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A Systematic Review on Critical Thinking Intervention Studies in Higher Education across Professional Fields

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A Systematic Review on Critical Thinking Intervention Studies in Higher Education across Professional Fields

This study provides a systematic review on the Critical Thinking (CT) intervention studies reported in the national literature of the countries involved in the CRITHINKEDU project. The aim of this paper is to characterise critical thinking intervention studies in higher education institutions across different fields. The review process has been carried out by applying content analysis and it is comprised of five stages. A rubric was built in conjunction with literature review on CT interventions and data analysis. Slight differences were identified among the examined fields. The main results show that immersion is the most frequent approach in all of the fields, followed by infusion, which is only implemented in STEM and social sciences. All of the interventions are short-term and address either CT skills exclusively, or deal with skills and dispositions together. Further research is needed in order to explore which aspects of the CT interventions are successful in the promotion of CT in higher education (HE), as well as the CT components, which are targeted during instruction.

Keywords: critical thinking; higher education; CT interventions; professional fields.

Critical Thinking Interventions in Higher Education Across Professional Fields

Critical Thinking (CT) is a seminal goal in higher education (HE), and it is one of the key competences included in the European Reference Framework (Hoskins and Deacon Crick 2010). It is considered as a set of skills which are necessary in order to foster students' success in college and in the workplace (Partnership for 21st Century Skills 2003). HE institutions are committed to developing students' CT skills. Nevertheless, there is a lack of consensus on how CT is defined, and discussions on the manner in which CT can be achieved through educational efforts persist (Niu, Behar-Horenstein and Garvan 2013). The American Philosophical Association convened an authoritative panel of 46 international experts on CT in order to produce a definitive account of the

concept as included in the Delphi Report (Facione 1990). In order to obtain an operational definition of CT, researchers have identified a set of specific CT skills which can serve as learning goals of instructional interventions (Niu *et al*. 2013). This study draws on experts' views on how CT is conceptualised, both as a set of skills (Facione 1990), and as a set of dispositions (Ennis 1998). While researchers and educators agree on the importance of teaching CT skills in HE, the debate lies on whether and how such skills could be promoted through instructional interventions and how this could be achieved (Tsui 2002). A widely supported position which is upheld by the authors of this paper, is that CT can be taught and learned (Niu *et al.* 2013), meaning therefore, that thinking skills can be improved through instruction which has been specifically designed for that purpose (Halpern 2001). In line with Behar-Horenstein and Niu (2011), we believe that changing instructional approaches from 'what to think' to 'how to think' would require a major shift in thinking about instructional paradigms. Trends in educational research indicate a growing interest in the way in which teaching strategies may influence the development of CT, particularly with regards to what characteristics of teaching strategies and learning environments support the development of CT (Ennis 2016).

This paper presents a literature review on empirical studies about CT interventions in HE across the professional fields. There is a consensus about the need for giving opportunities to apply CT skills and dispositions in a wide range of contexts and subject areas; however, there is a controversy related to which CT skills and dispositions learned in one context are transferable to new contexts. Research has shown that CT skills vary among different academic disciplines (Gordon 2000) and other factors given that CT takes place within the structure and knowledge bases that these provide. Moreover, the practice of CT can also vary within a field, since what are

understood as ‘good reasons’ may differ among the topics that are under discussion (McPeck 1981).

A wealth of empirical studies has been conducted in order to measure the effects of educational interventions on the development of CT in college students; however, the results of these studies are not consistent, and limited information has been provided regarding the conditions under which instruction enhances students’ CT (e.g., Abrami *et al.* 2008; Behar-Horenstein and Niu 2011; Niu *et al.* 2013; Tiruneh, Verburgh, and Elen 2014). These studies point out that longer interventions tend to be more effective in increasing the CT abilities of HE students than shorter interventions. Another remarkable issue emphasised by Tiruneh *et al*. (2014), is that CT skills are effectively enhanced when either a general or mixed approach is employed. Nevertheless, studies in which these two approaches have been adopted are somewhat limited in number, especially when compared to the infusion and immersion approaches. Furthermore, the examination of the CT interventions commonly used in diverse disciplines, indicates that health professions often rely on degree programmes, whereas in the social sciences they rely to a greater extent on discussion and CT instruction, independent from subject instruction (Niu, Behar-Horenstein and Garvan, 2013).

Considering these results, a literature review on CT intervention studies in HE across the different fields was performed by the partners of 11 European Higher Education Institutions in accordance with the framework for the European Project, CRITHINKEDU ‘Critical Thinking Across the European Higher Education Curricula.’

