysis used?	Y	Y	Y	Y	Y	100
Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	N/A	N/A	Y	N	N	40

Appendix Table 4. Quality appraisal non-randomized controlled trials.

	Feeg et al. [29]	Kewcharoen et al. [38]	Kühl et al. [42]	Montpetit-Tourangeau et al. [33]	Van Lankfeld et al. [34]	%
Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	Y	Y	Y	Y	Y	100
Were the participants included in any comparisons similar?	N	Y	Y	Y	Y	80
Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Y	Y	Y	Y	Y	100
Was there a control group?	Y	Y	Y	N	Y	80
Were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Y	Y	Y	Y	Y	100
Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	N	N	N	N/A	Y	30
Were the outcomes of participants included in any comparisons measured in the same way?	Y	Y	Y	Y	Y	100
Were outcomes measured in a reliable way?	N	N	Y	Y	Y	60
Was appropriate statistical analysis used?	N	N	Y	Y	Y	60

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