The Effectiveness of Critical Thinking Instructional Strategies in Health Professions Education: A Systematic Review

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This review intends to reveal the current status of the instructional practices used to enhance Critical Thinking (CrT), Clinical Reasoning (CR) and Clinical Judgement (CJ) skills and dispositions in Health Sciences Higher Education programmes. After a three-step filtering process, 28 empirical studies on the effectiveness of the instructional strategies were analysed, following PICOS methodology. The analysis tackled the type of strategy, methods and outcomes, the research design, and assessment tools used. Diverse instructional designs, different in length, were used with variable success when compared with traditional lecturing. Several limitations were found, such as insufficient information regarding the intervention design and the alignment between learning outcomes and the assessment instruments. Due to the variability in sample sizes and research designs, it is difficult to conclude on the effectiveness of particular instructional strategies. Researchers ought to recognize the concerns herein discussed when designing, implementing and assessing future interventions.

Keywords: critical thinking; clinical reasoning; clinical judgement; higher education; instructional strategies; systematic review

Introduction

Health education stakeholders expect graduates not only to master the core scientific and technical knowledge of the profession, but also advanced thinking skills and dispositions allowing them to engage in reasoning and judgment processes, mainly in the complex and uncertain nature of healthcare situations (e.g., in an emergency) (Hildenbrand and Schultz 2012; Aglen 2016; Dominguez 2018).

Critical thinking (CrT), understood herein as collection of skills and dispositions leading to the purposeful reflective process that results in the interpretation, analysis, and evaluation of data, as well as the use of multiple considerations (e.g., evidential, conceptual, methodological, criteriological, or contextual) to reach a judgment (Cruz, Payan-Carreira, and Dominguez 2017).

Some argue that CrT conceptualization has slight nuances depending on the disciplinary and practice contexts in which the thinking takes place (White & Kahlke, 2013). As recently demonstrated, different fields have particular understandings of CrT skills and dispositions, albeit sharing common conceptualization of CrT traits (ca. Dominguez, 2018, pp. 57-58; Kahlke & Eva, 2018). Participants from the biomedical field see Critical Thinking and Clinical Reasoning (CR) as nearly synonymous (Kahlke & Eva, 2018), echoing those arguing that CrT and CR share skills and attitudes (White & Kahlke, 2013; Alfaro-LeFevre 2015) and have overlapping conceptualization. Accordingly, in the literature tackling CrT in the medical field CrT, CR and Clinical Judgment (CJ) are terms often used interchangeably to describe the processes used to solve complex clinical problems and reach a clinical decision in the clinical practice (Faucher, 2011). CR is understood as the deliberate CrT process over a clinical situation to reach a reasonable decision regarding an outcome, a diagnosis, a therapeutic action or the resolution of a particular patient problem (Hawkins, Elder, and Paul; 2013; Ten Cate, 2018). Clear links can be established between CrT and CR (Christensen et al., 2008): the intentional commitment to raise well-formulated and clear questions; to gather and assess relevant information; to think open-mindedly the available alternatives; to recognize and assess assumptions, implications and its associated practical consequences; to communicate effectively with others in engaging with and finding solutions to complex situations. Like CrT, CR requires a constant monitoring to judge the reasonableness of thinking and reflexivity, as well as the use of self-correction

(Behar-Horenstein, Schneider-Mitchell, and Graff, 2009). Metacognition is present in the entire process of reasoning in health professions.

CJ refers to the interpretation, conclusion or action regarding a patient's needs, concerns or health problems (Tanner 2006; Victor-Chmil 2013). Albeit CJ is enhanced with practice and experience, it also entails knowledge and continuous critical analysis (Kienle and Kiene, 2011). The dimensions associated with CJ include evaluation (focused observation), interpretation, a confident and flexible decision making and effective reflection (Tanner 2006; van Graan, and Williams, 2017), which are also recognised as CrT skills.

For health professionals, CrT is particularly important to improve reasoning during diagnosis (e.g., pattern recognition, medical screening), prescription (e.g., to assess alternative scenarios or prioritize actions in a time-bound situation), and follow-up treatment of a specific patient, as well as to self-monitor their own performance during the clinical practice (Dominguez 2018). According to Alfaro-LeFevre (2015), CR and CJ are key features of CrT.

Albeit CrT/CR/CJ domains emphasize slightly different aspects of behaviour, in health literature they are often seemed as synonyms. Aiming to include as many possible relevant literature that addresses high-order thinking, the three terms were included in the search. They are strongly related to evidence-based practice (Aglen 2016) and clinical decision-making (Higgs and Jones 2008), involving the interplay between the cognitive and metacognitive components. They also involve the clinical attitudes and caregiving behaviour showed through the actions and behaviours of a sound health professional (Facione and Facione 2008; Victor-Chmil 2013).

CrT is an essential skill for competent healthcare professionals. It has been shown that round 75% of the diagnostic errors, albeit multifactorial in origin, may be attributed to cognitive biases or flaws (Graber, Franklin, and Gordon, 2005). Over the past decades, the acquisition of CrT/CR/CJ skills and dispositions during the academic course has recaptured the interest of Higher Education Institutions (HEI), namely on how they can be enhanced to facilitate the transition of newly graduates to the workforce. By reducing the gap between theory and practice, HEI will empower the recent graduates and ease their integration into a team or service of health professionals, guaranteeing the stability (quality and safety) of the service provided to patients. This expectation resulted in a variety of strategies and instructional methods used to promote, attain and enhance the acquisition of CrT/CR/CJ in students of healthcare professions (Chan 2016).

Huang, Newman and Schwartzstein (2014) argued that strategies used to foster CrT among students must be action- and problem-oriented, compelling the students to justify their discussions and self-reflect on their thinking process, forcing them to think explicit and apply knowledge. Some experimental studies that examined the impact of specific educational interventions in development of CrT/CR/CJ skills, recognized Problem-Based Learning (PBL), concept mapping and simulation as the most effective and commonly used strategies in health education (Chan 2016; Oliveira et al. 2016).

Despite the increasing research interest in the topic, different limitations and future needs have been identified (Simpson and Courtney 2002). For instance, the scarce existence of unequivocal evidences about the effectiveness of these strategies in the development of CrT/CR/CJ skills and dispositions of undergraduate students in health-related programmes, regarding not only the permanency but also its transferability into the future professional practice (Lapkin et al. 2010). Other concerns remain, such as the small sample size, the lack of research designs using randomized pre-test/post-test format (Kong et al. 2014), and the different validity and reliability of the assessment instruments applied, which might influence the outcome (Abrami et al. 2008; Behar-Horenstein and Niu 2011; Tiruneh, Verburgh, and Elen 2014; Aglen 2016; Cruz, Payan-Carreira, and Dominguez 2017).