The review is focused on analysing the characteristics of CT intervention studies across different professional fields in HE institutions of CRITHINKEDU partner countries (Portugal, Italy, Greece, Ireland, Belgium, Lithuania, Czech Republic, Romania and Spain). It is a multinational review that aims to contribute to the

development of a set of guidelines for CT instruction in HE in Europe. The design and implementation of CT training courses will be developed in CRITHINKEDU HE institutions, taking into consideration the results of this review. Previous systematic reviews about this topic in the context of HE carried out at national levels are unknown to our understanding, making this the main contribution of our article.

Methods

A systematic literature review was conducted on a national level in order to identify and retrieve empirical data on CT interventions in HE across the different CRITHINKEDU partner countries. All partners collaborated in this literature review. Each one searched papers written by authors who are affiliated to institutions in their own countries. The raw data was then analysed by the authors of this paper. The contribution made by the CRITHINKEDU partners in this study is specified bellow for each step of the review process. It has been adapted from Bennet *et al*.'s (2005) steps, and consists of five stages which are summarised in Figure 1.

Figure 1. Review process, data extraction and analysis. [near here].

Each of the steps of the review process are discussed below:

(1) *Database and Keywords identification*: the papers were searched by all of the CRITHINKEDU partners in both national and international databases, with content published both in English and in their national language. Table 1 shows the number of papers by country before and after applying the inclusion and exclusion criteria. The databases used were: Web of Science, SCOPUS, EBSCO, PROQUEST, ERIC, JSTOR, RCAAP, ESCI, SCIELO, INDEX COPERNICUS, RACO, DIALNET,

LITHUANITISKA, ADION, GOOGLE SCHOLAR, ERC, ACNP, ROMA TRE DISCOVERY, ESCI, MLA and C.E.E.O.L. The keywords selected for the search were critical thinking, higher education and interventions. Other terms related to these keywords were included and connected with bolean operators (or, and) to extend, define and ensure the quality of the search, as follow:

- Critical thinking (skills OR dispositions OR attitudes) AND,
- Higher Education OR universities OR faculties, AND,
- Interventions OR strategies OR practices

All of these keywords were used in English and were also translated into the language of each partner country. A total of 276 studies were found.

(2) *Selection of papers and inclusion and exclusion criteria:* Only the papers found by each of the partners, which met the three inclusion and exclusion criteria specified in Figure 1 were selected. The selected papers had to be peer-reviewed articles regarding CT interventions in HE and empirically-based research. Book chapters, proceedings and theses were excluded from the initial corpus. Moreover, the studies must present some kind of instructional intervention, which involves either teacher-led classroom instruction or computer-based instruction, or any other some sort of instruction by the teacher or researcher (Tiruneh *et al*. 2014). This resulted in 27 papers, which are marked with an * in the references.

Table 1. Number of papers by country, before and after applying the inclusion and exclusion criteria. [near here]

(3) *Distribution of papers into the professional fields:* All of the papers were classified into the four professional fields which represent the curricular areas which have been adapted from several European classifications, including the Erasmus Subject

Areas Codes (UNESCO-UIS 2015) and the Deutsche Forschungsgemeinschaft (DFG) Classification of Scientific Disciplines (DFG 2017), namely: biomedical sciences, STEM (science, technology, engineering and mathematics), social sciences, and humanities. Intervention studies developed in several curricular areas were categorised as interdisciplinary; for instance, one paper is framed in arts, law, biotechnology, economy, education and health. Table 2 summarises the distribution of the papers by fields and databases.

Table 2. Distribution of the analysed papers by fields and databases [near here].

(4) Data-extraction and analysis: For the characterisation of CT interventions, a rubric was built in conjunction with the literature on CT interventions (e.g. Abrami *et al*. 2015; Ennis 1989, 2016; Facione 1990) and the data, in discussion with the CRITHINKEDU partners. The rubric includes the 7 dimensions described below.

a. Type of study: it comprises of the three methods used for research design and draws by Creswell and Creswell (2013): *quantitative,* when the study aims to test CT by examining the relationship among variables that can be measured on instruments, allowing for numeric data to be analysed; *qualitative,* if the study explores the meaning that participants (individuals or groups) ascribe to CT; and *mixed methods,* when the study combines elements of qualitative and quantitative approaches for the purposes of breadth and depth of understanding.

b. CT aims: the categories have been drawn from the APA Delphi Report (Facione 1990) and include skills, dispositions and a combination of both elements.

c. CT approach: we draw from Ennis' (1989) and Sternberg's (1986) categories of CT instruction that include: the *general approach,* in which CT is taught separately

from the content of an existing subject-matter; the *infusion approach,* which attempts to integrate CT instruction into standard subject-matter instruction and makes the general principles of CT explicit to the students; the *immersion approach,* which tries to incorporate CT within standard subject-matter instruction, but without making the general CT principles and procedures explicit to students; and the *mixed approach, which* consists of a combination of the general approach with either the infusion or the immersion approach.

d. Type of interventions: the categories have been taken from Abrami *et al*.'s (2015) categorisation of instruction interventions. *Self-study* includes instructional techniques and learning activities that are based on the students' individual work. *Dialogue* encompasses learning through discussion. *Authentic instruction* consists of presenting students with real problems, or problems that make sense to them, engaging them, and stimulating them to enquire. The category *other* includes any interventions that do not fit in the previous categories as described by Abrami *et al*.'s (2015).

e. Teaching strategies: this dimension includes the two teaching methods for promoting CT as described by Ennis (2016): Lecture-discussion teaching (LDT) and Problem-Based Learning (PBL), together with their combinations (LDT+PBL) and other strategies. LDT consists of a lecture (usually accompanied by some textbook reading) presenting one or various aspects of the subject matter, followed by a discussion section (or a discussion at the end of the period in which the lecture was presented). PBL deals with a subject-matter issue, which usually requires researching, developing, testing, and discussing hypotheses or solutions and possible alternatives.

f. Learning materials: this corresponds to items or activities used in CT interventions and includes four emerging categories from the data analysis.

g. Reported difficulties: this includes five emerging categories encountered in the intervention studies from the data analysis.

According to the rubric, each partner carried out the analysis of the papers following the process described previously, these then had to be completed with a description for each dimension. Subsequently, the partners shared their results with the authors who revised the analysis and summarised the final results.

CT intervention studies in HE institutions in professional fields

This section provides an overview on CT interventions in European HE institutions based on the analysis of the literature review. The studies were implemented in four fields (Figure 1). Almost half of the studies were developed in Social Sciences (13 out of 27), with education being the most frequent domain within this field (11 out of 13). Biomedical Sciences was the second most frequent field (6 out of 27) with a predominance of health domain-oriented papers (4 out of 6). Five studies were carried out in STEM, one in humanities and the other two were interdisciplinary. The interdisciplinary papers were implemented in several fields; one was carried out in STEM, Social Sciences, Biomedical Science and in Humanities, and the other one includes STEM and Social Sciences.

Regarding the level of HE, the majority of the studies were carried out with undergraduate students (15 out of 27), and the others with graduate students (12 out of 27).

The analysis of CT interventions in HE across the fields is summarised in Table 3. The frequencies in each dimension may be higher than the total number of papers analysed (N=27), given that a particular paper may be included in several categories. Furthermore, categories with no examples (e.g. mentoring) have been omitted from Table 3.

Table 3. Summary of the characteristics of CT interventions in the European HE institutions by fields [Near here].

Three out of five *STEM* studies targeted CT skills as analysis, evaluation and explanation (Laiton Poveda 2011), whereas the other two focused on skills and dispositions, with analysis, explanation and open-mindedness, appearing most frequently (Torres Merchán and Solbes 2016). Most studies (3 out of 5) opted to use mixed methods, followed by qualitative and quantitative methods, with the same distribution. Furthermore, immersion was adopted as the CT approach in four of the papers. Regarding the type of intervention, self-study and dialogue were the most common types of intervention, and when it came to teaching strategies, LDT was more commonly used (3 out of 5) than PBL, and LDT combined with PBL. The intervention design for all STEM studies included learning materials that promote argumentation skills, such as texts or articles that engage participants in discussions (Dominguez *et al*., 2014; Martinho, Almeida, and Teixeira-Dias 2014) or authentic problems (Laiton Poveda 2011; Martinho *et al*. 2014; Torres Merchán and Solbes 2016). Data shows that there is a preference for using texts, articles, books, etc. which cover a diverse range of topics such as socio-scientific issues within this field. Difficulties were related to the design of the intervention in two of the studies. For instance, Dominguez *et al*. (2014) considered time constraints as a difficulty. Two studies (Dominguez *et al*. 2014; Martinho *et al*. 2014) pointed to the teachers' lack of pedagogical knowledge, whereas Andreu-Andrés and García-Casas' (2014) mentioned problems with the assessment rubric. The other two studies did not report any difficulties (Laiton Poveda 2011; Torres Merchán and Solbes 2016).