This review intends to assess the status of current instructional practices in enhancing CrT/CR/CJ skills and dispositions in HEI students in health-related programmes, through the analysis of different scientific sources reporting the value of learning strategies employed in undergraduate or graduate programmes.

Methods

To evaluate the current status of the CrT/CR/CJ teaching and instruction reported in the English-language literature in the Health Sciences education field, we employed a systematic literature search in five online databases, namely the *PubMed* (National Center for Biotechnology Information, NCBI), *Web of Science* (Core Collection, Clarivate Analytics), *Scopus* (Elsevier), *EBSCO* and *Scielo* (Scientific Electronic Library Online). The following Boolean search combination of phrases was used: ("Critical thinking" OR "Clinical reasoning" OR "Clinical judgement") AND (skill OR ability OR disposition OR attitude) AND (High* education OR universities OR faculties OR tertiary education OR college) AND (Interventions OR strategies OR practice OR train*) AND (Clinical Sciences OR Health OR Medicine OR nursing).

The inclusion and exclusion criteria applied in this review (Figure 1), defined before the literature search, were developed using the **PICOS** tool (Methley et al. 2014):

P (Population) – BSc. and MSc. students of health-related programmes;

I (Interventions) **–** CrT/CR/CJ instructional strategies;
C (Comparison) **–** CrT/CR/CJ instructional strategies and assessment tools by targeted learning outcomes;
O (Outcomes) – The effective development of CrT/CR/CJ skills and dispositions based on different instructional strategies and assessment tools;
S (Study Design) **–** Any quantitative study.

The initial set of retrieved papers (n=1059) was submitted to a stepwise filtering process (Figure 2). Step 1 used the title, language, type of paper (e.g., conference proceedings, book chapter, thesis or dissertations), and date as screening determinants; in step 2, the abstract was screened by applying the exclusion criteria (no access to the full text; review or non-empirical paper; not concerning the BSc or MSc levels; out of the health sciences field; poor description of the intervention, without assessment of CrT/CR/CJ skills or dispositions; poor or fairly description of the instrument used to asses skills or dispositions; use of mixed methods), while in step 3 the same criteria were applied to the full paper. In the end, 28 articles were extracted matching the defined criteria and presenting good quality for the research methodology (clear description of the instructional strategy, targeted skills/dispositions and assessment descriptors, and quantitative assessment of the learning outcomes/gains). Extracted papers were then analysed using a specific rubric (Supplementary Table 1), created to retrieve relevant data and to appraise the publications. The intervention approach was categorized as general (i.e., CrT/CR/CJ principles are learned independently of the subject content), infusive (i.e., CrT/CR/CJ principles, subject-related, are made explicit to the students), immersive (i.e., CrT/CR/CJ principles, subject-related, are not made explicit to the students) or mixed (i.e., the general approach is combined with one of the other two) (Ennis 1989). As most interventions deployed more than one strategy (e.g., self-study, authentic situations, lecture-discussions, debriefing, role-play), only the main strategy(ies) focused in the CrT/CR/CJ assessment was used to categorize the intervention approach. Each paper was analysed jointly by two reviewers.

In the analysis, the different learning strategies were grouped into three main domains based on their aims and targeted learning outcomes: CrT strategies, CR strategies or CJ strategies. A large variety of instruments and tools were used to measure CrT/CR/CJ, and were categorised as follows:

(1) General Standardized Tests (referred in 7 papers)– Non-specific domain tests with general use and application measuring CrT skills and dispositions [e.g., The California Critical Thinking Skills Test (CCTST), The Cornell Critical Thinking Test (CCTTZ) - Level Z];

(2) Domain-specific Standardized Tests (referred in 14 papers) – used specifically in health sciences domain to measure CrT/CR/CJ skills and dispositions [e.g., The Health Science Reasoning Test (HSRT) or the Objective Structured Clinical Examination (OSCE)];

(3) Domain-specific Rubrics, Surveys or Questionnaires (referred in 8 papers) – usually non-standardized and of a self-report type, created or used by the researchers to specifically evaluate the learning experience, namely the students' knowledge retention, self-confidence, satisfaction (e.g., The Diagnostic Thinking Inventory, Comprehensive Course-Exams, Clinical Follow-up Questionnaire).

Regarding the enhancement of CrT/CR/CJ skills or dispositions, the outcomes were categorised as follows:

(1) General gain (++) – when a statistically significant gain in terms of general set of CrT/CR/CJ skills or dispositions was verified (e.g., general score of a standardized test or rubric)

(2) Specific gain (+) – when a statistically significant gain was reported for a specific CrT/CR/CJ skill or disposition (e.g., individual score relative to a specific item of a standardized test or rubric);

(3) No gain (-) – when no statistically significant gain, in either a specific or a set of CrT/CR/CJ skill or disposition was mentioned.

Results

Population

Of the 28 papers found suitable for the review, 20 reported interventions in Nursing and four in Medicine; other programmes were only sporadically represented (Figure 3). Only one study involved MSc students, all the other addressed BSc programmes (Supplementary Table 2). A variable sample size was found, the smallest one with 23 (Kiran et al. 2016) and the largest with 382 students (Han et al. 2014).

Interventions

Regarding the instructional approach, 82% (23/28) of the papers used immersion and one the infusion (4%), while 4 papers (14%) used the mixed approach (Supplementary Table 2). A variety of learning strategies were used to foster CrT/CR/CJ skills and dispositions in Health Sciences students (Figure 4). The most frequently used was simulation (32%; 9/28), followed by PBL (18%; 5/28) and reflective writing (14%; 4/28). The case-based learning (CBL) and concept maps were mentioned in three papers (11%) (Supplementary Table 2), while debriefing (Dreifuerst 2012) or systems engineering (e.g., flow analysis techniques; Simpson, McComb, and Kirkpatrick 2017) were mentioned as the main learning strategy. Two papers investigated a combination of strategies. One combined CBL and game-based learning with role-playing

(DeSimone 2016), while another used CBL with both simulation and lectures (Ahn and Kim 2015).

There were slight variances in the application of the simulation learning strategies. Some interventions used video simulation (Sharpnack et al. 2013), other used virtual patients (Reinhardt et al. 2012; Allaire 2015; Kim and Kim 2015; Kleinert et al. 2015), or physical manikins (Wood and Toronto 2012; Shin and Kim 2014; Ahn and Kim 2015; Park et al. 2017).