Most of the *Social Sciences* studies aimed to analyse CT skills (6 out of 13), or both skills and dispositions (4 out of 13). The analysis and evaluation skills and the dispositions of analyticity and systematicity were the most common. For instance, Dumitru's (2012) paper focused on all of the skills proposed by Facione (1990), while Vertecchi, Poce, Agrusti, and Re (2017) opted to exclusively target the skills of interpretation and analysis. Corcione, Iovine and Poce (2013) addressed the skills of inference, analysis, interpretation, evaluation and explanation, as well as the dispositions of analyticity, systematicity, inquisitiveness and cognitive maturity. Finally, there were three studies in which the CT aims were not specified. With regards to the methodology, six studies used quantitative methods; four, qualitative; and three, mixed methods. The most common CT approach was immersion (6 out of 13), and it is worth mentioning that Social Sciences is the only field in which two other studies reported a combination of approaches, namely: general with infusion and general with mixed. Concerning the types of intervention, self-study is the most frequent (8 out 13), with authentic instruction being reported in fewer studies. LDT is present in five studies, whereas LDT+PBL is only present in three studies. This field presented other teaching strategies, namely: peer-observation and self-assessment (Janulevičienė and Kavaliauskienė 2012), and cooperative learning (Klimovienė, Urbonienė and Barzdžiukienė 2006). The reviewed papers provided diverse contexts and learning materials for the promotion of CT, with most of them implementing writing activities and debates. Some (Corcione *et al*. 2013; Poce, Corcione, and Iovine 2012; Silva *et al*. 2016) used virtual learning environments and one of them used a weblog (Janulevičienė and Kavaliauskienė 2012). Although seven studies did not mention which learning materials were used, five of the studies (e.g., Corcione *et al*. 2013; Poce *et al*. 2012;

Silva *et al*. 2016) mentioned the use of articles, texts and essays as learning materials. In this field no difficulties were reported.

Biomedical Science studies targeted the development of CT skills (4 out of 6) and CT skills and dispositions (2 out of 6). Analysis and evaluation were the most frequent skills, as well as the disposition of inquisitiveness. Fardilha, Schrader, da Cruz e Silva and Silva (2010) focused on the development of interpretation, analysis, evaluation and self-regulation, whereas Siri, Del Puente, Martini and Bragazzi (2017) examined the skills of analysis and evaluation, and the dispositions of truth-seeking and inquisitiveness. Three studies used mixed methods; two used qualitative methods; and another used quantitative methods. All of the studies followed the immersion approach with a range of intervention designs as explained below. Self-study and authentic instruction were the most frequent types of intervention, with the same distribution (4 out of 6 each), followed by dialogue (1 out of 6). Biomedical science is the only field in which PBL and LDT+PBL have a higher presence (3 and 2 out of 6, respectively) than LDT, which is only present in one study. The most commonly used learning materials are authentic situations (de Abreu and Loureiro 2007; Fardilha *et al*. 2010; Santos 2003; Palese, Saiani, Brugnolli and Regattin 2008). With regards to the difficulties faced, 2 out of the 6 studies presented some examples. Fardilha *et al*. (2010) referred to the design of the intervention, recommending smaller PBL groups and Siri *et al.* (2017) pointed out the lack of standardised questionnaires and approaches for assessing CT.

Humanities presented one intervention study (Balčiūnienė 2006). This piece of research focused on CT skills, although they were not made explicit. It used a qualitative method, as well as an immersion approach, and self-study and dialogue were present as types of intervention. The teaching strategy used was categorised in the *other* category, specifically, a metacognitive learning strategy. The intervention was carried

out in two courses and was comprised of learning materials, which included a blog, essay, diary and lectures. No difficulties were reported.

Interdisciplinary papers aimed to develop CT skills, although the authors did not specify which skills were targeted. Two studies were found; both of them implemented qualitative methodology. One reported a general approach (Veiga, da Costa, Cardoso and Jácomo 2016) and the other an immersion approach (Pedrosa de Jesus, Almeida, and Watts 2004). Self-study and dialogue were present in both studies, although authentic instruction was only found in the latter. Pedrosa de Jesus *et al.* (2004) presented LDT as a teaching strategy, while Veiga *et al*. (2016) used LDT in combination with PBL. Veiga *et al.*'s study (2016) was based on seminars in which the learning materials used were texts that engaged participants in: reflecting about problems, debating, elaborating individual work and justifying their decision-making. Pedrosa de Jesus *et al.* (2004), on the other hand, did not mention any learning materials. In terms of the difficulties, Veiga *et al*. (2016) reported institutional barriers, such as the need for additional resources to support students' work and the academic culture. The other study did not mention any difficulties.

In summary, the analysis carried out shows that there are many commonalities among CT interventions in all of the fields regarding the CT aims, CT approach, learning materials and teaching strategies. Social Sciences is the field that differs most, which might be related to the higher number of studies. One of the most remarkable findings is the use of an immersion approach in all fields. This shows a tendency of encouraging the embedding of CT within domain-specific fields as a way of helping students to become critical thinkers, rather than teaching CT as a separate subject. The differences in CT intervention across the examined fields are minor. As in the case of Humanities and Interdisciplinary studies, there is a tendency in STEM and Biomedical

Science to follow an immersion approach. However, Social Science, in turn, seems to use more diverse approaches. Regarding the type of interventions, STEM applies LDT through texts, Biomedical Science seems to apply PBL based on authentic problems, and Social Science uses a greater variety of interventions, probably due to the higher number of studies available in this field.

Discussion and conclusion

The literature review shows that there are slight differences in CT interventions among the fields examined. With regards to CT aims, we can conclude that a large majority of the papers focused on teaching CT skills rather than dispositions. Although humanities and interdisciplinary studies do not make them explicit, it seems that *analysis* and *evaluation* are the most frequently addressed CT skills in STEM, Social Sciences and Biomedical Science studies. Despite previous reviews on CT (Tiruneh *et al*. 2014) indicated that CT skills and dispositions were not addressed in instructional designs, this analysis shows that CT dispositions, together with CT skills seem to be the aim of several interventions. The limited attention shown to dispositions may be related to the fact that all the interventions mentioned in this review were short-term, making their appropriate development a difficult task.

Another finding is that most of the interventions carried out in all of the fields used an immersion approach, and the infusion approach was the second most common approach, which is consistent with previous reviews (Abrami *et al*. 2008; Behar-Horenstein and Niu 2011). This points to a tendency of supporting encouraging the embedding of CT within specific subject-domains as a way to of helping students to become critical thinkers, rather than teaching CT as a separate subject. However, as Tiruneh *et al*.'s review (2014) concluded, CT skills seem to be more effectively promoted when either the general or the mixed approaches are implemented, rather than

the immersion approach. Based on the studies, it is apparent that improvements in the students' CT are more likely to occur when the teaching of said skills is explicit rather than implicit (Behar-Horenstein and Niu 2011). We consider that in order to make CT instruction explicit, CT must be integrated directly into the course goals, activities and assessment, making sure that the students are aware of the CT development within the domain-specific instruction. This review does not help to uncover how these aspects are embedded in the interventions carried out in the fields analysed. With regards to this concern, learning materials have been mentioned in all of the fields, but limited information has been provided about how and to what extent they enhance CT skills and dispositions. For instance, in most fields, texts and articles are used for discussions, although the interventions do not describe what aspects of CT are required in order to engage students in those debates in a critical way.

The combination of more than one teaching strategy is frequent, above all in Social Sciences. This combination might have an influence on CT instruction in terms of its effectiveness and the teachers' and students' performances. However, given the relatively small sample of empirical studies, the potential examination of factors related to the effective teaching of CT is clearly limited.

This review presents some limitations due to the small number of papers that meet the selection criteria and the insufficient number of studies representing the Humanities field. The analysis provides scarce evidence of which aspects of CT interventions are successful in promoting CT in HE and which components of CT are targeted during the instruction. Furthermore, although it was not the aim of the analysis, some constraints emerged concerning CT assessment. Most of the papers based their CT results exclusively on the opinions of students and/or teachers, as well as on other factors such as students' motivation, or their level of engagement to the task. Some

intervention studies based their CT results on students' perceptions, learning reflections and their participation in the task, and others even did not assess CT. The assessment of CT is a problematic issue that has been addressed in previous studies (Tiruneh, De Cock, Weldeslasssie, Elen and Janssen 2017). Despite there being a wide range of quantitative instruments for measuring diverse aspects of CT (e.g, Ennis and Weir 1985; Newman, Johnson, Webb and Cochrane 1997), more emphasis must be placed on qualitative assessment instruments, since this analysis shows that the qualitative methods are predominantly used in the reviewed papers, followed by mixed methods. Moreover, in line with Tiruneh et al. (2017), we consider that further research on the assessment of CT skills and dispositions in specific fields is required.

An important issue that must be addressed in future designs of CT is the inclusion of CT as an explicit aim. Research suggests that learning to become a good 'critical thinker' must be explicitly acknowledged as an aim (Pithers and Soden 2010). This requires careful consideration of the components of CT as goals of the instruction, as well as the assessment of these CT components, contributing to a better understanding of how CT can be improved among HE students.

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References

Abrami, P. C., R. M. Bernard, E. Borokhovski, A. Wade, M. A. Surkes, R. Tamim and D. Zhang. 2008. "Instructional Interventions Affecting Critical Thinking Skills and Dispositions: A Stage 1 Meta-Analysis". *Review of Educational Research* 78 (4): 1102-1134. doi: 10.3102/0034654308326084.