Although the duration of the interventions was not mentioned in 6 of the 28 studies (Kaddoura 2011; Reinhardt et al. 2012; Lindsey and Jenkins 2013; Wojcikowski and Brownie 2013; Kleinert et al. 2015; Yu et al. 2015), in the remainder studies it was quite variable. In four studies, the interventions were shorter than two days (2-hour in Wood and Toronto 2012; 3-hour in Lee et al. 2010; 4-hour in Dreifuerst, 2012; and 30-hour in Park et al. 2017). In 18 studies, interventions length ranged from three weeks (Shin and Kim 2014) to one year (Allaire 2015; DeSimone 2016; Kiran et al. 2016; Simpson, McComb, and Kirkpatrick 2017; Zhang et al. 2017) (Supplementary table 2; Figure 5). In eight studies, it took around one semester (between 12 and 17 weeks, or three months; n=8) (Supplementary table 2).

Comparison

Of the 28 papers, 57% (16/28) described the learning strategies used to enhance CrT skills in health sciences students, eight (29%) addressed the development of CR, while only four papers (14%) tackled the development of CJ skills or dispositions (Figure 6; Supplementary table 3). Supplementary Table 4 summarizes the learning outcomes established for those activities.

Figure 7 compares the assessment instruments used to evaluate the proposed learning outcomes. Some of the studies (n=11) used a combination of two or more instruments, such as general or domain-specific standardized tests together with a domain-specific rubric, survey or questionnaire. Overall, the general standardized tests were used to measure CrT skills or dispositions (e.g., Kaddoura, Van-Dyke, and Yang 2016), whereas the domain-specific standardized tests, rubrics, surveys or questionnaires were mostly used to assess CR and CJ (e.g., Raupach et al. 2016, or Arrue et al. 2017).

Outcomes and Study design

The majority of the papers (25/28) measured the gains through the statistical significance of the results obtained in each intervention (the P-value) but did not assess the size effect (substantive significance) that could provide information on the magnitude of the differences between groups. Therefore, from this point of the manuscript, gains are reported only in terms of statistical significance.

From the papers reporting 'Immersion' (n=23) general and specific gains in CrT/CR/CJ were reported in 70% (16/23) and 44% (10/23) of the cases, whereas 13% (3/23) reported no gains. Respecting the 'Mixed' instructional approach (n=4), three of the papers reported the existence of general gains, while no gains whatsoever were obtained in the other paper. The sole paper reporting the use of 'Infusion' referred to have found general CrT/CR/CJ gains.

Figure 8 summarizes the reported CrT/CR/CJ gains considering the instructional strategy described. In five papers, both general and specific gains in CrT/CR/CJ skills or dispositions were reported (Chen et al. 2011; Shin and Kim 2014; Kiran et al. 2016; Simpson, McComb, and Kirkpatrick 2017; Zhang et al. 2017). Four of these studies described mid/long-term interventions (between 15 weeks and 12 months) in experimental or quasi-experimental designs (with control group and pre/post-test). However, all of them differed regarding the strategies (e.g., concept mapping, reflective writing, systems engineering and simulation), CT approaches (e.g., mixed, immersion), or CT measures (e.g., CrT general standardized tests, CJ domain-specific standardized tests or rubrics).

Although most learning strategies reported general or specific gains (Supplementary table 3), four papers obtained no gains in students´ CrT/CT/CJ skills or dispositions. From the latter, three cases described particular strategies, such as high-fidelity computer-assisted simulation (Reinhardt et al. 2012; Allaire 2015), CBL using generic or individualized reflective feedback (Wojcikowski and Brownie 2013), and a comparison between high-fidelity simulation and lecturing plus CBL (Ahn and Kim 2015).

The duration of the intervention apparently did not affect CrT/CR/CJ gain (Figure 9), because both short-term (<2-day to one semester) and mid-term interventions (6 - 12 months) reported general or specific as well as no gains (Supplementary table 3). Furthermore, none of the 28 papers analysed the permanency of reported gains or its transferability into other situations.

Table 1 summarizes the information regarding the study design described in the extracted papers. From those papers, 68% (19/28) reported experimental or quasi-experimental studies using pre- and post-test designs, while 21% (6/28) reported exploratory descriptive studies. The use of a control group was found in 20 of the 28 studies. Only two papers presented comparative descriptive studies of two strategies with post-test design (Kaddoura 2011; Wojcikowski and Brownie 2013), and one study presented a longitudinal and follow-up design (Lee et al. 2013). All these studies reported general and/or specific gains (Table 1).

Figure 10 summarizes the outcomes reported in the papers resulting from different assessment instruments. Overall, studies using domain-specific rubrics, surveys or questionnaires mainly reported no gains in students' acquisition of CrT/CR/CJ skills and dispositions. Fewer improvements in the development of students' skills or dispositions were reported in studies using domain-specific standardized tests even though three of the papers reported general or specific gains using domain-specific assessment tools where no gains were detected by general standardized tests (or vice-versa) (Yu et al. 2015; ZarifSanaiey, Amini, and Saadat 2016; Ferguson et al. 2017).

Discussion

Regarding the effectiveness of instructional approaches, Immersion was adopted in the majority of the studies analysed (over 80%), and reported significant improvements of both general and specific gains in CrT/CR/CJ. This suggests that embedding CrT/CR/CJ instruction within specific subject matter courses instead of teaching it in separate classes may be more helpful for students' success, which agrees with findings in previous studies (Abrami et al. 2008; Behar-Horenstein and Niu 2011; Tiruneh, Verburgh, and Elen 2014). Notwithstanding, due to the uneven representativeness in instructional approach in the analysed papers, it was impossible to outline any recommendation. Besides, due to the absence of information, it is impossible to drawn a conclusion on which approach would allow better acquisition, permanency or transferability of CrT/CR/CJ skills or dispositions.

Most studies in this review focused on the effectiveness of learning strategies to enhance CrT or CR skills; those focusing on fostering dispositions were limited. Mostly they focused the development of CrT skills transversal to different fields, being oblivious of the specificities of the professional practice and the skills or disposition foreseen by stakeholders in recent-graduates (Dominguez, 2018). On the other hand, studies focusing in CR and CJ were profession-oriented, and targeted the development of diagnostic and decision-making skills.

Conversely, the majority of the studies reported short-term interventions, raising the question of whether the effective gains reported will remain through professional life. In fact, regarding the gains reported for interventions shorter than 2 days, one could question if those gains were indeed associated to the intervention described or might result from the natural increase in specific core knowledge in multiple clinical subjects. Permanency and transferability related issues were not addressed in any of the papers analysed, thereby leading to a serious gap regarding the assessment of the efficiency of learning strategies designed to enhance CrT/CR/CJ. Notwithstanding, this review suggests that the duration of an intervention is an insufficient condition for the development of CrT/CR/CJ skills and dispositions, although probably is a necessary condition to obtain significant changes. This assumption results from the comparison the studies by Shin and Kim (2014), Simpson, McComb, and Kirkpatrick. (2017), and Zhang et al. (2017) – which obtained general plus specific gains assessed by standardized CrT tests following long-term interventions – with those of Wood and Toronto (2012) and Naber and Wyatt (2014) – that used the same or identical tests after shorter interventions and reported only specific or no gains. We agree with Masek and Yamin (2011) who defend that CrT/CR/CJ dispositions or skills will most likely happen over an extended period.

In this review, it was not easy to extract clear evidence on the most effective learning strategy to enhance CrT/CR/CJ. When comparing different strategies, in general, the most effective seems to be the simulation and reflective writing, followed by concept mapping, PBL, and CBL. Besides, comparing the studies using the same strategy, its effects on students' CrT/CR/CJ were not similar, and for any instructional strategy, there were studies reporting conflictual outcomes. Furthermore, most studies compared the effectiveness of the strategy with traditional and non-active learning strategies (e.g., lecturing with delivering of the course material by the teachers). Only one study compared two active strategies (Ahn and Yeom 2014), namely simulation *vs.* lecture plus CBL, but neither achieved any gain. Caution must be taken as the study relies only upon a post-test assessment. In another study, significant gains were reported in the students' practical learning, but not on CrT/CR/CJ development, when simulation-based training was used instead of integrated training (simulation with PBL strategies) (Zarifsanaiey, Amini, and Saadat 2016). The reasons that may explain these controversial results include differences in the instructional strategies and design principles employed, diverse student- and teacher-related variables, or the CrT assessment tools (Behar-Horenstein and Niu 2011; Tiruneh, Verburgh, and Elen 2014).

Even though most papers have focused only on the main instructional strategy employed by the teachers/researchers, in many cases the reported intervention was a combination of different strategies, which were poorly described and often without presenting an instruction design rationale. It seems that a good instructional design framework (e.g., Jonassen 2000; Merrill 2015; van Merriënboer and Kirschner 2018) is lacking for most of the studies. For instance, most PBL studies lack an explicit analysis of the nature of problems to be solved (e.g., well-structured vs. ill-structured, level of complexity, domain specificity; ca. Jonassen 2000 for a review) and explanations of the chosen teaching methods (e.g., goal-free problems, worked examples, completion or conventional problems; see van Merriënboer and Sweller 2005 for an overview of methods). Developing CrT/CR/CJ skills represents complex learning, challenging as it is likely to involve the learner to coordinate and integrate a number of skills (e.g. interpretation, analysis and evaluation) to perform real-life tasks (van Merriënboer, Schuurman, de Croock, and Paas 2002). The acquisition of such a coordinated and integrated set of knowledge and skills requires deliberate practice that is carefully designed (Clark 1988; Ericsson 1993; van Merriënboer, Schuurman, de Croock, and Paas 2002). In the field of instructional design, evidence-based frameworks have been well-established. For instance, the 4-Components instructional design model (van Merriënboer and Kirschner 2018), is considered one of the effective instructional design models for designing powerful learning environments that facilitate the acquisition of integrated sets of knowledge and skills (Merrill 2002, 2006; van Merriënboer and Paas 2003). However, little is mentioned in the reviewed literature on CrT, CR or CJ instruction, which is considered an important limitation. Without a clear design rationale, it is harder to make inferences on the purposefulness and appropriate assess the effectiveness of the instructional strategies (Tiruneh, Verburgh, and Elen 2014).

Another concern arising from this review is the suitability of the assessment tools (tests *vs.* rubrics or surveys; standardized vs. non-standardized) used to quantify the learning gains. Many authors of reviewed papers did not succeed to assess the targeted CrT/CR/CJ skills and dispositions. In agreement with Chan (2016), most of the CrT/CR/CJ focused on the results of summative assessment and poorly monitored them during the learning process.

CrT standardized tests were the most used type of assessment instruments, and also the ones that less commonly showed general CrT/CR/CJ gains, compared with domain-specific standardized tests. In a few papers, these were used in combination with non-standardized tests (e.g., domain-specific rubrics, surveys or questionnaires).

Ferguson et al. (2017) used the Cornell Critical Thinking Test (CCTTZ, Level Z) and a rubric to assess the students' CrT during and after some Clinical Critical Thinking (CCT) exercises; the latter revealed significant results that were not detected with the CCTTZ, suggesting that different competencies have been captured with different assessment instruments. However, most rubrics or surveys used in the extracted papers had not been screened for validity and reliability, which is a weakness in itself. When researchers decide to use one type or combine different types of measures, the decision needs to be supported by a clear justification.

In this review, most papers used the statistical significance (the P-value) as the only measure of the effectiveness of CrT/CR/CJ learning strategies, which is a critical limitation. An intervention may affect students' learning, as it may impact learning in different degrees. Different measures can be used to report the size effect of each intervention (e.g., Cohen's d, Hedges' g, Glass's ∂; Sullivan and Feinn 2012) to emphasize the difference in CrT/CR/CJ outcomes.

The lack of proper controls and methodological rigour when using quasi-experimental and descriptive designs represents another concern in this review. A large part of the analysed studies adopted quasi-experimental designs, with convenience samples or descriptive designs, without a control group and using only a post-test assessment. As suggested in previous studies (Lapkin et al. 2010; Behar-Horenstein and Niu 2011; Oliveira et al. 2016), future research requires better description of the design and methodology, which can be improved by including design elements such as random assignment, matching and stratifying, post-test observations of non-equivalent dependent variables, and repeated pre-tests over time.

Conclusion

The present review confirmed that learning strategies that actively engage students in learning, along with longer interventions, might be preferred than traditional lectures to enhance CrT/CR/CJ skills and dispositions. However, the limited number of studies comparing different active strategies, along with the lack of a solid theoretical background and characterization of the intervention design, the variability of the sampled population, and the type of assessment instruments, impairs the comparison of the effectiveness of the described learning activities. Briefly, we strongly belief that better studies are needed.