Abrami, P. C., R. M. Bernard, E. Borokhovski, D.I. Waddington, A. Wade and T. Persson. 2015. “Strategies for teaching students to think critically: A meta-analysis”. *Review of Educational Research* 85(2): 275-314. doi:10.3102/0034654308326084.

*Andreu-Andrés, M. A., and M. García-Casas. 2014. “Evaluación del pensamiento crítico en el trabajo en grupo”. *Revista de Investigación Educativa* 32 (1): 203-222. doi: 10.6018/rie.32.1.157631.

*Aušrienė, M. 2003. “Making teaching and learning more effective: educational modelling of a critical thinking-oriented university syllabus”. *Bridges: scientific journal* 2: 11 - 117.

*Balčiūnienė, I. 2006. “Refleksyvių metodų analizė ir įvertinimas dirbant pagal kooperuotų studijų programą”. *Jaunųjų mokslininkų darbai* 4 (11): 44–53.

Behar-Horenstein, L., and L. Niu. 2011. “Teaching Critical Thinking Skills in Higher Education: A Review of the Literature”. *Journal of College Teaching and Learning* 8 (2): 25-42. doi: 10.19030/tlc.v8i2.3554.

Bennett, J., F. Lubben, S. Hogarth, and B. Campbell. 2005. “Systematic reviews of research in science education: rigour or rigidity?” *International Journal of Science Education* 27 (4): 387-406. doi: 10.1080/0950069042000323719.

Creswell, J. W., and J. D. Creswell. 2013. *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*. 4th ed. Los Angeles: SAGE Publications.

*Corcione, L., A. Iovine, and A. Poce. 2013. “Contributi per la definizione di una tecnologia critica interdisciplinare”. *Cadmo* (1): 41-62. doi:10.3280/cad2013-001004.

*Daukilas, S. 2006. “Žemės ūkio verslo vadybininkų kritinio mąstymo ugdymas aksiologinės logikos kontekste”. *Management theory and studies for rural business and infrastructure development* 7: 37-40.

*de Abreu, C. D. C. F., and C. R. E. C. Loureiro. 2007. “Aprendizagem por Resolução de Problemas – Uma experiência pluridisciplinar e multicultural”. *Referencia: Revista Cientifica da Unidade de Investigação em Ciências da Saúde: Domínio de Enfermagem* 5:7-15.

Deutsche Forschungsgemeinschaft. 2017. *DFG Classification of Scientific Disciplines, Research Areas, Review Boards and Subject Areas (2016-2019)*. Bonn: Deutsche Forschungsgemeinschaft.

*Dominguez, C., M. M. Nascimento, R. Payan-Carreira, G. Cruz, H. Silva, J. Lopes, F. Morais, and E. Morais. 2014. “Adding value to the learning process by online peer review activities: towards the elaboration of a methodology to promote critical thinking in future engineers”. *European Journal of Engineering Education* 40(5): 573-591. doi:10.1080/03043797.2014.987649.

*Dulamă, E. M. and Ilovan, O. 2009. “Study on Students’ Critical Thinking Capacities during Seminars of the Didactics of Geography”. *Acta Didactica Napocensia* 2 (3): 19-30.

*Dumitru, D. 2012. “Critical Thinking and Integrated Programs. The Problem of Transferability”. *Procedia-Social and Behavorial Sciences* 33: 143-147. doi: 10.1016/j.sbspro.2012.01.100.

Ennis, R. H. 2016. “Critical Thinking Across the Curriculum: A Vision”. *Topoi* 37 (1): 1-20. doi:10.1007/s11245-016-9401-4.

Ennis, R. H. 1989. “Critical thinking and subject specificity: Clarification and needed research”. *Educational Researcher* 18 (3): 4-10. doi:10.2307/1174885.

Ennis, R. H. and E. Weir. 1985. *The Ennis-Weir Critical Thinking Essay Test*. Pacific Grove: CA: Critical Thinking Press and Software.

Facione, P. A. 1990. *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. Research findings and recommendations*. Millbrae, CA: The California Academic Press.

*Fardilha, M., M. Schrader, O. A. B. da Cruz e Silva, and E. F. da Cruz e Silva. 2010. "Understanding fatty acid metabolism through an active learning approach". *Biochemistry and Molecular Biology Education* 38 (2): 65-69. doi: 10.1002/bmb.20330.

Gordon, B. 2000. "Congruency in defining critical thinking by nurse educators and non-nurse scholars". *Journal of Nursing Education* 39: 340-351.

Halpern, D. F. 2001. "Assessing the effectiveness of critical thinking instruction". *The Journal of General Education* 50 (4): 270–286.

* Janulevičienė, V., and G. Kavaliauskienė. 2012. "The development of critical thinking skills through self-evaluation in a tertiary ESP (English for Specific Purposes) course". *Societal studies: scientific journal* 4 (4): 1357–1370.