The limitations identified above sought to be carefully considered when describing the outcomes of activities suitable for the development of CrT/CR/CJ (e.g., targeted skills and outcomes, learning tasks, students' roles, teachers' guidance). The empirical evidence, in general, is inconclusive regarding the effectiveness of the strategies in the teaching and learning of CrT/CR/CJ skills. This might be explained by the lack of information on the instructional principles applied in the design, the alignment between the targeted learning outcomes and the assessment during and/or after the learning process, the variability in the sample size or the research design. Therefore, practical suggestions to future reports include the following: Interventions must be carefully designed and attending to different critical elements, such as the roles of the learning facilitator/tutor and of students, the explicitness of the targeted skills and outcomes, learning tasks, teachers' guidance. Additional research should address internal validity threats (e.g., by adopting at least quasi-experimental designs with randomized sampling), use larger sample sizes and be cautious about controlling variables such as age, gender, academic achievement, and teachers' pedagogical knowledge. It is also crucial that future studies also gather information on the permanency and transferability of CrT/CR/CJ gains and explore the alignment of the proposed educational output with the workplace expectations. We recommend that teachers do not take what they read from empirical studies without recognizing the limitations mentioned before. No "magic recipe" exists. Thus each one should follow the complex and harder pathway for design each activity, considering the different aspects and concerns herein discussed.

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Figures and Captions

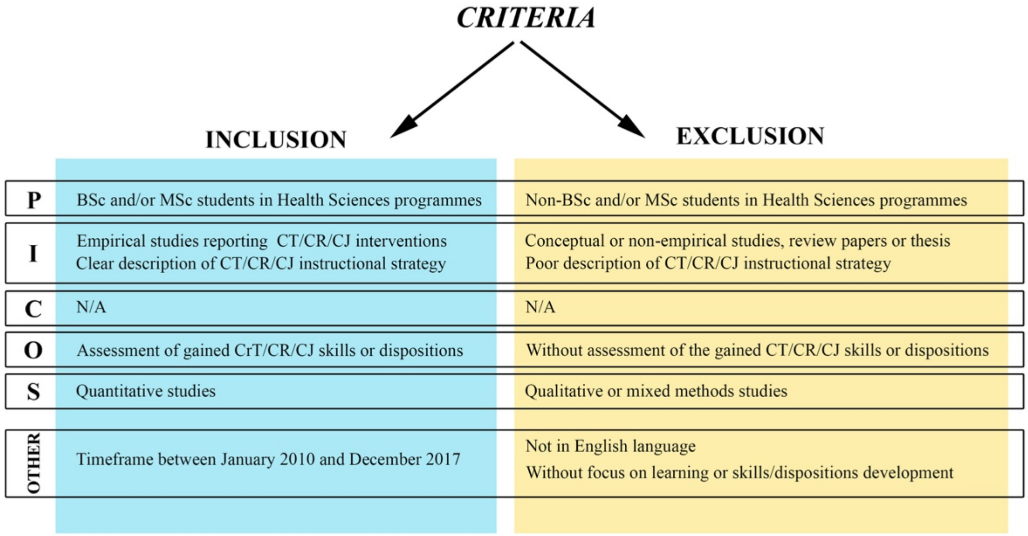

Figure 1. Inclusion and exclusion criteria used for screening the literature.

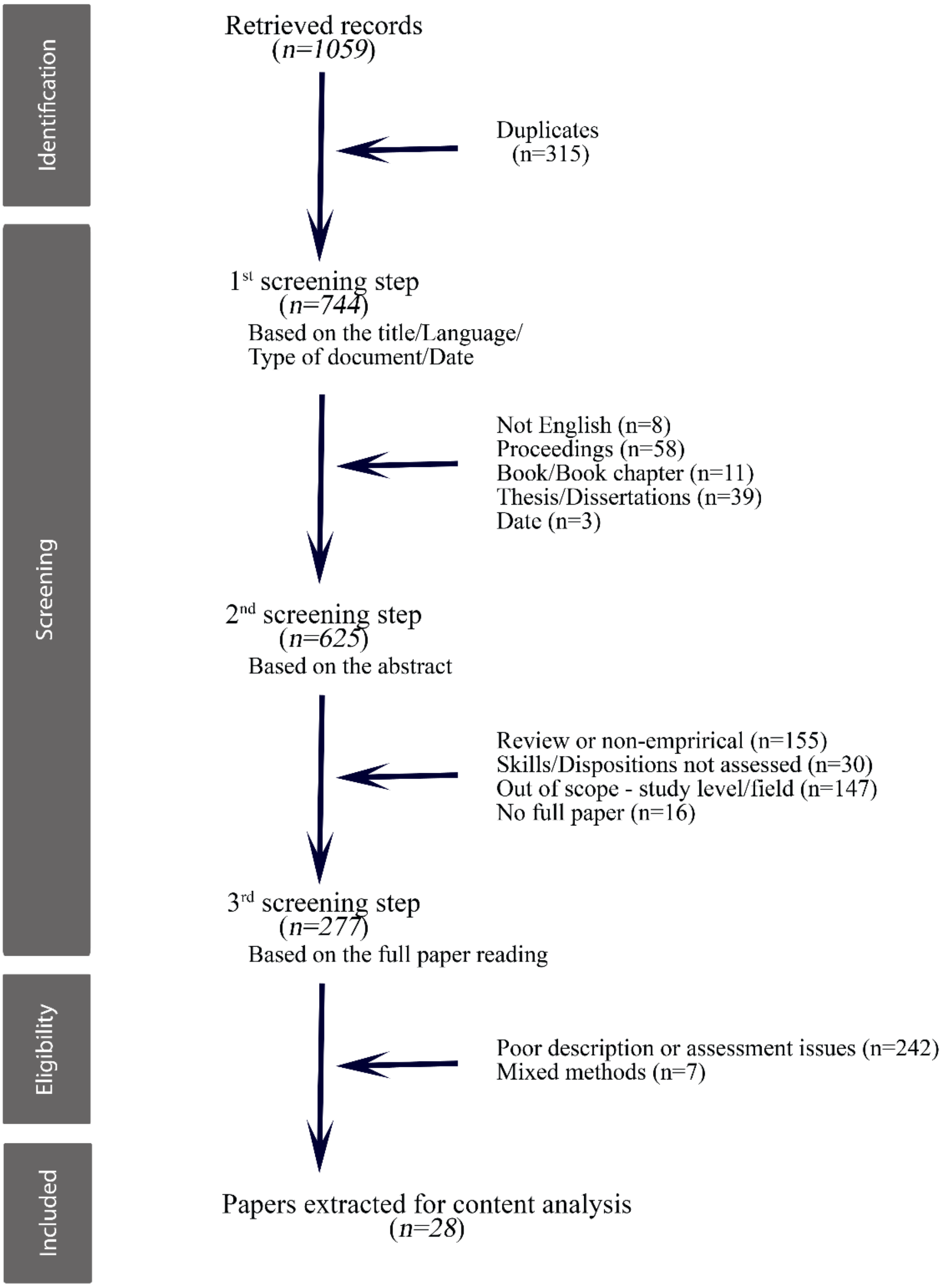

Figure 2. PRISMA flow diagram detailing the stepwise filtering screening of the literature

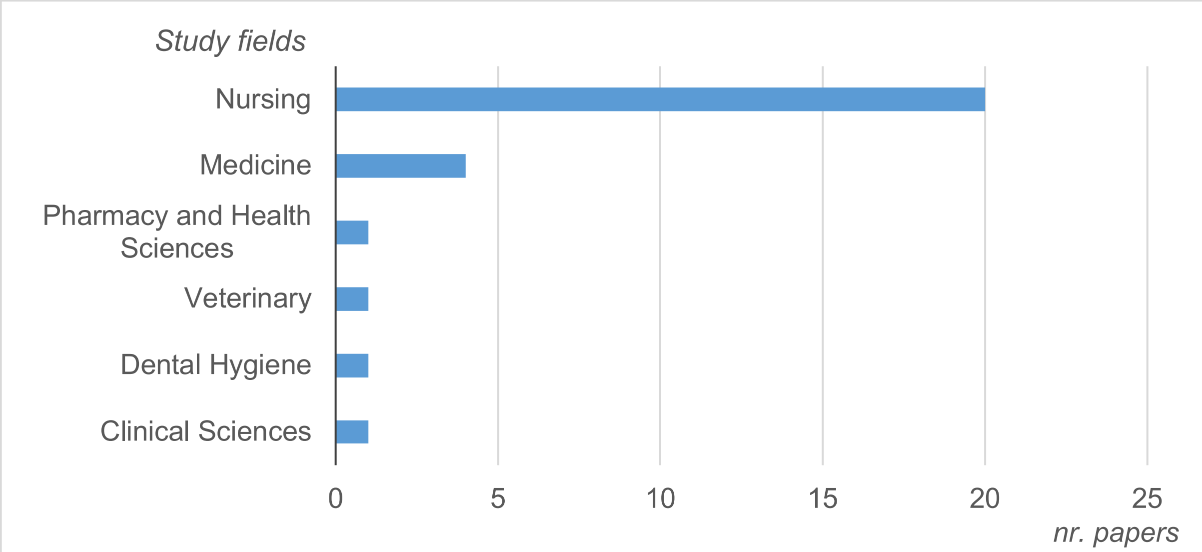

Figure 3. Study fields representing the Health Sciences domain in the reviewed literature (n= 28)

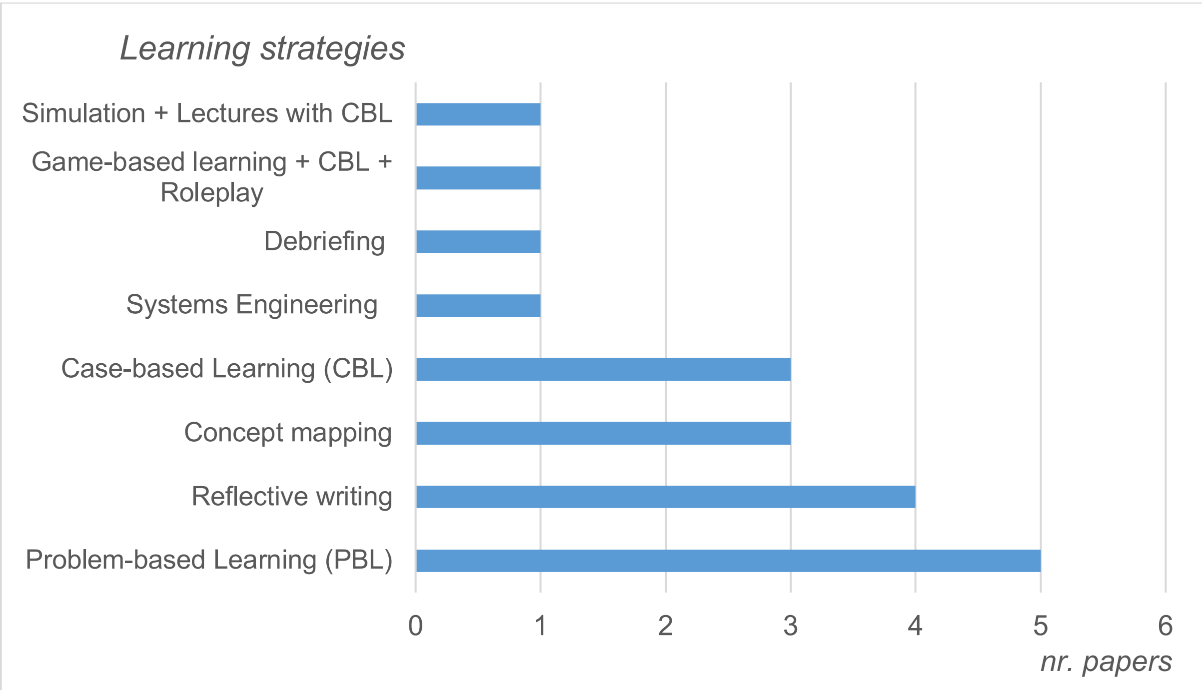

Figure 4. Learning strategies represented in the literature review (n=28)

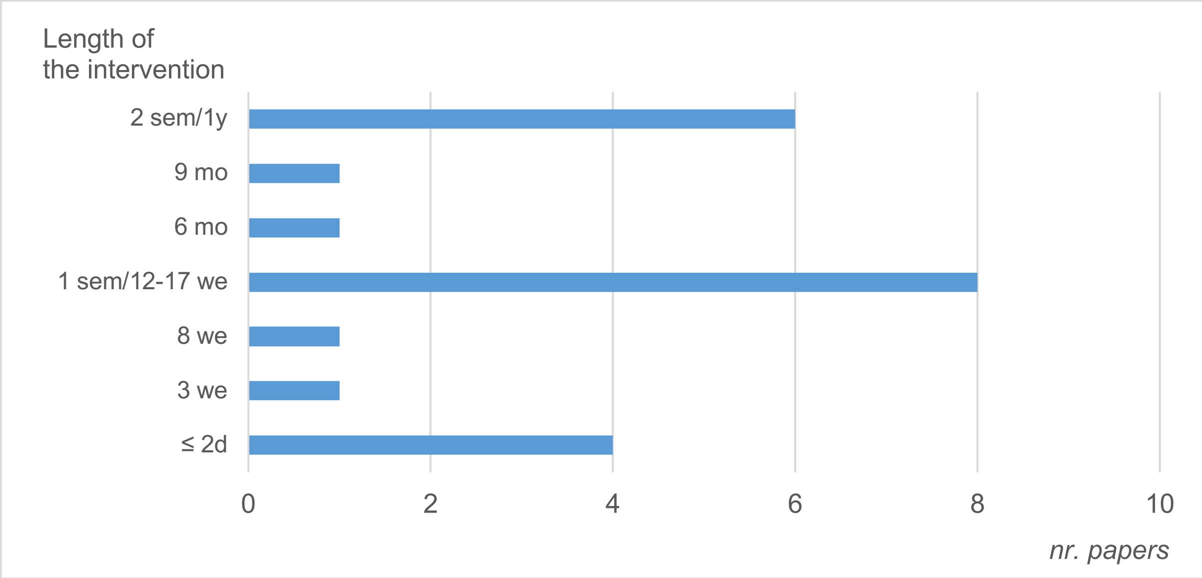

Figure 5. Length of the interventions as described in the reviewed papers (n=28) (y – year; sem – semester; mo – months; we – weeks; d – day)