*Klimovienė, G., J. Urbonienė, and R. Barzdžiukienė. 2006. "Developing critical thinking through cooperative learning". *Studies about languages* 9: 77 - 84.

*Laiton Poveda, I. 2011. "¿Es posible desarrollar el pensamiento crítico a través de la resolución de problemas en fisica mecánica?". *Revista Eureka sobre enseñanza y divulgación de las ciencias* 8 (1): 54-70. doi: 10.25267/rev_eureka_ensen_divulg_cienc.2011.v8.il.05.

*Martinho, M., P. A. Almeida, and J. Teixeira-Dias. 2014. "Fostering students questioning through Moodle: does it work?". *Procedia-Social and Behavioral Sciences* 116: 2537-2542. doi: 10.1016/j.sbspro.2014.01.607 .

McPeck, J. E. 1981. *Critical Thinking and Education*. London: Routledge.

* Maumevičienė, D. 2007. "Critical thinking while teaching English". *Kalba ir kontekstai* 2: 362–372.

Newman, D. R., C. Johnson, B. Webb and C. Cochrane. 1997. “Evaluating the Quality of Learning in Computer Supported Co-Operative Learning”. *Journal of the American Society for Information Science* 48(6): 484-495. doi: 10.1002/(sici)1097-4571(199706)48:6<484::aid-asi2>3.0.co;2-q.

Niu, L., L. Behar-Horenstein, and C. W. Garvan, C. 2013. “Do instructional interventions influence college students’ critical thinking skills? A meta-analysis”. *Educational Research Review* 9: 114–128. doi:10.1016/j.edurev.2012.12.002.

*Palese, A., L. Saiani, A. Brugnolli, and L. Regattin. 2008. “The impact of tutorial strategies on student nurses' accuracy in diagnostic reasoning in different educational settings: a double pragmatic trial”. *International Journal of Nursing Studies* 45: 1285-1298. doi:10.1016/j.ijnurstu.2007.10.00.3.

Partnership for 21st Century Skills. 2003. *Learning for the 21st century*. Washington, DC: Partnership for 21st Century Learning.

*Pedrosa de Jesus, H., P. C. Almeida, and M. Watts. 2004. “Questioning styles and students' learning: Four case studies”. *Educational Psychology* 24(4): 531-548. doi:10.1080/0144341042000228889.

Pithers, R. T. and R. Soden. 2000. “Critical Thinking in Education: A Review”. *Educational Research* 42: 237-249. doi: 10.1080/001318800440579.

*Poce, A., L. Corcione, and A. Iovine. 2012. “Content analysis and critical thinking. An assessment study”. *Cadmo* 20 (1): 47-63.

* Rimienė, V. 2013. “Studentų kritinio mąstymo dispozicijų, įgūdžių bei intelekto sąsajos“. *Ugdymo Psichologija* 24: 6-13.

*Santos, E. 2003. “Pensamento crítico: estratégias de desenvolvimento no ensino da enfermagem pediátrica”. *Referência* 10:17-23.

*Silva, H., J. Lopes, C. Dominguez, R. Payan-Carreira, E. Morais, M. M. Nascimento, and F. Morais. 2016. “Fostering critical thinking through peer review between cooperative learning groups”. *Revista Lusófona de Educação* 32: 31-45.

*Siri, A., G. del Puente, M. Martini, and N. L. Bragazzi. 2017. “Ethnopsychiatry fosters creativity and the adoption of critical and reflexive thinking in higher education students: insights from a qualitative analysis of a preliminary pilot experience at the Faculty of Medicine and Surgery, University of Genoa, Italy”. *Advances in Medical Education and Practice* 8: 321-324. doi: 10.2147/amep.s114473.

Sternberg, R. J. 1986. *Critical thinking: Its nature, measurement, and improvement*. Washington, DC: National Institute for Education.

*Stunžėnienė, D. 2006. “Developing critical thinking through cooperative learning”. *Applied Research in Lithuanian Colleges* 1: 56 - 61.

Tiruneh, D. T., M. De Cock, A. Weldeslassie, J. Elen and R. Janssen. 2017. “Measuring critical thinking in physics: Development and validation of a critical thinking test in electricity and magnetism”. *International Journal of Science and Mathematics Education* 15(4): 663-682. doi:10.1007/s10763-016-9723-0

Tiruneh, D. T., A. Verburgh, and J. Elen. 2014. “Effectiveness of critical thinking instruction in higher education: A systematic review of intervention studies”. *Higher Education Studies* 4(1): 1–17. doi:10.5539/hes.v4n1p1

Tiruneh, D. T., A. Weldeslassie, A. Kassa, Z. Tefera, M. De Cock and J. Elen. 2015. “Systematic design of a learning environment for domain-specific and domain-general critical thinking skills”. *Educational Technology Research and Development* 64(3): 481-505. doi: 10.1007/s11423-015-9417-2

*Tolutienė, G. 2010. “Andragogikos specialybės studentų kritinio mąstymo ugdymosi galimybės universitetinių studijų procese”. *Mokytojų ugdymas* 14(1): 63–76.