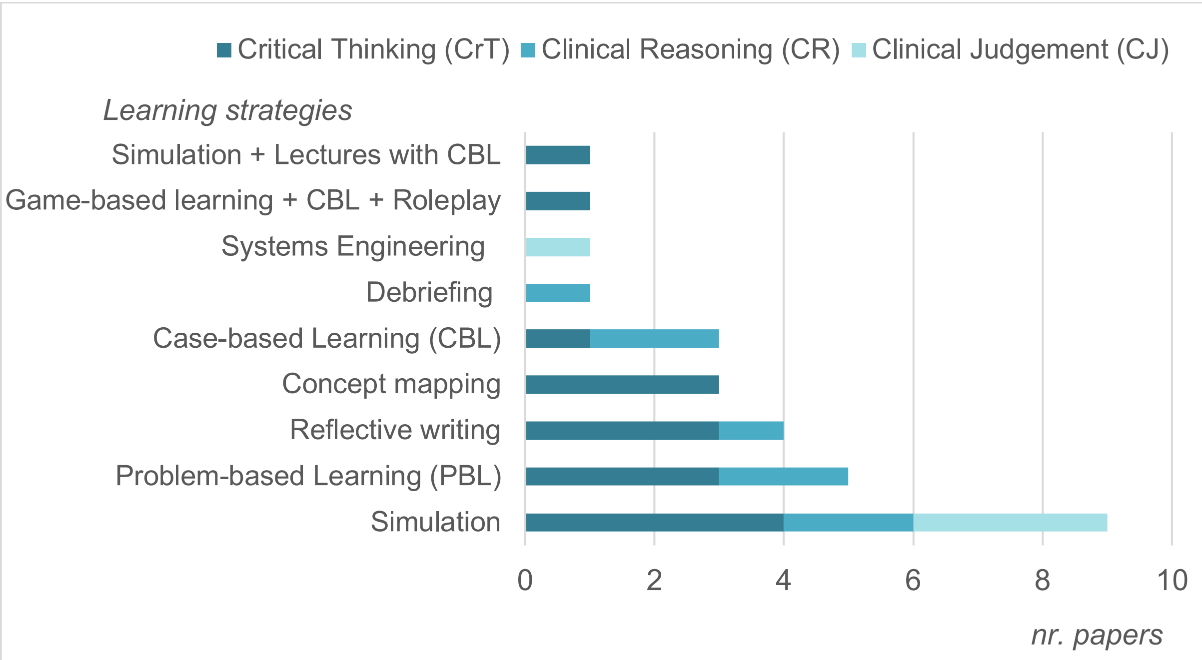

Figure 6. Learning strategies by targeted learning outcomes (n=28)

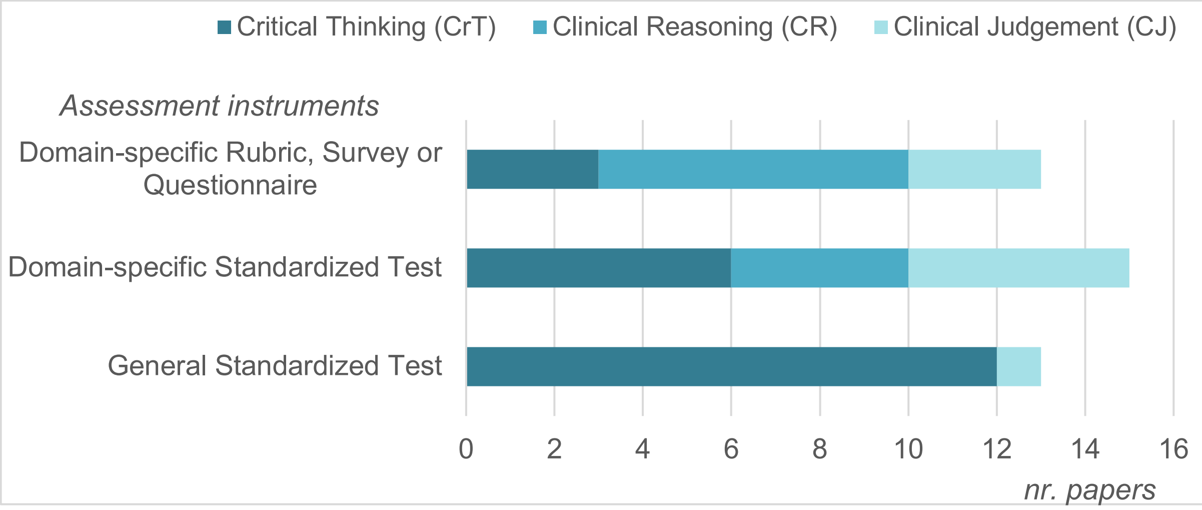

Figure 7. Assessment instruments by targeted learning outcomes (n=28)

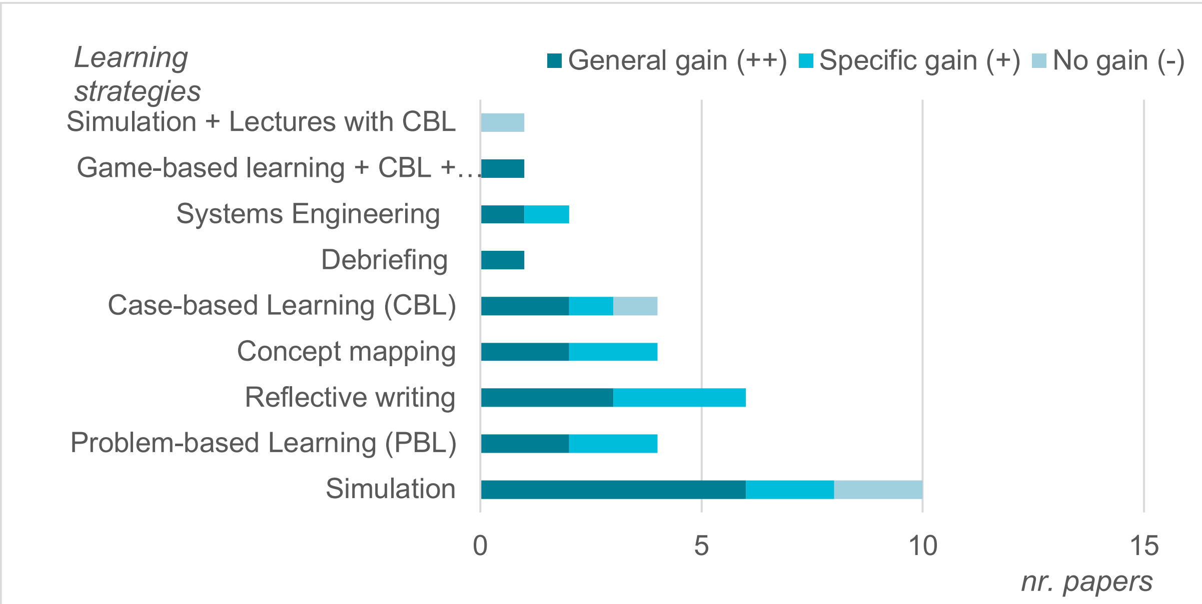

Figure 8. Learning strategies by assessed gains (n=28). (Five papers reported both general and specific gains)

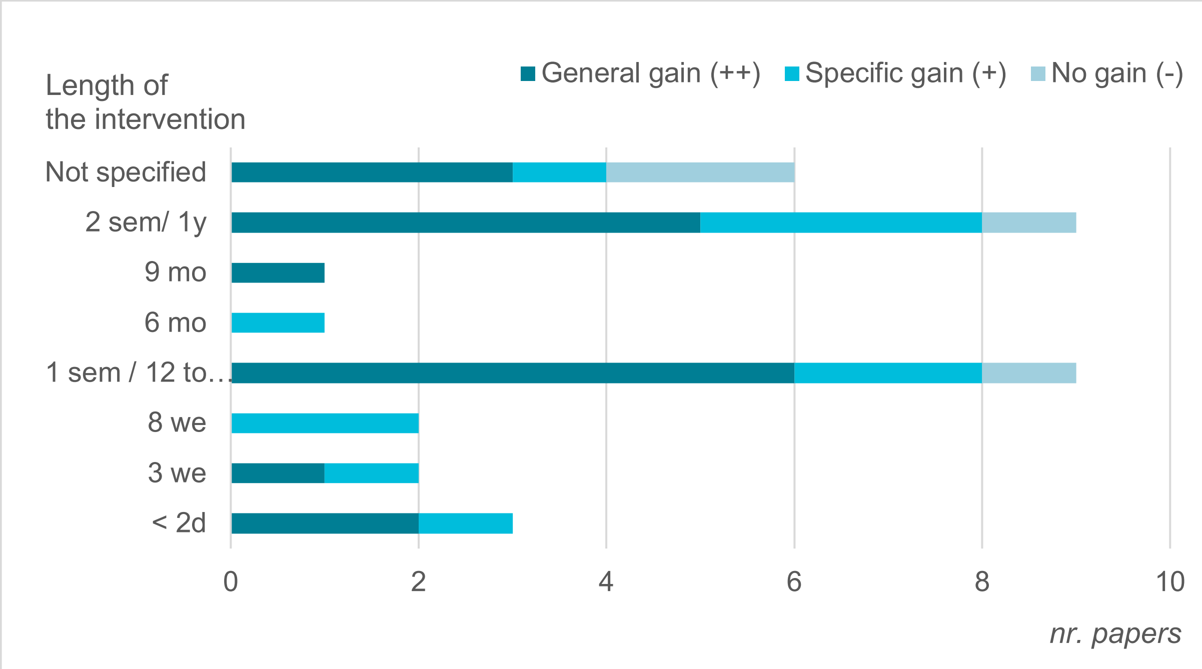

Figure 9. Duration of the intervention by assessed gains (n=28). (Five papers reported both general and specific gains) (y – year; sem – semester; mo – months; we – weeks; d – day)

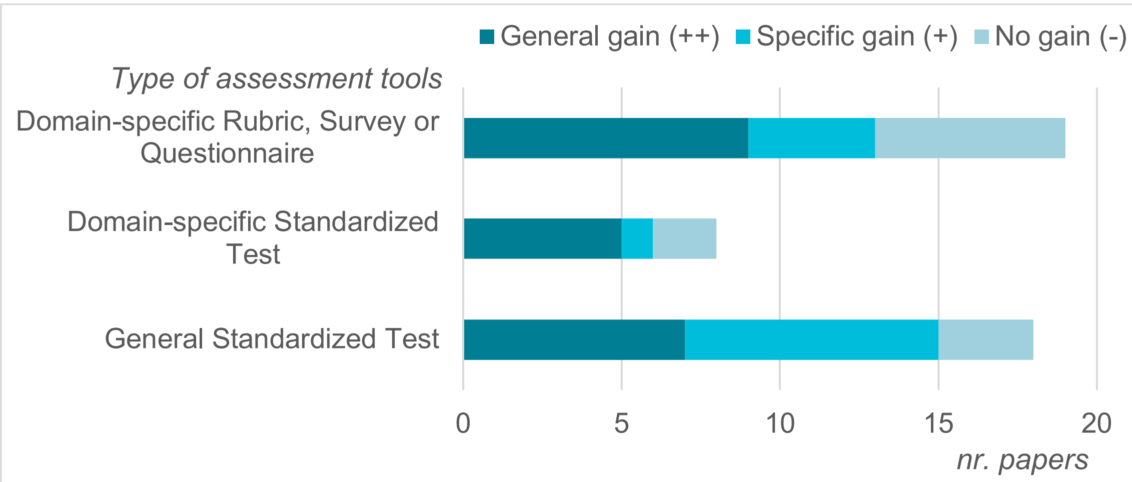

Figure 10. Assessment instruments and respective gains (n=28)

Table 1. Study design from the papers extracted in the literature review.

Study and Design		Assessment	Nr papers	Gain		No gain (-)
				General (++)	Specific (+)	
Experimental	Randomized sample	Pre- and post-test design	11	7	4	2
		Only post-test design	1	1	0	0
Quasi-experimental	Convenience sample	Pre- and post-test design	7	4	3	0
	Convenience sample Longitudinal and follow-up study		1	1	1	0
Exploratory descriptive	Convenience sample Without control group	Pre- and post-test design	6	4	2	1
Comparative descriptive	Convenience sample Comparing two intervention groups	Only post-test design	2	1	1	1