*Torres Merchán, N. Y., and J. Solbes. 2016. “Contribuciones de una intervención didáctica usando cuestiones sociocientíficas para desarrollar el pensamiento crítico”. *Enseñanza de las Ciencias* 34 (2): 43-65. doi: 10.5565/rev/ensciencias.1638

Tsui, L. 2002. “Fostering Critical Thinking through Effective Pedagogy: Evidence from Four Institutional Case Studies”. *Journal of Higher Education* 73 (6): 740-763. doi: 10.1080/00221546.2002.11777179

*Veiga, E., H. G. da Costa, E. Cardoso, and A. Jácomo. 2016. “A perspetiva dos alunos sobre um projeto de desenvolvimento do pensamento crítico no ensino superior”. *Revista Lusófona de Educação* 32:109-121.

*Vertecchi, B., A. Poce, F. Agrusti, and M. R. Re. 2017. “Pen or keyboard. An empirical study on the effects of technology on writing skills”. *Cadmo, Giornale italiano di Pedagogia sperimental* 25 (1): 33-44. doi:10.3280/cad2016-002004

Table 1. Number of papers by country before and after applying the inclusion and exclusion criteria.

	Papers by country	
Countries	Before applying the exclusion criteria	After applying the exclusion criteria
Portugal	72	8
Italy	42	5
Greece	2	0
Ireland	11	0
Belgium	100	0
Lithuania	17	9
Czech Republic	16	0
Romania	7	2
Spain	9	3
TOTAL	**276**	**27**

Table 2. Distribution of the analysed papers by fields and databases. Legend: SS= Social Science; BS= Biomedical Sciences; H= Humanities; I= Interdisciplinary

Database	**Fields**				
	STEM	**SS**	**BS**	**H**	**I**
Web of Science	0	3	2	0	0
SCOPUS	2	1	0	0	2
EBSCO	1	3	0	0	0
ESCI	1	0	0	0	0

SCIELO	0	0	2	0	0
I.COPERNICUS	0	2	0	0	0
LITHUANITISKA	0	2	0	0	0
C.E.E.O.L	0	1	0	1	0
RTD	0	1	2	0	0
TOTAL	**5**	**13**	**6**	**1**	**2**

Table 3. Summary of the characteristics of CT interventions in the European HE institutions by fields. Legend: SS= Social Sciences; BS= Biomedical Sciences; H= Humanities; I= Interdisciplinary; T= total

		STEM (N=5)	**SS (N=13)**	**BS (N=6)**	**H (N=1)**	**I (N=2)**	**T**
Type of study	*Quantitative*	1	6	1	0	0	8
	Qualitative	1	4	2	1	2	10
	Mixed methods	3	3	3	0	0	9
CT aims	*Skills*	3	6	4	1	2	16
	Dispositions	0	0	0	0	0	0
	Skills and dispositions	2	4	2	0	0	8
	Not specified	0	3	0	0	0	3
CT approach	*Immersion*	4	6	6	1	1	18
	Infusion	1	3	0	0	0	4

	General	0	0	0	0	1	1
	Mixed	0	2	0	0	0	2
	General + Infusion	0	1	0	0	0	1
	General + Mixed	0	1	0	0	0	1
Type of intervention	*Self-study*	5	8	4	1	2	20
	Dialogue	3	6	3	1	2	15
	Authentic instruction	2	1	4	0	1	8
Teaching strategies	*LDT*	3	5	1	0	1	10
	PBL	1	2	3	0	0	6
	LDT + PBL	1	3	2	0	1	6
	Not defined	0	1	0	0	0	1
	Other	0	2	0	1	0	3
Learning materials	*Texts (articles, essays,..)*	3	5	1	1	1	10
	E-learning activities	0	3	1	0	0	4
	Authentic	1	1	4	0	0	6

	problems						
	Not specified	1	7	2	0	1	12
Reported difficulties	*Design of CT intervention*	1	0	1	0	0	2
	The teacher's pedagogical knowledge	2	0	0	0	0	2
	Lack of assessment tools	1	0	1	0	0	2
	Institutional barriers	0	0	0	0	2	2
	Not reported	2	13	4	1	1	21

Figure 1. Review process, data extraction and analysis.